The Role of the Industrial Designer in Malaysian Small and Medium Industries

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A thesis submitted to the University of Northumbria at Newcastle
in partial fulfilment of the requirements for the degree of
DOCTOR OF PHILOSOPHY

Department of Design
University of Northumbria at Newcastle

July 1999

Vol.I (Main Text)

ABSTRACT

The principal objective of this study is to assist Malaysian SMIs to improve their NPD process through the creation of design guidelines from an industrial design perspective. The approach adopted in this study was an investigation of the role of the industrial designer in the process of NPD in a selected number of Malaysian SMIs and to contrast them with theoretical knowledge and best practice in UK based companies.

This research combined quantitative and qualitative data collection methods including a literature review, questionnaire survey and case studies. Case studies include semi-structured interviews with senior management staff directly involved in the process of NPD, questionnaire surveys helped to provide background and validate findings from the secondary sources and questionnaire survey. The present study concentrates on four successful Malaysian SMIs and four UK SMEs. In this way, a set of detailed descriptions of best practice principles and elements in the NPD process in both countries were obtained. The case studies focus on four important issues ('purpose', 'culture', 'process and performance', and, 'people') derived from the principal of Business Process Analysis (BPA) research. The adoption and adaptation of BPA to this investigation represents a novel development for design research methods. BPA was considered appropriate since these issues are recognised to be particularly pertinent to the investigation and provide a specific focus for analysis.

This study reveals that most Malaysian SMI's products have been successfully developed by 'localising' existing products and employing foreign technology. However, such activities need to be reviewed because emerging ASEAN region countries and the implementation of the ASEAN Free Trade and Agreement (AFTA) in the year 2003 are likely to change the future conditions of the new product market within this region. No particular design process models were identified and most Malaysian SMIs have not implemented concurrent engineering or other similar methods, unlike companies in the West, while carrying out design development. The case studies confirm that most Malaysian SMIs have not conducted market surveys, believing they have sufficient business experience to determine customer requirements. From the quantitative survey and qualitative study results, it has been established that industrial design should be integrated more centrally within the NPD process, that is; combining rational thinking based on experience with creative interpretation, in order to maximise the success of product concepts in new and existing markets. In this respect, Industrial Designers can command an effective role as project leaders or as part of the NPD team.

This thesis concludes that the diverse nature of problems associated with NPD require a synthesis approach that should involve four major parties (the government, industry, education and the consumer public). The research shares the value of using industrial designers in a central role in the NPD process, to integrate the requirements of these parties.

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ABBREVIATIONS

AFTA	ASEAN Free Trade and Agreement
ASEAN	Association of South East Asia Nations
BH	*Berita Harian* (newspaper)
BS	British Standards
BT	Business Times (newspaper)
Bumiputera	Sons of the soil
CAD	Computer Aided Design
CADEM	Computer Aided Design, Engineering and Manufacturing
CDR	Centre for Design Research
CE	Concurrent Engineering
CEO	Chief Executive of Organisation
DTI	Department of Trade and Industry
FMM	Federation of Malaysian Manufacturer
FRIM	Forest Research Institute of Malaysia
GATT	General Agreement on Tariffs and Trade
IPDP	Integrated Product Development and Process
IPPD	Integrated Product and Process Development
IRPA	Intensification of Research in Priority Areas
ISO	International Organisation of Standardisation
ITAF	Industrial Technical Assistance Fund
ITM	*Institut Teknologi MARA* (MARA Institute of Technology)
LSI	Large Scale Industry
MDC	Malaysian Design Council (see MRM)
MEC	Malaysian Electrical Corporation
MIDS	Malaysia Industrial Designers Society
MIFF	Malaysian International Furniture Fair
MIMOS	Malaysian Institute of Microelectronics Systems
MINDEX	Malaysian Invention and Design Exhibition
MINDS	Malaysian Invention and Design Society
MITI	Ministry of International Trade and Industry
MM	Malay Mail (newspaper)
MNC	Multi-National Company
MODENAS	*Motosikal dan Enjin Nasional* (National Motorcyle and Engine)
MRM	*Majlis Reka Bentuk Malaysia* (see MDC)
MTIB	Malaysian Timber Industry Board
NEDO	National Economic Development Office
NIC	Newly Industrialised Country
NPD	New Product Development
NST	News Strait Times (newspaper)
OECD	Organisation for Economic Co-operation and Development
OPP2	Second Outline Perspective Plan
PIA	Promotion of Investments Act

PROTON	*Perusahaan Otomobil Nasional* (National Automobile Industry)
R&D	Research and Development
RM	*Ringgit Malaysia* (Malaysian Ringgit)
SDN. BHD.	*Sendirian Berhad* (Private Limited)
SIRIM	Standards and Industrial Research Institute of Malaysia
SME	Small and Medium Enterprise
SMI	Small and Medium Industry
SMIDEC	Small and Medium Industries Development Corporation
SMP	Sixth Malaysian Plan
SPSS	Statistical Package for the Social Sciences
TQM	Total Quality Management
UM	*Utusan Malaysia* (newspaper)
UNN	University of Northumbria at Newcastle
VOC	Voice of the Customers

ACKNOWLEDGEMENTS

Thanks are due to a number of people from whom I have received a great deal of assistance, encouragement and support. My greatest debt of gratitude is to my Director of Studies, Dr. R.A.Young, Director of Centre for Design Research (CDR) University of Northumbria at Newcastle (UNN), for his valuable guidance and constructive criticism without which this thesis would not have come to fruition. His expertise in inter-disciplinary research and open-minded willlingness to guide and motivate when the research presented me with apparently insurmountable obstacles was always invaluable. I would like also to thank my second supervisor, Professor Bill Hills, Director of the Regional Centre for Innovation in Engineering Design, University of Newcastle-upon-Tyne, in suggesting directions for the research and for his comments and advice. Acknowledgement should also be made to my former supervisor, Brian Wilson (former Director of CDR UNN) for his advice on aspects of industrial design during initial stages of this research.

I am also especially thankful to the managers in Malaysia and the UK who took part in the case studies. Without their time, interest and information, the collection of data and research findings presented here would not have been possible. I am also very indebted to the Institut Teknologi MARA (ITM) for its financial support to undertake this study. This support is gratefully acknowledged.

In addition, I would like to extend my gratitude to David Williams for proof reading draft copies of the thesis, and to the staff of CDR UNN and CADEM Centre ITM, for their assistance during the period of research activity. Gratitude must also be extended to my late father, my mother, my brothers, sisters and my parents in law for their personal support and encouragement.

Finally, I would like to express heartfelt gratitude to my wife Norein and my children Afeeq and Afeeqa for their patience, good humour and support that has in no small way led to this thesis becoming a reality.

CHAPTER ONE

INTRODUCTION, PURPOSE AND APPROACH

The main purpose of this chapter is to discuss the background and the reasons behind the current research. The introduction (section 1.1) is followed by a consideration of the reasons for the study in 1.2. Section 1.3 discusses the research aims and section 1.4 outlines the research methodology. Section 1.5 details and summarises the content of each chapter in the study.

1.1 Introduction

The aim of this research project is to help Malaysian small and medium industries (SMIs) improve the process of new product development (NPD) through the creation of design guidelines from an industrial design perspective. The approach adopted in this study is an investigation of the role of the industrial designer in the process of NPD amongst selected Malaysian SMIs. It aims to contrast this with state of the art theoretical knowledge and notable aspects of best practice in UK based companies. The UK has been chosen for comparison because there is a considerable body of literature on best practice relating to product development. This literature recognises the importance of design to business success and locates the responsibility for managing design at the highest level of management in successful UK based companies.

Although there are several influential texts which focus on best practice in NPD in the manufacturing industry, they tend to be rather general in scope and are influenced by the activities of large firms (often multinationals associated with the consumer electronics or automotive industries). Thus, doubt can be raised about such commentary on best practice in its relation to transferability to other industrial sectors or corporate scales. Therefore, the present study attempts to highlight a number of existing best practices in selected SMEs in the UK, leading to possible

recommendations for best practice in Malaysia SMIs. This study is distinctive because, to date, no studies have been conducted that relate best practice from an industrial design perspective to a cross cultural context involving Malaysian SMIs.

1.2 Rationale for the Study

The importance of industrial design and the role of the industrial designer in the NPD process is one of the key issues for Malaysian companies involved in product development. This is based on the Malaysian government's aspiration that the evolution of Malaysian-made products bearing unique and world-renowned Malaysian designs should meet not only the demands of the highest international standards but also the most discerning and competitive market. In this respect, industrial design in Malaysia can be seen as important to the country's economic development and well being. To highlight this need, Dato' Seri Mohd. Najib Tun Razak (Education Minister) suggests:

> 'Malaysia needs its own **industrial designers** that are able to design products that are innovative, sophisticated and functionality appropriate to the user to compete in world markets' (Kwong 1995).

Moreover, the Malaysian Rising Star (1995) indicated that:

> 'There is a need to increase production efficiency and improve product quality via better organisation, greater efficiency, advanced and productive capital in order to produce newer and better quality products. These require the development of an advanced R&D capability and highlight the need for a critical mass of inventors, **designers** and innovators who are able to produce new ideas, products and processes'.

This importance (of the industrial design profession) has been recognised by the government since 1994 when the Malaysian Design Council (MDC) was established. The Malaysian government is thus taking steps to show that design is considered as one of the major factors influencing indigenous product success and hence Malaysia

development. The Standards Industrial Research Institute of Malaysia (SIRIM), for example, who created the MDC have indicated that:

> 'The **design** element in manufacturing is becoming increasingly important as it can give Malaysian products a competitive edge over others in the global arena. There is a big demand for design that can be mass-produced for the international market. It is an important component of **product development'**.
> - Dato' Dr. Ahmad Tajuddin Ali, Director General SIRIM Berhad (Shan 1996)

As well as an international context, SIRIM suggests local industry will also benefit from these government initiatives:

> 'The local manufacturers need to be educated on the right quality and quantity to produce in order to meet the needs of consumers. The electronics, electrical, textile and footwear industries have all been identified as areas where **industrial designs** should be encouraged to ensure value added outputs.' - Dr. Ahmad Tajuddin Ali, Controller, SIRIM (MM 10th July 1991)

The importance of industrial design as a means to industrialisation and to create design awareness among the public and manufacturing industry has been facilitated through the MDC via promotions on industrial design activities such as the *'Concept Car Competition'*, the *'Malaysian Young Designers Award'*, and the *'Malaysia Good Design Mark'*. The 'Concept Car Competition' (launched in 1993), for example, aimed to promote the development of inventions, innovations and designs in the Malaysian automobile industry and to transform creative ideas into commercial products. Similarly, the 'Malaysian Young Designers Award' (1996) aimed to promote an awareness among the young generation on the importance of innovative and quality design in the production of world class, marketable products. The more recent 'Malaysia Good Design Mark' (April 1997) principle purpose was to act as a benchmark for good design in Malaysia. This is possible since it enhances design awareness among local designers and manufacturers and encourages local designers and manufacturers to create innovative products and packaging designs.

Furthermore in 1990, the Malaysian government announced that SMIs needed to improve their efforts in the design and production of high quality consumer products to create a wider global market for Malaysian products. To do this, the government has provided financial assistance to SMIs particularly in the areas of product design and the development of industrial and consumer products. The government is thus taking a proactive stance on design through a variety of mechanisms as Dr. Mohd Ariffin Aton discusses with respect to the Industrial Technical Assistance Fund (ITAF):

> 'The government has put **various schemes** in place to encourage the growth of local industries in manufacturing activities. These include the **ITAF** and the establishment of the Industrial Instrumentation and Electronics centre in SIRIM Bhd. The fund is aimed at assisting the development of SMIs, viewed as essential for the industrial development of the country. SMIs should take advantage of the ITAF grant scheme, particularly the product development and design scheme. Since it is aimed at **enhancing local product design and development** capability through indigenous technological know-how'.
> - Dr. Mohd Ariffin Aton, President and Chief Executive ,SIRIM Bhd. (The SUN 25th Sept. 1996)

Despite the emphasis and importance of the industrial design profession and the role of industrial designers in NPD recognised by the government, most companies in Malaysia and in particular SMIs have yet to realise the potential contribution they can make to corporate operations. This point is illustrated by Azizi Ahmad:

> 'Manufacturers **are not playing their role in helping local designers** market their designs. Companies are more interested in meeting deadlines for completion and marketing of their products. As a result, there is no place or time for new designs to be accepted and marketed.'
> - Nor Azizi Ahmad, Designer (NST 9th March 1995)

As a result, some SMIs produce poor designs and are dependent on local and regional markets for their major output rather than producing for a global market. To

compound these issues many SMIs are single-product companies and are thus more dependent on non-price competition.

> 'Local manufacturers **do not concentrate on up-to-date designs** since most of their products are **marketed locally**. However, the competition is global. There are many imported products, which provide stiff competition. As such, efforts to create new products with the latest designs must be strengthened'.
> - Datuk Dr. Ahmad Tajuddin Ali, Director- General, SIRIM.
> (BT 20th June 1996)

It is evident from the above discussion that, in spite of the Malaysian government initiatives, efforts to value the importance of industrial design and the role of industrial designers in NPD process has been neglected in many Malaysian industries. It is this discrepancy that prompts the current research. It is at the general lack of understanding by SMIs on the role of industrial designers that the study is aimed. This will hopefully contribute design knowledge to the discipline and lead to effective management of the new product development process. The precept of the research is that effective management can only take place when an understanding of the importance of industrial design and links between industrial designers and other participants in the product development process are made.

A wider aspiration is that the work can be utilised by manufacturing industries in Malaysia, and emergent industries elsewhere so that both may purposely direct their product development strategies. It may also go some way to inform young industrial design professions within these countries. In this way economic prosperity may be achieved.

1.3 Research Aims

The principal objective of this study is to assist Malaysian SMIs in improving their NPD process. The main aims are:

- To investigate the role that the industrial designer currently plays in the process of NPD.

- To determine the characteristics that can be taken as a basis for explaining the success of NPD.

- To determine guidelines from an industrial design perspective, which will assist small and medium sized industries in Malaysia in the improvement of their NPD process

In pursuit of these objectives, two key questions are addressed and considered throughout this study. These are:

- How to determine the characteristic factors that can be taken as the basis of success in NPD.

- How to develop a conceptual framework in which all the aspects/activities of development of new products can be carefully managed, effectively organised, planned and also efficiently controlled and directed.

The conceptual framework will form the basis of the new design guidelines that are created. The study will verify the claim that new products are important to a company's prosperity and companies which employ industrial designers to develop new products are the most commercially successful in competitive markets. In this respect, the study requires both theoretical and practice based studies.

1.4 Methodology

Three phases were involved in this study: literature search and review, questionnaire survey and case studies. A summary of work carried out in each of three phases is as follow:

1.4.1 Stage One : Literature Search and Review

The review of recent research and literature in the subject area and topics related to industrial design and product development focused on identifying the major trends

and nature of the NPD process. It was intended that this should culminate in the formation of a basic hypothesis about the role played by the industrial designer in the process of NPD.

This review of previous and current work concerning the role of the industrial designer in the process of NPD forms the main literature critique for the research. It serves to form a firm base for identification of research problems and to facilitate construction of the questionnaire survey, which the research rationale determined as the primary data collection tool.

The literature search constitutes an important part of the interdisciplinary research strategy and relies on literature from a number of different disciplines including engineering, marketing and management.

1.4.2 Stage Two : Questionnaire Survey

Initially, this process began by examining the merits of three different methods of survey research: personal-interview surveys, telephone surveys and mail surveys. Since the respondents in this study were geographically distant from the researcher (Malaysia), mail surveys were preferred. As well as being expedient in this respect mail surveys were considered as being time and cost efficient. In this study, closed-ended questions were used compiled from factors identified in the literature search and review. Key questions covered topics ranging from design in general to production and marketing. Questionnaires were posted to selected industrial designers, engineers and marketers in companies and design consultants involved in the process of NPD in both Malaysia and the UK. All the data gathered were subjected to descriptive statistics including frequency distributions and means, and inferential statistics such as cross-tabulation and chi-square test. The statistical analysis was carried out using SPSS software. The use of inferential statistics was made to identify and establish relationships, differences and similarities between

Malaysian and UK respondents. The overall statistical findings of the questionnaire research were utilised to form a basic theoretical background for the case studies.

1.4.3 Stage Three : Case Studies

Case studies were conducted on three successful Malaysian SMIs and three from the UK. As well as these, one successful design consultancy from each country participated. The main aim of the case studies was to provide a set of detailed descriptions of best practice principles and elements in the NPD process, both in Malaysian SMIs and the UK SMEs. Case studies were selected based on notable, successful design projects and the general perception of reputation for design leadership, particularly within the consumer durable product market sector. The case studies focused on four issues which have been previously derived from the concept of Business Process Analysis (BPA) research. Data was gathered through interviews with senior management staff directly involved in the process of new product development, reviews of documentary sources, and direct observations at the visited sites and were analysed using 'grounded theory'. The results from the case studies enabled the researcher to understand in a detailed and comprehensive manner, the actual conditions of the NPD process in both Malaysian and UK companies. They also helped to highlight the issues related to the product development process in both countries. The case studies also aimed to acquire knowledge about new product development so that it might be used as supportive material to the complete research thesis.

The final analysis synthesised results from the case studies, questionnaire surveys and literature review so that an industrial design perspective could be developed to help small and medium sizes industries in Malaysia improve their NPD process. Based on recent literature, a number of existing models of best practice in UK SMEs were highlighted and compared with Malaysian SMIs product development in order to gauge the advocacy of their recommendation as best practice in the management of

NPD procedures for Malaysia. It is anticipated such recommendations will be useful as a written guide for student designers and as a general guidance for practising designers and industries involved in the process of new product development. This may prove to be useful to government agencies such as the Ministry of International Trade and Industry (MITI) and the Standards and Industrial Research Institute of Malaysia (SIRIM) since they are involved in policy and legislation of new product development.

1.5 Order of Presentation

The purpose of this section is to provide a guide to the thesis organisation and presentation. The thesis consists of eleven chapters. The first of these chapters features the introduction.

Chapter Two presents a review of recent research work and literature in the subject area and topics related to industrial design and product development. It serves as a background and helps widen the understanding of the current situation in industrial design and NPD. The review supplies a good base and provides background information in a variety of related fields. It is also valuable since it helps the researcher to form a firm base for identification of the research problems and enables construction of the questionnaire survey.

Chapter Three is an attempt to provide a background to industrial design and manufacturing activities in Malaysia. Since there is a paucity in information in this area, the review is mainly based on journals, magazines, newspapers and theses of previous researchers from Malaysia. The reviews touch specifically on the topic of manufacturing activity, SMIs and the role of government in promoting industrial design in order to enhance product development activities in Malaysia. The chapter deals with industrial design, it's history and education in Malaysia society. From this review, it was found that the contribution of industrial design to NPD has been

recognised by the government since the establishment of the Malaysian Design Council (MDC) in August 1994. The chapter details the governmental understanding that design is important to market success. It also indicates the need for Malaysian manufacturers to be more aware of the potential of industrial design. This has been encouraged by a comprehensive set of incentives by the government to ensure that Malaysia becomes a fully industrialised nation by 2020.

Chapter Four describes the research methodology and the development of the questionnaire and case studies employed. It starts with an overview of qualitative and quantitative methods and discusses the advantages and limitations of adopting these methods. It then focuses on the actual research methods applied in this study. These assess the research design approach for the questionnaire and case study methods. The actual method used to analyse the data is also presented here.

Chapter Five continues the themes begun in chapter four and presents the data collection methods. The selection of the sample and its suitability are also discussed. Finally, the response rate to the overall inquiry are considered.

Chapter Six describes the analysis and findings of the questionnaire survey. It starts with general considerations and discussion of the statistical procedures used in this study focusing on descriptive and inferential statistics. The types of statistical analysis are identified and used to establish relationships, differences and similarities between Malaysian and UK respondents. Through this statistical analysis, comparative studies of Malaysia and the UK from the questionnaire survey findings are identified and key findings presented. The overall statistical findings of this research are utilised to form the basic theoretical background for the case studies.

Chapter Seven discusses, in detail, the eight case studies of the UK and Malaysia which has been conducted in Phase Three. The collection of data through interviews,

observations and documentary sources is critically considered with respect to grounded theory.

Chapter Eight presents the results and findings of the case studies at the eight companies studied in Malaysia and the UK. It starts with an overview of the case studies and discusses their role and content in formulating this study. A synthesis of findings from the case studies results for both countries are presented in the last section of the chapter.

Chapter Nine provides an overview of how a 'model of best practice' proposed for this study was developed. It shows how the findings from literature are used as a theoretical framework in order to guide the researcher in developing a 'model of best practice'. It then proposes the core factors identified through the literature review to support a 'model of best practice'. The core factors are identified as: (1) Customer and Marketing Factors, (2) Product Design and Development Factors, (3) Technical Factors, and, (4) Management Factors.

Chapter Ten discusses the cross-case analysis of the elements of best practice in the Malaysian and UK companies involved in the case studies. It shows how evaluation methods are organised in order to perform best practice comparative analysis. General findings are also drawn. In order to illustrate the main conclusions of the research, the findings from the comparative analysis are then correlated with a proposed model of best practice derived from previous literature. The synthesis of the correlation are also presented in order to guide the researcher to develop best practice guidelines for the Malaysian SMIs context.

Finally, Chapter Eleven presents a summary and conclusions of the research. These include qualitative and quantitative survey findings for both Malaysia and the UK. Recommendations arising from the current research and suggestions for future research are also considered.

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CHAPTER TWO

LITERATURE REVIEW

The purpose of this chapter is to discuss the literature review concerned with industrial design and new product development. This chapter begins with a design section (2.1.) followed by a section on industrial design (2.2) where engineering design is also discussed in order to provide an understanding of the relationship of both professions. New product development is discussed in sections 2.3. The chapter ends with a summary and conclusion in section 2.4.

2.1 Design

2.1.1 Definitions of Design

Before examining industrial design in some detail, it is instructive to firstly be clear about what is meant by 'design'. The term 'design' has a range of different meanings and is used in a variety of contexts. Traditionally, design has been closely related to art-oriented activities and has been used as an aesthetic term applied to the appeal of artefacts (Chung 1989).

The Design Council's (1988) [see Walsh et al 1992] however has defined design in terms of four subsets. These are shown below and displayed in Figure 2.1.

1) Product Design (all products ranging from ceramics and toys to scientific instruments);
2) Graphics Design (ranging from corporate identity and packaging to magazines and film);
3) Interior Design (such as shops, buildings and exhibitions) and;
4) Fashion and Textile Design (including clothing, carpets and jewellery).

A widely accepted definition of design is that of Professor L Bruce Archer (Baynes 1976):

> 'Design is the area of human experience, skill and knowledge that reflect man's concern with the appreciation and adaptation of his surroundings in the light of his material and spiritual needs. In particular, it relates with configuration; composition, meaning, value and purpose in man-made phenomenon'.

Walsh et al (1988) cite the Swedish language as a useful way to define 'design' since the language has two words for it: 'engineering' and 'product'. However in English design is used to cover all design disciplines such as graphics, ceramics, jewellery, interiors, and architectures. Walsh et al thus believe that since design is a multifaceted concept including not only function and appearance, but also choices and decisions and thus should be seen in a wider sense than is commonly adopted in English.

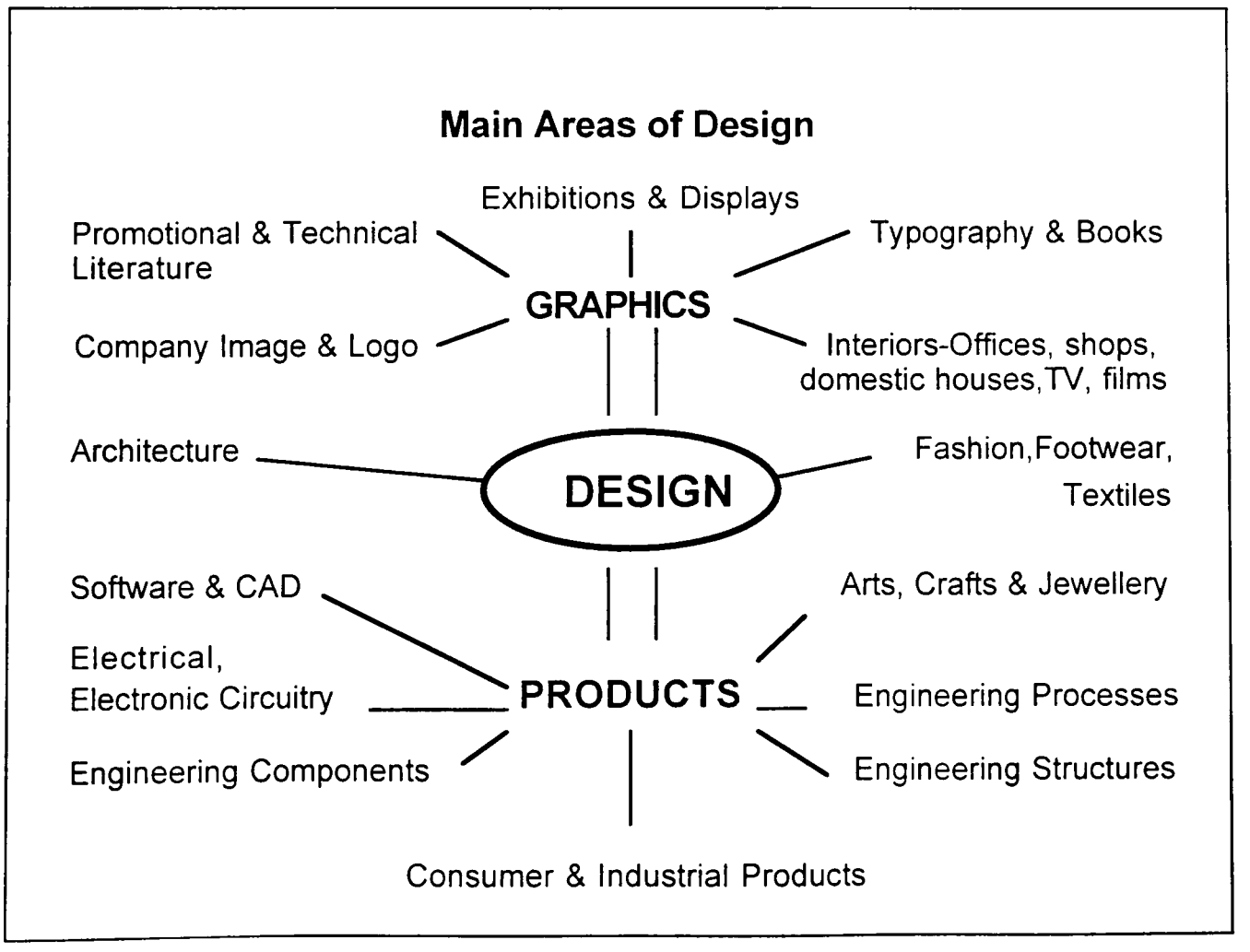

FIGURE 2.1 : The Main Areas of Design
source : Walsh et al (1988)

2.1.2 The Importance of Design

Research has shown that investment in design yields the largest returns for a manufacturing company (DTI 1991). A study carried out by the Open University and UMIST between 1987 and 1990 examined the benefits and costs of investment in design and showed that almost half the projects paid back their total investment in under a year. In total, more than four fifths of the projects recovered their full costs.

Fraser (1990) has examined the strong effect that design can have on sales and estimates (based on the Industrial Designers Society of America study) that sales can yield as much as US2500 for every dollar spent on design. However, this yield increases where a company's sales exceed US1 billion. In this latter case, returns amount to approximately US4000 for every US1 spent on design. Design also has a central role to play in improving productivity and reducing manufacturing costs. A high percentage (some report as high as 95%) of product quality is 'locked in' at the time of design according to Salomone (1995), Syan and Menon (1994), Storer (1993) and Turino (1992). These authors have shown that for some designs, as much as 80% of the costs are set at the time of design, thus meaning that manufacturing can only influence 20% of total costs.

In the context of product design, a study by the DTI (1991) shows that design can also contribute to improve competitiveness in three main areas: cost, product acceptability and service. For product acceptability the DTI indicates that design governs a product's performance and specification and affects aspects such as product uniqueness, reliability, appearance, ease of use and safety. In terms of service, design has an important role in packaging and presentation.

2.2 Industrial Design

2.2.1 Definitions of Industrial Design

The definition of 'industrial design' has until modern times been unclear and even confused. However, a widely accepted definition of industrial design that has emerged is the International Council of Societies of Industrial Design (ICSID) definition formulated by Dr Thomas Maldanado in 1964 [see Bainton 1986].

> 'Industrial design is a creative activity whose aim is to determine the formal qualities of objects produced by industry. These formal qualities include the external features but are principally those structural and functional relationships which convert a system to a coherent unity both from the point of view of the producer and user. Industrial Design extends to embrace all aspects of the human environment which are conditioned by industrial production'.

As well as the ICSID definition, the World Intellectual Property Organisation (WIPO 1982) 'design' idea is also widely used by academia.

> 'An industrial design is the ornamental or aesthetic aspect of a useful article. The ornamental aspect may consist of the shape and/or pattern and/or colour of the article. The ornamental or aesthetic aspect must appeal to the sense of sight. The article must be producable by industrial means; this is why the design is called "industrial". If this element is missing, the creation may rather come under the category of a work of art'.

A further definition allows industrial design to include all the products of industry, not only those made in a factory, but large-scale objects such as ships, vehicles, and general utility articles such as lamps and other machines (Cloag 1947). Thus by these ideas, industrial design may be sub-divided into the following categories:

1. Design which affects the function, form and finish of a manufactured object such as radio or television set, kitchen utensil, a toothbrush or a safety razor.

2. Design which affects the form and finish of a manufactured object with a mobile or static mechanical function, such as a motor car, a vacuum cleaner. a typewriter and a sewing machine.

3. Design which is concerned primarily with decoration, and which may be described as industrial decorative art, and which affects industries that still operate on a craft basis, such as those manufacturing domestic glass, pottery, textiles and wallpaper.

2.2.2 Industrial Design History : A Global Perspective

According to Lorenz (1986) the earliest recorded official use of 'industrial design', with its specific meaning, came in 1913. However, the birth of industrial design often pre dates this by six years and originates from Germany and not the US. Industrial design was introduced by Germany's architects and designers and known as the '*Werkbund*'. This aimed to improve the technical and aesthetic values of final products with the utility of the end-user in mind. The efforts made by the *Werkbund* and the Bahaus design school started a new era of design with better quality in products. Due to these developments, Germany became a focus of attention as a role model in industrial development.

As for early industrial designers, Heskett (1980) explains that in 1920s most came from backgrounds connected with advertising and presentation. From these backgrounds, industrial designers adapted the organisation and methods of the consulting agency by working for a variety of clients. In the mid-1920s, a significant development saw experimentation with three-dimensional design - this came about due to the work of **Walter Dorwin Teaque**, a successful graphic artist. In 1927, he was commissioned by Eastman Kodak to design cameras and packaging, and in 1928 he released a design which displayed an ability to blend technical factors with aesthetic value. On this success, he set up his own design consultancy to help industries develop new products.

Similarly, the French illustrator and display designer **Raymond Loewy** also successfully combined appearance and operating efficiency in his design. In 1935, Loewy designed the 'Coldspot' refrigerator which on release of his new design saw dramatic sales increases in five years (from 15,000 to 275,000 units). Loewy's practice like Teaque's also grew rapidly, and by 1947, he had 77 clients in the area of product design, transportation, vehicles, equipment and packaging.

A third designer, **Henry Dreyfuss** who had previously been a stage designer opened an industrial design office in 1929. He is known for his work on data on the human body, its proportions and capabilities. This work culminated in 1961 with his book 'The Measure of Man' which has helped establish ergonomics as an essential tool for designers.

2.2.3 The Importance of Industrial Design

Companies have begun to realise the importance of industrial design (Lorenz 1986) and have stopped treating the industrial design profession as an afterthought. Instead, companies have elevated industrial design to full membership of the corporate hierarchy, as has been for some years in design-minded companies such as Olivetti and IBM. Moreover, Lorenz has shown that companies have gone even further by recognising that design is so central to the company's purpose that industrial designers play a *catalytic role* in the product development process. All levels of companies can boast successful products conceived by industrial designers working informally as *product planners* and *project leaders* (Lorenz 1990).

Harkins (1994) reported that MIT's Sloan School of Management suggests 8 specific criteria to determine the importance of industrial design for a product. These include ergonomic considerations: 'ease of use and maintenance', 'the number of and difficulty of user interactions', 'safety' and aesthetic considerations such as 'product differentiation', 'pride of ownership', and 'pride of manufacture'. The more

important each of these is to product success, the greater the need for industrial design. Industrial design optimises the *function, value* and *appearance* of products and works for the benefit of both the user and manufacturer. Its concern is not simply the external packaging or aesthetics of a product, but the product itself as a functional, manufacturable, and marketable artefact.

2.2.4 The Industrial Designer

According to Thornton (1987), an 'industrial designer' who works in product development may call himself a 'product designer'. This is similar to the people involved in 'product engineering' or 'design engineering' from a mechanical or electronic engineering backgrounds. This dual usage of the term however obscures the fact that an industrial designer and product engineer have distinctly different roles in developing products. The former deals with usability and aesthetics; the latter with technical specifications. Therefore, Thornton suggests that if a company has a product designer who is also an engineer, it will still need a product designer who is an industrial designer.

Pilditch (1976) describes a good industrial designer as one who is aware of good form, is practical and imaginative. The good industrial designer should stand between the factory and the consumer. According to Pilditch, the good industrial designer requires knowledge of the four 'M's'- *Materials, Machinery* and *Methods of Manufacture*. The industrial designer can suggest designs that not only look attractive and are easy for operators to work with, but also ones that use the correct materials and are economical to produce.

Harkins (1994), suggests that a good industrial designer is trained to be a holistic thinker. The good industrial designer draws from a diverse view of markets and can cross-fertilise ideas to create new features in products. He is familiar with a broad range of manufacturing processes and can combine the best to create innovative and

cost-competitive products. According to Harkin, a good industrial designer functions as a *development integrator* with the ultimate goal of producing not just sketches, but workable and manufacturable products. Furthermore, good industrial designers are able to see the product from the viewpoint of all users and not just from their own view.

2.2.5 The Role of Industrial Designer in NPD Process

The new product development (NPD) concerns the total process of idea generation and development to the point of successfully marketing a new product. This activity must be methodological and carefully managed and directed in order to have a positive outcome in the market place. Therefore, someone who 'speaks for' the user needs to be involved at the start of the product development process. This person should be the *industrial designer*. In this way the industrial designer plays a catalytic role in the NPD process not only as source of ideas, but as a *'facilitator'* (Wilson 1995, Lorenz 1990), *'co-ordinator'* (Lorenz 1990), *'collaborator'* (Thornton 1987) and *'completer'* (Lorenz 1990). According to Braham (1992), because so many products today are technologically similar, industrial designers are being called to make a *'difference'*. Industrial designers are more than just a small cog in the NPD process, they are in fact one of the *'key players'*.

Thornton (1987) believes that since the NPD process should be proactive and not reactive, it is necessary to acquire the services of an industrial designer from the beginning. He can be either in-house or brought in from outside, but should be an integral part of the project team and encouraged to play an active role. According to Thornton, as a member of the product development team, the industrial designer's task is to create the all important product definition: how the product will work, the interface with the user, and the manufacture of the product. According to Thornton, industrial designers make three vital contributions to the NPD process:

1. They make the product as *simple* and *easy to use* as possible.

2. They oversee product *aesthetics* so that the product is made as *attractive* as possible to potential buyers.

3. They make the product *easy to manufacture* - which has a direct bearing on the cost of the product, and thus, the *competitive price* of the product. For example they may reduce the number of parts used, specify more economical parts or materials, reducing the shipping weight of the product.

Thornton believes that in the NPD process, the industrial designer acts as a *concepts creator* and *facilitator* . This he does by defining the product or by acting as the buyer's or end-user's representative when problems concerning the product's use and operation arise. Thus, he *bridges the gap* between marketing and engineering.

Finally a study by Besford (1987) shows that the main reason for successful new products in a number of European countries and Japan was due to the role of the industrial designer in the NPD process being understood and his contribution valued. In Italy especially, designers often see themselves, and are seen by others as *creators*, whose job is to inspire new ideas or create new approaches to a problem. The empathy between managers and designers and acknowledgement of the benefits of the interaction of designers and companies have produced significantly effective results (Bruce et al 1995).

2.2.6 Industrial Designers in NPD Teams

NPD is a total company activity, requiring for a positive lead from senior company management, and demanding willing and continuous liaison between the departments involved (Swindells 1972). Therefore, in any NPD team, a fair element of overlap between team members of different backgrounds needs to be formed. According to Fairhead (1991), NPD team might consist of a product engineer, an industrial designer, a marketer and a production engineer (Figure 2.2). Once these members are designated, most other functional linkages are covered. Thus sufficient overlapping

of competence to ensure internal checks, balances and integration are built into the team. The team size is also important. This is reiterated by Quinn (1985), who suggests that an effective NPD team needs between five and seven members and no more. Part of the reason for limiting numbers is that as he suggests, as a team size increases, the number of possible one-way communication channels increases dramatically, exponentially and could jeopardise the team's effectiveness.

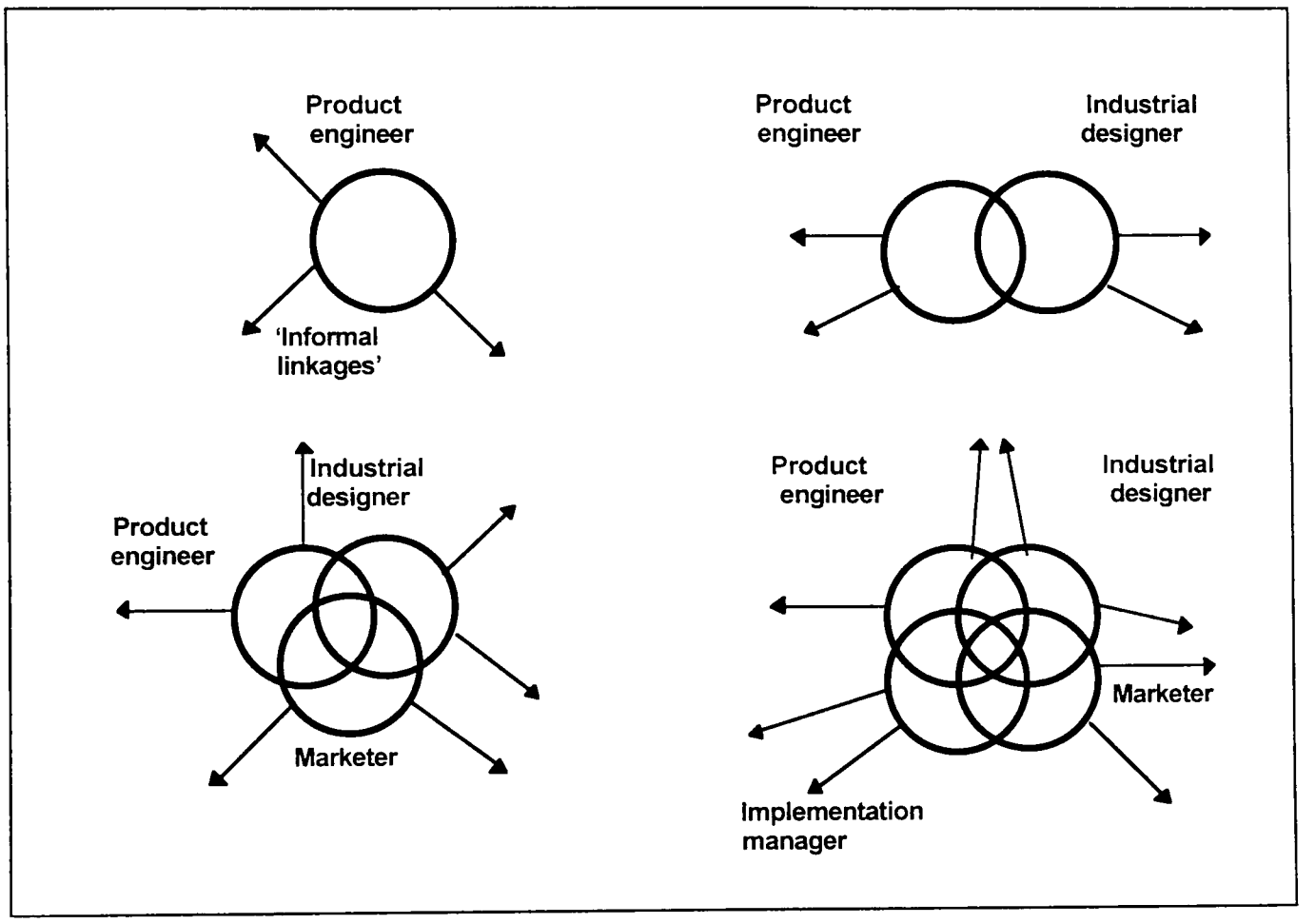

FIGURE 2.2 : The NPD Cell
source: Fairhead (1991)

2.2.7 Industrial Design and Engineering

Figure 2.3 illustrates in a simple way how products can require a varying mix of design skills. It shows how textiles is completely within the domain of the art-based or industrial design, whereas submarine cables are created wholly by the engineering designer. A telephone needs approximately a 50/50 contribution from both sides - to ensure the visual and ergonomic qualities of the product and to cope with the

problems of electronics and interfaces. This concept can be expanded (Figure 2.4) to illustrate the scale of the contributions made by the industrial designer and engineering designer over a wide range of products.

Although both figures clearly show the boundary between the two disciplines, many writers have shown that engineers and industrial designers often antagonise one another during product development. For example, Flurscheim (1983) shows how conflicts have arisen between industrial designers and engineers because of misconceptions about each other's roles. This is because, engineers see industrial designers as 'stylists' while industrial designers see engineers as 'mechanical'. Similarly, Rothwell and Gardiner (1984) revealed that conflicts arise from a difference in approach to technical matters. An industrial designer's interest is in finding a technical solution to enhance the overall general design of the product, while an engineer prefers to utilise a proven technical solution and adapt the general design of the product to accommodate it. Engineers regard improvising with components of existing products as ingenious, whereas this procedure is an anathema to industrial designers. Rothwell and Gardiner suggest that engineers need to be aware of the limits of their own expertise. Engineers should appreciate that the industrial designer is an integral member of the product development process. Being competitive and getting quality products quickly to market requires good teamwork.

To this end, collaboration between industrial designers and engineers has been encouraged by the sharing of design tools. Industrial designers and engineers now work through the medium of CAD, which has brought the two team members together. Cross (1992) however goes further to suggest that good product design practice is converging towards the 'industrial design engineer'. This is a designer (or design team) with knowledge and skills from *both* engineering and industrial design.

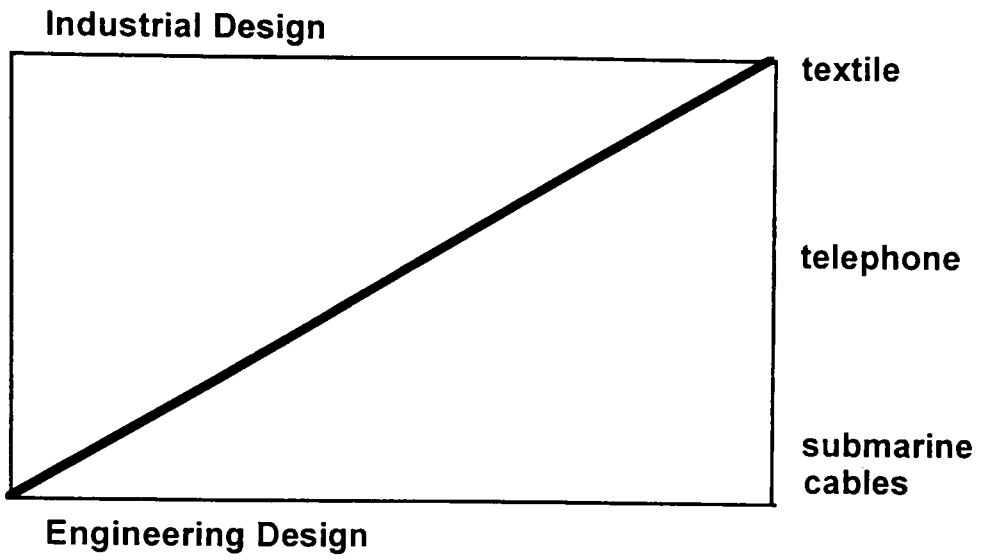

FIGURE 2.3 : Spectrum of Design Disciplines
source : William (1988)

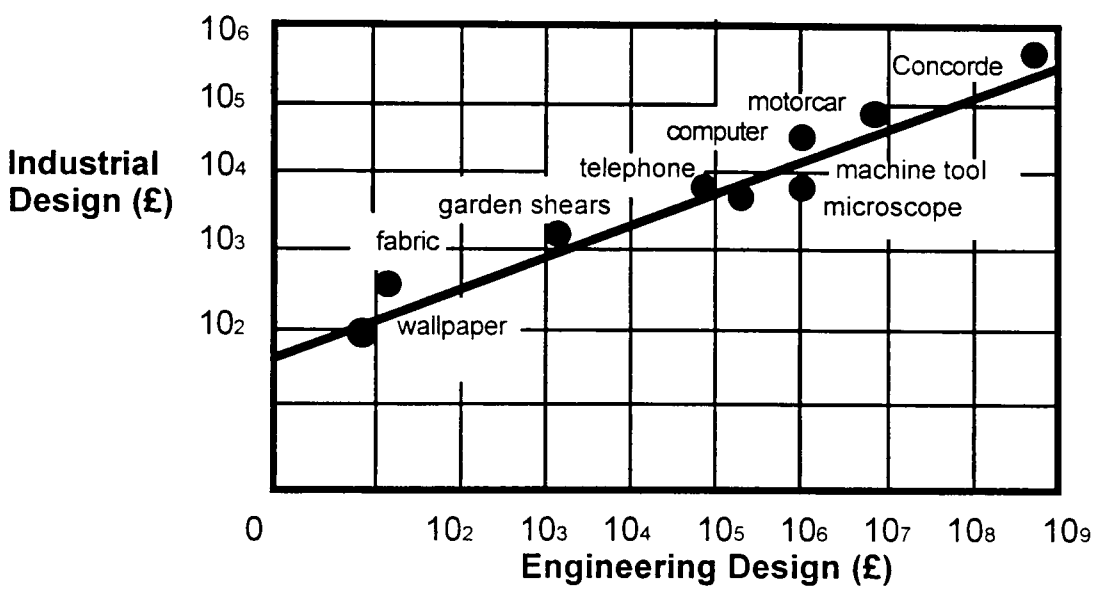

FIGURE 2.4 : Contributions Made by the Industrial Designer and Engineer
source :William (1988)

In an interview with James Dyson, designer and inventor of Dyson's Appliances Limited, Dagger (1996) found that it is engineers and designers who decide what is going to be in the product, not the people in the Marketing Department. Moreover Dyson claimed that their designers and engineers had *'empirical'* skill i.e. a practical skill dealing with practical products. Dagger suggests that the future of companies may lie with designers and engineers as it is they who know about products.

Bassil (1994), suggests that clashes between industrial designers and engineers *can* be avoided when the two disciplines work concurrently on a project. He suggests that

companies should not establish separate engineering and industrial design departments and should appoint project managers who have a good appreciation of both industrial design and engineering. Moreover, Bassil proposes that engineers and industrial designers use a single title - 'designer' in order to avoid conflicts based on work identity.

2.3 New Product Development

2.3.1 New Products and Their Importance

The importance of new products to a company's prosperity is clearly show by Hopkins (1980) [see Didier 1986] who reported that over 25% of the firms in his study attributed more than 30% of their current sales to products. Booz et al (1982) also reported that companies derive nearly one-third of their profits from new products. In this sense, new products are the 'lifeblood' of manufacturing organisation (Floyd et al 1997) and thus crucial to long term company success. According to Kraushar (1977), new product success depends on it meeting company development criteria. New products are thus vital and it is important here to explain that new products do not necessarily only refer to products not produced before. Kraushar has found types of new product, these are outlined here:

- **Type one** are those that have undergone small changes to an existing brand by way of new packaging, new sizes or the addition of new varieties.
- **Type 2** are those that represent major innovations in a company's existing markets.
- **Type 3** are products similar or identical to one already being marketed by a competitor, but in a market new to the company concerned.
- **Type 4** are products different from any being marketed in the same country, but already in existance overseas.
- **The fifth** type is the conventional interpretation of a new product in that it is a product that is different from any marketed by anyone anywhere, i.e. true innovation.

Companies also have to consider that customers are becoming more discerning and require products that suit their needs. Mynott et al (1994) thus suggests that companies must now focus on new products that:

1. Are right for the customer;
2. Are available in advance of the competition;
3. Offer more features, more variety and better performance, and;
4. Give value for money in the eyes of the customer through a balance of cost and quality.

These requirements are forcing many companies to reconsider their approach to NPD.

Despite these requirements, DTI (1994) reports that there is no simple 'fix-it' formula or single technique for delivering a successful product. This is because product development is a subtle and complex process that involves many interactions and trade-offs between aspects such as:

1) The level of functionality of the product;
2) The cost of producing the product;
3) The cost of developing the product;
4) The timing of product introductions;
5) The product life-cycle, service and support costs, and;
6) The positioning of the product within a company's portfolio.

2.3.2 New Product Development Process

The NPD process is one that transforms technical ideas or market needs and opportunities into a new product for the market. It is also the activity that transforms the brief or initial market specification into a design concept or prototype and translates them into detailed drawings, technical specifications and other instructions needed to manufacture new products (Walsh et al 1992).

Carter et al (1992) view the NPD process in a similar way although they suggest it is with the needs of the customer that the NPD is concerned. Focus on customer requirements are thus paramount.

At a more philosophical level, Booz et al (1982) see the NPD process as a road map that provides direction for new product efforts. In these sense, it reminds practitioners that a series of relevant steps need to be followed for its success.

2.3.3 Model of the New Product Development Process

NPD is a process in the sense that new product design proceeds through phases, steps, or stages. Although these terms have been utilised in different contexts by different authors, they have all implied a sequential progression of NPD from a preliminary phase (Ideation/Conceptual) to a more advanced phase (Production/Manufacturing). The specific phases (steps or stages) in the process may, however, vary from company to company although most NPD processes have between three and eight phases. Hence many models have been proposed. Here the author will outline some of the models that represent a wide cross-section of ideas in NPD process.

1) The model produced by **Pahl and Beitz** (1984) has been widely accepted by industries sometime. In this model, the NPD process comprises four phases

   Phase 1 : Specification

   Phase 2 : Conceptual Design

   Phase 3 : Embodiment Design

   Phase 4 : Detail Design

Pahl and Beitz emphasise conceptual design as the phase where a high level of conceptual abstraction of the product is achieved. They also propose a mechanism by which design functions are translated into a set of *design solutions.*

2) **Bruce** (1985) divides the schematic model of the NPD process used by manufacturers in the electronic equipment business into three main stages

   Phase 1 : Planning
   Phase 2 : Design and Development
   Phase 3 : Manufacture and Sales

His model suggests that prototype development, component costing and testing for production feasibility are undertaken in parallel (so-called concurrent engineering). To speed the process further however, critics indicate a greater overlap between stages is required.

3) The **British Standard Institution** in its BS 7000 (1989), identifies the NPD process as normally following a chronological sequence and is presented in four stages.

   Stage 1 : Conceptual Design
   Stage 2 : Embodiment Design
   Stage 3 : Detail Design
   Stage 4 : Design for Manufacture

The clause covering BS7000 is intended to provide guidance to those whose main responsibility is the management of design, including all steps from the initial concepts to product and customer support.

4) In **Oakley**'s (1984) model, the main components of the NPD process are seen as four major activities and can be identified as :

1. **Formulation**	problem investigation problem definition product specification design brief
2. **Evolution**	idea generation solution refinement prototype development design freeze
3. **Transfer**	manufacturing drawing/data compilation process modification finalised start-up tests full scale production delivery of new product to customer
4. **Reaction**	customer appraisal after-sales service activities problem investigation

He stresses, however, that no matter how efficient a firm's manufacturing and distribution system may be, no long term success can be achieved unless the product is of a high standard, uses the most up-to-date technology and satisfies the desires of the customer. This indicates how each stage of NPD is inter-linked and are not independent of one another.

5) The NPD process suggest by **Moore et al** (1993) consists of seven steps.

Step 1 : New Product Strategy

Step 2 : Idea Search

Step 3 : Screening

Step 4 : Business Analysis

Step 5 : Product and Process Development

Step 6 : Product Testing and Test Marketing

Step 7 : Introduction

Moore et al emphasise that modifications to the NPD process on the basis of the product's 'newness' to the company are possible. For this reason, the specific steps in the process should be confirmed prior to initiation so as to maintain the process.

Johne and Snelson (1987) contradict the convention that there is a chronology of events followed in a step-wise fashion. They suggest that it can be advantageous to undertake the tasks in *parallel* in order to complete developments ahead of competitors and thus be first to market.

2.3.4 Successful New Product Development

Successful NPD is the process that satisfies current or anticipated market needs by an intimate combination of technical and commercial endeavours consistent with the business objectives of the developer (Servi 1990). Supporting these ideas, Inwood et al (1993) suggest three core elements are required to enable successful NPD:

1. Having a customer focused approach
2. Producing differential advantage through products; and
3. Getting products into the market rapidly

Inwood also indicates some main techniques which help to contribute towards successful new product development. These are:

Total product management	developing all aspects of a product not just its look and how it is made;
Simultaneous engineering	rapid and parallel development of marketing, *industrial design,* engineering and production
Risk management	deliberate planned activity to allow the phased reduction of risk from any source;
Marketing	management activity which seeks to anticipate and fulfil customer requirements profitably;
Team building	activities that lead to good teamwork and enable other things 'to happen'

2.3.5 Integrated Product and Process Development

Integrated product and process development (IPPD) is the implementation of the concurrent engineering philosophy by cross-functional teams using quality-function-deployment and variability-reduction tools and techniques to optimise materials and process. IPPD focuses on the right people using the right tools at the right time to do the right things. In this way it ensures the lowest cost and shortest cycle time for the design-and-development process itself (Revelle et al 1995).

As shown in Figure 2.5, the traditional product development process has been essentially linear and segmented, with some very hard breaks between phases of the process. This *'throw it over the wall'* model shows that each participating department attempts to finish its own work before handing it over to the next department in line. Because of this, most work has been carried out with minimal reference to other departments' needs.

However, the modern approach requires that all departments work simultaneously, in an integrated manner, to achieve a successful programme (as shown in Figure 2.6). Product planning is one of the truly cross-functional departments that can facilitate an integrated, simultaneous product development approach, from the beginning to the end of the process. According to Allen (1993) almost all successful product programmes today use some form of this more *parallel approach.*

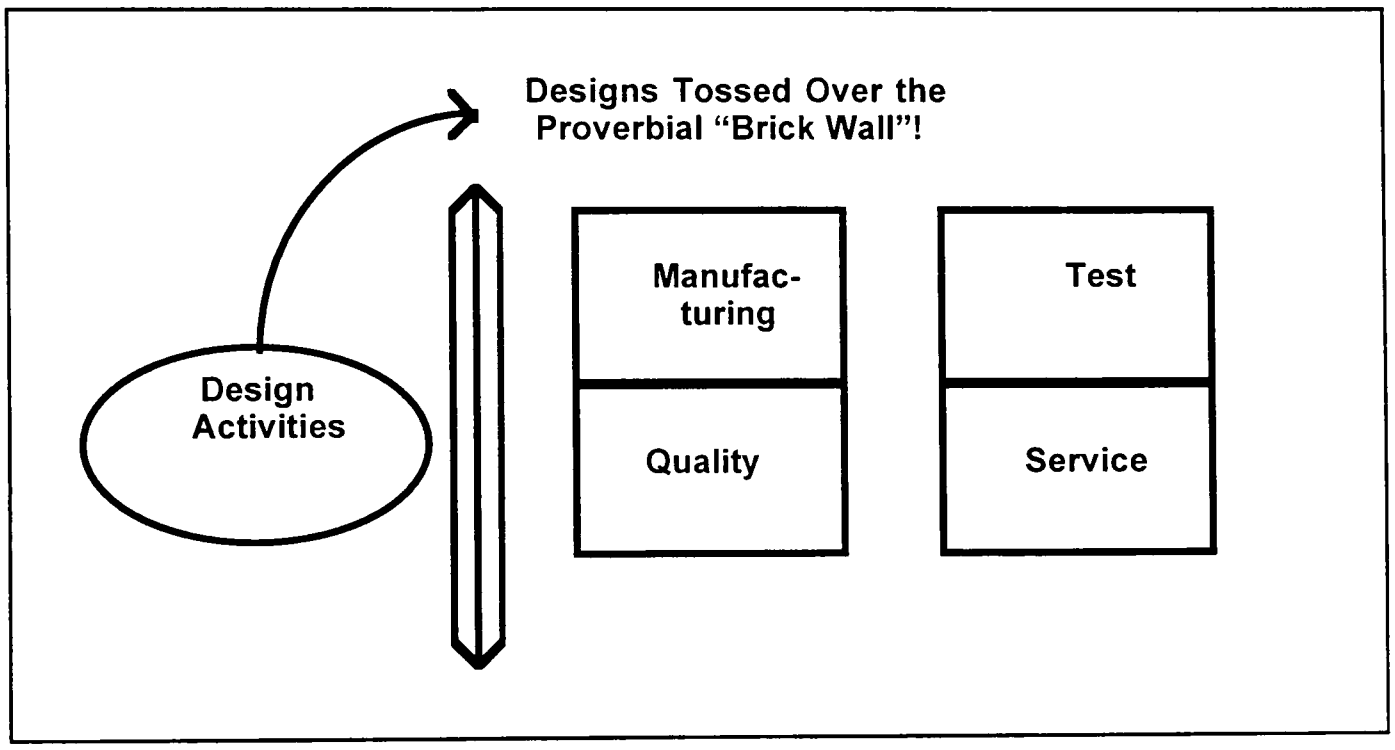

FIGURE 2.5 : The Traditional Design Environment
source : Turino (1992)

Some authors suggest that this means under IPPD programme, all stages of the product development need to proceed in parallel (Kusiak 1992). This has its benefits and means that it takes for a product to reach the market and thus reduces the total cost as well as improving the interface between different stages. In addition to shortened lead time and reduced cost, IPPD can improve design quality by elimination of sub-optimisation that features strongly in the sequential product design approach. Kusiak thus believes that IPPD is an appropriate strategy for the introduction of new products that require a rapid entry to a competitive environment.

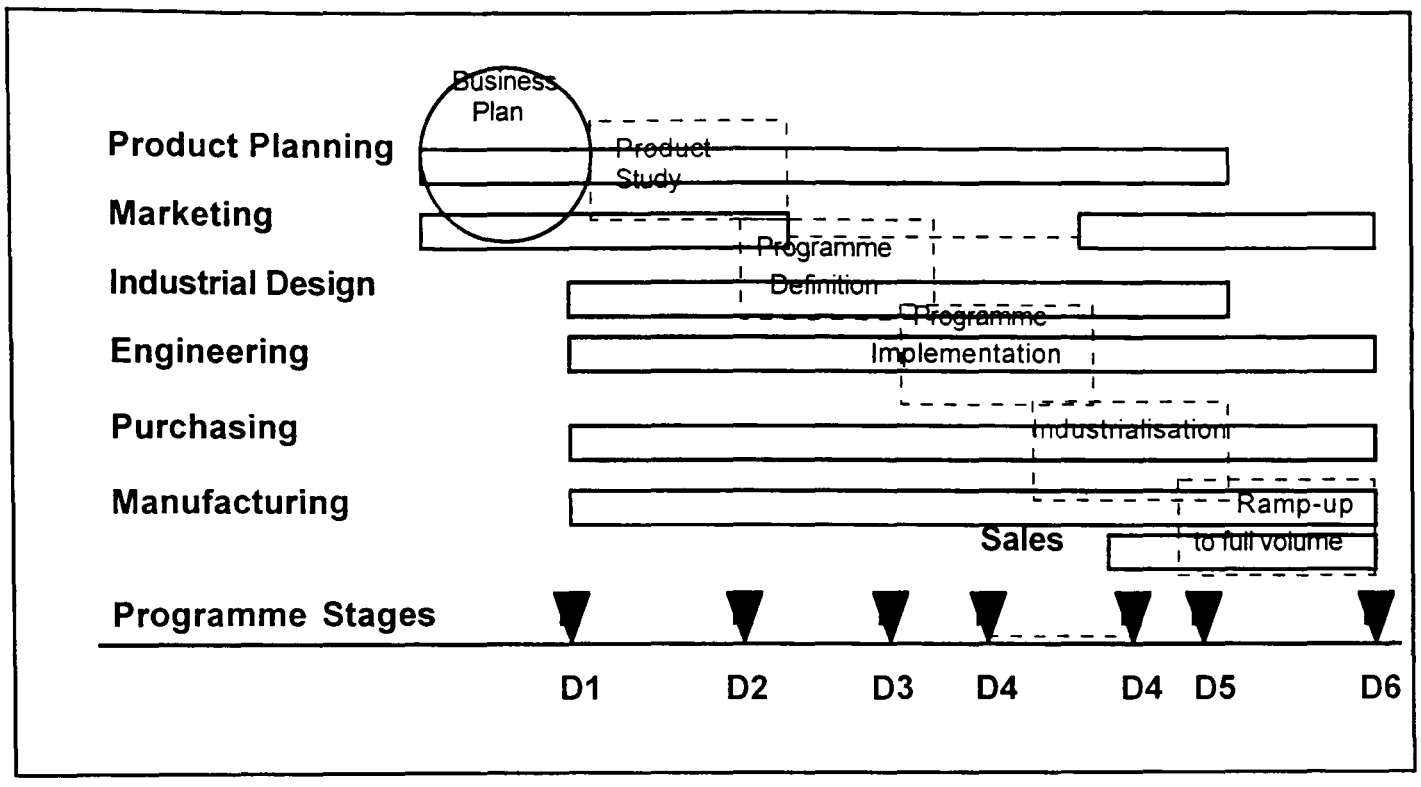

FIGURE 2.6 : Simultaneous Programme Execution
source : Allen (1993)

As well as benefits to cost and inter-stage interface relations, Kambhampati and Cutkosky (1990) claim that the philosophy of IPPD is the best way to achieve design-for-manufacturability. By integrating design and process planning activities, IPPD positively effects the manufacturing process as it allows design to evolve. To facilitate this, IPPD requires teams of designers and engineers to create a team that can take collective responsibility for developing designs, analyses and process plans.

2.4 Summary and Conclusions

Much of the literature here has presented and discussed the importance of the role of the industrial designer in the process of new product development. He or she can be either a project leader or a member in the NPD team. It has also examined the relationship of industrial design to engineering design and suggested ways in which these two areas could be successfully integrated into the NPD process.

It has also been shown here how successful NPD requires the application of teamwork throughout the whole of the development process. Such teamwork

involves a critical interplay of inter-functional involvement which in turn requires effective co-ordination. The use of Integrated Product and Process Development (IPPD) integrating company culture and operation simultaneously can thus ensure successful NPD.

Although this literature search and review has enabled the researcher to gain an understanding of the nature of the NPD and the role that industrial designers play in this process, it is not exhaustive or definite. This is because it has relied entirely on secondary information and could not adequately collect specific information about industrial design and NPD with regard to SMIs which is a central focus for the current research. Thus, an investigation (such as the current one) of the role of the industrial designer in NPD in Malaysian and UK industries is considered to be vital. It is hoped that this may help to set up a new link between the conceptual framework of the literature search and review and the empirical study.

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CHAPTER THREE

INDUSTRIAL DESIGN AND MANUFACTURING ACTIVITIES IN MALAYSIA

The purpose of this chapter is to discuss industrial design and manufacturing activities in Malaysia. A background to Malaysia is presented in 3.1 and is followed by an overview of Malaysian industrial design in section 3.2. Section 3.3 discusses the development of manufacturing activities in Malaysia with particular attention to SMIs in section 3.3.4. A summary is drawn and conclusions made in section 3.4.

3.1 Background

Malaysia was born in 1963. It consists of thirteen states, and one federal territory. Eleven of the thirteen states and the capital are situated in Peninsular Malaysia. The other two states are located on the island of Borneo (Sabah and Sarawak). Malaysia is a multi-cultural nation consisting of 3 major groups. These are the bumiputra (Malay), Chinese and Indian groups. According to MIMOS (1996a) the population of Malaysia in 1995 was approximately 20 million people.

Since independence from Britain in 1957, Malaysia has become a rapidly developing country. The government has implemented various development programmes such as the 5 years Malaysia Plan. The objective of such programmes has been to co-ordinate the socio-economy of Malaysia's multi-racial society. Amongst the plans, the most important has been the New Economic Policy (NEP) with its fundamental objective of eradicating poverty.

With high annual economic growth at least 8% between 1991-1997, Malaysia is one of the most rapidly developing nations in the ASEAN region. Moreover, in 1996, Malaysia was ranked the world's nineteenth largest trading nation and the 3rd most competitive among non-OECD (Organisation for Economic Co-operation and Development) countries (MIMOS 1996b). Although the economic slow down in

East and South East Asia in recent years has effected the economy of Malaysia. research carried out by the CNBC Asia Business News and the Far Eastern Economic Review has shown that Malaysia continues to be the most attractive place to invest in Asia . This research shows that among 10 Asian countries (Australia, South Korea, Hong Kong, Philippines, Thailand, Japan, Indonesia, Taiwan, Singapore and Malaysia), it was Malaysia that was voted first (41.6%) by top executives and decision makers. The research also reveals that Malaysia still has one of the best managed economies despite the economic slowdown currently experienced throughout the region (Krishnamoorthy 1998).

3.2 Industrial Design in Malaysia

3.2.1 History of Industrial Design in Malaysia

The origin of industrial design in Malaysian is unclear, however Bajuri (1988) has shown that it is possible to relate the design activities in Malaysia with the activities of local craftsmen. During the establishment of the first British trading settlement in Penang in 1786, craftsmen in the states of Kelantan, Terengganu and Malacca traded their traditionally hand made crafts and pottery (Kennedy 1970) [see Bajuri 1988]. These craftsmen designed their own specialised tools to supplement the income of their daily life as farmers or fishermen. Some of their traditional ways of making craft items are still practised in certain rural areas in the country.

In 1957 Malaysia gained independence from Britain. Since this time, significant improvements in the standard of living and the development of manufacturing industries to meet consumer demand have taken place. By the 1960s, the importance of design for industries was first witnessed when Prime Minister, Tun Abdul Razak, (often called the 'Father of Development') called for the need for national identity by urging local designers to explore new technology in order to reduce imported product dependency (Fuziah 1984) [see Bajuri 1988]. By 1971, a

New Economic Policy was established with the main aim of encouraging local manufacturers to assemble and manufacture products to satisfy this aim.

By the 1980s, the importance of design and industrial design had been recognised and was highlighted through two successful projects (1) the image of National trains, and, (2) the design of the Malaysian national car, Proton Saga (Husain 1986). The importance of industrial designers in NPD was also highlighted when the Japanese company, Matsushita, became the first company in Malaysia to employ Institut Teknologi MARA (ITM) industrial design graduates (Bajuri 1988), and it also became the first company to form an industrial design office in Malaysia.

By 1990, Malaysia had made a successful transition from being a commodity based exporter to becoming a producer of manufactured products. The progress of Malaysian industrialisation had also received a new impetus with a government commitment to converting the nation into an industrialised country by the year 2020. The establishment of the Malaysian Design Council (MDC), Malaysian Electrical Corporation (MEC), Proton, Perodua (Malaysian cars), Modenas (Malaysian motorcycle) are some examples in this decade of the commitment to and support given by the government in order to achieve the 2020 vision. Today, industrial designers are employed in a variety of commercial and non-commercial activities and in a variety of sectors. As suggested by Salleh (1991) industrial designers in Malaysia are now receiving due recognition as agents of progress in local industry.

3.2.2 Industrial Design Education

Formal industrial design education in Malaysia began in 1967 with the establishment of the Department of Art and Design as part of the School of Applied Arts and Architecture at the Institut Teknologi MARA (ITM). By 1972, the department of

Art and Design was separated from the School of Architecture to become the School of Art and Design where the Department of Industrial Design was established.

According to Ibrahim (1995), in the early years of the Department of Industrial Design, only nine students and two foreign design lecturers were enticed to enrol. Ibrahim added that since in 1973, only seven of the nine students had graduated. They became the first batch of industrial design graduates in Malaysia and due to limited domestic expertise became pioneers in the development of industrial design in Malaysia. Between 1973-1982, the Department of Industrial Design, ITM successfully produced sixty-seven students. This number increased by 33% (eighty-nine students designers) for the period of 1983-1992. By 1995, some twenty eight years after the Department of Industrial Design was established, more than three hundred industrial designers had graduated and planned to answer the call made by the government in its 2020 vision statement.

Today, with the Malaysian government's emphasis on industrialisation acting with the high profile given to the industrial design profession, ITM is not the only higher learning institution that offers courses in industrial design. Other universities such as Universiti Teknologi Malaysia (UTM), Universiti Putra Malaysia (UPM), University Malaysia Sarawak (UNIMAS) and other commercial art institutions such as Centre for Advanced Design (CENfAD), Malaysian Institute of Art (MIA) and the Limkokwing Institute for Creative Technology (LICT) also offer similar courses in industrial design. In the near future, the Universiti Sains Malaysia (USM) and several polytechnics throughout Malaysia are likely to expand the educational opportunities in industrial design.

As Malaysia moves towards modernisation, the Malaysian Government has realised the importance of design education to modernisation and industrialisation. Since the Malaysian government is aware that educating the younger generation in Malaysia is vital to development of design capabilities in the industrial sector it has made great

efforts in widening the concept of design to include Art Education in primary and secondary schools by 1995 (BH 9th Jan. 1995). The government has also implemented 'learning through design education programmes' in all primary and secondary schools as well as in one hundred and forty-four upper *secondary* schools throughout the country since 1996 (BH 17th June 1995). The government has also introduced Computer Aided Design (CAD) into secondary schools to help students produce innovative design (BH 3rd June 1993). Moreover as many as two hundred design societies have been established in schools in Malaysia in order to develop the concept of design and raise consciousness of design amongst students since 1991 (BH 28th June 1991).

In higher learning institutions, the government has allocated some RM45.5 million to research and development projects and to help rejuvenate the sense of creativity and innovation amongst the lecturers and students (BH 28th June 1991). The government has also allocated RM1 million to the Department of Industrial Design ITM, for training and learning programmes in industrial design (UM 28th June 1991). Through all the incentives and support given, the government of Malaysia is hoping that the education of industrial design will provide greater focus on the development of Malaysia's own products and in turn realise the nation's aspiration of becoming fully industrialised by the year 2020.

3.2.3 The Employment Sectors of Industrial Designers

The number of ITM graduates practising industrial design has been shown to be limited, with most graduates working as graphic artists, craftsmen or positions unrelated to design. Indeed less than 6% were found to be employed within the industry, though Bajuri (1988) suggests this may be a result of the structure of Malaysian industry at the time of his study. A second study of industrial designers in industry was made in 1990 by Mujir (1991). According to this survey, a total of 186 students who graduated from ITM, eighty-two (44%) were working in

manufacturing sectors, 29% with design consultants, 12% were in semi-government, 6% in higher education institutions and 9% were working in other professions. Significantly this study also revealed that the furniture industry made up some 46% of total employment of industrial designers. Other areas of employment according to this study included product and plastic industries (32%), and transport production and assembly industries (22%). These observations suggest that industrial designers are clustered into particular sectors thus limiting the scope of employment as intimated in Bajuri's study above.

In June 1997, the researcher carried out his own survey in order to identify where industrial designers were located in industry, with a view to compare findings with Bajuri and Mujir's own surveys. The researcher gathered data through personal contacts and by using 'snowball sampling' (Polit and Hungler 1997), and managed to acquire two hundred and eight names of industrial designers working in various areas of industry. From this survey, some similarities and differences with Bajuri's (1988) and Mujir's (1991) works were found. For example, the results from the researcher's own survey found that 49% of industrial designers work in manufacturing sectors (including consumer durable products, transportation, furniture and plastic industries). This figure is similar to Mujir's (44%). Both these findings contradict those of by Bajuri who claims that just 5.5% industrial designers are practising their profession in industry. However, considering factors such as economy, government policy and incentives given to industries today, not available at the time Bajuri conducted his research, the researcher believes that Bajuri's finding reflects the true picture at that time.

The survey carried out by the researcher also found that 38% of graduates were working with government, higher learning institutions and research institutes. A further 18% were involved in industrial design consultancies or as other consultants in interior design, advertising or graphics.

The summary of the findings of industrial designers in industry made by the researcher is presented in Table 3.1 below.

TABLE 3.1 : Working Sector of Industrial Designers in Malaysia

Working Sector	*No. of People*	*(%)*	*Total %*
Consumer Durable Products	**45**	22%	
Transportation	**18**	8%	
Furniture	**26**	13%	
Plastic Products	**12**	6%	**49%**
Government Agency	**11**	5%	
Higher Learning Institution	**28**	14%	
Art Teacher	**18**	8%	
Research Institute	**12**	6%	**33%**
Industrial Design Consultants	**6**	3%	
Other Consultants (Graphics/Advertising/Interior)	**32**	15%	**18%**
TOTAL	**208**	100%	**100%**

This survey covered two hundred and eight people, and the researcher believes it is valid and is representative of the wider population [see Sekaran 1992 pg. 253 for discussion of sample size determination]. This is because, according to researcher's knowledge and experience of working in one of the higher learning institutions in Malaysia, the total number of industrial designers in Malaysia including students graduated from other higher learning institutions did not exceed four hundred people in 1997. The two hundred and eight sample thus represents more than half of the population and can thus give enough grounding for the researcher to make valid observations.

3.2.4 The Role of Industrial Designers in Malaysian Industries

The literature on the industrial designer's role shows that more often than not they are misunderstood by industry in Malaysia. Most industrial designers are considered as an 'artist' or 'aesthetician' working with engineers or marketers to help market a

product. Although most Malaysian industries rely totally on their own in-house designers, since there are only a few design consultants directly involved in product design and development (Isa 1995), most industries do not seem to value the contributions made by their designers. As a result, most industrial designers feel frustrated and often leave the profession (NST 9th March 1995) or 'jump' from one company to another to find a better working environment (Manan 1991).

Most industries in Malaysia have not employed industrial designers expertise (Salleh 1996, Ali 1991) since they believe that it has survived without industrial designers (Bajuri and Bidin 1996). Table 3.2 is a compilation of quotations from various authors regarding the role played by the industrial designer in Malaysian industries. From this table, the observations by industry concerning the role of the industrial designer can be seen clearly. Many see them as a *'backroom boys'* (Salleh 1996) or working in *isolation* to industry (Salleh 1996, Ali 1991). As a result, some industries in Malaysia produce very poor designs, and are largely dependent on local and regional markets for their major output.

The role of the industrial designer has for this reason been highlighted by the Malaysian Design Council (MDC) through promotions such as design competitions, design exhibitions and training programmes more recently (since 1994). Through these promotions, industries especially SMIs are beginning to understand that they require the industrial designer's services in order to help them design and produce high quality consumer products and thus compete in the market.

Based on the researcher's personal observations at various industrial settings in Malaysia, it is evident that some early initiative has been taken by industry towards industrial design. For example, most industries in Malaysia have now started to co-operate with research centres and higher learning institutions in order to upgrade their understanding of industrial design as well as to acquire the transfer of

knowledge, technology and know-how. Some companies have even begun supporting design activities by sponsoring design short courses and design projects.

TABLE 3.2 : Quotations Illustrating the Role of Industrial Designers in Malaysian Industries

Authors	*Description of Industrial Designers Role*
Salleh (1996 pp.2-4)	♦ Industrial designers are mostly 'backroom boys' ♦ Industrial designers are not on top of the employment priority list ♦ Industrial designers work as all-rounders. ♦ Industrial designers are usually isolated and there is no effort to consolidate or network between each other. ♦ Companies are wary of promoting their designer for fear of him being recruited by competitors.
Bajuri and Bidin (1996 pg.5)	♦ The firms have survived without an industrial designer.
Awang (1995)	♦ Poor contribution by local industrial designers.
Azizi Ahmad [see NST 9th March 1995]	♦ Malaysian manufacturers are not playing their role in helping local designers.
Ali (1991 pg.16)	♦ Malaysian industrial designers are working in isolation in industry. ♦ Freelance industrial designers are commissioned to facelift products. ♦ Most local industries do *not* employ industrial designer's expertise. ♦ Lack of collaboration between industrial designers and engineers.

3.2.5 Malaysia Design Council (MDC)

In realising the importance of industrial design as a tool to industrialisation, the government of Malaysia set up the Malaysia Design Council or MDC 1994. The main objective of the Council being to lead and co-ordinate design activities in order to enhance the competitiveness of Malaysian manufactured products in the local and international markets and to promote good design generally. The functions of the MDC are:

- to assist industry in appreciating the importance of quality design and effective design management in the manufacture of products which can compete in the open market

- to develop activities so that locally designed products can be promoted internationally

- to be a repository of information and other reference materials on design in order to assist local industries in developing design capabilities

- to co-ordinate advisory services to industry
- to promote programmes for upgrading the capability of local industries in product design and

- to promote greater public awareness of quality design (MDC 1994).

MDC programmes and activities to support these functions include design awareness and promotion, exhibitions, education and training programmes, and design information data-bases. As well as these, in an effort to promote design and design awareness, MDC set up a resource centre handling all aspects of design. To promote it's international dimension the Council plans to introduce award-winning and outstanding product designs from abroad to inspire local designers to higher levels of creativity (Berita SIRIM 1995).

MDC also aims to cement a dynamic partnership between designers and industry particularly SMIs through workshops. Through these, a pool of skilled and highly trained people can develop, and will help establish Malaysia's own design mark for products as a standard of recognition for consumers. For example the MDC has already begun to forge links with SMIs to establish common areas of co-operation in product design and development. Furthermore, MDC has affiliated with foreign bodies such as the International Council of Societies of Industries Design (ICSID) to raise the MDC international profile (Berita SIRIM 1995).

Berita SIRIM q

3.2.6 Industrial Design Activities

3.2.6.1 Design Association/Society in Malaysia

At present, the Malaysian Invention and Design Society (MINDS) is the only design society in Malaysia. MINDS was established in 1990 with the function of assisting local inventors and designers in promoting their designs. Industrial designers have formed their own society 'the Malaysia Industrial Designers Society' or MIDS. The researcher was one of the 'task force' committee members who set up this association in the early 1990's. As a society, MIDS promotes industrial designer work to industry, acts as a watchdog on unethical design practices and can act as a consultative body to the industry and the government on issues relating to industrial design (Salleh 1996).

3.2.6.2 Local Industrial Design Magazine/Journal

'Malaysia DESIGN' is the only local industrial design magazine in Malaysia and is published by Malaysian Design Council. The first issue was published in conjunction with the First International Industrial Design Conference, held in Kuala Lumpur, in 1991.

3.2.6.3 Design Promotions

Design promotion activities began in the 1970s with the first seminar on Industrial Design being held in 1976. Foreign design experts from the UK, Sweden and Germany were invited to give lectures at the seminar (Er 1994). However, despite the enthusiasm and the support from the various media, the outcome of the seminar was very poor (Bajuri 1988).

A second seminar (a furniture design workshop) took place in 1985, and was organised by a German furniture design and manufacturing consultancy and the

Malaysian Timber Industry Board (MTIB). The researcher was one of the industrial design students representing ITM, working together with German designers in producing designs for the local market at that time. A third promotion was made through a workshop on furniture design, finishing and jointing techniques, and was held in 1986. This workshop was jointly organised by the ASEAN Promotion Centre on Trade, Investment and Tourism and the MTIB. The researcher was again sent by the ITM as a participant to represent industrial design students.

In July 1991, the first International Industrial Design conference and exhibition was held in Kuala Lumpur. The conference theme 'Quality Through Design' was chosen to emphasise the importance of industrial design in creating a quality product in both appearance and performance. This conference was organised by the SIRIM. With hindsight this event appears to have been very important in the development process of industrial design in Malaysia as it marks the beginning of governmental commitment to design as a part of long term economic and industrial development policy. At this international conference the formation of the MDC was proposed by the former Deputy Prime Minister, Ghafar Baba. As mentioned, Malaysia's first design magazine 'Malaysia DESIGN' was launched after this conference. The researcher was one of the participants in this conference representing ITM.

The most recent design conference 'Design Facilitates Industrialisation' was held in 1996 in Kuala Lumpur. This was the first conference organised by the MDC involving local designers, design education and industry. This conference was part of the MDC promotion in order to upgrade the capability of local industries in product design and to promote greater public awareness of quality design.

As well as design conferences and seminars, the Malaysian government through the MDC and the MTIB, has taken a positive step by holding competitions on industrial design activities. This began with the launch of the *Concept Car Competition* in 1993. Other successful MDC competitions for industrial design

include *Malaysia First Anugerah Pereka Muda Malaysia* in 1993 and *the Malaysia Good Design Mark* in 1997 [see Chapter One section 1.2]. Moreover, MTIB has conducted furniture design competitions annually in conjunction with the Malaysian International Furniture Fair (MIFF). This competition is an avenue for all Malaysians to freely explore and display their best ideas in furniture design and to show an awareness of the importance of Malaysian identity in furniture design. Malaysian Invention and Design Society (MINDS) has also conducted design competitions and exhibitions on an annual basis known as the Malaysian Invention and Design Exhibition or MINDEX. This competition and exhibition is held in conjunction with Malaysia Science and Technology week and encourages local designers and inventors involved in design and innovation. The researcher was involved in MINDEX representing ITM as a judge for the competition and also as one of the committee members for the exhibition.

3.2.6.4 Industrial Design Act

Malaysia is in the process of implementing the Industrial Design Act, in order to protect local industrial designers and to systemise the registration of industrial design. Previously, registered owners' rights were protected by the United Kingdom Designs (Protection) Act 1949 of West Malaysia, the United Kingdom Designs (Protection) Ordinance, (Chapter 152) of Sabah and the Designs (United Kingdom) Ordinance, (Chapter 59) of Sarawak (Star 24th July 1996).

3.3 The Development of Manufacturing Activities in Malaysia

3.3.1 Overview of Current Environment

Since independence in the late 1950's, Malaysia has proven its ability to build a manufacturing industry by concentrating its resources in the manufacturing industry. By doing so Malaysia has successful shifted from an agricultural based society to a modern manufacturing based one.

The manufacturing sector growth exceeds 10% annually and in 1993 manufacturing made up 31.5% of GDP while export earnings from manufactured goods made up 77.5% of total exports (MIMOS 1996). In terms of composition, electrical and electronic products and wood products were the leading export groups amounting to 73% of the total exports (MITI 1994).

Manufacturing activities in Malaysia are still dominated by large-scale industries (LSIs) and multi national companies (MNCs). Most of these MNCs concentrate on product assembly for the export market (Awang 1995). Local Malaysian companies, especially SMIs have a very limited capacity for R&D and therefore concentrate on pre-design, and made-to-order products for local and export markets. Thus, Awang claims that local design input in the area of product development is very low and with a poor contribution from the local industrial designers. However, he believes with stiffer international price competition and increasing labour costs, the manufacturers will need the help of industrial designers in order to develop value added products.

3.3.2 Malaysian-Made Products

Most of the products produced by industries in Malaysia are under license. In the 1980's the Malaysian made products came only from the furniture and craft industries. With support and incentives from the government, companies have realised that they cannot depend on traditional industry and must develop value added products and higher quality consumer products (MDC 1995).

Today, Malaysian-made products have already begun to make an impact on the international market. Malaysian products now win international prizes and are widely recognised. Royal Selangor pewter products, Nova Controls smart lamps and Sapura telephones [see Figure 3.1], have all won international design competitions (NST 21st May 1995). Noval Smartlamp for example received a Silver Medal Award

FIGURE 3.1 : Malaysian Companies Award-Winning Products
source : Malaysian DESIGN magazine, Inaugural issue (1995) and July issue (1991)

at the 21st International Exhibition of Invention in Geneva, 1993 and a Gold Medal from the World Intellectual Property Organisation (WIPO) also in 1993. Sapura S2000 received the 'Design and Engineering' Honours Award at the 1994 International Summer Consumer Electronics Show organised by the Consumer Electronics Show (CES) and Electronics Industries Association, of the USA. Royal Selangor Tankard received an award from the American Pewter Guild's in the 1994 International Design Competition (MDC 1995).

3.3.3 R&D in Malaysia

R&D activities in Malaysia are still in their infancy. A survey on R&D conducted by SIRIM (BT 25th Sept.1996) discovered that in 1995, 18.4% of R&D activities were conducted abroad with only 7.3% carried out locally. According to this survey, most of the R&D activities in Malaysia were focused on processes which used only 13.4% on total sales revenue. The survey also showed that 'Product R&D' only utilised 12.2% of 1995 total sales. According to Dr. Mohd Ariffin Aton, President and Chief Executive SIRIM Bhd., industries with intensive R&D activities were the electrical and electronics, chemical products and food and beverages sectors. However he noted that the problems faced by industries in carrying out R&D included the difficulty in obtaining local expertise. This may be due to the limited number of financial institutions offering R&D financing. As a result, little progress has been made in local design. Product and engineering and the industry has largely remained as an assembly plant and following foreign technology. Consequently he indicated that R&D experts are required in process engineering, product development and design areas. And despite the difficulty in obtaining funds, it should not be a major obstacle as some funding is now available for the commercialisation of research activities through SIRIM who now manage the ITAF fund (aimed at aiding SMI development and enhancing local product development and design capabilities).

MITI (1994) also indicates that, the government of Malaysia has introduced a package of incentives to encourage industries involved in R&D. For example, companies which carry out in-house R&D are allowed a research allowance of 50% and buildings used for R&D are permitted industrial building allowances. As well as these income tax exemptions, exemption of various duties on equipment used for R&D and double deduction for expenditure are also offered by the government.

In order to become the centre of capital goods in ASEAN, the government continues to support and take bold measures to support industries (especially SMIs) in investing in R&D activities. The International Trade and Industry Minister, Datuk Seri Rafidah Aziz (NST 11th July 1996) indicates that to achieve this, SMIs should expect to have in-house R&D facilities and brand their own products. She also suggests that SMIs need to modernise their present operations and technology so that increases in the efficiency of production and quality of products produced is the result. She suggests that the government's emphasis on R&D was evident in the allocation for R&D through the Small and Medium Industries Development Corporatisation (SMIDEC), an agency under the Ministry of International Trade and Industry (MITI). To illustrate the scale and development of this allocation the budget increased from RM400 million to RM600 million in the 1991-1995 Plan.

3.3.4 Small and Medium Industries

SMIs comprise 92.6% of the total manufacturing establishments in Malaysia (MITI 1994). A survey of the manufacturing industry undertaken by the Department of Statistics indicated that there were three thousand seven hundred and twenty two small scale industries (64% of total), 1,638 or 28.1% medium scale industries and four hundred and sixty (7.9%) large scale companies. Small scale industries are currently engaged in a wide variety of non-agricultural economic activities, producing finished products such as, furniture, metal products, furniture, wood and plastic based products. The medium scale industries are more active in producing electrical

and electronic products, production of automotive component and parts etc. (Zahari 1996).

According to Lim (1992), the government's awareness of and concern for SMIs was first expressed in the First Malaysia Plan (1966-1970) by providing them financial assistance. During the second plan period (1971-1975), a wider range of management and technical assistance was provided in order to integrate SMIs into the modern industrial framework. The Third (1976-1980) and Fourth Malaysia Plans (1981-1985) recognised the importance of training, savings and inter-industry linkages as a grounding for future SMIs businesses and assisted accordingly. In the Fifth Malaysia Plan (1986-1990), the government orientation shifted toward exports. At this time, the emphasis for SMIs was the improvement and modernisation of SMIs through improvements to the incentive system, developing R&D activities and strengthening institutions involved directly with SMIs.

The role of SMIs as the backbone of Malaysia's industrialisation process has been clearly stated in the Second Outline Perspective Plan (OPP2 [1991-2000]) and the Sixth Malaysian Plan (SMP [1990-1995]) (MITI 1994). The government has identified SMIs as one of the most important sectors for development and strengthening, so that Malaysian may become a fully industrialised nation. In this respect, the capabilities and competencies of SMIs in managing product development need to be strengthened and the government has offered and granted SMIs a comprehensive incentive package including:

1. A RM18 million fund to promote design in SMIs
2. Tax concessions and financial incentives to companies who introduce R&D
3. The Industrial Technical Assistance Fund (ITAF)

   ITAF is a trust fund set up by the government in 1990 with an initial allocation of RM50 million. This fund was set up with the purpose of providing grants to SMIs who participate in any of the following schemes:

- Consultancy Service Scheme (ITAF 1)

- Product Development and Design Scheme (ITAF 2)
  The purpose of this scheme is to provide grants to SMIs for improving and upgrading local product development and design, upgrading indigenous technology through the development of new products/processes and improving existing products/ processes.

- Quality and Productivity Improvement Scheme (ITAF 3)

- Market Development Scheme (ITAF 4)

Assistance under ITAF is given in the form of a matching grant whereby 50% of the project cost is borne by the government and the remainder is borne by the company. Priority will be given to SMIs which manufacture or *intend* to manufacture product(s) promoted under the Promotion of Investments Act (PIA) 1986.

4. The Incubator Programme

This programme provides an integrated facility and positive environment for helping in the initial development of manufacturing industries under this programme. Companies are provided with basic facilities, manufacturing technology and consultancy services. SMIs may reach their full potential through the following integrated process:

- Stage One : Development and Design of Product/Process
- Stage Two : Product or Process Improvement
- Stage Three : Manufacturing

5. The Intensification of Research in Priority Areas (IRPA)

IRPA has been introduced with the aim of improving the efficiency and competitiveness of local SMIs particularly in the areas of product design and development, and in industrial and consumer products.

6. SIRIM Training Programme

In order to assist SMIs upgrade their skill and knowledge in product development and new technology, SIRIM offered several courses, seminars and workshops. In addition to these programmes, SIRIM also provides 'in-house' training based on the organisation or company's requirements.

Although the Malaysian government has offered and granted SMIs a comprehensive incentives package, most SMIs are still cost-driven and are extremely wary of investing in new designs. According to Idris Jusoh, the Deputy Entrepreneur Minister of Malaysia (BT 20th June 1996), SMIs cannot afford to invest in NPD since the investment outlay is too expensive and the rewards unquantifiable. Idris believes that this decision is not governed by technology or market demands but by short term financial objectives. Therefore, he urges Malaysian SMIs need to give more emphasise on NPD in order to compete in a competitive market. He believes that new designs are crucial in determining the commercial success of a product because only well designed products will have the possibility of generating greater sales.

Similarly, Datuk Dr. Ahmad Tajuddin Ali, Director General of SIRIM (BT 20th June 1996) suggests Malaysian SMIs need to make greater effort in developing new products and in strengthening their design capabilities to compete with foreign products. Due to out dated designs he claims that Malaysian SMIs are focused to sell their products in the local market and thus cannot benefit from international recognition or scale. In this respect Abdul Razak Ramli, the International Trade and Industry Ministry's Director of the ASEAN Economic Co-operation Division (NST 22nd May 1997) remarks that SMIs are reluctant to venture into the international markets to test their product capability and acceptability is in agreement. Consequently Malaysian products are not sold abroad. As a way out of this conduit he points to the opportunities possible under the ASEAN Free Trade and Agreement (AFTA) which will be implemented in 2003.

As well as these issues, most SMIs do not use statistical quality control but tend to inspect their products whenever there was a problem (Lim 1992). His study indicates that only 18% of the SMIs manufacture their products according to ISO, while the rest use their own standards. This is because SMIs lacked the basic management know-how and because most of them adopt an autocratic approach in managing their businesses. Consequently, many SMIs are poorly managed, lack production know-how and produce low quality products at non-competitive prices.

3.3.4.1 The Importance of NPD to Malaysian SMIs

Malaysian SMIs are now more aware of the importance of the NPD since the Malaysian government initiatives. Moreover, Malaysian industries now face new challenges since the loss of GATT (General Agreement on Tariffs and Trade) priviledges due to the industrialised nation status having been given to Malaysia. As a result, foreign manufacturers are slowly moving to new countries offering cheap labour leaving the local SMIs to fend for themselves. In order to survive nationally and internationally, these SMIs do not have any other choice but to produce higher quality local products (Salleh 1996).

The importance of the NPD is also highlighted by the implementation of the AFTA in the year 2003. According to Abdul Razak Ramli, the International Trade and Industry Ministry's Director of the ASEAN Economic Co-operation Division (NST 22nd May 1997), Malaysian SMIs should take advantage of the opportunity offered under the AFTA. AFTA will offer SMIs a way to move into export markets by tapping the large regional market. The removal of tariffs will assists SMIs in doing business in the regional free trade area as would the increased market size with Cambodia, Laos and Myanmar all joining the ASEAN region.

Similarly Datuk Soong Siew Hoong (NST 22nd May 1997), Chairman of Federation of Malaysian Manufacturers's (FMM) Committee on SMIs believes that the

competition will be keener with the implementation of AFTA. He suggests that if SMIs are not efficient, quality-conscious or price-competitive, their products will not be able to enter other ASEAN countries. He thus urges Malaysian SMIs to take advantage of the facilities being offered to compete on a level playing field under AFTA.

3.3.4.2 The Role of Government in NPD Promotion in Malaysian SMIs

Government involvement in SMIs began after the implementation of the Third Malaysian Plan (1976-1980). In the First (1966-1970) and Second (1971-1975) Malaysia Plan, only the Rural Industries Development Authority (RIDA) was directly involved with SMIs. This was because after independence the prime objective of the government at that time was industrialisation and that meant the establishment of large companies (Zahari 1996). However, according to Zahari (1996), in the Third Malaysian Plan, the government saw SMIs as 'an integral part of Malaysia's industrial development'. Not only were agencies connected with the development of SMIs set up but the government also offered SMIs training and research programmes to assist them in product development and manufacturing.

The 1980's have brought a new economic direction with the government looking to develop capabilities for and knowledge of value-added production in place of assembling or sub-contracting. The government call to industrialise Malaysia in the Fifth Malaysia Plan (1986-1990) gave further impetus to SMI's involved in NPD to develop their abilities.

A high priority has thus been placed on the development of R&D for NPD under the Sixth Malaysian Plan (1991-1995). According to Zahari (1996), this is accordance with the nations plans to be fully developed by 2020. Promotion of increased linkages between SMIs and acceleration of industrial restructuring and modernisation of the fledgling industries were the main agenda points. However, changes were also

made to legislation to promote the growth of the manufacturing sector and procedures affecting the manufacturing sector were simplified to reaffirmed the government's policy of providing assistance to SMIs. In line with this, MITI now acts as the 'leader agency' and has removed existing bureaucratic delay to speed up assistance to SMIs.

In order to enhance the NPD in the area of industrial design, the government have approved a variety of projects to be undertaken by industry. In the furniture industry for example, a total of one hundred and eighty two furniture projects were approved involving investments of RM1.1 billion between 1994 to 1998 (BH 3rd March 1999). Due to these projects the furniture industry has registered steady growth and expansion with exports up of RM4.4 billions in 1998 compared with RM2.3 billions as recently as 1995. This positive trend in exports for furniture products reflects the success of government policy in encouraging the furniture industry.

Similarly 'plastic' manufacturing projects were also encouraged by the Malaysian government. In approving sixty three projects involving RM640.2 million investments in 1994 an increase of 184%. Over the 1993 figure of RM 225.2 million was attained (BH 20th Apr. 1995).

3.4 Summary and Conclusions

The era of industrial design in Malaysia is still young. The contribution of industrial design to product development only appeared in the Fifth Malaysia Plan (1986-1990) after the industrial-based nation status was articulated by the government. This has given local industrial designers an impetus to show their ability to produce creative designs. The role of the industrial design profession has been highlighted by the government through the establishment of the Malaysian Design Council (MDC)

in 1994. By this move the government recognises that design is one of the major factors influencing the market success of Malaysian products.

However, Malaysian manufacturing companies need to be more aware of the potential of industrial design since they are required to improve their effort to design and produce high quality consumer products by the government of Malaysia. The government has put various schemes in place to encourage the growth of SMIs in NPD and manufacturing activities. These include the ITAF, IRPA, tax concession and training programmes. These schemes are aimed at enhancing local NPD capability, which is viewed as essential for the industrial development of Malaysia. These incentives also reaffirmed the government's policy of providing assistance to SMIs.

The creation of AFTA in 2003 will also facilitate more liberal trade and investment flows in which Malaysia has already been a major. The new and expanded market opportunities will encourage Malaysian SMIs to set up new production capacities. Opportunities for the development of new products to cater for the needs of the ASEAN market as a whole will necessitate investment in R & D and the adoption of NPD in manufacturing processes.

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CHAPTER FOUR

RESEARCH METHODOLOGY AND DEVELOPMENT OF QUESTIONNAIRE SURVEY AND CASE STUDIES

The purpose of this chapter is to discuss the research methodology and design adopted in this study. It starts with an introduction (section 4.1) followed by an overview of research methods in section 4.2. Section 4.3 discusses the research methods, focusing on the advantages and disadvantages of major qualitative and quantitative methods. Section 4.4 deals with the overall research design used here and is followed by a literature review (4.5) and section 4.6 discusses the initial study on previous research. Sections 4.7-4.8 describe the rationale behind the development of the questionnaire and the case studies for collecting data for this research. The chapter ends with a summary and conclusion in section 4.9.

4.1 Introduction

This chapter describes the research methodology and development of the questionnaire survey and case studies adopted in this research. As described in Chapter One, three phases of data collection were adopted. In the first phase, a literature search and review was carried out in order to obtain information regarding industrial design and NPD in Malaysia and the UK. Using factors identified in the literature search and review, several research questions were developed and compiled. Using a questionnaire survey, the research questions raised in phase one were tested in phase two. In the third phase, case studies were conducted with four successful Malaysian SMIs and four UK SMEs in order to provide a set of detailed descriptions of best practice principles and elements in the NPD process in both countries.

4.2 Overview of Research Methods

According to Ogier (1998) both method and methodology relate to the way in which the researcher attempts to fulfil the aim of the study. According to Ogier, methodology includes such aspects as research design, sample size and selection, the research tools used and the way of collecting and analysing data. Since there has been no previous study specifically on industrial design in relation to new product development in Malaysian SMIs context, the researcher was unable to consider any previous research methodology and design for the current research. However, there have been studies by scholars that refer to industrial design and NPD in their works; e.g. Awang (1995), Er (1994), Chung (1989), Kim (1989) and Ughanwa (1986). Although these works are indirectly related to industrial design and NPD, their research design and data collection methods were considered and helped guide the researcher to select the most appropriate research method for this study.

In his study of the potential contribution of industrial design to the adaptation of agricultural machinery for use in Malaysia, Awang (1995) considered both, qualitative (case study and interviews) and quantitative (questionnaire survey) as the major data collecting methods. In his study of the emergence and development patterns of industrial design in NICs, Er (1994) chose semi-structured interviews and case studies as the major data collection methods. In Chung's (1989) study of the role of industrial design in new product strategy, case studies were employed as data collection method. Similarly, Kim (1989) utilised the case study approach in his attitude survey of company managers and designers in investigating the role of industrial design in international competition. Finally, in his study of the role of new product design in international competitiveness, Ughanwa (1986) applied longitudinal interviews and postal questionnaires.

In summary, quantitative, qualitative and combined methodologies have been emphasised and pursued by researchers in the industrial design and NPD discipline. Therefore in this study, the researcher considers both, quantitative and qualitative

research methods. Before describing the chosen research methods, the next section will discuss the advantages and disadvantages of both, quantitative and qualitative methods.

4.3 A Discussion of Research Methods

In order to obtain information regarding NPD process, particularly in Malaysian and UK companies, both quantitative and qualitative methods were considered. Qualitative methods were considered since the resultant findings are 'well-grounded', and represent 'rich', 'vivid' and 'meaningful' data likely to lead to 'serendipitous' findings (Miles and Huberman 1994). As well as the qualitative method, the quantitative method was adopted in this study since the data obtained tend to be 'systematic', 'standardised', and 'easily presented'. In addition, quantitative measures have the strength of being 'succinct', 'parsimonious', and 'easily aggregated' for analysis (Patton 1987).

Qualitative methods have the strength to uncover and understand what may lie behind a phenomenon that is difficult to convey via quantitative methods. Hakim (1987) for example shows how qualitative research is a specific research design concerned with individuals' accounts of their attitudes, motivations and behaviour. Producing rich descriptive reports is unlikely to be possible by quantitative methods. Similarly, Strauss and Corbin (1990) indicate that qualitative research is a kind of research that produces findings not arrived at by means of statistical procedures. Instead, it is concerned with a person's behaviour, organisational functioning and social movements.

Well collected data using qualitative methods have a number of strengths that make them attractive to researchers. Miles and Huberman (1994 pg. 10) summarise these strengths;

1. Qualitative data focus on naturally occurring: ordinary events in natural settings, so they offer a strong indication of what 'real life' is like. In this way it emphasises people's 'lived experience': it is thus fundamentally well suited for locating the meanings people place on the events, processes, and structures of their lives: 'perceptions, assumptions, pre-judgements and presuppositions' can all be taken on board and connected to the social world around them.

2. Local groundedness: qualitative data are collected in close proximity to a specific situation, rather than through the mail or over the phone. The emphasis is on a specific case, a focused and bounded phenomenon embedded in its context.

3. Their richness and holism: qualitative data have strong potential for revealing complexity. They can provide 'thick descriptions', 'nested' in a real context, and can have a 'truth' that has strong impact on the reader. Since qualitative data is flexible it gives added confidence to the phenomena being examined

4. Data are often collected over a sustained period. This makes them powerful for studying any process: In this way qualitative data can go beyond 'snapshots' of 'what?', or 'how many?' to how and why things happen as they do - and even assess causality as it actually happens in a particular setting.

5. Qualitative data have the ability to test new areas and hence can assess whether specific predictions hold true. Finally and perhaps most importantly to the processes of reflexivity and future research, qualitative data are useful as they may be used to supplement, validate, explain, illuminate or reinterpret quantitative data gathered from the same setting.

Many researchers draw divisions between qualitative and quantitative methods. According to Yin (1993) some label quantitative methods as 'hard-nosed', 'data driven', 'outcome-oriented' or 'truly scientific' while qualitative methods are seen as being 'soft', and dealing with inadequate evidence. Zelditch (1962) [see Fielding and Fielding 1986 pg.10] also indicates polar contrasts by stating that 'quantitative data are often thought of as hard and qualitative as real and deep'. However, Holloway and Wheeler (1996) believe that qualitative and quantitative methods are not in competition. They consider that the respective methods have respective research applications, thus researchers need to choose the methods most appropriate to their own research question or topic.

According to Patton (1987 pp.9-14), there are no specific rules that can be set out for making data method and collection decisions in research. He suggests that consideration of the research method leads directly to consideration of the relative strengths and weakness of both qualitative and quantitative approaches. Patton summarises the strength and weakness of qualitative and quantitative methods as follows:

> Qualitative methods permit the evaluator to study selected issues, cases, or events in depth and detail. Data collection is not constrained by predetermined categories of analysis and thus has depth and detail. Quantitative methods however use standardised measures to fit diverse opinions and experiences into predetermined response categories which 'reduces' the data richness.
>
> Qualitative methods can produce detailed data about a much smaller number of people and cases than quantitative methods. It also provides depth through direct quotation and careful description of program situations, events, people, interactions and observed behaviours. By contrast, quantitative approaches measure the reactions of many people

to a limited set of questions. This facilitates comparison and statistical aggregation of the data and gives a broad, generalisable set of findings.

Qualitative findings are longer, more detailed, and variable in content however analysis is difficult since responses tend to be neither systematic nor standardised. By contrast, quantitative measures are succinct, and easily aggregated for analysis: Furthermore quantitative data are systematic, standardised, and can be easily presented.

Although there are no rigid rules that can guide research data collection, the researcher believes that it is appropriate to consider both qualitative and quantitative methods in order to obtain reliable and valid data for the current research. Such a dual methodological approach is supported by Holloway and Wheeler (1996), who suggest that a research study can be strengthened by adopting this.

Within both qualitative and quantitative approaches, there are a number of data collection techniques. Within qualitative approaches, there are three kinds of data collection: (1) in-depth, open-ended interview; (2) direct observations; and (3) written documents (Patton 1990). Data from interviews consists of direct quotations from people about their experiences, their opinions, and knowledge. Data from observation consist of detailed descriptions of people's activities, behaviour and action while document analysis yields excerpts, quotations, official reports and open-ended written responses to questionnaires and surveys. In the quantitative approach, data collection is based on a numeric quantified form such as questionnaire surveys and structured interviews (Polit and Hungler 1997).

Since this study needs to gain generalised as well as detailed findings from several organisations (i.e. respondents), the researcher believed that it would be most appropriate to combine the strengths of both qualitative and quantitative methods. According to Patton (1990 pg.14) 'because qualitative and quantitative methods

involve differing strengths and weakness, they constitute alternative, but not mutually exclusive, strategies for research. Both qualitative and quantitative data can be collected in the same study'. The quantitative approach was operationalised here by the questionnaire survey whilst the qualitative approach was made by case studies. From the quantitative method of questionnaire survey, the researcher hopes to provide generalised findings with respect to the role of industrial designers in NPD process both in Malaysian SMIs and UK SMEs. By using the qualitative approach, the researcher was able to provide a set of detailed descriptions of best practice principles and elements in the NPD process. It was recognised in this study that the quantitative approach such as the questionnaire survey could only gather superficial information. Thus the more detailed and meaningful information where close linkage with subject organisations is a pre-requisite, was obtained through case studies.

4.4 The Overall Research Design

Research methodology is concerned mainly with the nature and means of obtaining explanations. Once a research methodology has been formulated, construction of the research design, a plan of procedures for data collection and analysis is required. Hakim (1987 pg.171) describes research design as 'aiming in the right direction, getting your bearing right (from previous studies) and making sure you are adequately equipped to get there and back'. He adds that 'research designs which fail in their original intentions are not always quite so lucky, but it helps if one is clear that the original plan made sense, can offer some reasons on why it went awry, and describes what was discovered instead'. He suggests that research projects that are poorly designed are likely to fail. According to Sekaran (1992) research design relates to all aspects of the research process from the duration and location of the study to the extent of researcher control and the level of analysis to be employed. Yin (1989), however, suggests that research design is an 'action plan' for getting from here to there. 'Here' he suggests is the initial set of questions to be answered, and 'there' is a

set of conclusions (or answers) about these questions. Between the 'here' and 'there', a number of steps, including the collection and analysis of data may be found.

The observations above show that research design is more than a workplan. Research design not only helps the researcher to find answers to the main research questions but guides him in testing the answers. In this research project, the research design incorporated three inter related phases. Phase One : Literature Search and Review, Phase Two : Questionnaire Survey, and Phase Three : Case Studies [see Figure 4.1]. These are examined in more detail below:

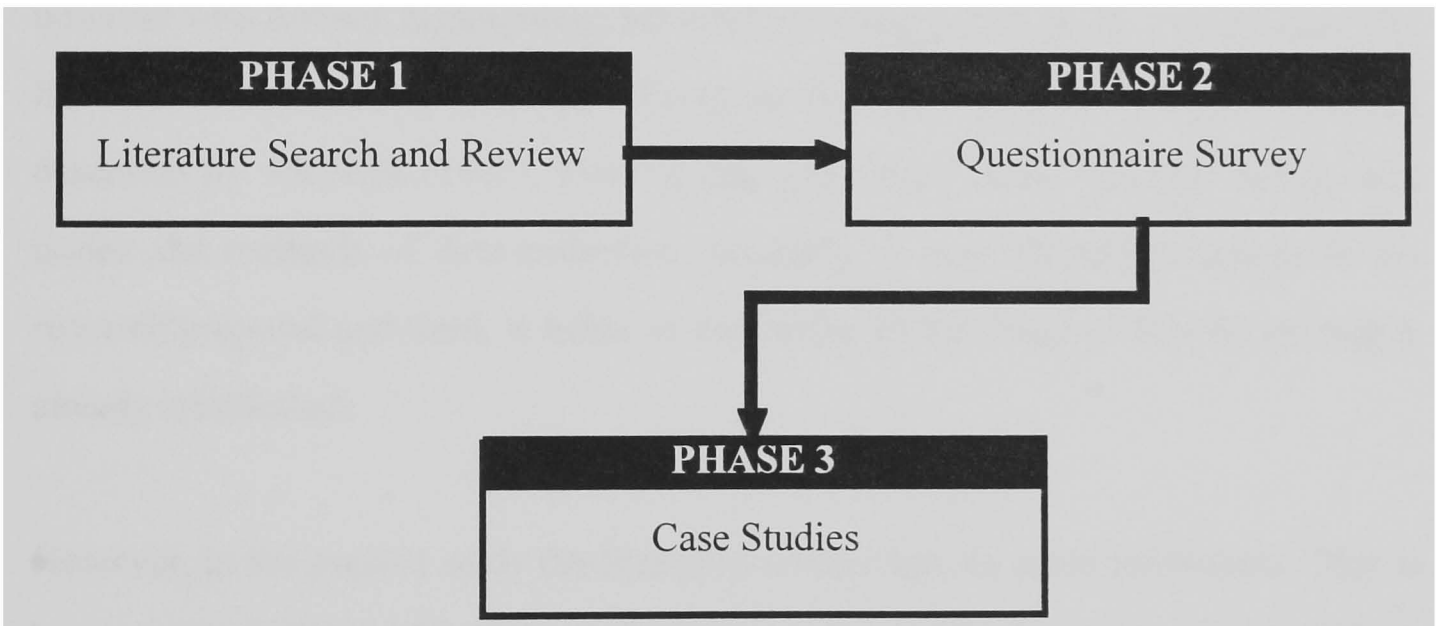

FIGURE 4.1 : Phases of Data Collection

4.5 Literature Search and Review

A wide range of literature was reviewed concerning NPD, new product design and innovation, industrial design and design management. The objectives of this search were to:

1. Gain an understanding of the nature of the NPD process;
2. Identify the role industrial designers play in NPD and;
3. Identify the efficient management practices of organisations who are involved in the process of NPD, and;
4. To create a knowledge based framework for the questionnaire survey and to construct a research design and research hypothesis.

The literature search constitutes an important part of the interdisciplinary research strategy creating a focus for the study. As well as this it enables a reflective look at previous authors work (Patton 1990). In this study it relied on the literature from a number of different disciplines including engineering, marketing and management. Literature on industrial design with reference to NPD in Malaysia context was however very limited, highlighting the need for a study such as the current one. The literature search and review helped the researcher to address needs similar to those described by McNeill (1990). First, it can give ideas about research design, key issues and methods of data collection. Secondly, it may identify problems in the research proposal and third, it helps to contribute to the body of knowledge that is already established.

However, in the present study the literature review had its some limitations. This is because, by definition it relied on secondary information. Secondly, although there are many texts discussing the importance of design, the review could not adequately collect specific information about industrial design with regard to NPD. A large part of the literature review can thus be described as re-reading 'marketing' or 'engineering' design literature from the viewpoint of an industrial designer, because 'design' literature itself is very limited. To compound this, there is no literature relating to SMI product development specifically. Therefore, an empirical investigation of NPD was considered to be vital so that it may set up a fresh link with the conceptual framework of the literature search and review.

The literature search and review continued throughout the research programme as suggested by Strauss and Corbin (1990). In this way a creative interplay between the processes of data collection, literature review and researcher introspection were possible (Patton 1990).

4.6 The Initial Study on Previous Research

The main purpose of the initial study was to form a firm base on which to develop an understanding of the research area, and establish the originality and viability of the research. A literature search of previous work was carried out in areas related to : 'industrial design/designers', 'product design' and 'new product development'. This helped to widen the understanding of the current situation in industrial design and NPD and in particular in Malaysia and the UK. Despite the limited resources regarding industrial design and NPD in Malaysia, some studies in this area that refer to industrial/product design have been made [see Awang 1995, Isa 1995, Bajuri 1988 and Hussain 1986]. The researcher also located relevant information from outside the design area [see Er 1994, Chung 1989, Kim 1989 and Ughanwa 1986] concerning the economic and business management aspects of industrial design and NPD. These supplied a good base for further research and provided background information in related fields as well as reiterating possible research design and data collection methods.

4.7 Questionnaire Survey

The questionnaire survey method was chosen for this study because of its flexibility in gathering information on a wide range of topics and sample sizes. It also represents an efficient data-collection mechanism where the researcher understands the requirements and measurement of variables. In addition, questionnaires are expedient in that they may be administered personally or mailed to the selected

respondents. In the Malaysian context, they have been shown to be successful in previous research as a means of collecting data (Sekaran 1992).

As well as these advantages, questionnaire surveys are cheap, can be designed to provide a degree of anonymity, or to enable the researcher to follow-up issues in the future. Moreover, a questionnaire can be completed at the respondent's own pace, and the respondent can overview the whole questionnaire before committing himself to anything. This helps avoid the problem of respondents beginning the task by answering in a very defensive way as may happen in a personal interview (Moore 1983).

Questionnaire surveys can take 3 forms: personal interview surveys, telephone surveys and mail surveys. The most common form of questionnaire survey is the mail (or postal) survey. Mail surveys are those in which questionnaires are sent and returned by mail and completed by respondents themselves thus eliminating expensive travel costs and interviewer time. The basic distinction between mail and other types of surveys is that, in mail surveys there is no person to ask the questions and guide the respondent, thus the questionnaire must be clear and concise yet able to address the research questions. (Table 4.1 presents some of the comparative advantages and limitations of the three types of survey research).

Since the respondents in the present study were geographically distant (i.e. in Malaysia), mail surveys were preferred. As well as this, time and cost savings provided by questionnaire survey were important (Warwick and Lininger 1975, Oppenheim 1992).

According to Moser and Kalton (1971), costs can be up to 1/3 of an equivalent interview survey. Alternatively, the sample size cost ratio is increased with questionnaire methodology. Bourque and Fielder (1995) support this view and indicate that mail surveys represent the cheapest survey methodology (compared to personal interview and telephone surveys).

Finally, questionnaires can be completed at respondents convenience and thus give time for reflection. This may give rise to more considered or precise responses.

The advantages of mail surveys over other methods have been summarised by Gardner (1978). This main findings are listed below:

1. Mail surveys are less personal since the questionnaires can be anonymous and do not need rapport;
2. They enable better standardisation of work since they use printed text instead of the spoken word. Subtle voice inflections, word emphasis, or change of words are thus not introduced;
3. There are no interviewer errors or bias effects and the respondent is free from any pressure of being observed;
4. Mail surveys are more cost effective and provide larger samples for lower total costs. They are less time-consuming and do not involve travel, and;
5. Mail surveys are more convenient to the respondent because he can fill in the questionnaire at his own preferred time and where factual information is required, the respondent can refer to records.

TABLE 4.1 : A Comparison of Three Main Types of Surveys Derived from Methodological Sources

		Types of Surveys		
No	**Considerations**	**Personal Interview**	**Telephone**	**Mail**
1	Cost	♦ relatively high cost due to the factors such as the travel expenses and the time expended to locate respondents whose address may have changed or who may be available at the scheduled time	♦ more expensive than mail surveys ♦ considerable amount of time can be spent in a waiting reply. Also respondent needs to orient themselves to the topic leading to possible cost increases	♦ most economical and provides larger samples for lower total costs ♦ can cost 50% less than telephone survey and 75% less than personal interview *(Bourque and Fielder 1995, pg9)*
2	Time and Distribution	♦ personal interview typically take more time than telephone interviews	♦ allows for a wider geographical spread and can be conducted from a single site. It becomes problematic if a substantial number of the respondents live outside the interviewer's area/site	♦ can be mailed anywhere in the world and enables substantial number of respondents to be contacted ♦ less time consuming and does not involve travel
3	Sample Size	♦ relatively small samples ♦ possibility of more representative samples	♦ relatively small samples compared to mail surveys	♦ large number of respondents possible leading to better overall findings
4	Response Rate	♦ can be made to yield an almost perfect participation rate ♦ typical response rate is about 95% *(Nachmias and Nachmias 1976 pg107)*	♦ a high response participation rate compared to mail surveys ♦ a lower response participation rate compared to personal interviews since some people may be reluctant to talk on the telephone ♦ some people do not have access to telephones ♦ response rate as high as 90-95% *(Revelle et al 1995 pg 47)*	♦ response rates do not typically exceed 20% *(Bourque and Fielder 1995, pg15)*
5	Bias and Inaccuracy	♦ the personal influence of the researcher can introduce bias ♦ interviewer may subtly change the intended meaning of questions through slight re-wording or word emphasis ♦ highly dependant upon the ability of the interviewers to be honest and to control bias ♦ Interviewer-interviewee relationship may influence reliability and validity measurements due to differences in social characteristics (e.g. race, sex, age ethnicity etc.) as well as personality characteristics		♦ less personal because it can be anonymous and the respondents do not need rapport ♦ no subtle voice inflections, word emphasis, or change of word can affect the impact of the questions ♦ respondents are free from any pressure as they are not 'observed'

Continued

No	Considerations	Personal Interview	Telephone	Mail
6	Questions	♦ respondents asked directly to articulate thoughts and opinions ♦ more personal, can generate rapport and replies can be more candid ♦ interviewer can sense if all questions are being understood and can re-word or repeat some questions to improve their chance of being clearly understood	♦ parties are linked by voice and thus lack the opportunity for communication through facial expressions, appearance, and physical presence.	♦ allows respondents to take their time in answering and to look up information if needed ♦ gives privacy to respondents ♦ allows respondents to see the context of a series of questions prior to beginning task
7	The Length of the Questions	♦ the length of the questions does not affect refusal rate ♦ questionnaire needs to be less demanding and needs to avoid sensitive subjects		♦ shorter answer more likely to give a high response rate ♦ inappropriate where spontaneous answers are wanted
8	Additional Data	♦ ability to clarify questions or probe for additional information ♦ ability to verify or cross check and collect supplement information about the respondent's personal characteristics and environment valuable in interpreting results and evaluating the representativeness of the persons surveyed.		♦ answers have to be accepted as final ♦ no opportunity to probe beyond the given answers ♦ no opportunity to supplement the respondent's answer by observational data
9	Accuracy of the Questions	♦ the language of the personal and telephone surveys can be adapted to the ability or educational level of the person interviewed and enable greater accuracy ♦ easier to avoid misinterpretations or misleading questions		♦ the questionnaire 'stands alone' ♦ all the information that the respondent is required to answer is on the questionnaire itself. No interviewer available to clarify instructions or provide additional information to eliminate confusion
10	Respondents	♦ the researcher can ensure the correct respondent is being interviewed		♦ the researcher cannot be sure that the right person completes the questionnaire
11	Data Collected	♦ personal and telephone interview surveys are a contemporary interpretative method that can to extract factual information from various people, explore questions in depth and in general, seek the 'rich' information in building a valid, holistic picture of a phenomenon.		♦ may produce incomplete and inaccurate data ♦ may lack qualitative depth ♦ inflexible and lack of control
12	Data Analysis	♦ data analysis is time consuming		♦ analysis less time consuming as categories are determined in advance

Source :Compiled from various authors

Despite these wide ranging benefits and advantages mail surveys are not without limitations. According to Moser and Kalton (1971), four main disadvantages dominate:

1. Mail surveys can only be considered when the questions are sufficiently simple and straightforward to be understood with the help of the printed instructions and definitions;
2. The answers to mail surveys have to be accepted as 'final'. There is no opportunity to probe beyond the given answer, to clarify an ambiguous one, to overcome unwillingness to answer a particular question or to appraise the validity of what a respondent said in the light of how he said it;
3. The mail survey is inappropriate where spontaneous answers are required or where a group concensus or less tangible human data are required, and;
4. Respondents can examine all questions before answering any of them, thus different answers cannot be treated as being independent of each other.

The principal method of data collection for the survey was by mail questionnaire. The following section discusses the processes behind the construction of the questionnaire. This involved the type, length and scale of questions as well as pilot testing. Further issues regarding data collection of the questionnaire survey are discussed in the next chapter (Chapter Five).

4.7.1 Questionnaire Survey Data Collection

4.7.1.1 Construction of Questionnaire

Based on an extensive review of literature and similar previous research (Awang 1995, Er 1994, Solomons 1988 and Ughanwa 1986) in the field, a draft questionnaire was produced. The researcher also found some relevant questions in a report by the Design Council (1983), undertaken by Chris Hayes Associates and Keller Dorsey

Associates. Discussion with the research supervisor assisted in improving the questionnaire.

According to Erdos (1970), a good questionnaire is easy to compose and to include all the salient questions. He suggests a questionnaire should appear brief, easy to complete and should not contain any items that could create bias. Phrasing, structure, and layout must be designed with the considerations to the respondent and researcher so that both time and money requirements may be reduced.

This study took into consideration all the factors mentioned above. The data collection instrument developed for this purpose was a six to nine page questionnaire (six pages for design consultants, eight pages for industrial designers and nine pages for engineers and marketers) that required between twenty to thirty minutes to complete. Most of the questions were scaled, but space was left at the end of the questionnaire for open ended responses. The idea of leaving space for open-ended response was based on a suggestion by Sudman and Bradburn (1984 pg.38) who remark 'it is courteous to leave space at the end of a questionnaire to enable any respondent who wishes to do so to make comments about any of the questions or to address topics that the questionnaire did not cover'

4.7.1.2 Layout of Questionnaire

The questionnaire was divided into 4 sections;

1. Section one dealt with nominal questions where respondents were asked to fill in their name, position, address and contact number.
2. Section two was designed to cover certain factors identified in the literature search and review. It covered various issues such as design in general, design and innovation, development of new design, design success and competitiveness, management of design and aspects of marketing and production. This section featured eighteen questions in the industrial designers questionnaire, twenty

three questions in the production engineers and marketers questionnaire, and seven questions for the questionnaire sent to design consultants.

3. Section three was designed to find out which skills, competencies, and attitudes industrial designers acquired in the current context of design practice. It also aimed to establish which skills, competencies and attitudes industrial designers needed to perform their functions or tasks effectively in the process of NPD. Section three contained six questions in the questionnaire sent to industrial designers and three questions in the questionnaire sent to both production engineers and marketers and design consultants.
4. Section four was an open-ended question, where respondents were asked to suggest ways in which the management of design may be improved.

The main objective of the questionnaire was stated clearly before the beginning of each question as were the objectives of each sections.

4.7.1.3 Length of Questionnaire

In terms of the length of a questionnaire, although a shorter questionnaire, may seem more likely to produce a high response rate, there is no concrete rule which can be applied. However, two rules of thumb were considered by the researcher. The first 'rule' was proposed by Erdos and Morgan (1970) who suggest that an eleven page questionnaire can be considered a general maximum. A second consideration taken into account was that there is little difference in the response rates for questionnaires of fewer than twelve pages and for questionnaires that contain fewer than one hundred and twenty five items (Dillman 1978) [see Sudman and Bradburn 1984].

Some studies have examined the correlation between questionnaire length and response rate and revealed that no statistically significant relationship appeared between the two. For example, a study by Adams and Gale (1982) [see Mangione 1995] comparing one, three and five page questionnaires found that there was no

significant difference in response rate among the three. Similarly, studies carried out by the Social and Community Planning Research (SCPR 1972) achieved responses of 67% with a *fifty page* questionnaire compared to a 45% response rate using a *one page* questionnaire. Similarly, Sletto's (1940) study [see Berdie 1973] found 68% responded to ten page questionnaires, 60% to twenty five page and 63% for thirty five page.

The length of a questionnaire is thus not an important variable in a questionnaire return. Although it was clear that length and response rate were not related, the researcher believes that a shorter questionnaire will on average be more respondent friendly than a longer one. The researcher has thus attempted to keep the questionnaires as short as possible in this study. The total number of pages in the questionnaires used here was between six and eight pages.

4.7.1.4 Choice of Scale

In the present study, a rating scale was considered since they tend to be received better by respondents than scales such as ranking (Moser and Kalton 1977). The advantages of rating are that the respondent is not forced to make a comparative judgement (Erdos 1970) and are easy to present to respondents and to administer (Alwin and Krosnick 1985). Despite these advantages, ratings may compromise the level of data precision although the validity of ratings is somewhat higher than that of rankings.

Based on these arguments, a five point rating scale was chosen in the questionnaire design since it can discriminate data more succinctly than either three point or seven points scales.

4.7.1.5 Type of Questionnaire Used

In this study, the closed-ended question was used because this type of question is user friendly. They require no writing and quantification is straightforward (Oppenheim 1992). Since categories are determined in advance, they are easy to pre-code responses, which facilitates rapid analysis. Closed-ended questions also have a frame of reference which guides respondents' replies. This can clarify the concepts used and make clear the kind of answer sought by the researcher (Heather and Stone 1984).

4.7.1.6 Pilot Testing

On 29th January 1997, a total of five questionnaires were sent out to five selected UK respondents; three design consultants and two manufacturers. A '*judgement sample*' was used in choosing the UK respondents together with a recommendation by the supervisor. Since the mail questionnaire used for respondents in UK was also used for respondents in Malaysia (to facilitate a direct comparison of research findings), the researcher felt that it would be important to get some views from Malaysia respondents regarding the questionnaire design. This was to help the researcher locate any language or terminology problems with the questionnaire amongst non-native English Speakers. Warwick and Lininger (1975 pg.132) have stressed that 'the researcher cannot simply assume that questions which prove intelligible to a pre-test sample of English speakers in Ann Arbor or Chicago will have the same meaning or will even be understood by other groups. Such problems are greatly complicated in multi-ethnic and multi-linguistic societies such as Malaysia....'. Therefore, the pilot study not only helped the researcher with the wording of the questions, vocabulary and ambiguity of questionnaires, but also with procedural matters such as the design of a cover letter, layout of questionnaires and incentives in order to achieve high response.

For the purpose of a Malaysia pilot test, four Malaysia respondents were drawn from postgraduate Malaysian students currently studying in the UK. The respondents were obtained through the researcher's own personal contacts. Although none of them were not industrial designers 'these students formed the 'sample' of the initial study' (Er 1995 pg. 98). This sample could be described as 'convenience' or 'accidental' sampling since it was conveniently available to provide this information (Fink 1985). The selection of Malaysian respondents was based on their professional experience in design and manufacturing and involvement in new product development in Malaysia.

Both the respondents in the UK and Malaysia were sent a set of questionnaires with a prepaid return envelope and a personally signed cover letter explaining the purpose of the pilot test. The respondents were asked to comment on questionnaire, vocabulary, length, structure and the ease of completion. The respondents that were selected for the pilot test were;

UK Respondents

	Name	*Position*	*Company*
1.	Steve Bailey	Design Director	Octo Design, Newcastle-upon-Tyne.
2.	John Rowley	Senior Partner	Gekko Design Studio, Cheshire.
3.	Nina Warburton	Project Manager	The Centre for Industrial Design, UNN.
4.	Liam Corbett	Design Manager	Asher Systems Furniture Ltd. London.
5.	Mattias Janssen	Studio Manager	Ind. Design Centre, Electrolux, Luton.

Malaysian Respondents

Name	*Area of Study*	*University*
1. Mohd. Hariri Abdullah	MA Transportation Design	Univ. of Coventry
2. Ruslan Abdul Rahim	PhD Computer Graphics	Univ. of Brighton
3. Abdul Halim Zulkifli	PhD Mechanical.Engineering	Univ. of Dundee
4. Mohamad Khalil Amran	PhD History of Design	Univ. of Northumbria

Of the nine respondents (Malaysia and UK), eight were completed and returned and included comments on questionnaire improvement. Overall, the completion rate for this pilot test was 89% .

The researcher found that the pilot test was very useful in helping improve the clarity, precision and quality of the questionnaire. At the same time it helped the researcher in identifying the suitability of questions which in turn may have given rise to a higher response in the actual study.

4.7.1.7 Final Draft of the Questionnaire

Based on comments by respondents, a number of questions in the pilot study were modified, deleted and eliminated before a final draft was made. A final version of the questionnaire was produced and administered to a wider sample of respondents. **Appendix 1** presents a sample of the final draft of the questionnaire which was sent to respondents in Malaysia and the UK.

4.7.1.8 Statistical Techniques Applied

In this study, *descriptive statistics* (frequency distributions and means) and *inferential statistics* (cross-tabulation and chi-square test) were employed to analyse the gathered data. This enabled detailed descriptions of the phenomenon and allowed inferences to be drawn from the sample to the population (Sekaran 1992).

In the present study, the data were subjected to 'frequency distribution' analysis at the initial stage in order to organise the data into a more readable and comprehensive form. According to Cohen and Holliday (1996), the first priority for a researcher after finishing data collection is to organise and summarise it into a form that allows further interpretation and analysis. They suggest that this can be done by constructing a 'frequency table' or 'frequency distribution' which arranges scores into groups or classes. Similarly, Reid (1987) suggests that the first task of statistical analysis, in the treatment of raw or unprocessed data, is that of translating them into a form that can be readily understood. He emphasises the importance of the construction of a 'frequency distribution' which he suggests will enable the researcher to identify any significant patterns in the distribution of cases and may provide 'leads' for further investigation. Since many writers have stressed the importance of frequency distribution as a first step or task in quantitative data analysis (also Bryman and Crymer 1994), the researcher has decided to employ this procedure into the present study. In this study, the frequency distribution procedure was used to establish how the cases are distributed and spread across the range of occurring values and to establish whether the data had been entered and coded correctly. By doing this any necessary corrections could be made an early stage.

The use of inferential statistics through cross-tabulations and chi-square test was used to identify and establish relationship, differences and similarity between Malaysian and UK respondents. The main statistical test used in this study was the chi-square (X^2) test. Chi-square is probably the most used of all non-parametric tests (Rose and Sullivan 1993). In this study the chi-square (X^2) was used as the primary test for statistical significance between the Malaysian and UK cases. In this way it helped the researcher to determine whether a systematic relationship existed between the industrial designer/engineer and marketer, and industrial designer/design consultants.

The statistical analysis in this research was carried out using the SPSS software. This software was chosen since this package is user-friendly and contains powerful programs which can perform many different statistical procedures with different kinds of data. The overall statistical findings of this research had a dual purpose. They were utilised to form the basic theoretical background for the case studies and also to support the case study findings.

4.8 Case Studies

Case studies were conducted with three successful Malaysian SMIs and three UK SMEs. As well as these one successful design consultant from each country were included. The background, development and current conditions which led to an effective of NPD process were identified. The main aim of this identification to provide a set of detailed descriptions of best practice principles and elements in the NPD process, in Malaysia and the UK, and to correlate these with best practices found in recent literature.

Case study is an in-depth examination of a real life or simulated situation carried out in order to illustrate particular characteristics. These characteristics may be specific to the case being studied or more general characteristics of the wider set to which it belongs (Ellington and Harris 1986). According to Stake (1995), the case study is the study of the particularity and complexity of a single case (particularisation) and coming to understand its activity within important circumstances. Since it involves particular cases, Stake indicates there is emphasis on uniqueness, and that implies knowledge of others that the case is different from, but the first emphasis is on understanding the case itself. The initial focus is thus on the cases themselves.

According to Adelman et al (1980) case study methods have a number of advantages that make them attractive to researchers. They describe these advantages as:

Case study data is 'strong in reality'. This strength in reality arises since case studies are down-to-earth and attention holding, in harmony with the reader's own experience, and thus provide a 'natural' basis of generalisation.

Case studies recognise the complexity and 'embededdness' of social truths. By carefully attending to social situations, case studies can represent the discrepancies or conflicts between the viewpoints held by participants.

Case studies may form an archive of descriptive material sufficiently rich to allow subsequent reinterpretation by different researchers with different agendas.

Case studies are 'a step to action'. Their insights may be directly interpreted and put to use: for staff or individual self-development, for formative evaluation; and or for policy making.

Case studies present research or evaluation data in a more publicly accessible form. It reduces the dependence of the reader upon unstated implicit assumptions. Case studies, therefore may contribute towards the 'democratisation' of decision-making (and knowledge itself).

Despite these considerations, Yin (1989) suggests that although the case study is a distinctive form of empirical inquiry, many investigators view it as less desirable compared to, for example, surveys. Case studies can lack rigour, allow biased views, provide very little basis for scientific generalisation and take too long to analyse. Moreover, they 'are [only] generalisable to theoretical propositions and not to populations or universes' and 'do not represent a 'sample' (pg. 21).

In case study research, a 'case' can be a person, an event, a programme, a time period, a critical incident, or a community (Patton 1987). According to Yin (1994) case studies are the preferred strategy when 'how' or 'why' questions are being posed. Since 'how' and 'why' questions leads to more explanatory data being revealed. Hence operational links needing to be traced over time, rather than frequencies or incidence are examined. Therefore, the researcher felt that case study approach was the most appropriate tool to use in conjunction with the quantitative

approach. Another important reason for adopting case study methodology was that industrial design with regard to NPD in Malaysia and UK is a new research subject with little previous study. In this respect, Patton's (1987) ideas that case studies become particularly useful where one needs to understand some particular problem or situation in great depth, and where one can obtain rich information are important. As well as this the case study can capture individual differences or unique variations which is a specific requirement of the current investigation.

4.8.1 Case Study Data Collection

4.8.1.1 Number of Cases

In terms of the number of cases, it is useful to select ones which are typical or representative of other cases, a sample of just a few is unlikely to be a strong representation of others. According to Hakim (1987), the number of cases for case study can range from one to hundreds of cases, and may range in project scale from a single self funded researcher to larger externally funded projects carried out by a team of researchers, of several years duration. Yin (1989) draws a comparison between the use of six or ten case studies organised as a multiple-case study, and conducting the same number of experimental investigations. He suggests 'a few cases (two or three) would be [sufficient to claim] literal replications, whereas a few other cases [four to six] would merely just strengthen ones conclusions' (pg.53).

Therefore, in the present study, multiple-case studies which involve eight cases, six companies and two design consultants in both, Malaysia and the UK were deemed sufficient by the researcher to obtain enough information about the elements of best practice in order to draw valid generalisation.

4.8.1.2 Case Study Sample

In the present study, 'focus sampling' was used in order to select samples and respondents for case study interviews. Focus sampling 'is the selective study of particular persons, groups, or institutions, or of particular relationships, processes or interactions that are expected to offer especially illuminating examples, or to provide especially good tests for propositions of a broad nature' (Hakim 1987). Langrish (1993) has identified six basic types of case study selection; the 'comparative', 'representative', 'best practice', 'ones next door', 'cor, look at that', and 'taxanomic'. In this study, the researcher believes that the selection of samples for both countries, UK and Malaysia may be described as 'representative' and as 'best practice' since they have been carefully selected based on notable, successful design projects and the general perception and reputation for design leadership, particularly within the consumer durable product market sector.

In terms of the selection of respondents for the case study interviews, it is largely based on their experience of the process of NPD and their identification by the researcher as key informants to the questions raised in the interviews. Respondents 'not only provide the case study investigator with insights into the subject matter but also can suggest sources of corroboratory evidence and initiate the access to such sources' (Yin 1989 pg.89).

4.8.1.3 Evidence for Case Study

In terms of evidence for case studies, Yin (1989) suggests that it may come from six sources; documents, archival records, interviews, direct observation, participant-observation, and physical artefacts. Data from documents can be in the form of administrative documents such as proposals and progress reports, written reports , newspaper clippings and other mass media sources. Data from archival records can be organisational records, maps and charts, survey data and personal records. Case study interviews may take several forms but the most common are the 'open ended'

and 'focused' interview. Direct observations can involve observations of meetings and factory visits or less formal observations such as during case study interviews. In participant-observation, the researcher may participate in the events being studied, by physical artefacts, a tool or instrument, such as a work of art or a technological device is collected or observed as part of a field visit.

Based on the above suggestions, in the present study, the data for each case was collected through (1) the case study interviews which involved semi-structured and open ended questions, (2) consideration of documentary sources, and, (3) direct observations at the visited sites.

4.8.1.4 Types of Data Collected

In the present study, the types of data collected for the case study involved Malaysian and UK companies can be summarised as follows:

1. General information about the organisation including it's history , number of employees, area of specialisation, organisational structure and any mission statements;
2. Information relating to any previous and current NPD undertaken with special focus on company product replacement and the strategic decision behind the changes;
3. Information on the management of design projects including the role of top managers in managing product design, design consultants and design teamwork;
4. Information on process and performance including the design processes, the application of CAD in design, concurrent engineering and the application of appropriate quality systems in each company;
5. Relevant data which could be used to identify the elements and factors of best practice and the role of industrial designers in the NPD process, and;
6. Other variables where they can be specifically identified.

4.8.1.5 Qualitative Data Analysis

The aim of analysing qualitative data from case studies is 'to make sense of massive amounts of data, reduce the volume of information, identify significant patterns and construct a framework for communicating the essence of what the data reveals' (Patton 1990 pg.371). This does, however, create problems since, according to Miles (1979), there are no fixed formulae to guide the researcher.

> '...the most serious and central difficulty in the use of qualitative data is that methods of analysis are not well formulated. For quantitative data, there are clear conventions the researcher can use. But the analyst faced with a bank of qualitative data has very few guidelines for protection against self-delusion, let alone the presentation of unreliable or invalid conclusions to scientific or policy-making audiences. How can we be sure that an 'earthy', 'undeniable', 'serendipitous' finding is not, in fact, wrong?' (Miles 1979 pg.591)

Although there is no fixed formula of qualitative data analysis, there are some guidelines and procedural suggestions to assist researchers in being systematic qualitative data analysis. For example, Miles and Huberman (1994) suggest that qualitative analysis should consist of three related and concurrent activities:

1. Data reduction;
2. Data display, and;
3. Conclusion drawing and verification.

Data reduction refers to the process of selecting, focusing, simplifying, abstracting, and transforming the data that appear in written-up field notes or transcriptions. Data is thus organised and compressed to information that permits conclusion drawing and action.

In case study analysis, both Patton (1990) and Miles and Huberman (1994) have suggested two different procedures that may be followed. Miles and Huberman promote a number of analytic techniques, these include;

- Putting information into different arrays;
- Making a matrix of categories and placing the evidence within such categories;
- Creating data displays - flow charts and other devices -for examining the data;
- Tabulating the frequency of different events;
- Examining the complexity of such tabulations and their relationships by calculating second-order numbers such as means and variances, and;
- Putting information into a chronology order or using some other temporal scheme.

Patton (1990) however suggests that the starting point for case study analysis is ensuring that the information for each case is as complete as possible. This should incorporate all the interview, observational and documentary data, as well as impressions and statements of others about the case and any other information accumulated about each particular case. These are the raw data for case analysis. Once the raw case data have been accumulated, the researcher may write a case record. The case record includes all the major information that will be used to construct a case study. The case study includes the information that will be communicated in the final report in other words it represents the descriptive data of the report. The report may consist of several case studies that are then compared and contrasted, however the basic descriptive data of the study are the cases. The description of the case should be holistic and comprehensive and formulated into an ideographic framework.

Table 4.2 shows how raw case data can be transformed into a written case study.

TABLE 4.2 : The Process of Constructing Case Studies

Step 1	***Assemble the raw case data*** These data consist of all the information collected about the person or programme for which a case study is to be written.
Step 2	***Construct a case record*** This is a condensation of the raw case data. Organisation, classification, and editing of the raw case data into a manageable and accessible package.
Step 3	***Write a case study narrative*** The case study is a readable, descriptive picture of a person or programme making all the information necessary to understand that person or programme accessible to the reader. The case study is presented either chronologically or thematically (sometimes both). The case study presents a holistic portrayal of a person or program.

Source : Patton (1990 pg.388)

In analysis of interviews and observations, Sekaran (1992 pg.271) suggests that the researcher considers the following;

> 'when responses to open-ended questions are obtained through interviews, or data are collected through observations or through open-ended questions in a questionnaire, they can be categorised and coded according to some meaningful classification scheme. Thereafter, frequency counts can be taken, and X^2 test or other appropriate non parametric tests can be done'

In the present study, the case studies were analysed mainly by the qualitative research approach Grounded Theory (Glaser and Strauss 1967). 'It is a scientific method and its procedures are designed so that if they are carefully carried out, the method meets the criteria for doing 'good' science: significance, theory-observation compatibility, generalisability, reproducibility, precision, rigour, and verification' (Strauss and Corbin 1990 pg.27). Although grounded theory has its origins in sociology, it can be used in other fields of study unstructured material such as interview transcripts, observations and documents.

In the present case study, the data collected through interviews, direct observations and document reviews was broken down, conceptualised and put back together in new ways. This is the central process by which theories are built from data. In this way, it was possible to extract themes, and develop descriptive theoretical frameworks of 'loosely interwoven concepts' (Strauss and Corbin 1990 pg.57). According to them, the analytic procedures of grounded theory are designed to:

1. Build rather than only test theory;
2. Give the research process the rigour necessary to make the theory 'good' science;
3. Help the analyst to break through the biases and assumptions brought to, and that can develop during, the research process, and;
4. Provide the grounding, build the density, and develop the sensitivity and integration needed to generate a rich, tightly woven, explanatory theory that closely approximates the reality it represents.

In the present study, the data collected through interviews, direct observations and document reviews will be coded and categorised using three major types of coding:

1. Open coding;
2. Axial coding, and;
3. Selective coding.

Open coding is a process of breaking down, examining, comparing, conceptualising and categorising data. Axial coding refers to a set of procedures whereby data are put back together in new ways after open coding and by making connections between categories. This is done by utilising a coding paradigm involving conditions, context, action/interactional strategies and consequences. In addition, selective coding is a process of selecting the core category and systematically relating it to other categories, validating those relationships, and filling in categories that need further refinement and development (Strauss and Corbin 1990)

4.9 Summary and Conclusions

The method chosen for the present research was a combined methodology making use of both qualitative and quantitative approaches. The quantitative approach was operationalised by questionnaire survey whilst the qualitative approach was enabled through case study. In this study, a pilot questionnaire survey was conducted prior to a final questionnaire being produced and sent out to Malaysian and UK respondents. All the questionnaires returned to the researcher were subjected to descriptive and inferential statistical analyses using SPSS software.

The case study took place immediately after the questionnaire survey phase. This second phase was intended to provide a set of detailed descriptions of best practice principles and elements found in the product development process, in Malaysia SMIs and UK SMEs. The case study analysis based on 'grounded theory' was later examined in order to generalise case study findings as well as to support the findings of the questionnaire survey.

In summary, the questionnaire survey and case studies are the main data collection methods. Three phases of data collection were employed in this research: literature search and review (Phase One), questionnaire survey (Phase Two) and case study (Phase Three). It is hoped that the methodology employed for this study would achieve the intended results and satisfy the stated aims.

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CHAPTER FIVE

DATA COLLECTION : QUESTIONNAIRE SURVEY

The purpose of this chapter is to describe the collection of data from the questionnaire survey from the Malaysia and UK studies. The chapter begins with an introduction (section 5.1) followed by a consideration of the focus of the study in section 5.2. Section 5.3 discusses the selection of Malaysian and UK respondents with special attention to sampling techniques and sample size. Data collection is discussed in section 5.4 including returned questionnaires response rates. The chapter ends with a summary and conclusions in section 5.5.

5.1 Introduction

On I7th of March 1997, a total of one hundred and thirty four questionnaires with accompanying explanatory letter were sent to the selected respondents in UK. From this figure, a total of eighty two sets of questionnaires were sent to companies and the further fifty two were sent to design consultants. On 24th of March 1997, a total of thirty three sets of questionnaires were sent from the UK to the selected respondents in Malaysia. In addition, on 17th April 1997 a further ten questionnaires were sent from Malaysia. The total number of questionnaires sent to respondents in Malaysia was forty three. Thirty eight of these were sent to companies and a further five were sent to design consultants. The rationale behind the data collection decisions are discussed below.

5.2 Focus of Study

The focus of the study is NPD in Malaysian and UK small and medium industries (SMIs/SMEs). In the present study, the sample was selected from three major areas of consumer durable products (office furniture, domestic electrical appliances, and plastic products). The consumer durable products sector was selected for this study

since it was perceived as being a rich area of data and is closer to industrial design than engineering design. In Malaysia specifically, consumer durable products have been prioritised as a key area of growth for Malaysian SMIs and there has been a stronger participation by industrial designer in designing consumer products than in other areas (Mujir 1990) [see 7.4 & 7.5 for details of SMIs and consumer durable products].

5.3 Selection of Malaysia and UK Respondents

5.3.1 Sampling Techniques

The selection of Malaysian and UK respondents were taken non-randomly. This method was preferred because they are easier to carry out (Mangione 1995). The selection of respondents for both, Malaysian and UK was based on a 'judgement sample'. The criteria for the judgemental selection were based on several studies by Ferman and Levin (1975), Sekaran (1992) and Hall and Hall (1996). Ferman and Levin describe that by using this method 'logic' or 'common-sense' is used as the basis for selecting a sample that is representative of a larger population. As well as this, a judgement sample involves the choice of subjects who are in the best position to provide the information required and is used when a limited category of people have the information that is sought (Sekaran 1992). Finally, Hall and Hall point out that the judgement sample relies on the researcher to try to obtain as wide a representation of individuals as possible, taking account of likely sources of difference in their view and experiences. In this study all these attributes were required and hence each authors observations were incorporated into the research design.

5.3.1.2 Malaysian Respondents

The list of Malaysian respondents was based on the mailing list of companies compiled by the researcher since there was no proper directory or readily available

mailing list of industrial designers working in SMIs in Malaysia. Although there were some mailing lists available from the Department of Industrial Design, Institut Teknologi MARA (ITM) Malaysia (the sponsoring establishment), these were incomplete. The researcher also used numerous personal contacts in the SMIs through the network of graduate designers who had previously studied at the researcher's sponsoring institute. Through these contacts, the researcher managed to acquire more than two hundred names of industrial designers who are working in more than ninety companies and design consultants, throughout Malaysia. The researcher also referred to the Malaysian SMI Directory (1996) and the Malaysia Furniture Manufacturers and Exporters Directory (1995/1996) for update information on SMIs. These two directories represent the most comprehensive lists of SMIs available in Malaysia. By using non-random samples (judgement sample), a total of forty three out of ninety companies and design consultants were selected for the survey. From these numbers, thirty eight were companies and a further five were design consultants [see **Appendix 2**].

5.3.1.3 UK Respondents

The selection of UK respondents was also made via a judgement sample, taken from UK design directories and magazines compiled with reference to design academics with detailed knowledge of the nature of companies in the UK. The mailing list of UK companies was based on the Kompass United Kingdom (1996/1997), The Biographical Guide to the UK Industrial and Commercial Community by Margetts (1992), Key British Enterprise (1996) and WorkPlace (1995). The mailing list of UK design consultants was based on Design magazine (1992), Design Business Association Directory (1995/1996), The Directory of UK Design Consultants (1997) and Design Directory (1995). Discussions were held with the research programme supervisor and a total of eighty two companies and fifty two consultants were selected for the survey [see **Appendix 3**]. These samples also adopted a judgement sample.

5.3.2 Selected Respondents for Survey

It was decided to send 3 different sets of questionnaire addressed to;

1. Selected industrial designers involved in the process of NPD;
2. Selected engineers and marketers familiar with the industrial design process, and;
3. Industrial designers with their own consultant firms.

These three groups were chosen for this survey as they were judged to be the best people to respond to the questionnaire based on their experience of the process of NPD and as key specialists responsible for industrial/product design activities in their companies.

5.3.3 Sample Size

The researcher found that there were no rules to follow concerning sample size and it tended to depend on what was deemed to be required. As Patton (1990) shows the; purpose, use, credibility and available resources also dictated this size. Representatives rather than scale were primary concerns as indicated by Oppenheim (1992) and Erdos (1972).

> '..... a survey based on a comparatively small number of questionnaires does not necessarily mean that it is poor; conversely, very large numbers do not guarantee excellence'. - Erdos (1970)

> '..... common sense suggests that a larger probability sample will give a better estimate of population parameters than a smaller one, but will also be more costly. A sample's accuracy is more important than its size'. - Oppenheim (1992)

As well as these issues the resultant figures need to mirror the target population and be replicable in future studies.

In terms of 'sample size' for this study, although samples of forty three for Malaysia and one hundred and thirty four for the UK were considered. the researcher felt that these numbers were in some way representative of the population since the data collected permitted detailed analysis and conclusions could be reached. The size used in this survey falls within those guidelines of Roscoe (1975) who suggests that between thirty and five hundred subjects are the most appropriate for a study.

5.4 Data Collection

5.4.1 Procedures on Increasing Response Rate

In order to obtain good response rate, some recognised procedures to increase mail questionnaire returns were applied in this study. These were based on research by Mangione (1995), Miller (1991), Kawash and Aleamoni (1971), Warwick and Lininger (1975), Dillman and Frey (1974) and Erdos (1970)

In response to Mangione (1995) and Miller (1991), an attractive cover letter emphasising the importance of each individual respondent to the success of the study, sending questionnaires through first-class mail and sending follow-up letters to non-respondents were all employed in this study.

As well as this, the cover letter was typed on letterhead and the length and appearance of the questionnaire were carefully considered. Moreover the cover letter included a hand written signature to personalise the nature of the project (Kawash and Aleamoni 1971, Dillman and Frey 1974).

According to Warwick and Lininger (1975) higher returns have been noted when questionnaires are sent out by first-class mail. Respondents also seemed to react favourably when multicoloured, small-denomination stamps are placed on the envelope, and when the packet includes a personally typed letter. Other useful

techniques include follow-up phone calls, suggested deadline dates and postcards sent as reminders.

Dillman and Frey (1974) reported that the high response to mail questionnaires depended on systematic manipulation of virtually all aspects of the procedure including personalised communications. 'Personalisation' is defined as the process of creating a belief on the part of the respondent that he is receiving the researcher's individual attention. Personalisation should include an individually typed letter and personal names, hand written signatures and some type of follow-up. In this way an increase of between 5.8 % can result.

The use of an appropriate incentive will usually increase the response rate, as reported by Erdos (1970) and Nederhof (1983). A wide variety of incentives have been enclosed or promised in mail surveys in order to induce mail survey recipients to answer questionnaires. These incentives include unused stamps, tie clips, pens and even golf balls, lottery tickets and instant coffee packages. Although Erdos and Nederhof studies showed that incentives raised the returns, it is possible that the use of incentives affect the validity of findings and the quality of survey results.

Some of the procedures noted above for increasing returns of mail questionnaires were followed in the present study. All questionnaires sent to selected respondents were sent with a return request, using first class mail which were individually addressed together with a stamped addressed envelope to the researcher's address. Included with the set of questionnaires was an attractive covering letter personally signed by the researcher explaining the purpose of the survey, how he/she was chosen as a participant and the importance of each individual respondent to the success of the study. A suggested deadline for questionnaire return and an offer to send a report on the results of the survey and assurances on the confidentiality of the research were made. Monetary incentives were not deemed to be suitable to this study.

The final record of returned questionnaires is shown below. The summary of the returned questionnaires of Malaysian respondents are shown in Tables 5.1,5.2 and 5.3. Tables 5.4,5.5 and 5.6 represent returned questionnaires for UK respondents.

5.4.2 Returned Questionnaires

5.4.2.1 Malaysia Respondents

The final record of returned questionnaires by selected companies and design consultants in Malaysia can be summarised as follows;

Companies

- Twenty seven of the thirty eight companies returned and completed the questionnaires;
- Five companies refused to answer the questionnaires;
- Two letters were returned marked 'unlocatable', and;
- Four questionnaires were not returned.

Design Consultants

- Four of the five design consultants returned and completed the questionnaires;
- One letter was returned marked 'unlocatable'.

This information summarised in Tables 5.1 and 5.2.

Those respondents in Malaysia, who failed to respond were contacted by telephone so as to speed up and increase the response rate. This idea followed the direction of Fowler (1993) who states that:

> '..... if the respond rate is still not satisfactory, probably the best next step is to call non-correspondents on the telephone'.

TABLE 5.1
Response to Mail Questionnaire by Companies (Malaysia)

Outcome	*No. Of companies*	*Percentage*
Returned and completed	27	71.0%
Refused to answer*	5	13.0%
Unlocatable+	2	5.5%
No response#	4	10.5%
Total Mailed	**38**	**100.0%**

* *Refused to answer: The companies refused to answer because the selected respondent was no longer working with them or had moved to another company.*
\+ *Unlocatable: Questionnaires mailed to respondents were returned as undeliverable by the Pos Malaysia (Malaysia Post).*
\# *No response: Including failure to contact, and outright refusal to participate.*

TABLE 5.2
Response to Mail Questionnaire by Design Consultants (Malaysia)

Outcome	*No. of Consultants*	*Percentage*
Returned and complete	4	80.0%
Unlocatable+	1	20.0%
Total Mailed	**5**	**100.0%**

\+ *Unlocatable: Questionnaires mailed to respondents were returned as undeliverable by the Pos Malaysia (Malaysia Post).*

This procedure was considered very practical because most of the respondents lived in the same state (Selangor) and could be contacted by telephone economically. In most cases three to five calls were made to each respondent at their office during office hours before each respondent was reachable. Table 5.3 summarised the response rate after the follow-up.

TABLE 5.3
Response to Mail Questionnaire by Using Follow-Up Procedure (Malaysia)

Mailing	*Number Returned**	*Number Sent*	*Percentage Returned*	*Percentage Increased+*
Companies				
Initial mailing	9	43	21%	
After follow-up	25	34	74%	**58%**
Consultants				
Initial mailing	4	5	80%	
After follow-up	1	1	100%	**20%**

* *Including returned but refused to answer and unlocatable*
\+ *Follow-up returned divided by initial mailing sent*

5.4.2.2 UK Respondents

The final record of returned questionnaires by selected companies and design consultants in UK can be summarised as follows;

Companies

- Fourteen of the eighty two companies returned and completed the questionnaires;
- Twenty one companies returned but refused to answer the questionnaires;
- Two letters were returned marked 'unlocatable', and;
- Forty five questionnaires were not returned.

Design Consultants

- Twenty one of the fifty two design consultants returned and completed the questionnaires;
- Five companies returned but refused to answer the questionnaires;
- Three letters were returned marked 'unlocatable', and;
- Twenty three questionnaires were not returned.

The summary of the returned questionnaires by selected companies and design consultants in UK are shown in Tables 5.4 and 5.5.

TABLE 5.4
Response to Mail Questionnaire by Companies (UK)

Outcome	*No. of companies*	*Percentage*
Returned and completed	14	17.0%
Returned but refused to answer	21	26.0%
Unlocatable+	2	2.0%
No response#	45	55.0%
Total Mailed	**82**	**100.0%**

* *Refused to answer: The companies refused to answer because the selected respondent was no longer working with them or had moved to another company.*
\+ *Unlocatable: Questionnaires mailed to respondents were returned as undeliverable by the Royal Mail because the addressee has gone away.*
\# *No response: Including failure to contact, and outright refusals.*

TABLE 5.5
Response to Mail Questionnaire by Design Consultants (UK)

Outcome	*No. of Consultants*	*Percentage*
Returned and completed	21	40.0%
Returned but refused to answer*	5	10.0%
Unlocatable+	3	6.0%
No response#	23	44.0%
Total Mailed	**52**	**100.0%**

* *Refused to answer: The companies refused to answer because the selected respondent was no longer working with them or had moved to another company.*
\+ *Unlocatable: Questionnaires mailed to respondents were returned as undeliverable by the Royal Mail because the addressee has gone away.*
\# *No response: Including failure to contact, and outright refusals.*

For UK respondents, follow-up letters (reminders) were mailed to the respondents who had not responded within 10 days of the initial mailing. The primary purpose of the follow-up letters was to reduce the percentage of non-respondents and thereby make the survey more representative. The adoption of the follow-up letter was based on Fowler (1993);

'..... about 10 days after the initial mailing, mail all non-corespondents a reminder card, emphasising the importance of the study and of a high rate of response'.

Non respondents received at least one reminder, and some of them contained a further copy of the questionnaire, together with a stamp addressed envelope. Table 5.6 summarises the response rate after the follow-up.

TABLE 5.6
Response to Mail Questionnaire by Using Follow-Up Procedure (UK)

Mailing	*Number Returned**	*Number Sent*	*Percentage Returned*	*Percentage Increased+*
Companies				
Initial mailing	19	82	23%	
After follow-up	18	63	29%	**22%**
Consultants				
Initial mailing	17	52	33%	
After follow-up	12	35	34%	**23%**

* *Including returned but refused to answer and unlocatable*
\+ *Follow-up returned divided by initial mailing sent*

5.4.3 Response Rate

One of the most common criteria by which a method is judged is the response rate it achieves. Mail questionnaires have been widely condemned because of the difficulty of securing an adequate response. As Heather and Stone (1984) indicate;

'It is likely that there will be a low level of response. On average, approximately **50%** of mailed questionnaires will be returned. This may distort the findings'.

However, according to De Vaus (1991), this is not true and may be misleading. He states that the response rate obtained in a particular study will be due to the combined effect of the topic, the nature of the sample, the length of the questionnaire and the care taken in implementing the particular survey. There will be situations where a well administrated mail survey will yield response rates at least equal to both personal and telephone interviews and be at a much lower cost. The important thing is to identify the situations in which different approaches should and should not be used.

Using proper procedures, mail questionnaires can produce very acceptable response rates for a range of topics. Using a random sample, Graetz (1985) has obtained response rates of 78% for a long general purpose social survey in Australia. In special purpose surveys even higher response rates of over 90% are attainable (De Vaus 1980). Dillman (1978) reports that average response rates of 74% are typical in the US.

A high response rate is a facet of a good mail survey. As De Vaus indicates above it depends on many aspects to do with the survey, procedural considerations and the nature of the respondents. According to Fowler (1993), the difficulties of getting the response rate to a reasonable level will also depend on how motivated respondents are, and how easy the task is for them. Clearly, the task will be easier if the sample is composed of motivated, well educated individuals.

According to Kviz (1977) the response rate should reflect the degree to which a researcher succeeds in obtaining the co-operation of all respondents included in the sample. Accordingly, it is logical to define it as the proportion of all sample members who are eligible to participate in the survey from whom a complete and usable set of data is collected. This is expressed in formula;

$$\textbf{Response rate} = C/E$$

where C = the number of completed questionnaires, and E = the number of eligible sample members.

5.4.3.1 Response Rate of Malaysian Respondents

Based on Kviz (1977) formula, the response rate for Malaysia industrial designers alone is:

$$\textbf{Response rate} = 27/31 \text{ @ } 87\%$$

The calculation is based on twenty seven selected industrial designers who completed the questionnaire, divided by thirty one, the number of ineligible samples. A further seven respondents were ineligible for inclusion; two were unlocatable respondents and five respondents refused to participate.

The response rate of 87% obtained from industrial designers for this study is considered as an excellent and a very high rate of return (Mangione 1995) and is in excess of rates achieved by similar research made by Awang (1995) of 72% and Isa (1995) 39%.

The response rate from companies to the mail questionnaire was 43%, whilst the response rate from design consultants was 100%. Perhaps the most important respondents for this research yielded a combined response rate of 88.6% (industrial designers and design consultants). A full summary of response rate of the Malaysia sample is shown in Table 5.7.

TABLE 5.7
Malaysia Questionnaire Response Rate

Sample	*No. Of Completed Questionnaire*	*No. Of Eligible Sample Members*	*Response Rate*
a) Company			
Industrial Designers	27	31	87.0%
Engineers	8	31	26.0%
Marketers	5	31	16.0%
Average	40	93	**43.0%**
b) Design Consultants	4	4	**100.0%**

5.4.3.2 Response Rate of UK Respondents

The response rate of the UK sample was calculated using the same formula adopted in calculating the response rate of the Malaysia sample. The response rate of UK industrial designers to this study was:

Response rate = *9 / 59 @ 15%*

The calculation is based on nine selected industrial designers who completed the questionnaires, divided by fifty nine, the number of eligible samples. In this study, two respondents were unlocatable and another twenty one respondents returned the questionnaire but refused to answer and were excluded from the survey. These respondents give some particular reason for refused which included;

- Industrial design or R&D activities were no longer carried out in their company;
- The information required was considered confidential;
- They did not have a design division, and;
- The questionnaire was too time consuming for them.

The response rate from industrial designers (15%) is considered low, but it is still acceptable and typical for a mail questionnaire. Studies by Erdos and Morgan (1970) have found that mail questionnaire responses can range from as little as 2% to 30%. A 10% response is thus considered a 'very satisfactory result'. Boyd and Westfall (1972) support these observations and indicate that response rates between 10% and 30% are common. Despite these low percentage return rates, Erdos (1970) suggests that the findings from a survey with a low response rate can be useful particularly where there is little or no information available on the subject under study. In these sense, the researcher believes that the response rate of 15% from UK industrial designers is acceptable and more importantly useful since the information regarding this issue is very limited.

The response rate from companies to this mail questionnaire was 11%, and the response rate from design consultants was 48%. The response rate of the industrial designers and design consultants in the UK sample was 29.1%. This response rate of the UK sample (29.1%) is similar to results obtained by previous research in this field. For example, Isa (1995) achieved between 27%-46% while Ughanwa (1986) achieved a 35% of response rate. A full summary of the response rates of the UK sample is shown in Table 5.8.

TABLE 5.8
UK Questionnaire Response Rate

Sample	*No. Of Completed Questionnaire*	*No. Of Eligible Sample Members*	*Response Rate*
a) Company			
Industrial Designers	9	59	15.0%
Engineers	5	59	8.0%
Marketers	5	59	8.0%
Average	19	177	**11.0%**
b) Design Consultants	21	44	**48.0%**

5.4.4 Completion Rate

Kviz (1977) suggests that the completion rate is closely related to the response rate. His formula for correlating completion rates utilises the same numerator as for the response rate, but use a denominator which includes ineligible as well as eligible sample members. The completion rate indicates the proportion of completed questionnaires obtained from a sample.

$$\textbf{Completion rate} = C / n$$

where C = the number of completed questionnaires, and n = the sample size.

Based on this formula, the total completion rate for the Malaysian sample in the survey questionnaire was;

$$\textbf{Completion rate} = 44 / 119 \text{ @ } 37\%$$

Similarly, the total completion rate for the UK sample in the survey questionnaire was;

$$\textbf{Completion rate} = 40 / 298 \text{ @ } 13\%$$

Although the total completion rate for the Malaysian and UK samples (13%-37%) is low, the researcher felt that this result is common and typical for a mail questionnaire. According to Warwick and Lininger (1975), completion rates on questionnaires can be notoriously low and figures of 40% or 50% are considered very good. The completion rate is a useful guide to deciding how many sampling units must be selected to obtain a given number of completed questionnaires from a particular population and is also important for planning, scheduling and budgeting fieldwork studies (Kviz 1977).

5.5 Summary and Conclusions

This chapter described how the questionnaire survey data was collected. A total of 177 sets of questionnaires were sent to the selected respondents in Malaysia and UK in the area of consumer durable products namely office furniture, domestic electrical appliances, and plastic products. The selection of Malaysian and UK respondents were taken non-randomly utilising the 'judgement sample' method. The response rate for Malaysian industrial designers and design consultants was 88.6% and 29.1% for the UK study. Although the total response rate for the UK study may be considered low, the researcher concludes that it is still acceptable and common for a mail questionnaire. Detailed discussions on the analysis and findings of questionnaire surveys are presented in the following chapter (Chapter Six).

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CHAPTER SIX

ANALYSIS AND FINDINGS FROM THE SURVEY (MALAYSIA AND UK)

The purpose of this chapter is to describe the analysis and findings of the questionnaire survey. This chapter begins with an overview of the questionnaire survey analysis (6.1) followed by a general consideration and discussion of the statistical procedures used (6.2). Section 6.3 discusses the data (variables) of the Malaysian and UK surveys. Key findings from the questionnaire survey are outlined in section 6.4 and a summary and conclusion follow in section 6.5.

6.1 Overview of Questionnaire Survey Analysis

According to Drew (1980) once the data have been collected and recorded in 'raw' form, the researcher usually has to process the data into a form that describes a group performance. He suggests that the compilation of such data generally involves the use of descriptive and inferential statistics.

Descriptive statistics refer to a collection of techniques used to organise, summarise and describe a sample. No predictions or inferences however are made this procedure regarding the process by which the data are generated (Cohen and Holliday 1996). It is, however, a basis for more advanced techniques (Fink 1985). These include the frequency, mean, median, and mode procedures. Inferential or inductive statistics on the other hand are used to infer or predict population parameters from sample measures. This is made by a process of inductive reasoning based on the theory of probability. Inferential statistics include the Pearson correlation, X^2 test, t-Test, ANOVA and regression analysis (Sekaran 1992).

6.2 Statistical Procedures Applied

In this study, for more objective quantitative analysis, descriptive statistics (frequency distributions and means) as well as inferential statistics (cross-tabulation and chi-square test) were employed to analyse the data. At the initial stage of statistical analysis, all variables were subjected to 'frequency distribution' so as to organise the data into a more readable and comprehensive form. Such frequency distributions enable the data to be 'cleaned up' (Norusis 1993) and provide 'leads' for further investigation (Reid 1987).

Since the questionnaire surveys for Malaysian and UK respondents in this study were primarily designed with an interval scale of measurement, the researcher believes that the mean would be the most appropriate measure of central tendency in comparison to either the median or the mode. As suggested by Cohen and Holliday (1996 pg.29) :

> '....the mode would be the appropriate statistics to use as a measure of the 'most fashionable' or 'most popular' when data are collected using a nominal scale. The median would generally be associated with ordinal level data. The mean would be used with interval level....'

The statistical mean procedure used in this study revealed the degree of preference given by respondents as well as identifying and establishing relationships, differences and similarity between each group with regard to the process of NPD. The use of the mean procedure also helped the researcher to test whether the difference in each group represented any true differences in the whole population.

The use of inferential statistics was considered essential in identifying and establishing relationships, differences and similarities between Malaysian and UK respondents in terms of their choice of variables. Cross tabulation is one of the simplest and most frequently used ways of demonstrating the presence or absence of such relationships. Cross tabulation is a joint frequency distribution of cases

according to two or more classificatory variables (Jollife 1986). The display of the distribution of cases by their position on two or more variables is the chief component of contingency table analysis and is the most commonly used analytic method in most studies. These joint frequency distributions can be statistically analysed by certain tests of significance such as the Chi-Square (X^2) statistic, to determine whether or not the variables are statistically independent. Thus, the researcher had to decide the most appropriate statistical significance (level of significance) to employ in this study. Since it is known that the higher the value of such a Chi-Square statistic the less likely it would emerge by chance and that in previous studies the 95% confidence level has been widely applied (i.e. there is a 1 in 20 chance that any pattern did occur by chance) the chosen level of significant was the 0.05 or 95% confidence level [see Frude 1987, Cohen and Holliday 1996].

The data collected were subjected to statistical analysis using SPSS (the Statistical Package for the Social Sciences) computer software. SPSS software was chosen since it is a professional tool, well known, is user-friendly and contains powerful programs. It may also perform different statistical procedures with many kinds of data and can produce fully labelled tables and graphs which can be easily incorporated into a report (Reaves 1992).

6.3 The Malaysia and UK Survey Data

In this study, the data for Malaysia and the UK were gathered from four different groups of respondents;

1. Industrial designers;
2. Engineers and marketers, and;
3. Industrial design consultants.

Three different sets of questionnaires were used with each questionnaire containing a different number of questions. In order to summarise and turn these questions into a

meaningful and readable form, all of them were categorised into several 'variables'. As can be seen in Table 6.1, there were eighteen variables for industrial designers, nineteen for engineers and marketers, and ten for industrial design consultants. There were three different categories of variables found in this study. These were categorised as:

1. Single variables;
2. *Combined variables*, and;
3. **Common variables.**

Single variables were used to reveal specific information from specific respondents. Respondents were industrial designers, engineers and marketers, and industrial design consultants. The second variable type (combined variables) enabled several questions from two different groups of respondents to be combined together. In this study, the industrial designer's group was combined with the engineers and marketer's group in order to further investigate the relationship between the two. The combination was made since these people often come from the same company or are members of the same department or same design team. The common variables were a combination of all groups. Several questions that appeared in industrial designers questionnaires have also featured in engineers and marketers, and industrial design consultants questionnaires. The common variables cross examined any differences or similarities existing between the three groups of respondents.

There were a total of eight single variables for industrial designers, nine for engineers and marketers and six for industrial design consultants. There were six combined variables and four common variables.

A list of single, combined and common variables are illustrated in Table 6.2. Variable labels in **bold** are common variables while combined variables are noted in *italic*.

TABLE 6.1 : LIST OF VARIABLES OF MALAYSIAN AND UK RESPONDENTS

GROUP 1 : **INDUSTRIAL DESIGNERS**

1.	YEAR	years involved in industrial design
2.	NOPROJ	no. of projects involved in
3.	*NOSTAF*	*no. of staff employed*
4.	*STAFIN*	*involvement in the projects*
5.	STAGE	stage at which industrial designers are involved
6.	NPDETER	factor which determined the design of the new products
7.	*LEVDES*	*design locations*
8.	*RESP*	*person who is responsible for product development*
9.	*RELATION*	*relationship of design and manufacture*
10.	**IDEROLE**	**the role of industrial designers**
11.	DESCONS	design considerations
12.	*FACTSUC*	*factors of a successful new product*
13.	SKILL	skills of industrial designers
14.	WORKNO	working knowledge of industrial designers
15.	FUNCT	functions of industrial designers
16.	**IDESKI**	**skills industrial designers need**
17.	**IDEWOR**	**working knowledge industrial designers need**
18.	**IDEFUN**	**functions industrial designers need**

GROUP 2 : **ENGINEERS AND MARKETERS**

1.	TYPE	type of company
2.	ORGANI	organisation
3.	*NOSTAF*	*no. of staff employed*
4.	*STAFIN*	*involvement in the projects*
5.	*RESP*	*person who is responsible for product development*
6.	*LEVDES*	*design locations*
7.	IDFUNC	functions of industrial design
8.	**IDEROLE**	**the role of industrial designers**
9.	IDECONT	contributions of industrial designers
10.	ARRANG	industrial design services arrangements
11.	*RELATION*	*relationship of design and manufacture*
12.	*FACTSUC*	*factors of a successful new product*
13.	INTERF	design/manufacture interface considerations
14.	SALEFACT	factors which influenced sale
15.	PROSTRA	new product strategies
16.	DESSTRA	design strategy
17.	**IDESKI**	**skills industrial designers need**
18.	**IDEWOR**	**working knowledge industrial designers need**
19.	**IDEFUN**	**functions industrial designers need**

GROUP 3 : **INDUSTRIAL DESIGN CONSULTANTS**

1.	TEAM	people in the design team
2.	STAGE	stage at which design considerations are brought in
3.	IDETASK	tasks of industrial designers
4.	CRITER	criteria used by clients in selecting design consultants
5.	DESCONS	design considerations
6.	**IDEROLE**	**the role of industrial designers**
7.	IDECONT	contributions of industrial designers
8.	**IDESKI**	**skills industrial designers need**
9.	**IDEWOR**	**working knowledge industrial designers need**
10.	**IDEFUN**	**functions industrial designers need**

TABLE 6.2 : SINGLE, *COMBINED* AND COMMON VARIABLES

SINGLE VARIABLE

INDUSTRIAL DESIGNERS

1.	YEAR	years involved in industrial design
2.	NOPROJ	no. of projects involved in
3.	STAGE	stage at which industrial designers are involved
4.	NPDETER	factors which determined the design of the new products
5.	DESCONS	design considerations
6.	SKILL	skills of industrial designers
7.	WORKNO	working knowledge of industrial designers
8.	FUNCT	functions of industrial designers

ENGINEERS AND MARKETERS

1.	TYPE	type of company
2.	ORGANI	organisation
3.	IDFUNC	functions of industrial design
4.	IDECONT	contributions of industrial designers
5.	ARRANG	industrial design services arrangements
6.	INTERF	design/manufacture interface considerations
7.	SALEFACT	factors which influenced sale
8.	PROSTRA	new product strategies
9.	DESSTRA	design strategy

INDUSTRIAL DESIGN CONSULTANTS

1.	TEAM	people in the design team
2.	STAGE	stage at which design considerations are brought in
3.	IDETASK	tasks of industrial designers
4.	CRITER	criteria used by clients in selecting design consultants
5.	DESCONS	design considerations
6.	IDECONT	contributions of industrial designers

COMBINED VARIABLES
(INDUSTRIAL DESIGNERS + ENGINEERS AND MARKETERS)

1.	*NOSTAF*	*no. of staff employed*
2.	*STAFIN*	*involvement in the projects*
3.	*LEVDES*	*design locations*
4.	*RESP*	*person who is responsible for product development*
5.	*RELATION*	*relationship of design and manufacture*
6.	*FACTSUC*	*factors of a successful new product*

COMMON VARIABLES
(INDUSTRIAL DESIGNERS + ENGINEERS AND MARKETERS + INDUSTRIAL DESIGN CONSULTANTS)

1.	**IDEROLE**	**the role of industrial designers**
2.	**IDESKI**	**skills industrial designers need**
3.	**IDEWOR**	**working knowledge industrial designers need**
4.	**IDEFUN**	**functions industrial designers need**

6.4 Findings from the Questionnaire Survey

To fulfil the objective of this study, data were gathered from three group of respondents: industrial designers, marketers and engineers, and design consultants. The following sections discuss the key findings of the Malaysian and UK studies based on the results of the statistical analyses (descriptive and inferential) using single, *combined,* and **common** variables, discussed above. A full report of the findings of the Questionnaire Survey is presented in **Appendix 4**.

6.4.1 Key Findings of Malaysian Respondents

Based on statistical results, the key findings of Malaysia respondents can be summarised as follows:

1. The involvement of Malaysian industrial designers in the process of new product development in Malaysian SMIs was found to be higher than the other key players involved in the process, (engineers and marketers). Most industrial designers were found to be involved from the beginning of the design project (first stage) through to the commercialisation stage. The majority of Malaysian industrial designers have between two to four years of experience in industrial/product design and have been involved in more than fifteen projects.

2. Products are designed and developed by a team of qualified engineering and industrial designers, and in the most cases, industrial designers see products through to commercialisation. This can lead to successful NPD for Malaysian SMIs.

3. Most industrial designers in Malaysia are employed by the companies as permanent staff in Research and Development (R&D) departments. There are also companies which employed engineers with knowledge of industrial design.

4. The design team in Malaysian SMIs comprise of industrial designers and engineers (mechanical, electrical and production). However, in terms of their employment as a whole, it was found that the ratio of industrial designers to engineers and marketers was at 2: 5 : 3. Thus for every five engineers employed in companies, there are two industrial designers and three marketers.

5. Industrial designers in Malaysian SMIs are mostly skilled in creating new design concepts and representing design solutions. They have a working knowledge of relevant computer techniques and presentation techniques as well as knowledge of ergonomics and current market trends. Their function is to think creatively, work successfully to deadlines and to re-design for improvement.

6. In Malaysia, the design function is mostly located in top management. The Managing Director is the person responsible for managing product development.

7. The design of new products is determined by customer pull and management. Factors such as sale price and appearance/shape of the products are very important for most Malaysian companies in order to help them increase their sales against those of their competitors. It was also found that most of the Malaysian SMIs introduce their new products in response to competitive pressures and at the same time try to protect their existing products through a process of innovation. They follow 'improvement' (incremental innovation leading to minor changes in the existing product) as a type of design strategy, while 'functionality' is the most important design factor to be considered in the design of new products. When making product design decisions, most of the companies in Malaysia were found to rely on the existing manufacturing processes and the suitability of existing manufacturing processes as the design/manufacture interface considerations.

8. Industrial designers in Malaysia are regarded by engineers, marketers and industrial design consultants as contributing to their companies by improving the quality of consumer goods, making products easier to use as well as increasing packaging quality and sales appeal. In addition, the function of industrial design to the company, according to engineers and marketers are to re-design for improvement, create a new product concept and represent alternative design solutions. In terms of the nature of the work/task of the industrial designer in designing new products from the perspective of industrial design consultants, creating a new product concept, visualising the product concept as well as final design selection are regarded as the most important work/tasks.

9. In Malaysia, the role of the industrial designer in the process of NPD is mainly that of an aesthetic specialist, working in consultation with other specialists and also in project co-ordination.

10. In Malaysia, the most preferred industrial designer skills were found to be able to create new design concepts and represent alternative design solutions. Knowledge of presentation techniques, relevant computer techniques, ergonomics and also current market trends were also seen as important to working knowledge. In terms of function, they are expected to create new product concepts, to think creatively and to re-design for improvement.

6.4.2 Key Findings of UK Respondents

Based on statistical results, the key findings of UK respondents can be summarised as follows:

1. The involvement of UK industrial designers in the process of new product development in UK industry was found to be higher than the other players. Most of them were found to be involved from the beginning of the design project

(first stage) to the commercialisation stage. The majority of UK industrial designers have more than fifteen years of experience in industrial/product design and have been involved in more than fifteen projects.

2. In the UK, close interaction with customers/users in the design and development stages and the replacement of old products are the factors which may lead to a successful NPD.

3. Industrial designers are employed by companies as full time staff within Design/Industrial Design Departments or in R&D Departments. Some companies employed engineers with a knowledge of industrial design. Some companies, however, co-opted professional industrial designer into the design team for the period of the project.

4. Most of the design teams in UK companies comprise of industrial designers, engineers (mechanical, electrical and production), ergonomists and market analysts. In terms of employment, it was found that the ratio of industrial designers to engineers and marketers was at 2: 6 : 2. Thus for every six engineers employed in companies, there are two industrial designers and two marketers were employed.

5. Industrial designers in UK companies are mostly skilled in presenting work visually, creating new design concepts and representing design solutions. They have a working knowledge of presentation techniques, relevant computer techniques and knowledge of ergonomics. Collaboration within a design team and thinking creatively are their main functions.

6. In the UK, the design function is located at top management and the R&D Director was personally responsible for managing product development.

7. The design of new products is determined by customer pull. Factors such as sale price and performance in the operation of products are very important for most of the UK companies so as to help them increase their sales against those of their competitors. It was also found that most of the UK companies introduced their new products into specific market-sectors. Most of the companies follow 'major innovation' (innovation leading to major changes in, or more addition to an existing product) as a design strategy while 'safety' and 'aesthetic value' were factors considered in the design of new products. When making product design decisions, most of the companies in the UK attempt to reduce the number of components and make use of the choice of materials (e.g. strength of materials) as key design/manufacture interface considerations.

8. Industrial designers in the UK are regarded by engineers, marketers and industrial design consultants as contributing to their company by improving the quality of consumer goods. In addition, the function of industrial design within the company, (according to engineers and marketers), is to re-design for improvement, create a new product concept and represent alternative design solutions. In terms of the nature of the work/task of the industrial designer in designing new products from the perspective of industrial design consultants, creating a new product concept, visualising the product concept and re-designing for improvement have been regarded as the most important work/task by them.

9. In the UK, the role of the industrial designer in the process of NPD is mainly that of aesthetic specialist working in consultation with other specialists.

10. In the UK, the most preferred skills industrial designers should acquire were found to be the ability to create new design concepts and represent alternative design solutions. In terms of working knowledge, industrial designers are seen to need to equip themselves with some knowledge of presentation techniques, relevant computer techniques and general technical knowledge. In terms of

functions, they are expected to work successfully to deadlines, to think creatively and to formulate new product concepts.

6.4.3 Comparative Studies of Malaysia and the UK from the Questionnaire Survey Findings

From the descriptive statistics of the Malaysian and UK survey samples, the researcher was able to extract some significant findings concerning the role of industrial designers in the process of NPD in both countries. These findings have enabled the researcher to identify similarities and differences between the UK and Malaysian NPD and to contrast them with existing literature sources.

6.4.3.1 The Differences Between the Malaysian and UK Respondents

Based on statistical results, the differences between the Malaysian and UK respondents are summarised below in the same order as the structure of the original questionnaire. Corroboratory evidence from existing literature sources are also given in support of the empirical findings.

1. The first difference found concerns the involvement of industrial designers in the process of NPD in both countries. The results show that the majority of Malaysian industrial/product design have between 2-4 years of experience in industrial/product design while most UK industrial designers have more than 15 years. This is due to the fact that the industrial design profession is more recent to Malaysia than the UK (a formal education programme on Art and Design (Industrial Design) was only introduced in Malaysia in 1967). In fact, the contribution of industrial design to NPD in Malaysia has only been observed in the last twelve years when industrial design became involved in two major

projects (the image of the National trains, and the design of the Malaysian national car, Proton) [see Salleh 1991].

By contrast, in the past, the UK has had an international reputation not only as a consumer of new technologies, but also as an inventor of them. According to Cooper et al (1995), a previous study by Japan's Ministry of Trade and Industry (MITI) found that not less than 55% of all the commercially important innovations made in the world since the war originated in Britain.

2. The factors leading to a successful new product were also different in both nations. In Malaysia, new products are designed and developed by a team of qualified engineering and industrial designers with the latter often seeing the product through to commercialisation. In the UK however, a close interaction with customers/users in design and development stages and the replacement of old products are the main factors which may lead to a successful new product. Griffin et al (1995), support this view since on average, approximately 70% of all sales derive from repeat purchase, a defensive strategy that focuses on keeping current customer as loyal purchasers of the company's goods is thus required. Similarly, Ulrich and Eppinger (1995) advocated that customers are particularly useful sources of data for the development of new products. Not only can they articulate their own needs, (since they have had to come to terms with any existing product inadequacies) but may have already invented their own solutions to these problems. By interacting with customers, the design team may thus be able to identify customer needs and this can help the design team in developing new products which meet these requirements.

3. A significance difference was also found in terms of the people who comprise the design team. Design teams in Malaysian SMIs comprised of just two disciplines: industrial designers and engineers (mechanical, electrical and production), whilst in UK, the design team comprised of people from a variety

of disciplines such as industrial designers, engineers (mechanical, electrical and production), ergonomists and market analysts.

In Malaysia, efforts to integrate industrial designers with other team members in the process of NPD is neglected in many industries. The traditional NPD process has been essentially linear and segmented with clear breaks between respective phases of the process. The most critical breaks are the gap between industrial design and engineering, and also between industrial design and marketing. Industrial designers and other members in NPD teams are thus seen as separate entities with clearly defined boundaries between them and other functions. This is supported by Salleh (1996) who indicates that the in-house industrial designers are mostly 'back-room boys' and are often very isolated. Most companies are wary of publicising their designers so as not to be victims of competitors attentions.

The value of an integrated NPD, (to employ a mix of professionals in the design and development of new products) is well documented. Rawsthorn (1991 pg.148) suggests that 'value lies in the in house design team, a group of designers, employed directly by a company to work closely with people from other disciplines such as production planning, sales and engineering. This is the integrated concept of industrial design which is widely practised in Italy, German and Japan'. For a successful NPD team, Fairhead (1991) also promotes multi disciplines within one team. With a variety of members included, most other functional linkages are covered and it provides sufficient overlapping of competence within the group to ensure internal checks, balances and integration. In this way the key business objective to produce profits may be realised (Oakley 1984).

4. The findings also show that most of the industrial designers in Malaysia were employed by companies as permanent staff within a R&D department. In the

UK this is in contrast since most of the industrial designers work within a Design/Industrial Design Department *or* within a R&D department.

The government of Malaysia has always been supportive of R&D and has encouraged companies to set-up their own R&D. The government has given tax concessions and financial incentives to companies that have done so and has continuously increased its own allocation for R&D activities. The Malaysian government, for example, introduced 'The Industrial Technical Assistance Fund' (ITAF) and 'The Intensification of Research in Priority Areas (IRPA) with the aim of improving the efficiency and competitiveness of local SMIs particularly in the areas of product design and the development of consumer products [see 3.3.4 pp.54-58].

In addition, the empirical findings here have also shown that most of the UK companies co-opted professional industrial designers into the design team for the period of the project. In Malaysian industry, this has not occurred. In Britain, the DTI in association with the Design Council has (since 1992) introduced the 'Support for Design' scheme which aims to encourage UK SMEs to employ a professional design consultant to work on a project involving product, packaging or graphic design (Walsh et al 1988). Under this scheme, outside design consultants are introduced to companies to assist them in product design and development projects, and sometimes also with the process development as well. With such initiatives, the UK has one of the strongest design consultancy industries in the world (Mc Alhone 1987). Interestingly, Roy (1987) discovered that although 90% of the UK firms surveyed employed in-house design staff as many as three-quarters of them *also* used design consultants. By contrast, there are only a few design consultants directly involved in product design and development in Malaysia, therefore most of the SMIs have to rely on their own in-house designers [see Isa 1995].

5. Although the statistical analysis results of the Malaysian and UK survey samples have shown some similarities in the skills and working knowledge of the industrial designers in both countries, there were some differences in terms of the functions of industrial designers in the respective processes of NPD. In Malaysia most industrial designers function in order to provide creative thinking and re-designing for improvement, while in the UK industrial designers function in order to collaborate, i.e. to act as process communicators or facilitators in a design team as well as to provide creative thinking.

   Re-designing for improvement is not something new in Malaysian SMIs. Salleh (1996 pg.2) suggests that, 'in Malaysia, we do things differently, we 'adopt' and 'adapt' the technology'. This adoption process comes with ready designed parts and components and thus there is little need for an industrial designer to contribute. He sees the only area where the industrial design could be useful in Malaysia as the 'cosmetic trim'.

6. Interestingly, the findings have shown that in both Malaysia and the UK, the design function is located at the top of the management process. However in the UK it is the R&D Director who is usually responsible for managing product development while in Malaysia it was the Managing Director.

   According to Oakley (1984), effective practice in a company means recognising the importance of design to business success and locating responsibility for managing design at the top management level. By doing so a logical approach which involves the definition of design objectives, design policies and design strategies is adopted. Also top management can encourage other people throughout the organisation to act as leaders by dissemination of company principles and purposes. Using this form of guideline, companies will be able to produce better products (Fairhead 1987). As well as promoting company philosophy and culture, top management is able to build a strong and flexible 'design culture' within a company by taking a lead in design issues.

7. In Malaysia, the research found that sale price and appearance/shape of products are the most important factors to companies in order to help *increase* their sales against those of their competitors in the market. In Malaysia, the general public awareness of good design has improved dramatically in the past ten to fifteen years. Design changes have affected individual daily lives and industry now recognises the need for good design in order to sell a product. Although tastes are more sophisticated and good design is appreciated, products are purchased based on price (Salleh 1991). Similarly, according to Bajuri and Bidin (1996) in Malaysia, it is very common for consumers to purchase imitation branded products, not only because they are very cheap, but also because such products resemble the 'original'. Malaysian consumers often consciously judge a product by its appearance and this explain why a number of companies in Malaysia are becoming aware of the benefits of good appearance/ shape in terms of customer appeal. As explained by Bajuri (1988) a common phrase often used by most of manufacturers is 'orang-orang Malaysia suka barang cantik' (Malaysians like beautiful things). According to most manufacturers, this has for many years been a 'magical' and profitable slogan in Malaysian manufacturing activities. This argument not withstanding Ali (1991) shows that Malaysian consumers are now more conscious of quality than ever before and are willing to pay for products that are not only superior aesthetically, but that also meet the highest specifications.

In the UK factors such as sale price and operational performance of products were most favoured by the majority of companies. According to a survey report by Neale and Associates Ltd (1988), most UK companies involved in the design and development of new products give a high rating to design for performance and a fairly high rating to design for cost. According to this report, the cost of products was genuinely unimportant to some companies because they were sold purely on performance, and by maintaining a performance advantage over the competition a majority of the market was guaranteed. The report by the National

Economic Development Office (NEDO) which has been carried out by Corfield (1979) also confirmed performance and price as fundamental to product success. It was also found that most UK companies introduced their new products into specific market-sectors while in Malaysia, most companies introduced their new products in response to competitive pressure relating to product price and moreover to protect their existing products.

8. Most Malaysian SMIs follow 'improvement' (incremental innovation leading to minor changes in the existing product) as the design strategy and 'functionality' as the design consideration factor in the design of new product. Studies by Bajuri and Bidin (1996) have shown that even though the words 'barang buatan Malaysia' (Malaysian made products) are used, most locally designed items are based on foreign standards via reference to magazines and catalogues. The absence of copyright laws or patents in the country has it seems benefited these manufacturers. The quality of the products is also less important to Malaysians since most consumers prefer to purchase imitation products as they 'function' like the original and usually much cheaper. However, according to Bajuri and Bidin (1996) the quality of such products has often been compromised since there has been little control over design. The situation has been further aggravated due to demand has exceeding supply and limited number of channels available for the voicing of complaints.

Most UK companies however follow 'major innovation' (innovation leading to major changes in, or more addition to an existing product) as the design strategy while 'safety' and 'aesthetic value' are the design factors considered when designing new products. According to Ughanwa (1986), the majority of commercially successful firms tend to pursue 'major innovation' and 'improvement' strategies. This offers designers the opportunity to make changes to an existing product to suit the varying needs and wants of consumers because without 'major innovation', series of minor changes could not occur.

9. When taking product design decisions, most of the companies in Malaysia rely on the existing manufacturing processes and the suitability of existing manufacturing processes (e.g. for design purpose). However, in the UK most companies tend to reduce the number of components and make use of choice of materials (e.g. strength of materials) as the design/manufacture interface considerations.

In Malaysia, most SMIs have to rely on existing or available manufacturing processes since most companies have limited capital production facilities and design capabilities. As a result, some SMIs produce poor designs, and are dependent on local and regional markets for their major. Most of these products are either locally assembled from parts designed and manufactured elsewhere, or are produced locally under licence agreements. The number of products designed and produced locally are much more limited and use very low technology despite the importance of industrial design in ensuring the marketability of manufactured goods having been long recognised by many Malaysian companies (Ali 1991). A study by Wah (1976) [see Bajuri and Bidin 1996] has shown that the designs of new product in Malaysia are 'ad hoc' in order to meet some 'evident' or 'anticipated' demand. For example, most of the products manufactured in Malaysia are based on Third World country survey reports. Due to report inaccuracies, many unnecessary and inappropriate products have entered the market place.

6.4.3.2 The Similarities Between the Malaysian and UK Respondents

Based on statistical results, the similarities of the Malaysian and UK respondents can be summarised as follows;

1. The involvement of industrial designers in the process of NPD in both countries was found to be higher than other key players involved in the process (engineers

and marketers). It was also found that industrial designers are involved from the beginning of the design project (first stage) to the commercialisation stage in both nations.

2. It was found that industrial designers in both countries are skilled in creating new design concepts and representing design solutions. Similarities were also found for the working knowledge variable, where both Malaysian and UK industrial designers found to have a working knowledge of presentation techniques, relevant computer techniques and the knowledge of ergonomics.

3. The design function is located at the top level of company management in both countries.

4. The design of new products is determined by customer pull in both countries

5. The findings from the two countries also showed that engineers and marketers preferred industrial designers to contribute to their company in order to improve the quality of consumer goods. In addition, engineers and marketers from both countries indicate that the functions of industrial design within their company are to re-design for improvement, create new product concept and represent alternative design solutions. In terms of the nature of the work/task of the industrial designer in designing new products, from the perspective of the industrial design consultants, creating a new product concept and visualising the product concept are among the highly preferred items given by the respondents in both countries.

6. The findings from the two countries showed that the role of industrial designers in the process of NPD is mainly that of an aesthetic specialist working in consultation with other specialists.

7. Finally, the statistical analysis results from both countries clearly show that industrial designers viewed the most preferred skills that they should acquire to be ; to create new design concepts and represent alternative design solutions. In terms of working knowledge, it was suggested industrial designers should equip themselves with knowledge of presentation techniques and relevant computer skills.

6.5 Summary and Conclusions

Descriptive and inferential statistics have been used to analyse data from Malaysian and UK respondents. The data was analysed through frequencies, mean, cross-tabulation and chi-square test. From these analyses, the researcher was able to gain information about industrial designers including their role, skills, working knowledge and function with regard to the process of NPD both in Malaysia and the UK.

The results from the Malaysian revealed the role of industrial designers in improving the process of NPD in Malaysian SMIs. Significant issues emerged from this study and provided the researcher with valuable information needed to pursue with the qualitative study. Results from the UK study revealed the role of industrial designers in improving the process of NPD in UK industry. These findings were used as a basis for explaining how UK industrial designers fulfil their role in the process of NPD in this country.

In order to examine role of industrial designers in the process of NPD in both countries, the results from the Malaysian and UK studies were combined and compared. The findings from comparative studies of Malaysia and the UK enabled the researcher to identify the similarities and differences that exist between the two countries in terms of NPD.

From the comparative analysis, the researcher found that there were similarities and differences existing between Malaysia and the UK respondents in terms of their choice or preference of variables. The researcher believes that these results reflect the true situation within these two countries.

Although findings from the statistical analysis satisfied the objectives of the questionnaire survey and enabled the researcher to uncover details of the role played by the industrial designer in the process of NPD both in Malaysia and the UK, that by itself was not seen sufficient. The similarities and differences that were found to exist between Malaysia and the UK in the quantitative findings raised a number of key questions that required a more qualitative approach (through case studies). To do this, direct reference to Malaysian product development managers using best practice product development were examined as detailed case study examples.

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CHAPTER SEVEN

DATA COLLECTION : CASE STUDIES

The purpose of this chapter is to describe the case studies data collection at the eight organisations studied in Malaysia and the UK. This chapter has been organised as follows: the introduction (section 7.1) is followed by the discussion of the use of multiple-case study method in section 7.2. Section 7.3 discusses the criteria of selecting Malaysian and UK companies for case studies. The reasons for choosing SMIs, consumer durable products as the sector and UK as a comparison are discussed in sections 7.4-7.6. The focus of study is discussed in section 7.7 and section 7.8 assesses the data collection. This chapter ends with a summary and conclusions (section 7.9).

7.1 Introduction

Phase Two of this research provided findings through questionnaire surveys. The statistical results from these surveys gave the researcher enough grounding to develop the case study phase (Stage Three). As already mentioned, since the use of statistical analysis in Phase Two was deemed insufficient by itself to satisfy the aims of the study, a more thorough and specific examination of Malaysian and UK cases was made. The main aim of the case studies was directly related to the second aim of this research, that is to identify the characteristics that could be taken as a basis for explaining the success of NPD. These case studies also helped to validate the quantitative findings in identifying the role of the industrial designer played in the process of NPD both in Malaysia SMIs and UK SMEs.

A preliminary explanation of the case study method has been presented in Chapter Four, thus here, an extended discussion of the case study approach focusing on multiple-case studies is given in order to detail the suitability of this method in the context of the current research.

7.2 The Use of Multiple-Case Studies Method

The use of case study research can be based on single or multiple-case studies (Stake 1995, Yin 1994 and Hakim 1987). In the present study, multiple-case studies involving eight cases, (six companies and two design consultants) in Malaysia and UK were adopted. A multiple-case design approach was chosen since it enables comparative or cross-case analysis to be conducted between organisations, i.e., Malaysian SMIs with UK SMEs.

The case study procedure was piloted first to ensure its effectiveness. The refined procedure was then replicated throughout different cases. As suggested by Yin (1993), multiple case studies assessing two or more cases within the same study can replicate each other-either as exact (direct) replications or predictably different (systematic) replications. This enables the researcher to compare and confirm the results of each case.

> 'Multiple-case studies should follow a replication, not sampling logic. This means that two or more cases should be included within the same study precisely because the investigator predicts that similar results (replications) will be found. If such replications are indeed found for several cases, you can have more confidence in the overall results. The development of consistent findings, or multiple cases and even multiple-studies, can then be considered a very robust finding'.
> - Yin (1993 pg.34)

In addition, Hakim (1987) emphasises that the use of multiple case study techniques allow data collected to be presented as more rounded and holistic, thus making the case study one of the more powerful research designs.

7.3 Criteria of Selecting Malaysia and UK Companies

The process of selecting and identifying suitable companies (including design consultants) for the case studies in Malaysia and UK was based on the following criteria:-

7.3.1 Size of Companies - Small and Medium

The focus of study is NPD in Malaysian and UK small and medium sized industries (SMIs/SMEs). Various criteria may be used to distinguish between different sizes of companies within an industry such as employment, fixed assets, investment and sales. In Malaysia, different government agencies have their own definitions of SMI. For example, the Co-ordinating Council for Development of SMI (CCDSI) defines SMIs as an organisation with fixed assets of less than RM250,000. or in case of companies, with shareholders' funds not exceeding RM250,000. This definition is in contrast to the Small Scale Industry Section of the Ministry of Trade and Industry who define small scale-industry as one which has shareholders' funds or assets not exceeding RM500,000 and a medium-scale industry as one with funds or assets between RM500.00 and RM2.5million (Lim 1992). In the UK, the European Commission (EC) considers the term SMI or SME (small and medium sized enterprise) to be subdivided into three components: micro-enterprises, those with between zero and nine employees; small enterprises, those with ten to ninety nine employees and medium enterprises, those with hundred to four hundred and ninety nine employees (Storey 1994).

Since there is no single definition of an SMI/SME, a combination of the CCDSI definition above and the Small Scale Industry Section in the Ministry of Trade and Industry Malaysia are used for the Malaysian study. The UK cases utilise the European Commission definition. Furthermore, despite the use of these definitions, some problems do arise with size as a proxy for classification. This is particularly so where companies are subsidiaries of larger groups e.g. Sharp Electronics (Malaysia)

Sdn. Bhd. and Sharp Corporation of Japan, Electrolux White Goods Spennymoor and Electrolux Group of Sweden.

7.3.2 Design Leadership.

The case studies selected from Malaysia and UK SMEs were also based on notable, successful design projects and the general perception and reputation of the company for design leadership, particularly within the consumer durable product market sector. For this study, companies and design consultants were considered 'successful' where they had demonstrated commercial success and had a high reputation for good product development. The selection process was also based on other related recognition and awards given to companies and design consultants.

7.3.3 Market Sector

Three successful Malaysian SMIs and three UK SMEs, as well as one successful design consultant in each country were selected for the case study. In order to give a more comprehensive overview of the case studies, the research focused on the consumer durable product market sector. The cases were thus a balanced presentation of the three market sectors (domestic electrical appliances, office furniture and plastic products). The selection of companies also attempted to give special emphasis to SMIs with at least five years experience, since new firms (less than five years), tend to lack trade references or track record in order to gauge credibility.

7.3.4 Permission and Willingness

Case studies were also selected based on the ability to gain access to organisations. The cases selected were those where entry to the companies was possible and where respondents involved were willing to assist. As Stake (1995 pg.4) suggests 'we need to pick cases which are easy to get to and hospitable to our inquiry, perhaps for

which a prospective informant can be identified and with actors (the people studied) willing to comment on certain draft materials'. Marshall and Rossman (1995 pg.51) support this by suggesting that where 'entry is possible, there is a high probability that a rich mix of the processes, people, programs, interactions, and structures of interest are present'. In this way the researcher is likely to be able to build trusting relations with the participants in the study and data quality and credibility of the study are reasonably assured' (also Marshall and Rossman 1995).

7.4 Reasons for Choosing SMIs

The focus on SMIs was made because at present the government of Malaysia has given priority to SMIs to help boost industrial growth and the national economy. The Malaysian government has identified SMIs as one of the most important sectors in need of development and strengthening in order to ensure the goals of Vision 2020. This has manifested itself in a wide range of government incentives such as ITAF and IRPA. In this respect, the government recognise that SMIs capabilities and competencies in managing resources, technology and quality need to be upgraded

7.5 Reasons for Choosing Consumer Durable Products

In the present study, the sample was selected from three major areas of consumer durable products: domestic electrical appliances, office furniture and plastic products. These were selected not only since they offer a rich source of data but because they are closer in nature to industrial design than engineering design. More specifically each product sector was chosen because:

1. *Domestic Electrical Appliances*

   Because the electrical and electronic industry is the largest contributor to employment in the manufacturing sector, it was given a priority status by the Malaysian government in the initiatives outlined in 7.4. Not only was the

electrical and electronics sector the leading contributor to foreign technology transfer agreements between 1970-1989 accounting for more than 20% (Luk 1996) but was also the leading sector for the Vendor Development Programme (VDP) between 1988 - 1994 (MITI 1995).

2. *Office Furniture*

Since the export of furniture reached an estimated RM1.5 billion (1994), exceeding the target of RM400 million set for 1997 (NST 8th. March 1995) and since a greater emphasis has been placed on the furniture industry under the Malaysian Industrial Master Plan launched in 1986. Furniture products have been designated as priority products since they have a high value added product (The Star 16th. Feb. 1994). For this reason the sector was deemed appropriate as a focus for this study.

3. *Plastic Products (houseware products).*

'Plastic' manufacturing projects have been encouraged by the Malaysian Government with some sixty three projects involving RM640.2 million invested in 1994. This is an increase of 184% and shows how dynamic the plastic product manufacturing sector is in Malaysia. It was chosen as a case study example in this study because it reflects modern Malaysian industrial activity.

In Malaysia, consumer durable products have been prioritised as a key area of growth for Malaysian SMIs. In view of the government's efforts to encourage the growth of SMIs throughout Malaysia, the researcher felt that the selection of consumer durable products was appropriate and in line with government policy. Strong external demand and expanded domestic production capacity is also expected from this area. Most of the industries involved in this area have increased their production efficiency and have improved their product quality through better organisation. Consumer durable products have also been identified as a priority area in the Sixth Malaysian Plan (MIMOS 1996).

As well as this, the participation of the Malaysian industrial designer in designing consumer products has been higher than in other areas. A survey by Mujir (1990) suggested that of one hundred and eighty six industrial designers, some 46% were associated with the furniture industry, 32% in product and plastic industries and a further 20% in the transportation industry.

7.6 Choice of UK as Comparison

The approach adopted in this study was to investigate the role of the industrial designer in the NPD process amongst selected Malaysian SMIs and to contrast this with state of the art theoretical knowledge and notable aspects of best practice in UK based companies. The UK was chosen for comparison because there is a considerable body of literature of best practice relating to product development, which recognises the importance of design to business success. As well as this on a global scale, the UK trains more industrial designers than any other country and the British government encourages industrial design consultants to regard themselves not as remote professionals but as an integral part of industry (Allen 1993).

Moreover Cooper et al (1995) indicates that the UK has one of the strongest design consultancy industries in the world with world class designers and has had an international reputation as an innovator of new products since the second world war (as many as 55% of all the commercially important innovations made globally since the war originated in Britain).

7.7 Focus of Study

The case studies focus on four important issues derived from the concept of Business Process Analysis (BPA) research, as suggested by Champy (1995) in 'Reengineering the Corporation'. These issues are:

- purpose
- culture
- process and performance
- people

'Reengineering the Corporation' was written with the purpose of improving business performance by showing managers how to revolutionise their key operational processes, i.e. product development. Using a concept similar to BPA, Darnton and Darnton (1997) believe that there are three elements that make up an organisation: the product or service, human factors and culture. These elements are in close agreement to Champy's findings.

This study is not concerned with reengineering organisations or redesigning business process, but is concerned with the elements and principles of best practice in the NPD process. However, reengineering, redesigning and principles of best practice have one important common feature: to achieve a positive outcome for the organisation. Thus, the researcher believes that the principal of BPA using the four key issues suggested by Champy is appropriate to adopt in the case study research.

According to Champy (1995), '*purpose*' has arisen as an important concept in the last few years for three reasons; Firstly, changes are applicable to all industries all over the world. Such changes oblige top management to ask themselves whether what they are doing has value, or whether they should do something different. Secondly, continuous change in the market place means that continuous change inside the corporation is vital. Therefore, managers need to be clear about the purpose of their business. Thirdly 'purpose' comes from the need and tasks of leadership. Champy has shown that, until recently, it was believed that only top management needed to know a corporation's business purposes, whereas today, all employees need to know details of the business. Therefore, top management need to define and express their business clearly. Champy indicates managers need to ask; 'what are we in business for'?, 'what are processes for'? and other questions about

the product, tasks and teams on a continual basis. In this respect the word 'purpose' is a better term to consider than a (company) 'mission'.

The second issue is '*culture*'. Although many cultural variables such as learned beliefs, values, habits and behaviour may come from a definition of culture, the attention in this study is on a *company's* culture. Champy states that a company culture 'cannot be proclaimed or easily manipulated' as it consists of the deeply shared values and beliefs of the people, and is displayed in how the company and its people behave. The issue of culture is thus important as it enables managers to develop a set of principles of desired behaviour. Since managers cannot force company culture/principles on their staff, the managers themselves must first change then lead the way as a 'model' of behaviour.

The third issue regards '*process and performance*'. A process is 'a set of linked activities that take an input, transform it, and create an output. Ideally, the transformation that occurs in a process should add value to the input and create an output that is more useful to and effective for the recipient' (Carr and Johansson 1995 pg.9). Process can also be some kind of activity within an organisation where people work together to achieve some desired outcome (Ould 1995). For example, companies who design new products may have a number of processes that it carries out in order to manufacture, market and sell a product profitably in the market place. Ould (1995 pg.1) suggests;

> 'A process involves activity: people and/or machines do things. A process also generally involves more than one person or machine: a process is about groups; it concerns collaborative activity. And a process has a goal: it is intended to achieve something'

Process can be divided into three categories; core, support and management. 'Core' processes concentrate on satisfying external customers (or 'stakeholders') and in general directly add value that can be perceived by the customer of the business.

'Core' processes respond to a customer request and generate customer satisfaction. 'Support' processes concentrate on satisfying internal customers, and often add value to the customer indirectly by supporting core processes by setting up a new project area or providing requested information. Furthermore, they are activities carried out on a continuing basis, providing an environment for the business. Finally, 'management' processes, concern themselves with managing the flow of cases through the 'core' processes or the 'support' processes, that is they concern themselves with planning at the business level (Ould, 1995 pg.185). Since the current study concentrates primarily on the process of NPD, it was decided to focus more on the 'core' business process in the case study research than on 'support' or 'management' processes. In terms of specific issues that need to be raised to address 'process and performance', Champy (1995) suggests acquisition of the correct process and obtaining staff performance levels as important.

Finally, the issue of '*people*' has also been identified as important in contributing to the success of NPD. Champy (1995) shows that most companies need to hire people to work with them so that they can be part of a community of shared inspirations and ideas. He believes that performance of a specific task is not enough, because today, companies need people who can add value to every process they touch, and who bring value to their companies as a whole. Champy indicates questions surrounding the suitability of staff to the corporation and how they may be hired as being essential to the human resource issue. For further discussion and consideration of Champy's work the reader is directed to Champy (1995-*Reengineering the Corporation*).

As well as attempting to find answers to these issues, the case studies also aimed to gather as much information about the NPD as possible, to give greater depth to the understanding and give strength to the entire research project.

7.8 Data Collection

7.8.1 Malaysia Case Studies

7.8.1.1 Initial Visit to Malaysian Companies

The research began by obtaining sources from selected SMIs in Malaysia. Before travelling to Malaysia, contacts were made through several letters, faxes and e-mails to explain the purpose of the research and to request SMIs co-operation. In order to obtain more information from SMIs in Malaysia, close contacts were established and several informal discussions were held with informants during the researcher's field work in Malaysia. The visits to Malaysian SMIs were planned for the three month period from April-June 1997 and during this period, the researcher carried out case study research by utilising interviews and direct observations. At this stage, it is important to mention that in the Malaysian cultural setting, it is more difficult to obtain information or to gain an interview with companies than it is in the UK. This is due to the fact that product design activities are considered to be highly sensitive and secretive as Salleh (1996 pg.4) says 'in Malaysia design development is usually very confidential'. Most of the companies in Malaysia will not respond to a request for information if they feel it is commercially sensitive, confidential or of little benefit to their businesses. Such problems of access were previously experienced by Bajuri (1988) who mentioned that 'while the letter from the supervisor that authorises the research was rather helpful in most instances, especially in bridging bureaucracy, there were times when officers just refused to accept the authoritativeness of the letter by saying that anyone could produce it'. Bajuri also showed that most Malaysian companies only provided information on the items in the showrooms, and not on the activities within their manufacturing processes itself. Therefore, the researcher believes that the initial stage of approaching firms was very important to this study to establish contacts, explain the purpose of the research and create a product researcher-respondent relationship.

The first stage of case studies selected a few well known Malaysian SMIs in product development. The initial selection of companies to be contacted for the case studies was based on a directory found in the questionnaire survey responses. Based on this record, ten companies and three design consultancies were selected and contacted for case studies. The companies and design consultants which were initially contacted were:

	Name of Company/Consultants	*Product*
1	Malpro Industri Sdn Bhd	Office Furniture
2	The Merryfair Chair System Sdn Bhd	Office Furniture
3	BFS R&D (M) Sdn Bhd	Office Furniture
4	Guthrie Furniture Sdn Bhd	Office Furniture
5	Sapura Research Sdn Bhd	Domestic Electrical Appliances
6	Sharp Electronics (M) Sdn Bhd	Domestic Electrical Appliances
7	Kee Huat Industries Berhad	Domestic Electrical Appliances
8	Plastictecnic (M) Sdn Bhd	Plastic Products
9	Ralco Plastic Sdn Bhd	Plastic Products
10	Usra Sdn Bhd	Plastic Products
11	Radiustech Sdn Bhd	Design Consultants
12	Sulik Design	Design Consultants
13	Orca Design	Design Consultants

All of these companies and design consultancies were visited to obtain accurate information regarding their involvement in product development. Information regarding each organisation and their respective activities was collected through their product/service catalogues and pamphlets. Informal discussions were also held with key people i.e., design managers, to establish their availibility to assist the researcher in undertaking a case study in their company. Generally, the initial visits to Malaysian SMIs were fruitful and beneficial in terms of collecting initial information for further study although some SMIs did refuse to assist the researcher.

7.8.1.2 Selection of Malaysian SMIs

Based on the initial visits and the reactions of key people in each organisation, five companies and two design consultants were selected and contacted for further discussions. Eventually three companies and one design consultancy were selected for the full case studies analysis. Due to time and cost considerations, the number of participating establishments was limited to these four:

	Name of Company/Consultants	*Product*	*Size*
1	Malpro Industri Sdn Bhd	Office Furniture	Small
2	Sharp Electronics (M) Sdn Bhd	Domestic Electrical Appliances	Medium
3	Plastictecnic (M) Sdn Bhd	Plastic Products	Small
4	Sulik Design Consultants	Design Consultants	Small

7.8.2 UK Case Studies

7.8.2.1 Selection of UK SMEs

The initial selection of UK companies and design consultants to be contacted for case studies was identified and selected from the list of the questionnaire survey responses. Based on this record and several discussions with the researcher's Director of Study, six companies and three design consultancies were carefully selected. The companies and design consultants contacted initially for the UK case studies were as follows:

	Name of Company/Consultants	*Product*
1	Morphy Richards Limited	Domestic Electrical Appliances
2	Electrolux Spennymoor	Domestic Electrical Appliances
3	Dyson Appliances Limited	Domestic Electrical Appliances
4	Evertaut Limited	Office Furniture
5	Addis Limited	Plastic Products
6	Thermos Limited	Plastic Products
7	IDEO Product Development	Design Consultants
8	Frazer Designers	Design Consultants
9	Tangerine	Design Consultants

Selected UK companies and design consultants were contacted by an official letter explaining the purpose of the research and requested their co-operation [see **Appendix 5** for sample letters sent to selected SMEs in the UK]. They were then contacted by the Director of Studies in order to discuss the acceptability of the proposal to the company concerned.

The organisations that indicated an interest in involvement in the case study interview stage were further contacted by the researcher. Finally after consultation with the Director of Studies, three UK companies and one design consultancy were selected for case studies, these were:

	Name of Company/Consultants	*Product*
1	Electrolux Spennymoor	Domestic Electrical Appliances
2	Evertaut Limited	Office Furniture
3	Thermos Limited	Plastic Products
4	IDEO Product Development	Design Consultants

7.8.3 Source of Information

To collect data for case studies, the method known as 'triangulation' was used. The term 'triangulation' denotes the examination of several 'angles', and making use of

two or more methods on the same research problem. Patton (1990) divides triangulation into four categories namely methods of triangulation, triangulation of data sources, triangulation through multiple analysts and theory/perspective triangulation. In the present study, triangulation of data sources as described by Patton was used. Triangulation of data sources involves triangulated data sources such as document reviews, standardised open-ended interviews and direct observations. By using this method any threats to the validity of the data were counteracted (Atkinson 1983). In the present study, the data for the case was thus collected through three inter-related stages: (1) review of documentary sources (2) interviews, and, (3) direct observations at the visited sites. The following section discusses and explains the process of data collection of case studies for the Malaysian and UK studies.

7.8.3.1 Stage One : Document Review

The main aim of the case studies was to provide a set of detailed descriptions of best practice principles and elements in the NPD process in Malaysian and UK SMEs. The case studies began with a reviews of documentary information (such as annual reports, written reports, newspaper cuttings, catalogues, brochures) about the companies and their product. These documents served as evidence of activity that the researcher could not observe directly. The documents also played an explicit role in data collection because they would be used to corroborate and augment evidence from other sources (Yin 1989).

7.8.3.2 Stage Two : Interview

The second stage of data collection was made by interviewing the key informants i.e. design managers and managers from other corporate functions such as marketers and engineers who were familiar with the industrial design process.

In the present case study, the interviews with the key informants served as a contemporary interpretative method that allowed for the flexibility required to extract factual information from various people, explore questions in depth and seek the 'rich' information to build a valid, holistic picture of the case under study. As described by Cottle (1978) [see Burgess 1982 pg.109]:

> 'Without allowing people to speak freely we will never know what their real intentions are, and what the true meaning of their words might be'

According to Gardner (1978), the general advantages of interviews are that they are more personal and can generate rapport furthermore replies can be more candid. Interviews are more flexible, less restrictive and simpler since respondents find it easier to discuss rather than to write. Gardner also indicates that interviews yield more complete data because the interviewer can sense whether all questions are being understood or not and can re-word or repeat questions to improve their chance of being clearly understood. Interviews also give the respondent no time to consult with others consequently the responses reflect more accurately the respondent's own views.

May (1993) outlines four types of interviews; the structured, the semi-structured, the group interview and the unstructured or focused interview. The unstructured and semi-structured types are the most useful in producing information amenable to qualitative analysis since questions can be adjusted to suit individual circumstances. As Fielding (1993) suggests:

> '.....the interviewer asks certain, major questions the same way each time, but is free to alter their sequence and to probe for more information '.

As well as this, a semi-structured interview combines aspects of structured interviews and standardised open-ended interviews. This is so since they can obtain

factual information and more interpretative data such as opinions, explanations or descriptions of behaviour or events.

In the present case study, semi-structured interviews were adopted not only to ensure systematic and thorough coverage of the specific issues but also to produce data, richer in detail, and of more close proximity to the 'truth'. As well as provide much more scope for discussion and recording of respondents' opinions and views, semi-structured interviews are less costly in time and effort to administer, simple to code and process, and can be used by interviewers not fully conversant with all the fine details of research (Moore 1983, Ackroyd and Hughes 1992). Hoinville (1978) reveals that the data provided by this type of interview are, to some extent, quantifiable since all respondents are asked the same questions in the same order.

A set of standardised open-ended questions were adopted in the present case study interviews so that each respondent's replies could be analysed systematically. This approach also makes data analysis simpler as it is possible to organise questions and answers that are similar (Patton 1987).

7.8.3.3 Stage Three : Direct Observations

Direct observations were the third source of evidence central to this study. This provided additional and relevant complementary information about the topic under study. As Patton (1990 pg.202) points out, observational information strength to research is:

> '...to describe the setting that was observed, the activities that took place in that setting, the people who participated in those activities, and the meanings of what was observed from the perspective of those observed'.

In the present study, the formal data such as observations during the visits to the case study 'site' and during the interviews with the respondents were collected. As

well as these, information such as the nature of the interview location and other context forming observations were made. This can be vitally important ancilliary data to the main core observations as Yin (1989 pg.91) points out:

> 'Less formally, direct observation might be made throughout a field visit, including those occasions during which other evidence such as that of interviews, is being collected. For instance, the condition of buildings or work spaces will indicate something about the climate or impoverishment of an organisation; similarly, the location or the furnishings of a respondent's office may be one indicator of the status of the respondent within an organisation'.

In addition, in the present case study, photographs of respondents, their products and organisations were taken with the consent of participants. Assurances that confidentiality would not be contravened were also given.

The following section will discuss the case study interview as a primary source of data in conducting case study research with respect to the eight companies in Malaysia and the UK.

7.8.4 Discussion of Case Study Interview with Malaysian and UK Companies

7.8.4.1 Introduction

The majority of Malaysia interviews were conducted during the period April-June 1997. UK company interviews took place in August 1998. A total of eight semi-structured interviews were conducted with informants familiar with the industrial design process at six selected companies and two industrial design consultants. The primary aim of these interviews was to provide a set of detailed descriptions of best practice principles and elements in the NPD process in Malaysia SMIs and UK SMEs. Prior to each interview, respondents were sent information about the project and its aims. In this way views expressed in interviews reflected a prior knowledge of the project purpose.

Interviews were semi-structured so as to ensure systematic and thorough coverage of all the specific issues. The characteristics of the interviews carried out during this study were similar to those of previous studies by Merton and Kendal (1946) [see Nachmias and Nachmias 1976 pg.101]. In their studies, they discovered that the semi structured interview has four characteristics;

1. It takes place with respondents known to have been involved in a particular experience;
2. It refers to situations that have been analysed prior to the interview;
3. It proceeds on the basis of an interview guide specifying topics related to the research hypotheses, and;
4. It is focused on the subjective experiences regarding the situations under study.

7.8.4.2 Selection of Respondents for Interview

As with any process or activity, the first step in interviewing is to identify the respondents to be interviewed. In the present case study, a 'focus sampling' was used in order to select respondents for the case study interview [see 4.8.1.2]. It was thus decided to interview industrial design managers and managers from different corporate functions, (e.g. marketers and engineers) who were familiar with the industrial design process. These people were judged to be in the best position to respond to the interview questions due to their experience of the process of NPD in their respective companies. Also, because they were responsible for industrial design activities, they provided the researcher with insights into the subject matter and suggested sources of corroboratory evidence [see Yin 1989 pg.89]. The researcher believes the selections made were representative and appropriate to the study.

A total of eight respondents were chosen for the case study interview involving eight organisations (four in Malaysia and four in the UK). The selected respondents for case study interview (Malaysia and UK) were as follows:-

Name	*Position*	*Company*
Malaysia		
1. Ruslee Hj Hashim	Managing Director	Malpro Industries
2. Tan Teck Kien	Managing Director	Plastictecnic
3. Ryu Kitagawa	Managing Director	Sharp Electronics
4. Suleiman Salleh	Managing Director	Sulik Design*
United Kingdom		
5. Paul Eccles	Technical Services Manager	Evertaut Ltd.
6. Tony Worsley	Project and Development Engineer	Thermos Ltd.
7. Sean Carney	Industrial Design Manager	Electrolux
8 Tim Brown	Director	IDEO Europe*

**Design Consultants*

7.8.4.3 The Interview Questionnaire

In the present case study interviews, a standard set of open-ended questions were used which allowed the respondent to elaborate freely while at the same time allowing the researcher to follow up responses with further 'probing' in order to get more in depth answers. The *standard* set of questions were also expedient in obtaining quantifiable data (since all respondents were asked the same questions in the same order). This made data analysis simpler and easier to organise. As Harrington (1991) suggests this gave the researcher a chance to introduce the topic and to give a structured simplicity and succintness yet still allowing for the rich data to emerge.

The standard set of open-ended questions used in the case study interviews for both, the UK and Malaysian studies are presented in **Appendix 6**. This set contained

twenty seven standard open-ended questions specifically designed to help the researcher identify the elements and principles of best practice of each organisation and to allow for comparative statistical considerations. In drafting and developing this questionnaire, reference was made to relevant questions from previous survey research such as Popplewell (1995), Maffin (1996) and DTI (1995). The case study interview questions focused on the following four issues:

- Purpose;
- Company's Culture;
- Process and performance, and;
- People.

These four key issues were adopted in this study and were addressed via twenty seven specific research questions. Since interviews were structured each discussed the topics in identical order.

1. Purpose
- *Business Structure and Strategy*

2. Company's Culture
- *Product*
- *Customer*
- *Leadership*

3. Process and Performance
- *Research and Development*
- *Product Development Process*
- *Role of the Industrial Designer*
- *Design Consultants and Other Collaborations*
- *Concurrent Engineering and Other Similar Methods*
- *Quality*
- *Computer Aided Design*

4. People
- *People*
- *Design Teamwork*

In order to enhance the validity of the questions, discussions were held with the Director of Studies. Finally, a questionnaire was produced in order to determine the following:-

1. **Purpose**

- *Business Structure and Strategy*
  Two questions were designed to identify the general background of the company, its structure and business strategy for the future.

2. **Company's Culture**

- *Product*
  Two questions attempted to reveal how often the company replaces their products and the strategic decision behind the changes.

- *Customer*
  Two questions were designed to identify the way in which a company identifies its customers level of satisfaction with the company's products.

- *Leadership*
  Two questions were aimed to identify the role that managers and other senior staff play in managing product design as well as in formulating business policy.

3. **Process and Performance**

- *Research and Development*
  Two questions were designed to discover how R&D worked in the company.

- *Product Development Process*
  Two questions were aimed at determining the nature of the product development process and whether any particular models had been adopted.

- *Role of the Industrial Designer*
  Two questions were aimed at determining the role of industrial designers in the product development process and the degree of involvement by other members of the team.

- *Design Consultants and Other Collaborations*
  Two questions were designed to discover the importance of industrial design consultants or any other collaborators.

- *Concurrent Engineering and Other Similar Methods*
  One question tried to reveal issues regarding concurrent engineering or any other methods applied in the company interviewed.

- *Quality*
  One question was designed to identify the application of appropriate quality systems in the company concerned.

- *Computer Aided Design*
  One question tried to reveal the potential of CAD as a design tool in the design process.

4. People

- *People*
  Three questions attempted to reveal how companies carried out human resource planning and the nature of communication between staff.

- *Design Teamwork*
  Four questions were aimed at determining how the company organised people to work together in project teams.

7.8.5 Process of Interview

7.8.5.1 Tape Recording

All the case study interviews were tape recorded. In the present case study interview, a tape recorder was used and answers were also recorded at the time of interview as suggested by Atkinson (1971 pg.95). Tape recording of interviews is a well documented technique in semi- structured interviews and help the researcher to devote full attention to asking, processing and interpreting questions and answers respectively. In this way, once transcribed, they offer the researcher a complete record of accounts (Spradley 1979) [see Ely et al 1991 pg. 83]. Based on these authors experiences, tape recorded interviews were preferred here.

The purpose of the study was explained to all the respondents prior to recording. Respondents were advised that they could withdraw from the interview at any time or ask for the tape recorder to be placed on pause.

All respondents gave consent to tape recordings being made and the researcher found that, after a short while most of the respondents seemed to be unaware of the tape recorder and found the discussions stimulating.

7.8.5.2 Duration of Interview

All interviews were carried out at the respondents offices and lasted between forty five to sixty minutes. Although Harrington (1991) indicates that interviews duration can be as much as two hours, the researcher believed that a shorter time, i.e. forty five to sixty minutes was more appropriate for interviews. Often short interviews are more effective than long ones and furthermore shorter interviews enabled the researcher to hold informed discussions with other staff such as industrial designer, or in some cases be offered conducted tours of premises.

7.8.6 Case Study Draft Report

After finishing the writing up of case study interview for each respondent, the transcribed interview together, evidence from documentary sources and direct observations in the form of a case study draft report were sent to the respondents for validation and confirmation of content. All respondents replied positively although some minor corrections were suggested. Samples of interview reports for Malaysian and UK case studies are presented in **Appendix 7**. Examples of the letters received from respondents confirming the content of the case study draft reports are also presented in **Appendix 8**.

The results and findings of these case studies (including interviews, document reviews and direct observations) are discussed in the next chapter (Chapter Eight).

7.9 Summary and Conclusions

This chapter explains and discusses case study data collection in Malaysia and the UK. Case studies in Malaysia and the UK involved eight organisations who had successful design projects and design leadership within the consumer durable product market sector. The researcher visited all of these organisations to carry out case studies. Semi structured interviews were conducted with eight managers involved directly in product development in each company using a standard set of open-ended questions. To compliment interviews, the researcher also carried out direct observational studies and reviewed documentary sources from each of the eight organisations. All the data collected were compiled into a case study draft and were sent out to respondents for validation. The information and data gathered using the case studies will be analysed to provide knowledge about the actual conditions and also to provide detailed descriptions of best practice principles and elements in the NPD process in both Malaysian SMIs and UK SMEs. The final analysis and findings of the case studies are presented in the following chapter (Chapter Eight). These findings will not only fulfil aim two of this research but also provide a basis for a discussion on the cross-case analysis of elements of best practice in the Malaysian and UK companies involved in this research.

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CHAPTER EIGHT

ANALYSIS AND FINDINGS OF CASE STUDIES (MALAYSIA AND UK)

The purpose of this chapter is to discuss the results and findings of the case studies which include interviews, document reviews and direct observations at the eight companies studied in Malaysia and the UK. This chapter starts with the overview of the case studies in Section 8.1. Section 8.2 discusses the role of the eight case studies and Section 8.3 discusses the contents of them. 8.4 deals with the analysis and findings of the Malaysian studies and is followed by Section 8.5 which discusses the UK study results. Finally, a summary and conclusion of both case study types are presented in 8.6.

8.1 Overview

The main aim of the case studies is to provide a set of detailed descriptions of best practice principles and elements in the NPD process, both in Malaysia and the UK SMEs, and to correlate these with best practices found in recent literature. This approach enables the researcher to develop a detailed and comprehensive review of the NPD process in the companies which were studied. Additionally, the qualitative findings derived from the case studies can be used as supportive evidence to the earlier findings and assist in fulfilling the aims of this study.

In the present study, the sample was selected from 3 major areas of consumer durable products: office furniture, domestic electrical appliances, and plastic products. The case studies in Malaysia involved the successful companies Plastictecnic, Malpro Industri, Sharp Electronics and Sulik Design, while in the UK it involved the companies Thermos, Evertaut, Electrolux White Goods and IDEO. Interviews were held with the managers and senior managers directly involved in the process of NPD. Although the use of case study as evidence in collecting data for research can be highly criticised because of it subjectivity, the use of semi-structured

questions for case study interview minimises this and enables the data collected to be interpreted systematically. The data from the interviews also represents the views of knowledgeable respondents who can be described as 'key informants' for this research. More importantly, they described their perception of the issues under discussion without bias from the researcher. The case studies are prepared from these discussions.

8.2 The Role of the Eight Case Studies

The case study field work which involved eight successful Malaysian and UK companies focused on four important issues: (1) Purpose, (2) Culture, (3) Process and Performance, and, (4) People. These were derived from the concept of Business Process Analysis (BPA) research [see 7.7]. Based on these issues, four aims of case study research were considered. The first aim was to identify the business strategy of the company concerned. The second aim was to identify the role the managers and other senior staff play in managing product design. The third aim of the case study fieldwork was to determine the actual NPD process in the company concerned. The final aim of the case study phase was to increase the understanding of how the company organised people to work together in project teams to develop new products successfully.

Although most of the aims stated above had been explored quantitatively in the second phase of the questionnaire survey, the case study qualitative findings can be used as supportive evidence to earlier findings. All of these aims were fundamental parts of the key aim of exploring and providing knowledge about the actual conditions of the factors and elements of best practice in these notable Malaysian and UK companies. Given these aims, the role of the case studies in this research can be summarised as follows:

1. They provided an opportunity for the researcher to collect both qualitative and quantitative data particularly in the area of the NPD process;

2. They allowed the researcher to be more interpretative of the materials and information provided by the key respondents (i.e. product design managers, senior managers) at the companies which were studied;

3. They provided an opportunity for the researcher to feed all the contents of initial findings of the organisation back to informants for their comment and approval;

4. They gave the researcher the chance to observe the reality of the NPD process, and how it is practised and managed in the companies which were studied, and;

5. They allowed the researcher to examine other intervening variables relevant to the current research undertaken.

A standard set of open-ended questions were used at each company in order to allow comparability in the subsequent analysis of the case material. The researcher also used published material such as annual reports, written reports, newspaper cuttings, catalogues, brochures and other related articles in order to get information about the companies and their products to supplement interview information. According to Yin (1989) these documents serve as evidence of activity that the researcher cannot observe directly and play an explicit role in data collection because they can be used to corroborate and augment evidence from other sources. A further source of evidence in this study was made through 'direct observations' during visits to the case study 'site' and during the interviews with the respondents. This source of evidence was important since it provided the researcher with additional and complementary information about the issues being investigated.

In summary, the case study analysis for these eight companies has been based on: (1) the case study interviews which involved semi-structured and open ended questions, (2) reviews of documentary sources, and, (3) direct observations at the visited sites.

8.3 Contents of Case Studies

As mentioned in Chapter Four, the case studies were mainly analysed using a qualitative research approach known as grounded theory [see Strauss and Corbin 1990]. The case studies were analysed and discussed using a standard set of open ended questions [see **Appendix 6**]. These questions were prepared specifically for the cases studies and the nature and order of questioning was as similar as possible in both the UK and Malaysian studies. This facilitated a more comparative dimension for the study. These questions were presented using the factors cited below as their guiding principle.

a) Business Strategy
b) Product
c) *Customers*
d) Leadership
*e) Research and Development**
f) Product Development Process
g) Role of the Industrial Designer
*h) Design Consultants and Other Collaborations***
i) Concurrent Engineering and Other Similar Methods
j) Quality
k) Computer Aided Design
l) People
m) Design Teamwork

Each analysis starts with the history and some general background of each organisation. It then moves to the business strategy of the company concerned. Discussion then turns to the company's new products, and the decision behind the replacement of their products in the market. The market of the product is identified as well as the strategies they are using in order to identify and satisfy their customers. Each case study then considers the role that managers and other senior staff play in managing product design and in formulating business policy for the

* *Not applicable for case studies with design consultants*
** *For case studies with design consultants, this factor will be reported as 'Clients and Collaborations'*

company concerned. The process and performance of the companies are identified through consideration of the company's R&D, NPD process, the role of industrial designers in the NPD process, the importance of industrial design consultants or any other collaborators to the company concerned, concurrent engineering, the application of appropriate quality systems as well as CAD as a design tool in the design process. Finally, each case study discusses the factors concerning human resource planning and focuses on how companies organise their staff to work together in project teams to develop new products successfully.

The following two sections will describe the analysis and findings of the eight case studies of Malaysian and UK companies central to this research.

8.4 Analysis and Findings of Malaysian Case Studies

8.4.1 Introduction

Prior to the case study interviews and observations in Malaysia, the researcher contacted and notified the selected SMIs regarding the proposed scheduled for the three month survey (April to June 1997). Contacts were made through several letters, faxes and e-mails to explain the purpose of the research and requested co-operation from SMIs. Initially, ten companies and three design consultancies were selected [see 7.8.1.1] and contacted for case studies based on companies listed in the questionnaire phase of this study [see 5.3.1.2].

In early April 1997, the researcher went to Malaysia to begin the case study research with Malaysian SMIs. The CADEM Centre (Computer Aided Design, Engineering and Manufacturing) of Institut Teknologi MARA (ITM) in Shah Alam, Selangor provided the necessary office accommodation and access to administrative and secretarial help.

During the first two weeks of the visit to Malaysia, the researcher visited all of these establishments in order to get accurate information regarding their involvement in product development. At this stage, the researcher's main purpose was to get to know the companies better and to learn some of the basic attributes of the organisations in order to conduct case studies. Informal discussions were held with key people in order to find out possible case study examples and at the same time semi-structured interviews, using a questionnaire, were piloted with them. The questionnaire itself was based on the previous findings of mail surveys reported in Chapter Six of this thesis. Based on this information and consideration of the selection criteria (e.g. size, reputation, willingness of the companies to participate in the case study and the geographical location of the SMIs) [see 7.3] three companies and one design consultancy were chosen and considered suitable as case studies. All of these companies were located in Selangor which includes Kuala Lumpur and the Klang Valley. The location of these companies within the State of Selangor (Figure 8.1) is appropriate for this study due to the research time frame and financial constraints. Also the case studies are very close to the researcher's office located in Shah Alam (also in the State of Selangor).

An initial letter requesting permission to conduct the case study was sent to key respondents (design managers, senior managers) in the chosen companies. Furthermore, the researcher contacted each company by telephone and again explained the nature of the project. Permission was later granted for the researcher to interview these managers at their offices at a time and date specified by them. In the middle of May 1997, visits were made to each company in the sample and interviews were conducted with key informants who were familiar with the industrial design process in the three companies and one industrial design consultancy. The interviews were conducted in English and were tape recorded in order to ease the process of data analysis at the later stage. All interviews were carried out at the respondents offices using a standard set of open-ended questions [see **Appendix 6**]. As well as collecting case study evidence from interviews, the

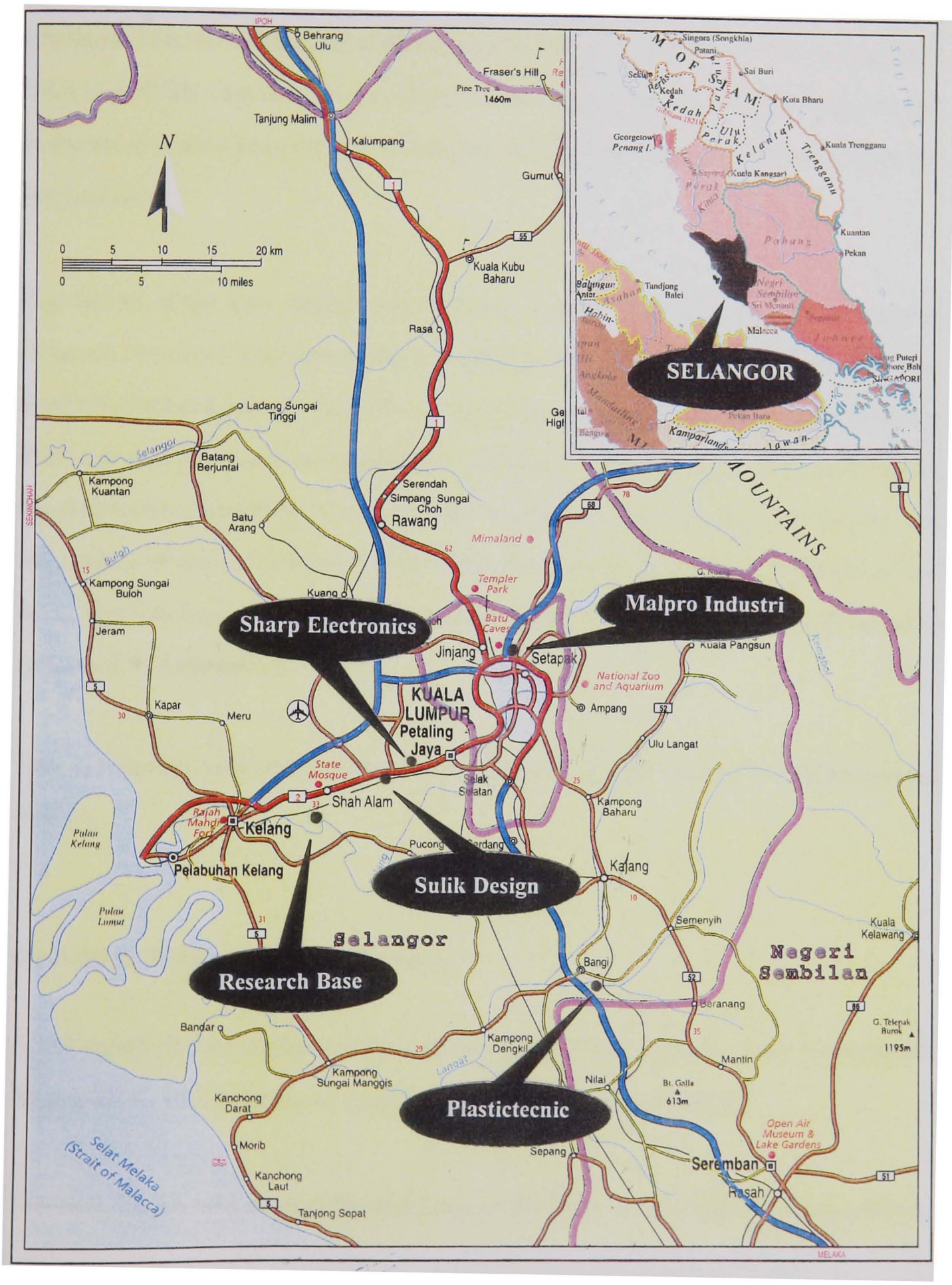

FIGURE 8.1
Location of Malaysian Companies Involved in Case Study

researcher also used other data collection methods such as documentary sources and direct observations at the visited sites to provide additional, complimentary information. In addition to this, in October 1998, the researcher conducted a further *telephone interview* with all four Malaysian companies from his research base. The main aim of this interview was to discuss issues that were not raised in Malaysia and at the same time to keep the researcher updated with the latest information from the respondents.

The results of the case studies were written as draft reports containing sources of evidence from both interviews, documentary sources and direct observations. These draft reports were sent to the SMIs for their approval of content. An example of the draft report is presented in **Appendix 7**. All drafts were checked and considered by the respondents and then returned to the researcher. By doing this it is hoped that the content of the case studies report would be accurate and precise. Example of the letter received from company confirming the content of the case study draft report is presented in **Appendix 8**.

The next section will describe the results of the four case studies of the Malaysian SMIs.

8.4.2 Malaysia Case Studies Results

A full report of case studies results with four Malaysian companies are presented in **Appendix 9**. The summary of these results is presented in Table 8.1.

The next section will discuss the synthesis of findings of the Malaysian case studies.

8.4.3 Synthesis of Findings from Case Studies Results

Synthesis of the findings from the case studies in Malaysia were based on an analysis under headings listed in the previous sections, which are discussed below.

a) Business Strategy

Each establishment has their own business strategy for the future. Plastictecnic for example has a vision of producing their own products in the future by setting up an industrial design centre in their company. Malpro has a vision to compete in global market while Sharp Electronics has a plan for Asian products especially in ASEAN. Sulik Design have a strategy to become involved in manufacturing in the near future. From the results, it can be concluded that every company has their own future plan to upgrade their respective operations in order to compete in the market place and have either a short or long term approach.

b) Product

There are rather mixed opinions regarding the replacement and planning for new products. Plastictecnic has suggested that product replacement depends on market need. Since Plastictecnic rely on existing products and foreign technology, they cannot plan far ahead. Instead they have to offer more choice to their customers by adding features such as new packaging, range of colours, new materials and finishes. Similarly, Malpro replace their product once a year with a planning period of three years. Since Malpro also rely on foreign design, they have to follow the design trends through foreign catalogues and magazines and send their staff to domestic and international shows to help create a product design base. Sulik Design rely on 'localisation' and 'modification' and cannot take many projects due to cost constrains. Sharp Electronics is the only company to rely totally on their own product and technology. They replace their products once a year and plan one year ahead. As a leader in technological innovation and manufacturing, Sharp Electronics have a strategic plan for the

Asia region by the establishment of the SEM (Sharp Electronics Malaysia) Asia Design Office in Malaysia. This Centre will become a focus for the Asia region database with all Sharp's designers world-wide able to work in close co-ordination by receiving and dispatching design information. Based on this development, the direction of future products for Asia is decided

c) *Customers*

There are several ideas regarding how companies determine their customers requirements. Malpro and Sulik Design indicate that, they do not have to conduct any market surveys on customers needs and wants since they have extensive business experience. Similarly, Sulik Design has not employed any marketers in it's organisation since it believes that it is not important for them. However, Plastictecnic and Sharp Electronics pointed out that they determine their customers needs through market surveys made by marketing and sales people. For them, market surveys are very important in helping the company predict future product trends.

In terms of involvement of customers in the NPD process, the results have shown that the majority of Malaysian companies exclude their customers and end-users in this process.

d) Leadership

The findings show that top management are responsible for all of business policy and business culture formulation and process. The results also indicate that top managers (e.g. Chairman, CEO, General Manager) have authority and power in most of the studied organisations. These people were found to be the decision makers that often have the determining hand in product development.

e) Research and Development

From the results of each establishment, it was found that all have an R&D department to assist the development of new products. Generally, there was a special budget allocated for R&D.

f) Product Development Process

There were generally no specific design processes or particular NPD models that were adopted while carrying out product design and development. The majority of companies still follow a sequential process (ideation to production). In the case of Sulik Design for example, the company has not followed a sequential process as they are involved with products for 'localisation', 'modification' and 'reverse engineering'. At Plastictecnic and Malpro reliance on foreign design and technology to develop their products was predominant. Sharp Electronics is the only company that has developed their own product based on innovation design. Currently this company has co-ordinated all design in Asia in order to produce one design for the whole ASEAN region.

g) Role of the Industrial Designer

From the results, it can be concluded that the roles of industrial designers in the process of NPD process were (1) as 'visualisers', (2) as 'aesthetic specialists', (3) as 'a middle man between production engineers and marketers', and, (4) as 'the bridge between the customer and marketing'. All the companies under investigation agree that industrial designers should be involved from the first stage (ideation) until the last stage (production).

h) Design Consultants and Other Collaborations

The findings show that most of the companies interviewed have not employed the services of industrial design consultants due to the fact that there are only a few design consultants in Malaysia involved in NPD. This is because most Malaysian design consultants operate as graphic design consultants. In this

study, only one company, Plastictecnic, commissioned design work from design consultants, when their own designers were unable to cope with the volume of works, and this way only on an occasional basis.

In terms of collaboration with other bodies, the results have shown that the majority of the companies which were studied have collaborated with higher education institutions, in particular ITM and other government bodies such as SIRIM and the Malaysian Design Council. By way of an example, Sharp Electronics have sponsored activities related to design and development as part of their commitment to the development of industrial design in Malaysia.

i) Concurrent Engineering and Other Similar Methods

Interestingly, three out of the four companies that participated in the case study have not implemented concurrent engineering.

j) Quality

The results show that three of the four Malaysian companies are intending to adopt a formal quality system and are currently in the process of getting quality certification such as ISO 9002 and BS 14001.

k) Computer Aided Design

The common CAD platform used in the companies which were studied are the PC and the Macintosh. All four companies used 'Autocad' and '3-D Studio' software programme. However, in carrying out design work, manual design methods were commonly used by the industrial designers with the computer used purely as a 'back-end design tool' instead of as a 'front-end design tool' despite computing technology offering this facility. As a 'back-end design tool' the computer is used extensively by the industrial designers after arriving at the final ideas to add colours, texture and background to presentation drawings.

l) People

Most of the companies participating in the case study have Human Resource Departments that plan and manage human resources. Most of them have short and long term staff plans.

The findings show that staff communicated through all methods of communication, particularly e-mail, telephone, round table discussion and daily assembly. However, none of these companies under study conduct surveys on the perceptions of their staff. All of the companies do, however, have their own procedure and format to gauge staff performance pay reviews. The majority of the companies also offer training and short courses for their staff for future development.

m) *Design Teamwork*

The companies in this study show that they do not encounter any serious problems arising from conflicts between different functions in the NPD team. Sulik Design, however did report that it has encountered a variety of conflicts between and amongst designers and team members. Most companies agree that, there are no particular methods to foster teamwork, however the development of relationships and mutual understanding among team members of multi-disciplines is crucial. As suggested by Sharp Electronics, team members need to work as a mutual team and respect each others role. Moreover, to foster mutual understanding, Plastictecnic has set up a committee to balance team work. Similarly, Malpro has set up a club in order to gather all the people in a team, both in and out of the office environment.

TABLE 8.1 : MALAYSIA CASE STUDY SUMMARY OF RESULTS

Factors \ Company	Case Study 1	Case Study 2	Case Study 3	Case Study 4
	Plastictecnic (M) Sdn. Bhd.	**Malpro Industri Sdn. Bhd.**	**Sharp Electronics (M) Sdn. Bhd.**	**Sulik Design Sdn. Bhd.**
a) Business Strategy	♦ Vision of producing their own products in the future ♦ Set up industrial design centre	♦ Vision to compete in global market ♦ To release a wide range of reasonably priced, stylish, quality products	♦ Plan for Asian products especially in ASEAN ♦ Aim for designs that can penetrate ASEAN market	♦ Involvement in manufacturing in future
b) Product	♦ Product replacement depends on market need ♦ Cannot plan far ahead since they rely on existing products and foreign technology ♦ To give greater choice (features, materials, finishing) for the customers in the future	♦ Replace at least once a year ♦ Plan 3 years ahead ♦ Follow current trends ♦ Send staff to domestic and international shows to help a product design base	♦ Replace once a year ♦ Plan one year ahead ♦ Establish SEM Asia Design Office in Malaysia for Asian products ♦ Command a network world-wide with Japan as its centre	♦ Fewer than 10 projects undertaken annually ♦ Projects limited due to cost ♦ Projects based on 'reverse engineering', 'modification' and 'localisation'
c) Customers	♦ Customer needs determined by market surveys ♦ Customers and end-users excluded in NPD process	♦ Market experience, not surveys, determine customer requirements ♦ Involvement of customers at all stages of NPD	♦ Customer needs were determined through market surveys ♦ Customers and end-users not involved in NPD	♦ Surveys not conducted to determine client demands ♦ No marketing team ♦ Involvement in client product development
d) Leadership	♦ Top managers and the CEO involved in business strategy ♦ Decision making determined by CEO	♦ Managers and head of departments are involved in formulation of business policy and business culture ♦ Chairman has authority and power	♦ Company's business policy and culture follows Sharp Corporation in Japan ♦ Final decisions depend entirely on top management ♦ Other managers indirectly involved in NPD	♦ Involvement of top managers in all aspects of business policy and business culture
e) Research and Development	♦ R&D department assists in R&D and production ♦ Special purchasing budget for production software and hardware	♦ Centralised R&D department for product development ♦ Special R&D budget	♦ Uncentralised R&D department assists development of new products ♦ No special R&D budget	♦ R&D not applicable to this company
f) Product Development Process	♦ No particular NPD model adopted ♦ Follows a sequential process (ideation to production)	♦ No particular NPD model adopted ♦ Product ideas based on foreign catalogues and exhibitions ♦ 'Localised' foreign design	♦ Follows Sharp Corporation in Japan ♦ Co-ordinates all designs in Asia to produce one design for the ASEAN region Follows a sequential process	♦ Influenced by Philips method ♦ No sequential process since products are involved in 'localisation', 'modification' and 'reverse engineering'

	Plastictecnic (M) Sdn. Bhd.	Malpro Industri Sdn. Bhd.	Sharp Electronics (M) Sdn. Bhd.	Sulik Design Sdn. Bhd.
g) Role of the Industrial Designer	♦ Involved from beginning to the end of projects ♦ Acts as 'visualiser' and 'aesthetic specialist'	♦ Involved from the first stage until marketing stage ♦ Design of new products and improvement of existing design	♦ Involved from the initial stage until the last ♦ Acts as 'middle man' between production engineers and marketers and as 'bridge' between the customer and marketing	♦ Involved from the first day to the last ♦ May contribute to the initial stages
h) Design Consultants and Other Collaboration	♦ Commissioning of some design work to design consultants ♦ Select design consultants based on quality and cost ♦ Collaboration with ITM and SIRIM	♦ No use of design consultant services ♦ Collaboration with ITM only	♦ Do not employ services of design consultants ♦ Close relations with higher learning institutions, Malaysian Design Council and SIRIM ♦ Sponsorship of activities related to design and development	**(Clients and Collaborations)** ♦ Clients gained through recommendations ♦ Selection based on track record and familiarity with clients market ♦ Close associations with higher education institutions and government bodies
i) Concurrent Engineering and Other Similar Methods	♦ No implementation of concurrent engineering	♦ No implementation of concurrent engineering	♦ Concurrent engineering began 4-5 years ago	♦ Adopted Philips working practice
j) Quality	♦ In the process of getting ISO 9002	♦ In the process of getting ISO 9002	♦ In the process of getting BS 14001	♦ Use of quality control and the 'bottom-up' method
k) Computer Aided Design	♦ Use of 'Macintosh' to produce 2-D and 3-D technical and presentation drawings ♦ Use CAD throughout design process	♦ Use of 'Autocad', '3-D Studio' and 'Pro-Engineer' to produce technical and production drawings ♦ CAD used in later stages	♦ Use of '3-D Studio', 'Photoshop' and 'Adobe Illustrator' to produce 3-D design, rendering and general assembly drawings ♦ CAD used after the final ideas for colours and background	♦ Use of 'Autocad Release 13' in designing and developing new products
l) People	♦ Human resources managed by Human Resource Department ♦ Has short and long term plans ♦ Staff communicate through round table meetings ♦ Own procedure to gauge performance ♦ Training and short courses for selected staff	♦ Planning for human resources is made through the company's plan ♦ Staff communicate through e-mail, memos, and discussion ♦ Has conducted staff pay review surveys ♦ Offers staff training	♦ Human resources managed by Human Resources Department ♦ Staff communicate through variety of methods ♦ Operates a 'workers union' ♦ Own standard format for staff pay rises ♦ Offer all staff training for future development	♦ Rely on subsidiaries for staff recruitment ♦ Operate long term and short term planning ♦ Staff communicate through face-to-face and telephone ♦ Pay rises based on performance and portfolios
m) Design Teamwork	♦ No conflicts between different functions ♦ Use concept of 'give' and 'take' ♦ Set up committee to balance teamwork	♦ No conflicts between different functions ♦ Set up a club to foster teamwork	♦ No serious problems encountered between different functions ♦ Work as a mutual team and respect each others roles	♦ Has encountered a lot of problems between different functions ♦ Conflicts among designers common

TABLE 8.2 : UK CASE STUDY SUMMARY OF RESULTS

Company / Factors	Case Study 1	Case Study 2	Case Study 3	Case Study 4
	Thermos Limited	**Evertaut Limited**	**Electrolux Spennymoor**	**IDEO Product Development**
a) Business Strategy	♦ Investment for the next 6 years ♦ Specific product development	♦ Operates a twelve month plan	♦ Vision to be product leader and become an environmental leader ♦ Introduction of 'plug in' products in the future	♦ No definite plan ♦ Move away from being conventional consultancy
b) Product	♦ New products replaced every 5 years - new features added annually ♦ Plans 3 years in advance ♦ Plans based on market demands and customer trends	♦ Continuous programme of upgrading/ replacing products in the market place ♦ Plans up to twelve months in advance ♦ Plan based on competitor's product analysis	♦ 'Generation plan' to upgrade products ♦ Plans 3-10 years into future ♦ 'Strategic planning' for general direction of future product development	♦ Undertake between 30-50 projects per annum
c) Customers	♦ Customers wants determined through extensive market research ♦ Workshops for customers ♦ Customers and end-users excluded from NPD	♦ Surveys not conducted to determine customers needs and wants ♦ Supply customers with catalogue for analysis ♦ Set up marketing department to analyse competitors ♦ Customers not involved in NPD	♦ Customers needs and demands determined by identifying scale and gaps in the retail market ♦ A note information system to evaluate customers and market demands ♦ Involvement of customers in different stages of NPD	♦ Customers requirements determined through 'user research' ♦ No involvement of their client's own customers in NPD ♦ Visits customers in own environment
d) Leadership	♦ Company's business policy and business culture is at Directors level ♦ Other managers indirectly involved in managing product development	♦ All managers and directors involved in business policy and formulation of business culture ♦ Each manager acts as his own director	♦ All project managers and IPDP co-ordinators are involved indirectly in business policy and formulation of business culture ♦ Project managers responsible for the overall project	♦ Project leaders manage projects and not top management
e) Research and Development	♦ No R&D department since all design works are out-sourced	♦ Centralised R&D department ♦ Special R&D budget	♦ Uncentralised R&D department ♦ Allocated a special R&D budget	♦ R&D not applicable to this company
f) Product Development Process	♦ No particular NPD model adopted ♦ Relies entirely on design consultants for design and development	♦ No particular NPD model adopted ♦ Follows a sequential process	♦ Adopted 'Integrated Product and Development Process' (IPDP) model as the Group Standard	♦ Employ a 'structural model' as a guide and procedures ♦ Strong engineering groups with deep technical understanding

	Thermos Limited	Evertaut Limited	Electrolux Spennymoor	IDEO Product Development
g) Role of the Industrial Designer	♦ External designers (design consultants) involved in all phases of design process ♦ Conceptualisation of design	♦ Involved throughout product development process ♦ Acts as 'aesthetic specialist'	♦ Involved at the beginning of the process and all phases of IPDP ♦ To help others in developing new products and give a design uniqueness	♦ Involved throughout product development process ♦ Have similar role to others, such as engineers and marketers
h) Design Consultants and Other Collaborations	♦ Employ the service of industrial design consultants ♦ Select design consultants based on their experience ♦ Linkages with universities	♦ Do not employ services of design consultants ♦ Not associated with other bodies except as a research base for testing	♦ Do not employ services of industrial design consultants ♦ Close relations with higher education institution world-wide	**(Clients and Collaborations)** ♦ Introduced to clients through reputation and recommendation ♦ Clients selected them based on their involvement in product innovation ♦ Global contacts with universities through teaching commitment
i) Concurrent Engineering and Other Similar Methods	♦ Began practising concurrent engineering 2-3 years ago	♦ Has practised concurrent engineering for a few years	♦ Has adopted IPDP (similar to concurrent engineering)	♦ Practises concurrent engineering
j) Quality	♦ Adopted ISO 9002	♦ Adopted ISO 9002, BS 549, 4875 and 5940	♦ Wide portfolio of quality certification	♦ Adopted own 'semi-formal' quality system
k) Computer Aided Design	♦ Use of 'Autocad Release 14' for sketches, idea development, 2-D and 3-D drawings ♦ Aims to adopt new system	♦ Use of 'Autocad' for 2-D drawing and 3-D Studio' for 3-D drawing ♦ CAD used from start to finish of design process	♦ Use of 'Vellum' and 'Alias' software installed with 'CAD Direct' so industrial designers can 'talk' to the main engineering tool ♦ CAD is used to produce 2-D and 3-D drawings ♦ CAD used after the 'ideation' stage	♦ Use of a variety of computer programme (e.g. 'Pro-Engineering', 'Solid Designer') ♦ Use of PC and Mac based system in designing (2-D and 3-D drawings) and engineering analysis ♦ CAD used from beginning of project
l) People	♦ Staff communicate through internal and external e-mail and text phone ♦ No surveys conducted on staff ♦ Staff monitoring adopted	♦ All activities regarding personnel planning are computerised ♦ Staff communicate through memo ♦ Staff surveys not conducted ♦ Training programmes for staff and general workers	♦ Activities focus on greater manager mobility between countries and operations ♦ Human resources based on strategic, long term approach ♦ Variety of staff communicative methods ♦ Conducts an 'Employee Attitude Survey' three times a year ♦ Comprehensive programme of staff development within Electrolux Univ.	♦ No formal way of getting people working for them ♦ Staff communicate through all methods of communication ♦ Conduct staff surveys ♦ Conduct review process to assess staff goals ♦ Training programme for staff development
m) Design Teamwork	♦ Encountered many problems between different disciplines ♦ No methods to foster teamwork adopted ♦ Emphasis on 'team'	♦ No serious problems or conflict between different functions ♦ One attitude to 'work together' in one team and respect others work	♦ No serious problems or conflict between different functions ♦ Staff understand each others role ♦ Staff responsibility for product	♦ No problems arising from conflicts between different functions ♦ A culture of product to teamwork, based on external goals

8.5 Analysis and Findings of UK Case Studies

8.5.1 Introduction

Case studies of the UK companies followed a similar pattern to the Malaysian case studies. An initial selection of UK companies and design consultants to be contacted for case studies was identified and selected from the list of companies obtained via questionnaire survey responses. Based on this record, six companies and three design consultancies were contacted [see 7.8.2.1].

An initial letter requesting permission to conduct the case study was sent to key respondents at each company. As with the Malaysian sample the selected UK companies were contacted by telephone. Again, the aim of the research was explained and co-operation was sought. In early August 1998, visits were made to each company in the sample and interviews were conducted with key informants, again using the same interview questions that had been used in Malaysia. All interviews were carried out at the offices of respondents and were tape recorded. The researcher also used other data collection methods, (i.e. review of documentary sources and direct observations at the visited sites) to provide additional information. Case studies of individual companies were then prepared in the form of draft reports and were sent to the companies for their approval of content. The drafts were sent back by respondents and confirmed the content of the case study draft report [see **Appendix 8**].

The next section will describe the results for the four UK company case studies.

8.5.2 UK Case Studies Results

A full report of the case study results with the four UK companies are presented in **Appendix 10**. The summary of these results is presented in Table 8.2. The next section is a discussion of the synthesis of findings of the UK case studies.

8.5.3 Synthesis of Findings from Case Studies Results

The synthesis of the findings from the case studies in the UK were based on an analysis under headings listed in the previous sections, which are discussed below.

a) Business Strategy

Each establishment involved in the case study have their own business strategy for the future. For example, Thermos has invested a million pounds for their six year expansion programme. It also has a vision of producing specific products in specific markets. Evertaut has a shorter twelve month plan for business growth while Electrolux's vision is to be a product and an environmental leader in the future. Although IDEO has no definite plan for the future, this company has plans to move away from being a conventional design consultancy. In summary, every company has their own future plan to upgrade their respective operations in order to compete with both a short and long term perspective.

b) Product

There are no specific answers regarding the replacement and planning for new products. For example, new products at Thermos are replaced every five years with new features added annually. In terms of planning, Thermos plan three years ahead. Evertaut has a continuous programme of upgrading and replacing their products. They plan up to twelve months in advance for new products. Similarly, Electrolux has a 'generation plan' in upgrading their products. Product planning at Electrolux is between three to ten years. In terms of direction for future product development, the majority of the companies interviewed base their plans on the market demands and customers trends. One good example is Electrolux, where 'strategic planning' for the general direction of future product development operates. The main purpose of this planning is to make sure they work on the right things and act as a guide to help them select the right project. 'Strategic planning' sets targets for customers, markets, products and services.

c) *Customers*

There are several ways in which companies determine customers requirements. For example, the marketing team at Thermos determine customer wants through extensive market research. Similarly, the team at IDEO conduct 'user research' which they claim is more empirical than market research. At Electrolux, however, customers needs and demands are determined by identifying the scale and any related gaps in the retail market. Interestingly it also has a 'note data information system' which enables key people to be involved in product development by evaluating customers and market demands. Evertaut, however, have a different approach in determining customers needs. This company has not conducted any surveys but has supplied their customers with a product catalogue which they analyse. Through this analysis, the company gauge the real needs of their customers and are able to improve any weaknesses in products.

In terms of involvement of customers in the NPD process, the results show that the majority of UK companies in this study have not involved customers and end-users. However, there is one company, Electrolux, who have included their customers in different stages of NPD process and hope in the near future that this involvement will increase.

d) Leadership

The majority of the UK companies involved in the case study have shown that top management are responsible for all business policy and business culture formulation and process. The results indicate that top managers and directors have authority and power in most of the companies which were studied and that the role of other managers is only to give advice or discuss any problems where necessary. However at IDEO, a different culture exists whereby project leaders manage the projects instead of management. As a project leader, they have power to control the resources within IDEO and can make decisions on which projects they undertake.

e) Research and Development

From the results of each establishment, it was found out that most of the companies in the UK have R&D departments to assist the development of new products. Generally, a special R&D budget is allocated for R&D. At Thermos, however, the company has not set up an R&D department since most of their design work is out-sourced using design consultancy services.

f) Product Development Process

There were generally no specific design processes or particular NPD models adopted while carrying product design and development at Thermos and Evertaut. These two companies still follow a sequential process (ideation to production). Electrolux has on the other hand invested one million pounds on an 'Integrated Product Development Process' known as IPDP. Since its introduction as the Group standard, IPDP has shown to be a powerful total quality management tool that has helped Electrolux achieve it's targets by maximising the use of Group resources. It also creates more value for its customers. Similarly, IDEO has a 'structural model' by which they can understand, visualise and evaluate. This model has been used by IDEO as a guide to procedures in developing new products.

g) Role of the Industrial Designer

From the results, it can be argued that the major role of industrial designers in the process of the NPD process is to help companies create a product image. Thermos believe that the role of industrial designers is to take the design and make it a reality, similarly, Evertaut suggest that industrial designers are 'aesthetic specialists'. Furthermore, Electrolux suggested that industrial designers can help others in developing new products by exploring the potential needs and by giving a uniqueness to the design. However, IDEO has a different view of the role of the industrial designer in the process of NPD. Since this company has moved from being a multi-disciplinary design company to a post-disciplinary

company, that is, they believe it is difficult to specify the actual role of industrial designers and stated that their role is similar to that of others, such as engineers and marketers. All the organisations studied did agree, however, that industrial designers should be involved from the first stage (ideation) until the last stage (production).

h) Design Consultants and Other Collaborations

The findings show that there are several reasons why companies do not employ the services of industrial design consultants. Electrolux for example, suggests that since it is attempting to develop core competence within the group itself and that industrial design consultant's are not necessary. Moreover, since the company has more than one hundred and twenty industrial designers world-wide it does not see any advantages in using external consultancy services. Evertaut has also not used design consultancy services since it claims it is a very 'risky' business and since most design consultants ideas are not always workable. Thermos however, has employed the service of industrial design consultants and finds that it enables the company to get fresh ideas as well as reducing costs.

In terms of collaboration with other bodies, the results have shown that the majority of the companies which were studied have collaborated with higher learning institutions. In fact, companies such as Electrolux and IDEO have close relations with higher learning institution throughout Europe, USA and Asia.

i) Concurrent Engineering and Other Similar Methods

Interestingly, the results show that all the companies that participated in the case study have implemented concurrent engineering or other similar methods (e.g. IPDP in Electrolux)

j) Quality

From the results, three of the four UK companies have adopted a formal quality system. IDEO, the fourth company, has adopted their own 'semi-formal' quality system.

k) Computer Aided Design

The common CAD platform used in the companies which were studied are the PC and the Macintosh although most of the companies reported the use of manual design methods. Two companies, Thermos and Evertaut used 'Autocad' software programme to produce sketches, idea development and create 2-D and 3-D drawings. For these two companies, it was found that the computer is used as a 'back-end design tool' and is useful for adding the colours, texture and background to presentation drawings. However, at Electrolux and IDEO the computer is used as a 'front-end design tool'. The latter companies use a variety of the latest computer software such as 'Vellum', 'Alias' and 'Pro-Engineer', not only for design, but also to deal with engineering and production analysis. Most of the companies under study used computers from the beginning of the project (ideation stage) and some of them beyond this stage.

l) People

Most of the companies participating in the case study have short and long term staff plans. At Electrolux, for example, human resources programmes are based on a strategic and long term approach. At Evertaut, this requirement is made possible by the extensive application of computers.

The findings show that staff in the companies which were studied communicated through all methods of communication such as memos, fax, internal and external e-mail, telephone and video conferencing. Two of the companies studied, Electrolux and IDEO have conducted surveys of the staff's perceptions of the organisation. In addition to this, IDEO also conducted a

review process to assess the goals and the objectives of their staff. All of the companies have their own procedure and format to gauge performance of their staff. The majority of the companies also offer staff training and short courses for future development.

m) *Design Teamwork*

The studied companies generally show that they do not encounter any serious problems arising from conflicts between different functions in the NPD team. IDEO for example, has not encountered any problems with their design teamwork since they operate a single disciplinary team style. However, Thermos have reported that they have encountered a lot of problems particularly between engineers and marketers. They did emphasise, however, that in such cases the team members always discuss their problems together. Most companies agreed that, there are no particular methods to foster teamwork but that relationships of mutual understanding among team members of multi-disciplines is crucial. As suggested by Electrolux, to foster teamwork, team members have to understand each others roles and be fully aware that they alone have complete responsibility towards the project and its end product. IDEO focuses on external project goals to create a culture of teamwork and is less conscious of the internal goals of disciplines. Finally, Thermos has emphasised that to work as a team is important and similarly Evertaut corporate attitude is to work together as one team and to respect fellow employees activities and tasks.

8.6 Summary and Conclusions

This chapter explains and discusses the Malaysia and UK case studies results. Case studies in the UK and Malaysia involved eight organisations selected from three major areas of consumer durable products: office furniture, domestic electrical appliances, and plastic products. The case studies in Malaysia involved the companies Plastictecnic, Malpro Industri, Sharp Electronics and Sulik Design, while

in the UK it included the companies Thermos, Evertaut, Electrolux and IDEO. Data were gathered through interviews with senior management staff directly involved in the process of NPD, reviews of documentary sources, and direct observations at the visited sites. Interview results were categorised based on the interview questionnaire as listed in **Appendix 6**. The interview findings were then examined, categorised and tabulated to fit into the explanation-building strategy as defined by Yin (1989) and were analysed using 'grounded theory' (discussed in Chapter 7) [also see Strauss and Corbin 1990].

The results from the eight case studies discussed in this chapter enabled the researcher to understand, in a detailed and comprehensive manner the actual conditions of the NPD process both in Malaysian and UK companies. They also highlight salient issues related to the NPD process in the UK and Malaysia. Additionally, the case studies' findings can be used as supportive evidence for questionnaire surveys and assist in fulfilling the aims of this study. In the following chapter, a set of detailed descriptions on best practise principles and elements of the NPD process in Malaysia and the UK will be examined with respect to recent literature in SMIs in the two nations.

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CHAPTER NINE

ELEMENTS OF BEST PRACTICE

The purpose of this chapter is to discuss elements of best practice in NPD. The chapter begins with an introduction (section 9.1) followed by an examination of best practice in section 9.2. Section 9.3 discusses the theoretical framework for best practice which includes a proposed model of best practice and the literature that supports this. The chapter ends with a summary and conclusions in section 9.4.

9.1 Introduction

The objective of this chapter is to gain a full and deep understanding of the elements of best practice in NPD process. In order to get detailed understanding of these issues, a literature search approach is adopted. Through this approach, a number of existing best practices, which are recommended to companies as representing best practice in the management of the NPD, are discussed. In order to highlight examples of best practice focused on in this study, numerous books and articles that covered issues of successful new products and successful NPD were examined. Most of these books and articles showed examples of best practice and excellence within specific companies citing specific problems and ideas. The findings from the literature were used as a theoretical framework in order to guide the researcher in developing a 'model of existing best practice'. By using a cross-case analysis procedure, this resultant model was compared against the case studies findings of Malaysian and UK SMEs. The main aim of the correlation is to identify any patterns and relationships with due consideration to the cultural differences between the two countries. The results of the correlation will form a valuable background to the manner in which these elements of best practice might be redefined and combined in order to make them applicable as best practice guidelines to the Malaysian SMI context. This best practice is very important since previous studies have shown the value of learning from other companies' best practice:

'....the adaptation of best practice helps an organisation avoid being ambushed by unexpected change. A company can accelerate its own rate of improvement by systematically studying others and by comparing its own operations and performance with the best and most effective practices of highly innovative and successful companies. The search for best practices quickly draws you outside the confines of your own culture and personal habits. Best practices benchmarking is therefore a pragmatic approach to managing change and performance improvement. Many organisations have demonstrated the power of best practices benchmarking'
- Bogan et al (1994 pg.7)

'.... a major responsibility of every company therefore must be to seek out and implement the best practice.... Companies must be open to new ideas from any source. They should assess their own organisation in terms of the features common to innovative firms, and see how it measures up. They must familiarise themselves with the practices of the most successful, and adapt and apply them in their own businesses'
- The Select Committee on Science and Technology (1991 pg. 32)

9.2 Best Practice

'Best practice' can be described as 'the most excellent or suitable exercise of a profession' [see The New English Dictionary and Thesaurus 1995]. Historically, best practice is not a new or revolutionary method. It was first introduced by the American, Francis Lowell in 1800s. According to Bogan and English (1994), the idea of transferring best practice methods came when Lowell travelled to England and saw the potential of using the British textile mill as a benchmark in order to upgrade business technology in the United States. As Bogan and English (1994 pg.2) put it:

> 'In the 1800s, British textile mills were absolutely the best in the world. In contrast, American mills were still in their infancy when it came to producing all types of textiles. Francis Lowell, a New England industrialist, sought out to change this situation by upgrading business technology in the United States. Lowell travelled to England when he studied the manufacturing techniques and industrial design of the best British mill factories. He saw that the British plants had

> much more sophisticated equipment but the British plant layouts did not effectively utilise labour. In short there was room for improvement. In 1815, Francis Lowell built a factory that employed much of the technology in the British plant but was designed to be much less labour intensive than the British facilities. It was a splendid example of innovative adaptation. In 1820, this textile mill centre became known as Lowell Massachusetts. By 1840, just two decades later, Lowell had grown to become the second largest city in America and the largest manufacturing complex in the country. This dynamic growth was largely fuelled by one man's vision and his ability to creatively adapt practices observed in the world's best mills'.

According to Buchanan and Howell (1989) best practice is an approach that helps improve management performance and can be applied at the corporate level as well as at the most basic manufacturing unit. This concept is powerful because it motivates people to action and simple; because it is easy to understand. Unfortunately, this concept is not used often enough since it requires an unusual combination of difficult and detailed analyses together with determined leadership capable of setting the right targets and implementing the right programmes. However, these difficulties are more easily overcome if managers realise how valuable and important the best practice approach can be. Buchanan and Howell suggested that in order to make best practice happen, four basic questions of comparison should be put forward:

1. Are we performing better than we ever have?
2. Are we performing better than other department or business units within the company?
3. Are we performing better than our competitors?
4. Are there any other industries that are performing particularly well from whom we can learn?

Today the best practice method has been used widely as benchmarking by most of the successful companies around the world in all sectors of business, in both manufacturing and service to help them become as good as or better than the best in the world in the most important aspects of their operations (DTI 1992).

9.2.1 Best Practice as Benchmarking

Benchmarking is a systematic way to identify, understand and creatively evolve superior products, services, design, equipmant, processes and practices to improve organisation's performance (Zairi 1996). According to Popplewell (1995 pg.10) benchmarking is 'the activity of comparing a particular process or result in one organisation with the equivalent in other organisations. It can form the basis for targeting and prioritising process improvement actions and for quantifying the potential for improvement'

Zairi (1996) cited that benchmarking is one of the oldest improvement tools in the world, and individuals and organisations have been benchmarking for centuries in order to:

- Find a better way of doing something;
- Understanding how it is being done, and;
- Adopt or adapt it to your environment.

Interestingly, Zairi revealed that Europeans such as Marco Polo had travelled to China to redefine their best practices and bring them back to improve the Europen way of life. It also occurred to Michaelangelo when he compared his paintings to Leonardo da Vinci's. Furthermore, Zairi claims that after World War II there was a massive invasion of benchmarking teams from Japan studying the US and European manufacturing approaches.

Karlöf (1995) cited that benchmarking is a method of improving operations by looking and learning from others and comparing yourself to them. Benchmarking is a long-term process and involves the whole organisation in searching for the best practice outside the company, not just for what is done best, but how it is done .

Best Practice Benchmarking or BPB according to DTI (1992 pg.1) comes in many forms, but essentially it will always involve the following:

- Establishing what makes the difference, in supplier customers' eyes, between an ordinary supplier and an excellent supplier;
- Setting standards in each product, according to the best practice they can find;
- Finding out how the best companies meet challenging standards, and;
- Applying both, other people's experience and their own ideas to meet the new standards, and if possible, to exceed them.

According to the DTI, this approach is a continuing basis and the main goal is that to build on the success of others to improve future performance. It helps companies to achieve the following:

- Better understanding of their customers and their competitors;
- Fewer complaints and more satisfied customers;
- Reduction in waste, quality problems and reworking;
- Faster awareness of important innovation and how they can be applied profitably;
- A stronger reputation within their markets, and;
- As a result of all these, increased profits and sales turnover.

The awareness of best practice benchmarking in Europe, especially in the UK has became very prominent after the launch of the European Quality Award and the UK Quality Award in 1992 [see DTI 1992 pg.2]

Bogan and English (1994) regarded benchmarking as a skill that should be communicated and utilised in day-to-day business operations. According to them, 'benchmarking has broad applications in problem solving, planning, goal setting, process improvement, innovation, re-engineering, strategy setting and in various other contexts. Quite simply, benchmarking is a fundamental business skill that supports quality excellence'(pg.3).

9.2.2 Overview of Best Practice in New Product Development

Studying and learning from best practices are of critical importance for every manager who wishes to lead their organisations to the winner's circle. Learning from the best not only requires seeking out the 'best', but also to define what this means in term of

the process being examined. There are many different perceptions of 'best' according to what is being considered.

For instance, in the case of NPD, there are many aspects to describe the best practice or the most successful NPD. Studies by the DTI (1994) have revealed that there is a core of best practice techniques and issues found to be common to over 50% of the companies in their case studies. According to this report (pg.12), the ten key techniques and issues can be categorised under four main heading as follows:

Market and Customer Issues

1. Being careful to understand the target market and aiming new products at specific market segments or customer groups.
2. Asking for feedback from customers and taking action on it.
3. Bringing a regular flow of new products to market and not just making a one-off effort to bring out a single new product range.

Product Planning and Design

4. Developing detailed market, specification and performance targets for a new product before starting on design and prototyping activities.
5. Designing new products with modular elements or system features, allowing the sharing of elements between different product ranges.
6. Handling projects in two main stages, pre-planning and implementation. All company function buy in or commit to the tasks and targets inherent in the new project as part of the pre-planning stage and before commitment to implement them is made.

New Product Processes

7. Having a clearly defined process for introducing new products which is widely understood, accepted and followed throughout the company.
8. Achieving fast response times to changes in market needs and constantly striving for faster time to market for new product programmes.
9. Controlling the new product process through a multi-disciplinary team structure, whether formal or informal, whereby each function has an input at all stages of the process.

Top Management Involvement

10. The company's chief executive is involved in sponsoring the new product process and in the management of project decisions as well as in creating the multi-disciplinary team for achieving the full benefits of concurrent engineering.

This report (pg.10) also indicated that successful companies show the following characteristics independent of the industry type.

1. They are customer led: they recognise the importance of being close to their customers, providing products and services that customers will buy and responding to customers as a first priority;

2. They have lean processes: they set up their organisations to work efficiently, to avoid waste and bureaucracy and to use the tools and techniques that enhance speed, accuracy and effectiveness in everything they do;

3. They operate in a 'people culture': they ensure they get the best out of their workforce by making it easy for employees to do a good job, and;

4. Responsibilities and authority are clearly defined and communicated, people have 'space' in which to add their own value to their work and are themselves valued.

Research in NPD has also shown the significant positive correlation between best practice and new product success [see Cooper 1983/1996, Maidique and Zirger 1984, Link 1987, Song and Parry 1997]. Since this study focuses on best practice in order to improve NPD process, it is beneficial to examine at the factors behind product success and to link this with best practice in NPD process. The results of such an examination will be very beneficial in terms of providing the researcher with a useful perspective for summarising new product success which can be correlated to best practice in the NPD process.

Although new product success is a multidimensional concept (Cooper and Kleinschmidt 1987), many studies have proved that there are relationships between new product success and the marketing tasks, market potential and technical aspects, which include R&D, engineering and production. For instance Maidique and Zirger (1984) noted that a British study on new product success and failure (project SAPPHO) undertaken by Rothwell et al (1974) showed that of one hundred and twenty two variables tested 34% (forty one variables) produced statistically

significant correlation with new product success. These results were then grouped into five general areas as follows:

1. Understanding of user needs;
2. Attention to marketing and publicity;
3. Efficiency of development;
4. Effective use of outside technology and external scientific communication;
5. Seniority and authority of responsible managers.

Maidique and Zirger summarised the two former groups as 'market factors', while the latter three were categorised under 'organisation variables'.

Maidique and Zirger (1984) also found some similarity with these findings using the study carried out by Cooper (1983). According to them, the overall results were divided into three general areas that were believed to be strongly correlated with new product successes. These were summarised as:

1. Having a unique or superior product in the eyes of the customer;
2. Having marketing knowledge and proficiency;
3. Having technical and production synergy and proficiency.

According to Maidique and Zirger, although Rothwell et al and Cooper's studies are superficially similar, there were also some differences. For example, Rothwell et al highlighted organisational factors such as seniority and the authority of responsible managers and effective use of outside technology in addition to market sectors, while largely ignoring the product itself. Cooper however, emphasises more on product characteristics as well to the market and organisational variables.

Similarly, Cooper (1983) established that in the Hungarian electronics industry (known as 'The Hungarian SAPPHO') also produced parallel results to the UK industries despite the differences between the two countries. According to her, the Hungarian situation is very similar to those in the British SAPPHO. These included:

1. Market need satisfaction;
2. Effective communication (internal and external);
3. Efficient development;
4. A market orientation;
5. The role of 'key individuals'.

Cooper further claims that a study undertaken by Kulvik (1977) in Finland yielded similar results to both the British and the Hungarian SAPPHO. Moreover, the Finland study also produced additional factors such as the effective utilisation of company potentials (good products/company fit); the utilisation of technical 'know how' of the company; and the exploitation of market opportunities (Cooper 1983 pg.4).

On a more international basis, studies undertaken on European and Japanese firms by Utterback et al (1974) [see Cooper 1983] have shown the following factors as important to successful new products:

1. No initial difficulties in marketing;
2. Real product advantage;
3. Market needs recognised prior to a solution;
4. More customer contact;
5. Involvement of top management initiation.

As well as these factors, Utterback also reveals that advance planning and the use of design consultants were related to the success. Cooper (1983) also found that research undertaken on Canadian industries (Project NewProd 1979) illustrated that the three most significant results of new product success were also related to marketing tasks, market potential and technical and production aspects. These may be summarised as:

1. Having a unique or superior product in the eyes of the customer;
2. Having marketing knowledge and proficiency;
3. Having technical and production synergy and proficiency.

Similarly Rubestein et al (1976) [see Cooper 1983 pg.4] revealed that most of the successful new American products were positively correlated to:

1. The existence of a strong product champion;
2. Marketing factors, such as need recognition;
3. Strong internal communications;
4. Superior techniques for data gathering, analysis and decision making;
5. Planned approaches to venture management.

In Link's (1987) study of successful new product, he found that there are six highly salient variables contributing to new product success:

1. New product synergy with existing marketing skills;
2. New product synergy with existing technical and manufacturing skills;
3. High product quality;
4. Products offer significant user benefits;
5. Appropriate targeting and pricing strategies, and;
6. Distribution channel support.

More recently, Cooper (1996 pg.8) has highlighted five core factors which relate to the success of new products:

1. New Product Process - including understanding user needs, extensive customer-producer interfacing and efficient performance of the development process.

2. Launch Effort and Product Offering - including strong selling (and marketing) effort and product and/or price advantages.

3. Nature of Venture - including market pull, technology push and closeness to the current market.

4. Organisational Descriptors - including better co-ordination of R&D, marketing, production and product champion or top management support.

5. External : Industry, Market, Environment - including industry maturity (affects nature of venture) and government role.

Finally, Cooper and Kleinschmidt (1987 pg.176) in their investigations into factors that discriminate between successful and unsuccessful new products identified five keys factors that determine new product success or failure. The details of the factors of product success include:

1. Product Factors - including a unique superior product in the eyes of the customer and a product with economic advantages to the user.

2. Market Factors - including a large and growing market and relatively weak competition.

3. Marketing Factors - including an understanding of user needs, market knowledge and marketing proficiency.

4. Synergy Factors - including marketing and technological synergy.

5. Management Factors - including management commitment to the project and good internal communication between the various groups involved in the projects.

9.3 Theoretical Framework

On the basis of this review, the researcher concludes that there are important similarities in the findings of new product success and successful NPD. Most of the findings have shown successful new products and the NPD process were more likely to be positively related to core factors such as marketing tasks, market potential, technical aspects which include engineering and production as well as management factors. These factors are found to be the most influential facilitators of the successful NPD process. The previous literature reveals that these success factors are repeated in much of the research quoted above (Song and Parry 1997, Cooper 1996, DTI 1994, Link 1987, Maidique and Zirger 1984, Cooper 1983). Most research has focused on these factors and have led to much discussion and research into successful NPD.

The current research supports the notion that these factors are important characteristics of successful NPD. These factors will thus serve as a conceptual framework which provides a useful perspective for summarising much of the recent literature on the determinants of successful NPD, as well as explaining the best practices in this process. Moreover, these findings will assist in the development and production of a best practice model for the current study. This will be done by evaluating and refining certain factors of new product success before adopting it as a best practice model. In this way the factors will be more applicable to the current research.

Despite the advantages of using previous findings as guidelines in developing a best practice model, they do have certain limitations. The first to consider is that they are based entirely on secondary sources. Secondly, although there are many texts discussing the elements of best practice, the review could not adequately collect specific information about NPD with regard to the consumer durable product market sector, in particular domestic electrical appliances, office furniture and plastic products (house-ware products) which is one of the concerns of this research. Thirdly, a large part of the literature review was based on marketing and business management with a limited literature from the industrial design perspective. Fourthly, there is a limited amount of literature relating to SMIs' NPD specifically. Much of the general best practice guidance to companies cited in the literature is influenced by the activities of large companies, i.e. Sony, Braun, Philips etc. Finally, the literature could not focus specifically on the NPD activities in the UK companies. This is because most of the companies are 'UK based' and not UK owned with their parent companies in countries such as Germany, Italy, USA and Japan.

Despite these limitations, the researcher believes that these broad based studies have generated insights into the rich complexity of the elements of best practice which are relevant to the main aims and research issues of this study.

9.3.1 Proposed Model of Best Practice

Based on the theoretical considerations above, the researcher has identified several key factors that are of considerable importance and applicability to adoption in a model of best practice. These key factors are considered to be the *core factors* of best practice that need to be correlated to findings of best practices in both Malaysia and UK companies. These key factors fall under the following headings:

1. Customer and Marketing Factors
2. Product Design and Development Factors
3. Technical Factors
4. Management Factors

The rationale for adopting these four key factors is that these issues have been identified as central to successful new product and NPD in numerous studies [see Song and Parry 1997, Cooper 1996, Mynott et al 1994, Maidique and Link 1987, Cooper and Kleinschmidt 1987, Zirger 1984, Cooper 1983]. Moreover these key factors appear in all phases of the NPD process model i.e. Pre-Study, Ideation, Design and Development, Production and Marketing as suggested [e.g. see Fawcett 1990, Edward 1987, Pahl and Beitz 1984 and Corfield 1979]. These four key factors thus cover the whole process of NPD as well as representing one or more activities in the whole NPD process. Underlying each of these key factors are a number of specific requirements that will be highlighted and discussed. These specific requirements are found to be related to the current subject and help to support the earlier findings of questionnaire surveys. The four key factors together with specific requirements can make up a 'model of best practice', which is based on earlier findings of the literature review.

Although earlier case studies which have been successfully carried out within Malaysian and the UK industries have outlined twenty seven specific questions from four key issues adopted from the concept of Business Process Analysis research, it is not possible to investigate and or examine all these questions within the current research parameters. This research will concern itself with some of the

key factors that *could* be taken as a basis of explaining NPD success. It attempts to review certain key areas of the efficiency of practice in recent literature, particularly in NPD process and contrasts it with the current practices found in Malaysian and UK industries through individual case studies. By doing this it is hoped that a better understanding and sharper focus on the issues which need to be investigated will arise. In the case of benchmarking for instance, the DTI (1992 pg.6) has suggested that 'the more precisely you define what you want to measure, the more useful the information you gather will be'. Considering this, the researcher believes that the four key factors above that have been proposed to make up the criteria of the elements of best practice model is appropriate for this study and provides a new focus that acts as a reference for this research.

9.3.2 Literature of Specific Requirements to Support Best Practice Core Factors

9.3.2.1. Customer and Marketing Factors

There are three specific requirements that have been identified as priority issues to be discussed to support Customer and Marketing Factors:

1. A Company's Products
2. Customer Expectations and Responses
3. Marketing Knowledge and Proficiency

Successful new product is one of the important requirements in the NPD process in accordance with best practice. A number of specific issues corroborated by the findings of the DTI (1994). According to the DTI (pp.2-3) successful companies need to produce products that:

- Are right for the customer;
- Are available in advance of the competition;
- Offer more features, more variety and better performance;
- Give value for money in the eyes of the customer through a balance of cost and quality.

In terms of customer expectations and responses, quoting Pilditch (1989), the Select Committee on Science and Technology (1991) state that 'being obsessive about customers', and 'have thirst for knowledge of customer behaviour and wishes' is described as successful NPD. It also highlights the importance of customers for company prosperity by observing that without customers, no new product can succeed: the lack of market understanding is a major weakness in many businesses. Pilditch adds that some evidence of successful NPD is found in Germany and Italy. In these countries successful companies were regarded as having a clear picture of their competitors comparative strengths and weaknesses.

The importance of the customer/company relationship has been investigated in various studies. Costanzo (1992) for example claims that 44% of companies involved in his surveys involve their customers in discussions from an early stage. The involvement of the customers in the early stage he claims is part of best practice procedure since customers can bring some information to help guide companies developing new products. A study by Fairhead (1987) also revealed the importance of customers as a source of information in developing new products. He gives the following examples where companies attempted to get 'closer' to their customers:

- Ford of Europe who used 'car clinics';
- Austin Rover who run a 'Young People' Committee;
- Sanyo who run an international 'life-style' library;
- Sony's Chairman visits discotheques and night-spots in Europe with the designer from his West German office.

According to Fairhead, all of these approaches are aimed at developing an understanding of their customers' behaviour yet are indirectly related to company needs. The purpose of gathering such information is to feed into the design process in order to help identify ways of improving the relative strength of a company's product range, as well as understanding competitors activities and strengths.

Identifying customer needs is an integral part of the concept development phase of the NPD process (Ulrich and Eppinger 1995). They claim that results from surveys on customers wants and needs are useful in guiding the team in developing product specifications, generating product concepts, and selecting a product concept for further development. Ulrich and Eppinger (1995 pg.50) indicate that the best means of identifying customers needs are based on six interdependent and chronological considerations.

1. Define the scope of the product development effort;
2. Gather raw data from customers;
3. Interpret the data in terms of customer needs;
4. Organise the needs into a hierarchy of primary, secondary, and tertiary needs;
5. Establish the relative importance of the needs, and;
6. Reflect on the results and the process.

Creating a high-quality information channel from customers ensures that a company involved in developing new products will fully understand the needs of their customer. Ulrich and Eppinger added that by using these criteria, 'products are focused on customer needs and that no critical customer need is forgotten' (pg.51). They also indicate that it develops a clear understanding amongst the development team and creates a data base of consumer concepts. It also establishes product specification and makes a record of the needs phase of the development process.

Similarly, Dimancescu and Dwenger (1996) suggest that the best practice of NPD is to translate the voice of the customer into products. According to them there is a concept of translating the voice of the customers (VOC) into products known as 'concept engineering'. This concept, a part of best practice emerged in the 1990s. This is a fifteen step procedure which breaks down requirements and incorporates a methodology for quantifying each requirement so that a design team can conceptualise a coherent solution. This fifteen step procedure is illustrated in Figure 9.1.

FIGURE 9.1 : The Fifteen Steps of the Voice of the Customers (VOC)

Understanding the customer's environment

1. plan for exploration.
2. collect the voice.
3. develop a common image of environment.

Converting understanding into requirements

4. transform the voice of the customer into requirements
5. select significant requirements
6. develop insight into requirements

Operationalising what has been learned

7. develop and administer questionnaires
8. generate metrics for requirements
9. integrate understanding

Concept generation

10. decompose
11. generate ideas
12. generate solutions

Concept selection

13. screen solutions
14. select concepts
15. re-select and finalise

According to Dimancescu and Dwenger (1996), these procedures will take approximately six to twelve weeks for a team to complete the actual VOC information. In order to get information of VOC, several well-developed techniques involving qualitative and quantitative methods have been used by successful companies.

As well as the consumer focus, marketing knowledge and proficiency play a vital role in best practice philosophy. According to Fairhead (1987 pg.14) companies that produce successful products 'understand the proper role of marketing, and use it as an essential part of the total design and NPD process'.

Similarly, Cooper (1983 pg.4) states that 'successful companies understood users needs better, and were able to assess whether these needs could be filled economically. Specific sales strategies were matched to market requirements'.

9.3.2.1.1. Key Aspects of Best Practice (Customer and Marketing)

The concept of best practice is based in determining what the customer wants. Using information originating from the customer, cost-effectively delivering products satisfies the customer needs and wants. 'Concept engineering' is another well known aspect of best practice where the voice of customers (VOC) is translated into a product that is both aesthetically pleasing and functionally desired by customers. In order to realise a successful product which satisfies customer expectations and responses, marketing knowledge and proficiency is vital. Through the marketer's skills in marketing strategy, new products will be delivered to customers successfully.

In collaboration with the literature search on customer and marketing factors, findings have shown that the elements of best practice of new product for customers include that the product : has a unique features/benefits for users, is highly innovative, is a first-to-the-market type of product, is a superior product, is technically advanced and is of higher quality than competing products. The findings have further shown that customer expectations and responses are related to : products meeting user needs better than competing products, products being accepted quickly by users, interpretation of the findings from consumer trials, and

the development by teams who fully understand user needs. Exceeding customer expectations requires much better knowledge and proficiency of marketing. Previous literature suggests that marketing knowledge and proficiency is concerned with : aiming new products at specific market segments/customer groups, developing with a clearer market strategy, comprehension of the competitors circumstances and a strong salesforce launch effort incorporating well targeted distribution.

9.3.2.2. Product Design and Development Factors

For Product Design and Development Factors, there are four specific requirements that need to be addressed individually:

1) New Product Design
2) Research and Development
3) Role of Industrial Designers
4) Design Consultants and External Expertise

The importance of new product design for a company's prosperity is shown by Hopkins (1980) who reported that most companies rely to a large extent on new products. Over 25% of the firms in his study attributed more than 30% of their current sales to products. Similarly, Booz et al (1982) revealed that companies are likely to derive nearly one-third of their profits over the next several years from new products.

Similarly, the DTI (1991a) indicated that most of the successful Japanese manufacturers used new products as the core strength of company success. Furthermore it revealed that most of the Japanese companies believed that their product development and design activities were their most powerful competitive tools.

Interestingly, studies by the DTI (1994) have shown that in order to compete with other competitors, companies; need to introduce new products, must be first in the market and supply the right new product to their customer. According to the DTI's survey, being six months late to market can reduce profits by up to 35%. However timely release even with a 50% overspend on development, can result in just 5% reduction in lifetime profits for a given product.

In terms of Research and Development (R&D), a report by DTI (1994) regarding an awareness programme encouraging UK SMEs to adopt management best practice showed that expenditure on R&D is a key indicator of the level of innovative activity within an economy. For instance, the DTI claims that countries like Japan and West Germany have spent considerably more financing in product development and consequently their industries have achieved relatively higher rates of return compared with other countries. This report suggests that the effectiveness of the spend and of the new products' result is more important than the amount spent on R&D itself.

The role of industrial designers in NPD is another factor of best practice in many successful companies. Many studies have shown the importance of industrial designers in the NPD process [e.g. see Lorenz 1990, Fairhead 1987, Thornton 1987]. This importance is based upon the requirement to improve effort to design and produce high quality consumer products in order to compete in international markets. According to Fairhead (1987), in a number of successful companies, the designer's role is a much wider one than is common in traditional, compartmentalised companies. Fairhead gives an example of the Sony Corporation where, he claims a wide range of designer capabilities exist. Concerning this Yasuo Koruki (the Head of Sony Design Centre) intimated:

> 'industrial designers should be the creators who fully understand all the facilities available to them in the company. They should be market creators who can make new products by combining social trends and the inner factors of their own corporation. There is a variety of individual skills within the design organisation. The process of co-ordinating these skills is design management' (pg.132)

According to Koruki, industrial designers can become *'visionaries'* who interpret environmental trends [see Fairhead 1987].

In the context of the concurrent product development process, industrial designers are seen as having a variety of roles and skills by an equal number of authors. Wilson (1995) for example sees industrial designers as being *'facilitators'* of the design teams. Hughes (1995) backs up this positive claim though sees them as playing an *'integrating role'* between customer needs and technical solutions. Other author's findings on the industrial designers role and skills are summarised below:

- Lyons (1995) - 'central' to the competitive process
- Hancock (1994) - 'value-adding collaborator'
- Harkins (1994) - 'development integrators' and 'holistic thinkers'
- Braham (1992) - 'key players' on the concurrent engineering team
- Lorenz (1990) - 'translator', 'bridges' and 'catalysts'
- Thornton (1987) - 'concepts creator', 'facilitator' and 'bridge the gap' between marketing and engineering

Sony, Olivetti, Braun, and even much larger companies such as Philips, as well as other 'minority' manufacturers can all boast successful products which were conceived by industrial designers working informally as *'product planners'* and *'project leaders'* (Lorenz 1990). Similar cases are also found in Cannon, Sharp, Yamaha and Atari where the industrial designer is in charge of *'integration'* and *'market linkages'* from concept to production (Fujimoto 1990). Besford (1987) reported that the successful practices of the NPD process found in Japan, Germany, Italy and many North European countries are due to the role of the industrial designer in the NPD process being understood and since his contribution is valued.

Bruce et al (1995) showed that in Italy, designers often see themselves, and are seen by others, as *'creators'* whose job is to inspire new ideas or approaches to problems. Furthermore empathy between managers and designers and the realisation of the benefits that such interaction can bring have demonstrably produced effective results.

According to Besford (1987 pg.137) best practice of the NPD process requires a combination from industrial designers, engineers and marketers:

> 'If marketing and engineering managers understand and appreciate the contribution of the designer and respect the role of the designer in the product development team, then the contribution of design will enhance the quality of the final product. However, the designer acting as a catalyst between engineering and marketing, must never lose sight of his ultimate target, the consumer'

Further, the combination between industrial designers, marketers and engineers is important in NPD process since industrial designers will spend the majority of their time with engineers, turning a product concept into reality or collaborating with marketing to respond to consumer requirements. Based on these ideas, Besford (1987 pg.136) outlines the role of industrial designers in developing new products with strict concern for the following priorities:

- The design brief (clarifying objectives);
- Product ideas generation (ideas for new and existing markets);
- Development of specific form concepts;
- The interpretation of human factors;
- Colours (functional and decorative);
- Product graphics (product legibility and brand development);
- Packaging (liasing with graphic designers), and;
- User manuals (liasing with graphic designers).

Ulrich and Eppinger (1995) have divided the industrial designer's role into three types of product; technology-driven, user driven and technology-and-user-driven.

According to them, the role of industrial design and industrial designers in the process of NPD varies according to these three types of product. Table 9.1 illustrates the fundamental differences between the three.

In the UK, The Design Council's Report (1983) on industrial design (the Carter Report) found on average, UK respondents gave industrial design a high rating, 4.0 out of 5.0, for its potential importance in achieving commercial success.

TABLE 9.1 : The Role of Industrial Design/Designers According to Product Type

Product Development Phase	Type of Product		
	Technology-Driven	**User-Driven**	**Technology-and-User Driven**
Identification of customer needs	ID typically has no involvement.	ID works closely with marketing to identify customer needs. Industrial designers participate in focus groups or one-on-one customer interviews.	ID works closely with marketing and engineering to identify customer needs. Industrial designers participate in focus groups or one-on-one customer interviews.
Concept generation and selection	ID works with marketing and engineering to assure that human factors and user-interface issues are addressed. Safety and maintenance issues are often of primary importance.	ID generates multiple concepts according to the industrial design process flow.	ID generates multiple concepts according to the industrial design process flow. ID must work closely with engineering during this phase.
System-level design	ID typically has little involvement.	ID narrows down the concepts and refines the most promising approaches.	The team narrows down the concepts, selects a final approach, and then finalises the design.
Detail design	ID is responsible for packaging the product once most of the engineering details have been addressed. ID receives product specifications and constraints from engineering and marketing.	ID selects a final concept, then co-ordinates with engineering, manufacturing, and marketing to finalise the design.	ID participates in a quality assurance role to affirm that engineering changes do not create ergonomic or aesthetic problems. Typically ID will work closely with engineering and marketing to resolve any design conflicts.

source : Ulrich and Eppinger (1995)

In terms of an industrial designer's functions, all respondents gave a high rating, 3.8 out of 5.0, for 'visualising the product' and 'representing alternative design solutions' compared to the other two categories, 'pre-design task' and 'supplementary tasks'.

Another element of best practice in the NPD process is to employ the services of industrial design consultants or to invite external expertise into companies. According to Eustace (1985), as the demands from customers increase, companies have to ask design consultants to help them design their products in order to maintain their position in the changing market. Eustace believes that design consultants can offer companies the skill they need and at the same time give them advice based on their wider experience working with other companies. According to Hancock (1995) one of the advantages to companies of employing the service of design consultants is that the company can work with the best rather than use in-house design consultants. She advises that in order for both to work successfully, they must understand each other's requirements and needs and develop mutual understanding. In this way long term profit can be established. By developing this type of approach, design consultancies can be bound up with the company almost as intimately as an in-house team would be. Thus they know the strengths and weaknesses of the company they work with which is important for design consultants in helping to strengthen company strategy. To demonstrate this importance, a report by Engineering magazine [see September edition 1991 pp.31-33] found that most of the winning products at the British Design Awards were originally designed by design consultants. For example, Land Rover's Discovery have used the Conran Design Group to develop the interior design of the vehicle. The result has been an interior which significantly different from other 4WD vehicles, complete with new colour schemes and surface textures. Conran provided not only a useful non-automotive view point on design, but also important knowledge of market factors. Other successful products cited by this report include the Soundcraft Delta mixing console designed in conjunction with consultants Rober Weaver Design, the Nomix-Chipman precise sprayer, designed by Raffo Design and the Neen Pain Xenos, an electronic pain relief device, developed by Cambridge Consultants.

The scale of design consultant usage by UK companies is illustrated with reference to Roy (1987). He showed that over 90% of the UK companies employed in-house design staff but that nearly three-quarters of these companies used design consultants. Furthermore, a study of two hundred and twenty one SMEs in the UK who employ the services of design consultants to help develop new or improved products, showed that 60% of all projects and 90% of the implemented ones were commercially successful. Other spin off benefits included the firms gaining design management skills and some impact on the UK trade balance (Bruce et al 1995). Chung (1989) backs this up and suggests that there are a number of UK design consultants that have been actively helping their clients in formulating appropriate product strategies. They have accumulated their practical knowledge, know-how as well as their experience with other clients. In terms of the major advantages of using design consultants, Chung's survey has shown that professionalism (the high quality of design services), creativity, objectivity, flexibility and freshness are amongst the factors of preference given by respondents.

An additional best practice approach is to appoint external expertise to work in the company as advisers to the company. Fairhead (1987) calls this approach the 'non-executive external designer approach'. He shows that the purpose of this approach is to appoint a top-level designer as a board adviser. His role is to advise on design policy and acts as a design champion for lower-level designers, a form of cross-functional and hierarchical short-circuit device. Fairhead reveals that companies such as Duracell, Olivetti, Sony, Wilkinson Sword, as well as Boots have all used this type of approach in their design process. In the case of Olivetti, he cites:

> 'At Olivetti, engineers and marketers have learned to work alongside some very talented external designers, who have the dual prestige of a wide ranging external practice , and the highest level contacts in general management. Because they are not expected to be 'company men', they are therefore in a strong position to fight their corner, if necessary, against 'departmental groupthink'. This has also for some time been the way at Wilkinson Sword. Sony also use well-known European and American external designers to give their products a sufficiently 'European' feel'. (pg.138)

9.3.2.2.1. Key Aspects of Best Practice (Product Design and Development)

Having a new product for the customer is widely considered to be an important contributory factor to strengthen the success of a company as well as being a powerful competitive tool. The best, most successful companies are those who place as much emphasis as possible on their R&D department. The best practice of most NPD processes also depends on the contribution of industrial designers in developing new products for a company. Research has shown that successful companies see the role of industrial designers in NPD not only as 'visionaries' who interpret customers needs, but also as having a variety of roles and skills in order to produce high quality consumer products in order to compete in international markets. Another best practice factor contributing to the success of a NPD process is the employment of design consultants or external expertise into companies to help them design their products. This is the best approach in helping companies maintain their position in the changing market.

The findings from the literature search on product design and development show that the elements of best practice of new product design include:

- designs made for the global market;
- the design of high quality products;
- less dependence on existing products, and;
- producing innovative and superior products.

In terms of R&D the findings have shown that it is important for the company to have a centralised R&D department, special budgets and suggest that R&D should control the pace of NPD.

Literature indicates that the role of the industrial designer in the NPD process includes :

- acting as a mediator within the multi-discipline team;
- co-ordination of a project;
- improving the quality of the product, and;
- cutting product and production costs and increasing sales.

Finally, the findings have confirmed that design consultants and external design expertise to companies provide valuable advice and contribute to design proposals based on previous work experience.

9.3.2.3. Technical Factors

There are three specific requirements under Technical Factors to be discussed. These are :

1) Product Development Process Model
2) Multi-Disciplinary Teamwork
3) Concurrent Engineering

Having a proper model of the product development process is widely considered as part of best practice in enhancing product success. Today, the model of the product development process is an increasingly popular way of organising NPD in most successful companies.

According to the DTI (1994) every company must have a clearly defined and understood step-by-step process for developing new products. Without a model, it would be impossible to identify where excessive time is consumed, or where more efficient planning and management could provide a more cost-effective and rapid response to the market and customer needs. The DTI reports that by adopting BS 5750, BS 7000 or TQM, a company will gain a clear view of its current standing, where it wants to be and which priorities are necessary for change. According to the DTI, to improve the design and development process, a company needs to know not

only where it is now, but also where it wants to be and what it needs to change in order to improve. The current process model will be invisible in many organisations apart from formal descriptions in quality or procedure manuals. The DTI referred to above has shown that companies that have models of the design and development process can use them to consider both the different stages of the product lifecycle and the differing characteristics of the industry or product.

The key for best practice in the design process is to put a team together comprising a mix of professional skills. A number of articles have shown that a multi disciplinary team approach to the NPD process is associated with success [see for example Dagger 1996, Hancok 1994, Braham 1992, Cross 1992]. Wasserman and Moggridge (1990) indicate that the best practice of a multi disciplinary team is to combine all professionals, industrial designers, engineers, marketers, ergonomists and sociologists into one team rather than having individual teams being co-ordinated.

Multi disciplinary teams have also been suggested by many researchers as a better means of developing products than traditional functional structures. For example, a study by Costanzo (1992) has shown that about 70% of manufacturing companies are now using multidisciplinary teams to develop new products. According to Pelled and Adler (1994) the essential difference between the team method and traditional product development process is that the traditional method focuses on sequential 'hand-offs' between functions while the team method brings together representatives from different and diverse departments such as marketing, manufacturing, R&D and quality assurance. By following this, the members of the team can visualise the product development project from inception to completion. This is important since it enables the members in the team to bring skills and knowledge into the design process at all phases, especially in the early stages of NPD. To illustrate this, between 75% to 85% of a product is committed during the early stages of the product development process (Salomone 1995, Turino 1992, Andreason et al 1988)

According to the DTI (1994 pg.7), multi disciplinary teams can also facilitate concurrent engineering if the team knows some specific approaches. These approaches include:

- Understanding how to add value for the customer;
- Shared goals, values and understanding the issues;
- Clear objectives, communication and decisions;
- Defined roles, responsibilities, accountabilities and authority;
- Understanding the new product stages and the effects of delay and lateness, and;
- Giving priority to the project and the company rather than to the needs of individual functions.

Roberts (1990) however has warned that many companies, in implementing multi skill teams, have not considered the purpose of the teamwork itself. According to him, to make teamwork function, members in the team must understand their role and tasks in the NPD process. Roberts supported the DTI on a number of points, suggesting that members in the team need to be aware of:

- How to add value to the customer;
- The business and competitive objectives of the project;
- The implications of achieving, a design- and the effects of lateness;
- The nature and attributes of the 'core' or critical competences of the product, and;
- The structure of the design process and the key interactions in the design.

He further adds that, most importantly, the team members should understand how to carry out their tasks in order to maximise the achievement of the whole design project.

Aune (1992) suggests that in order to create efficient teams, team members should have:

- Common, understood, and accepted goals;
- Open and free communication, with the team members listening to each other;
- Mutual trust (whereby all members know that statements and opinions will not be used against them at future dates);
- A social support mechanism between members;

- A recognition of individual differences, that bring benefit to the whole team:
- Joint decisions without voting, and;
- Flexible leadership so that the team member who is most familiar with a given topic leads the work centred on it.

Similarly, Fairhead (1987) claims the design process involves a combination of skills from a number of different functional specialists. Successful companies realise that the NPD process is not just *multi*-disciplinary but *inter*-disciplinary, implying that there is more free-flowing, *inter*-dependent and interactive communication between functional specialists. In terms of the role of industrial designers in the inter-disciplinary team, Fairhead (1987) showed that industrial designers play a varied role. For example, they may attend trade shows with marketing and sales colleagues, visit other manufacturers with engineering and production staff or even visit laboratories with R&D personnel. Olivetti, for example, recognised the importance of the role that industrial designers can play in inter-disciplinary team:

> 'the importance of keeping industrial designers involved in a wide range of inter-disciplinary activities is fully recognised, and designers are not only expected to get out into the market place, but they are deliberately kept as independent consultants. This is to give a degree of freshness, objectivity and independence to their work, and to ensure that their professionalism and competence is all the more respected by other members of the design team' (pg.135).

Fairhead concludes that as a result of this integration, designers are able to play a much more positive role in the NPD process. In the case of Olivetti, not only does it recognise industrial designer's aesthetic, conceptual and technical skills, but also has an intuitive feel for the user as well as its role as 'facilitator', working across functional boundaries in an inter-disciplinary co-operative manner.

Implementing Concurrent Engineering (CE) has found to be another best practice approach in most of successful companies. CE refers to a systematic approach for the integrated, simultaneous design of products and their related processes including

manufacturing, testing, and support. CE ensures that all 'downstream' product considerations are moved up front. The goal of CE is to optimise all critical product-and-process characteristics (Revelle et al 1995).

There are many well documented examples that show how the CE process can reduce time to market, improve design and product quality, reduce the number of design iterations, speed the manufacturing process, and lower product costs [see for example Salomone 1995, Blau 1994, Syan and Unny 1994, Drovak 1992, Turino 1992, Shina 1991, Nevin and Whitney 1989]. In this sense, it is a powerful approach within product design management as stated in DTI report (DTI 1991b) that CE can have its biggest impact by encouraging the design and development of both products and the actual manufacturing process to be considered in parallel. Its benefits include:

- Getting products to market more quickly;
- Incorporating more features or variety in products at less cost;
- Producing more new products more often.

According to the Manufacturing Attitudes Survey (Farish 1994), there were 88% of sites claiming awareness of the CE and 83% claimed that they were implementing a team based approach. The benefits of the approach were also widely recognised with 79% of respondents citing increased productivity and 77% reduced lead times as a result of implementation.

However, Pye (1993) reported that a survey undertaken by the Design Council has shown that CE is under-used especially in the SMEs sectors. Nevertheless, he reported that 43% of companies which claim to have implemented CE are achieving the business benefits of lower costs, better quality and shorter cycle times due to implementation.

In terms of companies involved in consumer products, Philips [see Corbett et al 1991] reported that by adopting CE, they have achieved the followings benefits:

- Volume of parts reduced by 25%;
- Assembly time reduced by 28%;
- Number of operations reduced by 30%;
- Parts which can be assembled automatically have increased by 200%.

According to Corbett et al (1991), Hitachi also reported some improvement in their video tele-recorder (VTR) producing 75000 per month. In agreement with the results found at Philips the improvements in their product development process included:

- Reduction in the number of parts;
- Easier assembly of parts;
- Easier assembly line resulting in a 83% reduction in labour costs;
- Improvement in quality.

Similarly, Motorola (USA) reported to have reduced parts used and assembly costs by 42% and 65% respectively (Miles 1989)

9.3.2.3.1. Key Aspects of Best Practice (Technical Factors)

Previous studies have shown that the best practice of the NPD process is achieved by having a proper model of the product development process. This enables efficient planning and management which can result in providing a more cost-effective and rapid response to the market and customer needs. Several tools such as BS 5750, BS 7000 or TQM all claim to improve the design and development process. The method of multi-disciplinary teamworking is another well known best practice of developing products. Through this approach all professionals are co-ordinated within one team. It incorporates visualisation of a product development project from the early stage - a stage crucial to the whole process. Multi disciplinary teams can also facilitate CE, another best practice element important to corporate success. This approach optimises all critical product-and-process characteristics and the benefits of the approach have been widely recognised.

Technical factors findings in the literature search show that one of the vital elements of best practice is for companies to have a clearly defined process. This process should be widely understood and accepted throughout the company with each function having an input at all stages of the process. In terms of multi-disciplinary teams, the findings have shown that it is related to:

- the degree of integration between design;
- marketing and manufacturing;
- involvement of the design team from the inception;
- recognition of the role of industrial designers;
- mutual trust between members in the team, and;
- mutual feedback and criticism between the team members.

Finally, literature findings have shown that companies who implemented CE have a good fit between the product and the company in terms of ;

- research and development;
- engineering and production;
- value of the importance of the role of industrial designers in this approach;
- minimal changes during design, development and production, and;
- working continuously for cost reduction and quality control.

9.3.2.4. Management Factors

Three specific requirements have been found as playing a part of best practice under Management concerns:

1) Management Style
2) Top Management Involvement
3) Role of the Product Development Manager

Some reference has already been made to the importance of a systematic management style as a part of best practice in managing the NPD process. For example. the report by the Select Committee on Science and Technology (1991 pg.9) summarised that successful companies should have management characterised by:

- Informed, committed leadership by both the board and management;
- Direct and frequent communication between all levels and sectors of the business;
- Delegation of responsibility to smaller, self-contained units, while maintaining clear strategic direction from the top;
- Flatter, less hierarchical structures, and;
- A company culture favouring the involvement of committed product champions.

Similarly, Johne and Snelson (1990) implied that the best practice of management is that where top managers have an open, imaginative and creative management style that encourages middle management to function effectively. The role of top management in successful NPD is highlighted by Johne and Snelson (1990) who claim that successful NPD 'depends so much on the person at the top'. Furthermore management support is vital in bringing new products to the marketplace. Similarly, Numata and Taura (1996) in their case study research have revealed this importance of top management. At Sony, top managers are directly involved in the process of NPD and are open to new ideas, are technically well informed and are aware of the new products for the next-generation. In fact, the top executives, including the founder and currently the honorary president of the Sony Corporation, played an important role in pushing forward the development of new products.

According to Oakley (1990) top managers are the key success in managing the product development process since they can structure their organisations in ways which will encourage inter-disciplinary tasks and the release of energy, imagination, talent and ideas. Top managers also have the ability to direct their organisations and establish reward standards of excellence. By doing this, they will be managing the NPD process in such a way that 'their company has every chance, not only of surviving, but of beating the competition, growing and enjoying the fruits of success'

(pg.135). Similarly, Bingham and Quigley (1990) advocate that top management can direct NPD by providing leadership.

The DTI (1991a pg.7) explains why top management should be held responsible for managing product design. It suggests that:

1. Design is the foundation on which a manufacturing company's success of failure is built, so the ultimate responsibility for design must clearly lie with the chief executive;

2. A company's product strategy forms the foundation of its corporate objectives. Unsuccessful product design will eventually bring the company down, however good its performance in other areas;

3. Successful design management demands integration of the design process with the company's other activities, from manufacturing through purchasing to finance.

The report goes on to state that the role of the chief executive is to ensure that the company's design activities are managed correctly. In this sense they must ensure objectives are set and that managers responsible for the day-to-day work understand and fulfil their function.

Johne and Snelson (1990) have suggested a 'Seven S's' list of criteria that top management need to display in order for products to become successful in the market place:

1. **S**trategy - top management should set broad objectives for organic growth.
2. **S**hared Value - top management must foster understanding of the need for genuinely new products.
3. **S**tyle - top management needs to be intimately involved, on a day-to-day basis.
4. **S**tructure - top management requires new organisational forms, such as business teams, to nurture important developments outside the mainstream organisation.
5. **S**kills - management should take interest in techno-commercial idea generation, screening and testing concepts since development work is often based on new technology.
6. **S**taff - the product development manager should be allowed to select his/her own team with whom rewards are shared.
7. **S**ystems - requirement for systems to be loose-tight using simultaneous approach.

According to Johne and Snelson (1990 pp.47-48) the key role of top management in NPD is equally ubiquitous with the need to envision, energise and enable projects to be undertaken. This is made possible by making the following contributions to the NPD environment:

- Encouragement and communication of a longer-term strategic vision for product change;
- Taking the lead in product developments;
- Selection of appropriate market-based product development strategies;
- Appropriate organisational designs for facilitating product development work;
- The development and communication of a strategic vision is entirely the responsibility of top management;
- Strategic planning in which longer-term objectives are accommodated;
- Top management takes a proactive approach to product development, and;
- Top management creates and nurtures cross-functional market-led product development teams.

Another specific requirement found to be of importance as best practice in managing the NPD process is top management's appointment of someone to be responsible for the process. He or she is known as the 'Product Development Manager' or 'Project Manager' and their duty is to manage the NPD process as well as to manage the NPD team. According to Revelle et al (1995) the Product Development Manager provides leadership in the development of the NPD process. This individual needs to have a global view of the enterprise and to see the NPD process as a business endeavour. They add that good Product Development Managers know that they must work closely with a variety of disciplines and must have a vision of what the product will do for the company and what determines success by understanding the technical issues involved, be able to identify critical obstacles, and make accurate decisions on the technology. They concluded that Product Development Managers must be chosen on the basis of their skills since their duty is to work with team members in order to produce a *'product champion'* that satisfies the needs and expectations of the customers.

Rosenthal (1994 pg.81) indicates that Product Development Managers should be placed in charge of providing leadership in meeting the targets through all phases of the NPD process. Their responsibilities should include:

- Defining the product requirements, and the costs and profitability associated with its introduction;
- Determining the viability of the product concept from the company's point of view;
- Working with functional managers to select a project team;
- Controlling the project's budget;
- Managing discussions and negotiations involving trade-offs in project goals and targets;
- Being a champion for the new product and role models for team members, and;
- Leading the team to accomplish the goals of the project.

Finally, Clark and Fujimoto (1991 pp.256-257) have compiled a list of characteristics of the role of Product Development Managers in successful companies.

- Co-ordination of responsibility over wide areas, including production and sales as well as engineering;
- Co-ordination of responsibility for the entire project period from concept to market;
- Responsibility for concept creation and championing as well as cross-functional co-ordination;
- Responsibility for specification, cost target, layout and major component choices;
- Responsibility for ensuring that the product concept is accurately translated in technical terms;
- Frequent and direct communication with designers and engineers at the working level as well as through liaisons;
- Maintenance of direct contact with customers;
- To possess multilingual and multidisciplined abilities in order to communicate effectively with multi-disciplinary team members;
- To take a role and show talent in managing conflict between team members;
- To possess market imagination and the ability to forecast future, and;
- To circulate among project people and strongly advocate the product concept rather than through paperwork and the conduct of formal meetings.

Clark and Fujimoto concluded that good Product Development Managers need to be responsible for two roles: as *internal integrators* and as *concept champions*. These assist in effective cross functional co-ordination and integrate insight and expectations into the details of development respectively.

9.3.2.4.1. Key Aspects of Best Practice (Management Factors)

Findings have shown that the best practice of NPD lies in a systematic management style. Some reference has been made to the advantages of less hierarchical structures as the best style of management. Furthermore, successful products in the marketplace have shown to be related to the support and involvement of top management. Their role is not just as a 'pusher' for the development of new products brought forward, but is also to direct their organisation through leadership to enable product success. Another specific requirement found to be important as best practice is regarding the role of the product development manager in managing the product development process and the team as a whole. With a global view of an enterprise, the product development manager becomes an internal integrator as well as a concept champion in meeting the targets of the NPD process.

In collaboration with the literature search on management factors, findings have shown that the elements of best practice of management style is related to flatter and less hierarchical structures. In terms of top management involvement, the findings have shown that it is related to:

- commitment to product champions;
- influence over NPD, and;
- involvement in the entire development process.

Literature findings have further shown that the role of Product Development Managers is related to:

- an informed and committed leadership;
- direct and frequent communication between all levels;
- clear strategic direction from the leader;
- established directions for team development;
- the making of major decisions for the team, and;
- the setting of objectives for team tasks and development.

9.4 Summary and Conclusions

The specific objective of this chapter is to provide a detailed understanding of the elements of best practice in NPD process. A number of existing best practices which are recommended to companies as representing best practice in the management of the NPD were discussed in detail. Based on these considerations, four key factors: (1) Customer and Marketing Factors, (2) Product Design and Development Factors, (3) Technical Factors, and, (4) Management Factors were identified as important and applicable to be adopted in a proposed model of best practice. The rationale for adopting these four key factors is that they have been identified as central to successful new product and NPD in previous studies. Underlying each of these key factors are a number of specific requirements that were discussed individually. The four key factors together with specific requirements made up a 'model of best practice' as presented in Table 9.2. These factors will be used as guidance for best practice evaluation between the proposed model of best practice and the findings from the case studies for the Malaysian and UK companies (discussed in the next chapter). The results from these evaluations will provide insights into the relative success of NPD practices in both Malaysian and British based companies.

TABLE 9.2 : PROPOSED MODEL OF BEST PRACTICE

1. CUSTOMER AND MARKETING FACTORS

Company's Products
Unique features/benefits for users
Highly innovative products, 'state of the art'
Difficult for competitors to copy
Superior products of higher quality than competitive products
First-to-the-market type products
Products should allow customers to reduce their costs

Customer Expectations and Responses
To meet user needs better than competing products
To be accepted quickly by users
Selection of customers for testing market acceptance
Involvement of customers in the design and development process
Development by teams which more fully understand user needs

Marketing Knowledge and Proficiency
Understanding of the target market
Understanding of users' needs and wants
Understanding of buyer's behaviour
Development with a clear market strategy
Knowledge of buyer price sensitivity
Knowledge of the competitive situation
Determination of market characteristics and trends
Study of feedback from customers regarding their product
Market research resources
Strong sales force launch effort
Strong advertising/promotion launch effort

2. PRODUCT DESIGN AND DEVELOPMENT FACTORS

New Product Design
Assessment of needs for new products
Translation of the product concept into business terms
Interaction with users in the development stage
Less dependency on existing products in the market
Close relationship to the company's areas of expertise
Industrial design to play a major role in product design
Use of new or advanced technology in design and production
Production of innovative and superior products
Global market centred design

Research and Development
Existence of own, centralised R&D department
Specific budget/allocation for R&D
Support by all levels of management

Role of Industrial Designers *is to:*
Visualise and create the product concept
Represent alternative design solutions
Act as mediator within the multi-discipline team
Co-ordinate projects
Improve the quality of products
Cut product and production costs
Making products easier to use
Develop product strategy
Package and publicise the products

Design Consultants and External Expertise
Employ service of industrial design to provide advice and contribute to design proposals
Appoint external expertise to advise the company

3. TECHNICAL FACTORS

Model of Process *should incorporate:*
A clearly defined process
A proper model of the design process
Standards by adopting quality standards i.e. BS, ISO, TQM etc.
A process widely understood and accepted throughout the company.
Each function having an input at all stages of the process

Multi-Disciplinary Teamwork *elements include:*
A high degree of integration between team members
Recognition of the importance of design/industrial design
Awareness of the role of industrial designers
Understanding of goals by all team members
Open and free communication
Mutual trust and assistance between members in the team
Understanding and recognition of other members tasks
Joint decision making

Concerns for ***Concurrent Engineering*** *are:*
Implementation
Reduce product development and production times
Performance efficiency
Interaction between inter-disciplinary teams
Relative importance and role of all members
Design, development and production changes to be kept to a minimum
Advantages to the company

4. MANAGEMENT FACTORS

Management Style
Flatter, less hierarchical structures
Flexibility leadership
Improved internal communication

Top Management
Commitment to product champions
Influence in new product development
Less individual power and directed authority
Involvement in the entire development process
Support by senior management

Role of Product Development Manager
Informed and committed in leadership
Direct and frequent communication between all levels
Create a clear strategic direction
Assign responsibilities to team members
Establish directions for team development
Make major decisions for the team
Set objectives for team tasks and development

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CHAPTER TEN

COMPARATIVE ANALYSIS OF ELEMENTS OF BEST PRACTICE

The main purpose of this chapter is to discuss the results of the cross-case analysis of elements of best practice in the Malaysian and UK companies involved in the case studies. The introduction (section 10.1) is followed by a proposed model of best practice in 10.2. Section 10.3 discusses the best practice evaluation and is followed by comparative analysis techniques and the selection of comparative analysis in sections 10.4 and 10.5 respectively. 10.6 and 10.7 deals with the key findings and comparative analysis of the Malaysian and UK case studies highlighting the differences and similarities between the two countries. Section 10.8 deals with correlation of best practice of both countries with a proposed model of best practice. Finally, findings and conclusions of this chapter are presented in 10.9.

10.1 Introduction

In Chapter Eight, the results and findings of the case studies including interviews, documentary reviews and direct observations at the eight companies studied in Malaysia and the UK were discussed in detail. The findings of the case studies helped to provide knowledge about the actual conditions of elements of best practice in both, Malaysian and UK companies. Although the findings of case studies for Malaysian and UK companies identified important determining principles and elements in the NPD process, this by itself seems insufficient. To establish more conclusively, how these elements and principles are related and can be adopted as best practice to support Malaysian SMIs in the real world, it was found necessary to compare UK and Malaysia practice to discover whether there are any significant differences and similarities between the two countries. In order to illustrate the main conclusions of the research, the findings from the comparative analysis were correlated with a proposed model of best practice derived from the previous literature.

In this chapter therefore, discussion focuses mainly on the cross-case analysis between Malaysia and the UK. The purpose of this chapter is to evaluate and identify the circumstances of the NPD process in Malaysia and UK companies. It raises some important issues of interest to this study which highlight the main themes of the research.

10.2 Model of Best Practice

As discussed in Chapter Nine, a model of best practice was established in order to provide a sharper focus for the issues under investigation. The model itself [see Table 9.2 pg.241] was based on four key factors: (1) Customer and Marketing Factors, (2) Product Design and Development Factors, (3) Technical Factors, and, (4) Management Factors, which were considered as 'core factors' of best practice based on conclusions from previous literature. The rationale for adopting these four key factors is that they have been identified as central to successful NPD [see 9.3 pg.212]. Moreover they appear at all phases of the NPD process and represent one or more activity in the whole process. These factors are related to the issues raised in Phase Two of the questionnaire survey, developed from key areas adopted from the concept of Business Process Analysis (BPA) research. Based on this consideration, the researcher believes that the four key factors stated above are appropriate as a focus for best practice evaluation in this research.

10.3 Best Practice Evaluation

In this study, the researcher attempts to evaluate the four core factors with respect to the specific requirements underlying them. These four core factors were used in the case studies to evaluate the element of best practice. These factors which were adopted as guidance for best practice evaluation can be summarised as follows:

1. **Customer and Marketing Factors**

Customer and marketing factors evaluate a company's products and how these products satisfy their customers. They also look at the way a company identifies its customers in order to measure the latter level of satisfaction. This is made possible by the measurement of how a company satisfies customer expectation and responses. Finally, it evaluates marketing factors by addressing the consistency of the marketing approach and strategy and matching it with the trend of customer expectation.

2. **Product Design and Development Factors**

These factors evaluate the importance of new product to the company and the type of products produced. They assess the way companies introduce their product and the reasons behind it. In terms of R&D, it considers whether a company has set up their own R&D department and the function of the R&D within the company. The evaluation also considers the role of industrial designers and other members of the team in the product development process. Finally, this factor evaluates the decision behind employing the services of industrial design consultants or external expertise to the company concerned.

3. **Technical Factors**

Technical Factors evaluate the NPD process with respect to particular models that have been adopted by the company concerned. It also looks at the way companies organise human resources into project teams to develop new products successfully. Additionally, it evaluates important issues regarding CE and other methods applied within a given company.

4. **Management Factors**

These factors attempt to evaluate aspects related to management style and the involvement of top management and senior managers in the process of NPD.

They also evaluate the involvement of Product Development Managers and how they deal with their staff in this process.

The results from these evaluations will provide insights into the relative success of NPD practices in both Malaysian and British based companies.

10.4 Overview of Comparative Analysis Techniques

The major aim of this research is to compare and contrast the NPD practice in Malaysian and UK companies. Although there are *no* standard procedures or analysis techniques indicating how comparative analysis should proceed, there are several approaches that have been outlined [see for example: Yin 1989, Merriam 1988, Miles and Huberman 1984]. The researcher has also found research by Song and Parry (1997), Maffin (1996), and Hart (1993) regarding techniques of comparative analysis very instructive. Since most of the works by these researchers relate to NPD, their comparative analyses were considered in order to guide the researcher in selecting the most appropriate comparative analysis for this study.

In their study of a cross-national comparative study of NPD between Japan and the USA, Song and Parry (1997) employed a zero-to-ten point scale to measure successful and unsuccessful management practices in the both countries. The cross-national comparative analysis they adopted was influenced by a procedure outlined by Douglas and Craig (1983) [see Song and Parry 1997 pg.6]. Similarly, Hart (1993) adopted a five-point Likert-type scale to gauge respondents' opinions regarding the dimensions of success in NPD. In addition to this, Hart also employed simple correlation to examine the characteristics of successful new products. In Maffin's research study (1996), formal assessment criteria to assess a benchmarking exercise against a composite of models of best practice factors were utilised. This allowed an ordinal score of 0 - 5 to be assigned to each factor, with a score of five being equivalent to best. Although similar scales have been adopted in other recent studies

[see Song and Parry 1997 pg.7], the researcher believes that this type of scale may not generate standardised measurement and may be rated differently by different people. This is because a zero-to-ten point rating, such as adopted by Song and Parry, is too intricate to differentiate. Moreover, the researcher believes that this type of measurement is more appropriate for data of a quantitative nature rather than qualitative one such as the case studies in this research.

10.5 Choice of Comparative Analysis Techniques

Based on the above discussion, in the present study, all the data derived from the case studies were analysed by a simple cross-case analysis procedure suggested by Yin (1989 pg.57 & 115). A cross-case analysis procedure was adopted with both UK and Malaysian circumstances being compared in order to discover the significant differences and/or similarities of best practice elements between respective SMIs and SMEs, with special consideration to the cultural differences between the two countries. As suggested by Miles and Huberman (1994), by adopting cross-case analysis, 'generability' and deepening of 'understanding and explanation' are enhanced. They also claim that cross-case analysis helps the researcher strengthen theory, built through examination of similarities and differences across cases. Similarly, Merriam (1988 pg.156) believes that cross-case analysis involves collecting and analysing data from several cases that can 'build categories, themes, or typologies that conceptualise the data from all the cases, or that can lead to building substantive theory offering an integrated framework covering multiple cases'. It is hoped that by comparing the cases of Malaysia and the UK in the present study, the researcher 'can establish the range of generability of findings or explanation' (Miles and Huberman 1984 pg.151).

In order to display and summarise the data in a more understandable and readable form, an unordered meta-matrix was adopted. The unordered meta-matrix is a 'chart organised by variables of interest to researchers that contains bits of narrative such

as key phrases, quotes, or illustrations of the category' (Merriam 1988 pg.155). This method is based on procedures outlined by Miles and Huberman (1994). According to Miles and Huberman, the unordered meta-matrix is a way of bringing together basic information from several cases into one big chart in a 'stacking' style. They claim not only this method can be easily adapted to studies where there are a few cases but it also displays the focus of the study and can maintain the richness of research findings.

Therefore in this study, all case study findings were categorised using key phrases and were displayed using the unordered meta-matrix. The result displays key findings of case studies for both Malaysia and the UK and form a model of best practice for both countries. Both case were then compared and contrasted in order to discover whether there were any patterns or relationships between the two counties. In order to illustrate the main conclusions of the research, the results from the comparative studies were then correlated with the derived conceptual model of best practice, with the aim of identifying any patterns and relationships that might exist. The results of the correlation form a valuable background to show how the elements of best practice might be redefined and combined in order to make them applicable as best practice guidelines to the Malaysian SMIs' context.

10.6 The Key Findings of Malaysian and UK Case Studies

The syntheses of results were analysed using the four core factors that formed a 'model of best practice' (discussed in sections 10.2 and 10.3). Evaluations on these four factors in both Malaysian and UK companies were carried out as a means of providing a clear understanding of the actual conditions of best practice in NPD for both countries. The major findings for both Malaysian and UK case studies (discussed below) are based on earlier case study findings presented in Chapter Eight.

10.6.1 Malaysian Case Studies Findings

1. Customer and Marketing Factors

The results show that Malaysian SMIs still rely on existing products and foreign technology in developing new products. Most of the products have been produced under licensing arrangements. Furthermore, most of SMIs produce very low quality products with a limited choice of design.

Most of the products produced by Malaysian SMIs go through a process of 'localisation' and 'modification' in order to be suitable for local market conditions. Thus products may have been visually or materially improved in order to give more choice to their customers.

In terms of the involvement of customers, the results show that the majority of Malaysian companies exclude their customers and end-users in the NPD process.

It was also found that rather than conducting market surveys, Malaysian companies rely on business experience to gauge customer requirements.

2. Product Design and Development Factors

Design and development of most Malaysian SMIs is still based on 'reverse engineering', 'modification' and 'localisation' to suit local needs. Therefore, most of the SMIs have to follow design trends via foreign catalogues and magazines. They also visit domestic and international trade exhibitions to help create a product design base.

The results show that most of the Malaysian SMIs have R&D departments to assist the development of new products. Generally, a special R&D budget is allocated for R&D.

In terms of the role of industrial designers, most of the companies agreed that they may contribute to the initial stage of the design process as 'visualisers' and 'aesthetic specialists' by creating ideas for new products or by improving existing ones. All of the companies agree that industrial designers should be involved from the first stage (ideation) to the final stage (production). The results also show that most of the in-house industrial designers work in a design team incorporating multi-disciplinary teams.

Most of the SMIs have not employed the services of industrial design consultants or external expertise. This is because there are only a few design consultants in Malaysia directly involved in NPD.

3. Technical Factors

The majority of Malaysian SMIs still follow a sequential process (ideation to production) in developing new products. Generally, most of them have not adopted any particular models of the design process to carry out design development. The results also show that most Malaysian SMIs are *intending* to adopt a formal quality system and are currently in the process of getting quality certification such as ISO and BS.

Most of the companies do not encounter any serious problems arising from conflicts between different functions in the NPD team. Companies reported that they have not adopted any methods to foster teamwork, however, the development of relationships and mutual understanding among team members is a key factor to foster teamwork.

In general, most of the SMIs involved in case studies have not implemented CE.

4. **Management Factors**

The findings show that top management are responsible for the formulation of all business policy and business culture as well as process. The results also indicate that top managers (e.g. Chairman, CEO, General Manager) have authority and power and act as determining decision makers in most of the Malaysian SMIs.

From the results, it can be concluded that most Product Development Managers in Malaysian SMIs are involved in, and responsible for the product design and development process. As leaders, they are responsible for their team and decisions on the final design of products. However, in most cases, the *final decision* about products is made by top management (e.g. Chairman, CEO, General Manager).

10.6.2 UK Case Studies Findings

1. **Customer and Marketing Factors**

The results show that most UK companies have their own products with their own specific markets. Furthermore, most of the UK companies have to maintain their products, to compete in the market, by upgrading product quality and introducing new product ranges. This is based on company market demand plans and customer trends.

In terms of the involvement of customers in the NPD process, the results show that the majority of UK companies in this study have not involved customers and end-user.

Most of the UK companies have conducted surveys in order to gauge the real needs of their customers and to improve their products. This has been made possible by 'user research' and 'catalogue analysis'.

2. Product Design and Development Factors

Design and development at most of the UK companies is based on strategic planning set to target customers and markets. Since most of the UK companies are less dependent on existing products in the market, they have a continuous programme of upgrading and replacing their products in order to follow market demands and customers trends.

Generally, most of the UK companies have R&D departments to assist the development of new products. Additionally, most of the companies have allocated a special budget for R&D.

In terms of the role of industrial designers, most UK companies agree that they may contribute to the initial stage of the design process by helping to create a product image. In this respect, most of the companies suggest that industrial designers are 'aesthetic specialists' and can 'give a uniqueness to the design'. All the companies studied agree that industrial designers should be involved from the first stage (ideation) until the last stage (production). The results also show that most of the in-house industrial designers work in a design team incorporating multi-disciplinary teams.

Most of the UK companies have not employed the services of industrial design consultants or external expertise. The reasons given for this are that it is 'not necessary' and that it is a 'risky business'. This arguments is not withstanding one company (who rely entirely on the services of industrial design consultants) who found that these services *do* enable their company to get fresh ideas and reduce costs.

3. Technical Factors

The majority of UK companies still follow a sequential process (ideation to production) in developing new products. Generally, most of them have not

adopted any particular design process model while carrying out design development. However, one company has adopted their own Integrated Product Development and Process (IPDP) programme. The results also show that most of the UK companies have adopted a formal quality certification such as ISO and BS.

Most of the companies show that they do not generally encounter any serious problems arising from conflicts between different functions in the NPD team. Furthermore, they reported that there are no particular methods to foster teamwork but that a relationship of mutual understanding among the multi disciplinary teams is crucial.

The results show that all the UK companies that participated in the case study have implemented CE or other similar methods.

4. Management Factors

The majority of the UK companies showed that top management are responsible for all business policy and business culture formulation and process. The findings show that top managers and directors have authority and power in most of the companies and that the role of other managers is only to give advice or discuss problems when necessary.

Additionally, the results show that most of the Product Development Managers in UK companies are involved and responsible for the product design and development process. As leaders, they are responsible for their team and decide on the final design of products proposed by the teams. However, the final decision about product lies with top management. One design consultant, involved in this study, however showed that their project leaders manage projects instead of the manager himself.

10.7 Comparative Analysis of Malaysian and the UK From the Case Studies Findings

From the above discussion of key findings of Malaysian and UK case studies, the researcher aimed to identify the background and actual conditions of best practice in both countries. By using a cross-case analysis procedure (Yin 1989 pg.57 & 115) cases were compared in such a way to reveal any similarities and differences that exist between the two countries in terms of their respective best practices. In order to compare and highlight the key findings of both cases, a model of best practice for both countries using a simple 'unordered meta-matrix' [see 10.5] is presented in Table 10.1. The major similarities and differences between UK and Malaysia SMIs are discussed below.

10.7.1 The Similarities Between Malaysian and UK Case Studies Findings

Based on the key findings of case studies discussed above, the similarities between the Malaysian and UK cases can be summarised as follows;

1. Companies in both countries have excluded customers and end-users from the NPD process.

2. In both Malaysia and the UK, R&D departments exist to assist the development of new products. A special budget is also allocated for R&D in both countries.

3. The role of industrial designers in the process of NPD is mainly that of 'aesthetic specialists', 'visualisers' and 'give a uniqueness to the design' in both countries. In addition, industrial designers are viewed as important activists from the first stage (ideation) until the last stage (production). Furthermore, findings show that industrial designers work in multi disciplinary design teams.

4. Most UK and Malaysia companies in this study have not employed the services of industrial design consultants or external expertise. The main reason for this in Malaysian companies is that there are only a few design consultants in the country directly involved in NPD. For UK companies, these services are seen as 'not necessary' or 'risky'.

5. The majority of Malaysian and UK companies still follow a sequential process (ideation to production) in developing new products. Most of the companies in both countries also reported not to have adopted any particular design process model while carrying out design development.

6. The findings from these two countries also show that they do not encounter any serious problems arising from conflicts between different functions in the NPD team. Most of the companies reported that they have not adopted any methods to foster teamwork. However, the development of relationships and mutual understanding among team members was shown to be a key factor to foster teamwork.

7. Top management is responsible for all of business policy and business culture formulation and processes in both, Malaysian and UK companies that participated in the case studies.

8. Following point 7 above, top managers (e.g. Chairman, CEO, Director, General Manager) also have authority and power in most of the companies and the role of other managers is more subordinate and is *only* to give advice or discuss problems when necessary.

9. Finally, the findings from both countries clearly show that most Product Development Managers are responsible for the product design and development process. They are also responsible for their team and decide on the final design of products proposed by the team. However, *final* decisions on the projects undertaken are made by top management.

TABLE 10.1: CROSS COMPARISON OF BEST PRACTICE* IN MALAYSIAN AND UK COMPANIES

MALAYSIAN MODEL OF BEST PRACTICE	UK MODEL OF BEST PRACTICE
1) Customer and Marketing Factors ♦ Rely on existing products and foreign technology ♦ Low quality and limited choice of design ♦ Process of 'localisation and 'modification' to suit local needs ♦ ***Customers and end-users excluded in NPD process*** ♦ Some companies do not conduct market surveys to determine customers demands	**1) Customer and Marketing Factors** ♦ Own products with specific markets ♦ Upgrade quality and introduce new product range ♦ Based on market demands and customers trends ♦ ***Customers and end-users excluded in NPD process*** ♦ Conduct market surveys to determine customers demands
2) Product Design and Development Factors ♦ Based on 'reverse engineering', 'modification' and 'localisation' ♦ Follow trends through foreign catalogues and visit exhibitions/shows ♦ ***Have R&D departments to assist development of new products*** ♦ ***Special R&D budgets*** ♦ ***Industrial designers:*** - ***act as 'visualisers' and 'aesthetic specialists'*** - ***involved from beginning to the end of projects*** - ***work carried out in multi-discipline teams*** ♦ ***No use of design consultancy services***	**2) Product Design and Development Factors** ♦ Follow market demand and customers trends ♦ Have continuous programme of upgrading and replacing products ♦ ***Have R&D departments to assist development of new products*** ♦ ***Special R&D budgets*** ♦ ***Industrial designers:*** - ***act as 'visualisers' and 'aesthetic specialists'*** - ***involved from beginning to the end of projects*** - ***work carried out in multi-discipline teams*** ♦ ***No use of design consultancy services*** [One company does rely on design consultants]
3) Technical Factors ♦ ***Follows a sequential process (ideation to production)*** ♦ ***No particular NPD model adopted*** ♦ In the process of acquiring formal quality systems ♦ ***No conflicts between different functions*** ♦ ***Work as a mutual team*** ♦ No implementation of concurrent engineering	**3) Technical Factors** ♦ ***Follows a sequential process (ideation to production)*** ♦ ***No particular NPD model adopted*** ♦ Adopted formal quality systems ♦ ***No conflicts between different functions*** ♦ ***Work as a mutual team*** ♦ Practising concurrent engineering
4) Management Factors ♦ ***Top management have authority and power*** ♦ ***Final decisions depend entirely on top managers*** ♦ ***Product development managers involved and responsible for managing NPD process***	**4) Management Factors** ♦ ***Top management have authority and power*** ♦ ***Final decisions depend entirely on top managers*** ♦ ***Product development managers involved and responsible for managing NPD process*** [One company gives this task to the project leader]

** Although this matrix displays the best practice elements of UK and Malaysian companies, the respective elements do not necessarily represent the actual practices as proposed by the 'Model of Best Practice' [see Table 9.2 pg.241].*
***Note**: Bold typeface indicates those elements that are apparent in both the UK and Malaysian case studies findings.*

10.7.2 The Differences Between Malaysian and UK Case Studies Findings

Based on the key findings of case studies discussed earlier, the differences between the Malaysian and UK companies are summarised below. Corroboratory evidence from existing literature sources with special attention to Malaysian culture are also given to support the findings.

1. The findings show that most of the Malaysian SMIs still rely on existing company products and foreign technology to develop new products while most of the UK companies innovate their own products according to their own specific markets. These findings confirm the questionnaire survey results discussed in Chapter Six. They show that most of the products produced by Malaysian SMIs are of a foreign standard based on magazines and catalogues. According to Datuk Abu Bakar Daud, Deputy Science, Technology and Environment Minister (BT 13th March 1996), the problem with most of the companies in Malaysia is that they import technology wholesale and are content to use it. Further to this, the companies involved fail to develop this imported technology. Thus, future phases require further importation. In the furniture industry for example, Sickinger (1992 pg.10) reports that 'the Malaysian furniture industry is mainly confined to just importation of the machinery and is content with just aping the design and the products of others. Craftsmanship and innovative ideas are abandoned for those tried, tested and marketable products - in short, wholesale copying'. Salleh (1996) also suggests that most of the companies in Malaysia do things differently to developed countries. He indicates that Malaysian companies 'adopt' and 'adapt' foreign design and technology whereas developed countries produce their own products. This 'adopt' and 'adapt' process includes ready designed parts and components. Therefore, he believes that there is little need for an industrial designer to contribute to design and development. Nevertheless, the industrial designer may be required in 'cosmetic trims', Salleh suggests.

In Malaysia, most products are produced under licensing arrangements, are of very low quality and provide limited choice of design. As well as this, most products are generally modified or given new features such as packaging, colours or materials in order to suit the local market requirements. This finding is endorsed by Bajuri (1988) who states that;

> 'Many products are manufactured in Malaysia, mainly for local consumption. However, most of these are either products locally assembled from parts designed and manufactured elsewhere, or products produced locally under licensing arrangements. The number of products locally designed and produced, is more limited, and covers chiefly intermediate and low technology'

By contrast, UK companies develop their own products to compete in the market. They upgrade the quality of the products and introduce new product ranges based on market demands and customers trends.

2. A second difference is related to how companies determine customers requirements. In the UK, companies determine customers wants and needs through methods such as 'user research' and 'catalogue analysis'. In Malaysia however, companies have not conducted any market surveys since they claim to have sufficient business experience to determine customer requirements. This finding can be related to the questionnaire survey findings (Phase Two). According to these, factors such as the sale price and appearance/shape of products are the most important in order to help companies increase their sales against their competitors in the market. The findings conclude that visual appearance is more important than, for example, the quality of the products. Therefore, most of the SMIs already understand the market needs and develop their products toward 'aesthetic' and 'price' appeal. Another reason to explain why most Malaysian SMIs have not carried out market surveys is that most of products produced by SMIs are based on existing products from foreign countries. Since most of these products have been tested in terms of the market and consumers in the original countries, Malaysian SMIs feel that they do not

have to re-do the market survey for the Malaysian environment. They have thus used these survey reports as a foundation and make some amendments to suit local conditions.

3. Product design and development also illustrated a difference. Most of the UK companies in this study base their design and development on strategic planning set to target customers and markets while in Malaysia this activity is still based on 'reverse engineering', 'modification' and 'localisation' to suit local needs. Similar findings have been made by previous studies. In his study of adaption design of agriculture machinery, Awang (1995) has found that most Malaysian companies have carried out 'reverse engineering' projects by adapting machinery or equipment. By using this technique, these companies were able to identify the various machine and equipment components and possibilities for fabricating/manufacturing them locally. Similarly, Er (1994) suggests that industrial design activities in newly industrialised countries (NICs) are based on 'product modification' rather than new product creation. Since Malaysia is categorised as NIC by Er, his research findings reflect the actual conditions of the NPD process in Malaysia. Furthermore, 'imitating foreign products' by 'reverse engineering' or 're-design' of the product to suit local requirements are part of the design activity in NICs. These activities are seen by him as the main function of industrial design in NICs and not the creation of new product concepts or the evaluation of market opportunities.

As well as this, most of the UK companies in this study, are less dependent on existing products and have continuous programmes of upgrading and replacing products in order to follow market demands and customer trends. By contrast, Malaysian company products are based on foreign sources such as catalogues, magazines, trade exhibitions and shows. Since these products are 'under license' and based on foreign design and technology, the design and technology of these products is often outdated. This finding agrees with research made by Bajuri (1988). He suggests that most Malaysian companies, especially SMIs, attempt

to replace imported products by imitating Western designs since consumers are less design conscious and thus accept 'imitated products'. Therefore, most products produced by Malaysian companies are based on foreign standards and do not suit market needs. He adds that the absence of copyright laws or patents has benefited these manufacturers. However, Wah (1976) [see Bajuri 1988] believes that unsatisfactory product design and quality is made worse by the consumers themselves. This is because, consumers do not make an effort to form organised or powerful consumer associations. Idris Jusoh (BT 20th June 1996), Deputy Entrepreneur Minister of Malaysia, indicates that most Malaysian SMIs are cost-driven and are wary of investing in new designs and thus produce lower quality products featuring outdated designs . Most SMIs claim that they cannot afford investment outlays and rewards are difficult to quantify. Most decisions taken are thus not governed by technology or market demands but by short term financial objectives. Similarly, Datuk Dr. Ahmad Tajuddin Ali (BT 20th June 1996), Director General of SIRIM shows that most local manufacturers (especially SMIs) do not concentrate on up-to-date designs since most of their products are marketed locally. Contrary to this, Abdul Razak Ramli (NST 22nd May 1997), The International Trade and Industry Ministry's Director of the ASEAN Economic Co-operation Division shows that most Malaysian SMIs are reluctant to venture into international markets to test their product capability and acceptability. Therefore, most of them are not outward-looking and rely heavily on the domestic market instead.

4. The results also show that quality certification demonstrates major UK-Malaysia differences. While most UK companies have adopted a formal quality certification, in Malaysia most are intending to adopt a formal quality system and are currently in the process of achieving this. This finding can be related to points 1 and 2 discussed above.

5. Finally, the findings show that most UK companies have implemented CE while the Malaysian companies have not.

10.8 The Correlation of Malaysian and UK Case Studies Findings with the Model of Best Practice

From the comparative analysis above, it can be concluded that there are a number of similarities or relationships between the UK and Malaysian cases. As well as this, differences also exist between the two countries in terms of elements of best practice in the NPD process. In order to illustrate the main conclusions of the research, the findings from the comparative analysis discussed above were correlated with the proposed model of best practice derived from previous literature. This involved a correlation of 'actual' practice against the 'model' of best practice guided by four key factors and specific requirements underlying them. The aim of this correlation was to identify patterns and relationships that might exist between the *'actual'* practice of Malaysian and UK companies with the *'model'* of best practice. It is hoped that this correlation will form a valuable framework to show how the elements of best practice might be redefined and combined in order to make them applicable as best practice guidelines to the Malaysian SMIs context.

The results below summarise the correlation of Malaysian and UK case studies findings with the model of best practice. The discussions are based on four key factors, or 'core factors', of best practice based on previous literature [see sections 10.2 and 10.3].

1) Customer and Marketing Factors

The results of correlation show that no elements of best practice of customer and marketing factors outlined by the model of best practice match the elements of best practice outlined in the Malaysian model. In the latter model, most of the products produced by Malaysian SMIs are developed based on existing products and foreign technology. The concepts of 'localisation' and 'modification' have been employed by Malaysian SMIs to produce low quality products with limited design choice. Also, most SMIs do not conduct market surveys to determine customers demand.

By contrast, part of the key aspects of best practice underlined in the model state that the product should have unique features/benefits for users, be a first-to-the-market type of product and have higher quality than competing products. However, the correlation shows that the elements of practice in the UK model were similar to the elements of best practice underlined in the model. For example, UK SMEs produce their own products for their own specific market, upgrade the quality and introduce new product ranges based on market demands and customers trends. In this way, this study recommends that Malaysian SMIs review the way they develop their products so that they are both, aesthetically pleasing and functionally desired by customers. To do this, the ways in which UK SMEs develop products and determine customer requirements is proposed as a possible solution.

Despite the differences between the two countries on the issues discussed above, both the Malaysian and UK models have shown that they have excluded customers and end-users in the NPD process. This element of practice clearly differs from the model of best practice that states companies *should* involve their customers from an early stage of design and development. According to the model, customer involvement is crucial since they can introduce information to help guide NPD. Thus, to develop products successfully, both the Malaysian and UK companies need to find a way to involve their customers in the early stages of NPD. Without this involvement, companies may not be able to study customer feedback regarding products. Consequently an inability to adjust to specific markets and users' need and wants may result.

2) Product Design and Development Factors

It is evident from the correlation that Malaysian SMIs are still far from UK SMEs and the model of best practice in terms of product design and development. For example, findings show that activity regarding design and development in Malaysian SMIs is still based on 'reverse engineering', 'modification' and 'localisation' and also

that products developed on foreign based design and technology can be outdated. Perhaps, some lesson may be drawn from the element of best practice outlined in the UK model whereby most of the UK companies base their design and development on strategic planning, set to target customers and markets. Moreover, UK SMEs are less dependent on existing products and have continuous programmes of upgrading and product replacement in order to follow market demands and customer trends. Most of the elements of best practice outlined in the UK model are similar to the elements outlined in the model of best practice. In agreement with the model, the elements of best practice of new product design include: designing for high quality products, less dependence on existing products and the use of new technology in design and production.

Findings from correlation show that both the UK and Malaysian models detail R&D departments to assist in the development of new products in both countries. Special budgets are also allocated for R&D in both Malaysia and UK. This is a feature of the model of best practice.

Moreover, both Malaysian and UK models show that companies use industrial designers from the first stage (ideation) to the last stage (production). Also, both cases show that the main role of the industrial designer is as 'aesthetic specialists' and 'visualisers' in the process of NPD. Although these elements of best practice are outlined in model, the researcher believes that these roles are too narrow and should be wider. The model outlines the role of industrial designers as not only to cover the elements discussed above but also to act as a mediator within the multi-discipline team. They also serve to co-ordinate projects, cut production and production costs and develop product strategy. In order for both, the UK and Malaysia to succeed in developing new products in the future, the role of industrial design in NPD process should be reconsidered and redefined. This is because, research has shown that, successful companies see the role of industrial designers in NPD not as subordinate to engineers or marketers but rather as having 'multi-tasking' roles and skills in order

to produce high quality consumer products to compete in markets. The researcher believes that the role of industrial designers in NPD in Malaysia and the UK depends heavily on company attitude. In this way, attitude will determine high standards in the design and development. Given a clearly defined and understood role, industrial designers can contribute to SMI and SMEs efforts in designing and producing successful high quality consumer products.

Nevertheless, the correlation results show that most UK and Malaysian companies have not employed the services of industrial design consultants or external expertise to help them design new products and strengthen company strategy. This practice contradicts the model of best practice which suggests that companies benefit from industrial design consultants advice and proposals. The model also indicates that companies should appoint external expertise to advise the company. In order for both UK and Malaysia companies to maintain their position in the changing market, this element of best practice should also be considered. If this is done, mutual understanding with industrial design consultants and external expertise will develop and help create long term profits. Although most Malaysian companies show that industrial design consultant services are limited in Malaysia, the researcher believes that without giving a chance to these services, Malaysian SMIs may not realise any benefits or allow the industrial design consultant industry to grow. Similarly, UK SMEs should encourage their companies to employ industrial design services. This is because companies who employ the services of design consultants to help develop new products show 90% of implemented services are commercially successful (Roy 1987). Furthermore, UK SMEs, unlike Malaysian SMIs, do not have problems engaging design consultant services since the UK has one of the strongest design consultancy industries in the world (Cooper et al 1995).

3) Technical Factors

The results of correlation also show that most UK and Malaysian SMIs have not adopted any particular design process models (except Electrolux), instead they used a sequential process (ideation to production) in developing new product. This is in contrast to the model of best practice which suggests that companies should have a proper model of their design process with each function having an input at all stages of the process.

However, in terms of the quality system, differences between UK and Malaysian models do exist. Generally, most of the Malaysian SMIs have not yet adopted a formal quality system, whereas UK SMEs have adopted one for some time. UK results are similar to the model of best practice which suggests that companies should adopt a quality standard in order to improve product quality.

The correlation also shows that both UK and Malaysian companies do not encounter serious problems arising from conflicts between different functions in the NPD team. This element of best practice is part of the multi-disciplinary teamwork element which features in the model of best practice.

In terms of CE, the results of the correlation show that most of the UK companies have implemented CE while the Malaysian companies have not. Since this method has been widely recognised as optimizing all critical product-and-process characteristics (Revelle et al 1995), it is important to Malaysian SMIs to consider adopting it. As suggested by the model of best practice, CE should also be implemented. As Pye (1993) reports some 43% of companies which have implemented CE achieve the benefits of lower costs, better quality and shorter cycle times.

4) Management Factors

The correlation of the findings of Malaysian and UK companies with the model of best practice showed that there were significant differences between them in terms of management style and the role of top management. The correlation shows that top management are responsible for all business policy, business culture formulation and processes in both Malaysia and the UK. In addition, top managers (e.g. Chairman, CEO, Director, General Manager) wield authority and power in most of the Malaysian and UK companies.

In the study, the importance of management styles in successful NPD is highlighted by the model of best practice. It suggests that management style should be flatter, less hierarchical and include flexibility leadership. As well as this, top management needs to commit itself to; promoting product champions, influencing NPD and be involved in the entire development process. However, in both the UK and Malaysian SMIs and SMEs, traditional old management practices of authority and power from top management remain. This is in stark contrast to the model of best practice. Therefore, to withdraw from old management practice, both countries should consider some changes to their management style so that middle management may function more effectively. Johne and Snelson (1990) [see pg.236] list of seven S's could be considered by Malaysian and UK companies to facilitate this and create a systematic management style as a part of best practice in managing the NPD process.

Finally, the correlation clearly showed that there is a relationship between Malaysian and UK models of best practice with the model of best practice derived from existing literature regarding the role of Product Development Manager. The correlation shows that most Product Development Managers in SMIs and SMEs are responsible for the product design and the development process and are responsible for their team as well as deciding on the final design of products proposed by the team.

10.8.1 Discussion of the Findings from Correlation Study

From the results of the correlation discussed above, several distinct features emerged which explain the patterns and relationships that exist between the 'actual' practice of Malaysian and UK companies with the 'model' of best practice derived from existing literature. Table 10.2 summarises the findings of this correlation. From the results of the correlation, the researcher found that there are only three elements of best practice that appear in the Malaysian model of best practice and seven in the UK model of best practice. Similarly, there are ten elements of *'very poor practice'* in the Malaysian model of best practice and six in the UK model. Based on this, the researcher is led to believe that UK companies may perform better than Malaysian companies with regard to NPD. Thus, Malaysian SMIs should study how and why UK companies perform better and could possibly adopt some elements of best practice where the UK model of best practice excels over and above the Malaysian model. However, the researcher believes that both UK and Malaysian companies *should* refer to the model of best practice in order to become more successful in a competitive market.

In summary, the ten elements of 'very poor practice' that appeared in the Malaysian model are:

1. Company Product
2. Customer Expectations and Responses
3. Marketing Knowledge and Proficiency
4. New Product Design
5. Role of Industrial Designers
6. Design Consultants and External Expertise
7. Model of Process
8. Concurrent Engineering
9. Management Style
10. Top Management

TABLE 10.2
SUMMARY RESULTS OF THE CORRELATION OF THE MALAYSIAN AND UK MODELS OF BEST PRACTICE WITH THE PROPOSED MODEL OF BEST PRACTICE

Model of Best Practice (Core Factors)	Malaysia	UK
1. CUSTOMER AND MARKETING FACTORS		
• *Company Product*	◊	✓
• *Customer Expectations and Responses*	◊	◊
• *Marketing Knowledge and Proficiency*	◊	✓
2. PRODUCT DESIGN AND DEVELOPMENT FACTORS		
• *New Product Design*	◊	✓
• *Research and Development*	✓	✓
• *Role of Industrial Designers*	◊	◊
• *Design Consultants and External Expertise*	◊	◊
3. TECHNICAL FACTORS		
• *Model of Process*	◊	◊
• *Multi-Disciplinary Teamwork*	✓	✓
• *Concurrent Engineering*	◊	✓
4. MANAGEMENT FACTORS		
• *Management Style*	◊	◊
• *Top Management*	◊	◊
• *Role of Product Development Manager*	✓	✓
Total of ✓	3	7
Total of ◊	10	6

✓ Best Practice [outstanding approach to practice or role model of practice]
◊ Very Poor Practice [considerable problems with progress]

Focusing on these elements as 'subject matter' helped the researcher in developing best practice guidelines for the Malaysian SMIs context. By doing this, it gave the research an insight as to how Malaysian SMIs could improve their NPD process. Furthermore, it helps determine the characteristics that can be taken as a basis for explaining the success of NPD and establishes industrial design perspective guidelines which may assist SMIs in Malaysia to improve their NPD process.

10.9 Summary and Conclusions

The major aim of this chapter has been to discuss the results of the cross-case analysis of elements of best practice in the Malaysian and UK companies involved in the case studies. A cross-case analysis procedure was adopted with the two national circumstances being compared and contrasted in order to discover the significant differences and similarities of best practice elements between Malaysian SMIs and UK SMEs. The data was summarised and displayed using an unordered meta-matrix with special reference to four key factors: (1) Customer and Marketing Factors, (2) Product Design and Development Factors, (3) Technical Factors, and, (4) Management Factors. These were considered as 'core factors' of best practice based on previous literature findings. From the comparative analysis, the researcher concluded that there are a number of similarities or relationships as well as differences between the UK and Malaysian cases regarding best practice in NPD.

The results of the comparative study between the two countries were then correlated with the derived conceptual model of best practice in order to identify any patterns or relationships that might exist. From the results of the correlation, the researcher found that there are more elements of *'very poor practice'* in the Malaysian model of best practice than in the UK model. Therefore, the researcher concludes that Malaysian SMIs are less successful in terms of NPD. This is because they still rely on existing products and foreign technology to develop new product, produce low quality products with limited design choices, do not conduct market surveys to

determine user requirements, have not adopted formal quality systems and have not implemented CE. In summary, this chapter enabled the researcher to produce valuable background of elements of best practice for both Malaysian and UK companies. The findings from this chapter helped to evaluate elements of best practice so that they may be applied as best practice guidelines for Malaysian SMIs. These are discussed in the next chapter.

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CHAPTER ELEVEN

GENERAL CONCLUSIONS, RECOMMENDATIONS AND FUTURE RESEARCH

The main purpose of this final chapter is to summarise and draw conclusions from the findings of the research. As well as this, some recommendations arising from this study and possible future research suggestions are made. These themes are discussed in sections 11.2, 11.3, 11.4 and 11.5. Section 11.1 acts as an introduction to these and reviews the framework within which the research took place.

11.1 Introduction

The principal objective of this study is to assist Malaysian SMIs in improving their NPD process through the creation of design guidelines from an industrial design perspective. The focus of the study was NPD in Malaysian SMIs. This focus was decided upon, at present the Malaysian government has given SMIs priority and has provided them with financial assistance to raise SMIs efficiency and competitiveness particularly in the areas of product design and the development of industrial and consumer products. The approach adopted in this study was to investigate the role of the industrial designer in the process of NPD in a selected number of Malaysian SMIs and to contrast them with theoretical knowledge and best practice in UK based companies. The UK has been chosen for comparison since there is a considerable body of literature on best practice relating to product development, which recognises the importance of design to UK based business success.

The study was conducted in three distinct phases : literature search and review (Phase One), questionnaire survey (Phase Two) and case studies (Phase Three). The literature search and review was carried out with the aim of identifying major trends and the nature of the NPD process. It was intended that this review should form the

main literature critique for the research and serve to form a firm base for identification of research problems and to facilitate construction of the questionnaire itself. The questionnaire survey was conducted to identify the role that industrial designers currently play in the process of NPD in Malaysian SMIs in comparison with UK SMEs. Closed-ended questions were adopted with the key questions covering design, production and marketing issues. This was posted to selected Malaysian and UK industrial designers, engineers, marketers and industrial design consultants. The data were analysed using descriptive and inferential statistics. The overall statistical findings were then utilised to form the basic theoretical background for the case studies. These case studies were conducted on four successful Malaysian SMIs and four UK SMEs so that a set of detailed descriptions of best practice principles and elements in the NPD process in both countries were obtained. The case studies focused on four important issues derived from the concept of Business Process Analysis (BPA) research. Data were gathered through interviews with senior management staff directly involved in the process of NPD, reviews of documentary sources, and direct observations at the visited sites and were analysed mainly using 'grounded theory'. A cross-case analysis of the key findings from the UK and Malaysia case studies were carried our at to discover the significant differences and similarities of best practice elements between respective SMIs and SMEs, with special consideration to the cultural differences between the two countries. The comparison was made within a framework of four core factors which were adopted as a guide for best practice evaluation. Finally, the results from the comparative studies between the two countries were then correlated with the conceptual derived model of best practice with the aim of identifying any patterns and relationships. The results of this final correlation form a valuable basis to show how the elements of best practice might be redefined and combined in order to make them applicable as best practice guidelines in the Malaysian SMIs context.

11.2 Summary of Research Findings

The literature search and review (Phase 1) was carried out in areas related to: 'industrial design/designers' and 'new product development'. This helped to widen the understanding of the current situation in industrial design and NPD in Malaysia and the UK. Although new product development design literature on industrial design is very limited, it supplies a good base for further research and provides background information for related areas of study.

Much of the literature cited here has discussed and described the importance of the role of the industrial designer in the process of NPD and has also provided examples of the role that industrial designers play in that process: i.e. to combine rational thinking based on experience with creative interpretation, giving a product a blend of familiarity and novelty in order to make it succeed in new and existing markets. In this respect, industrial designers can perform effective roles as project leaders or as part of the NPD team.
During the literature search and review, the researcher identified the need for research in the design, manufacturing and marketing skill areas. This is because there were no significant previous studies on industrial design in relation to NPD process which regard to the Malaysian context. Thus a paucity in the knowledge base with respect to industrial design in NPD process was found to exist.

In summary, this phase supplied the researcher with a base for research questions and provided vital background information. All the relevant information was identified and utilised in the design of the survey questionnaire (Phase Two).

In Phase Two, a total of one hundred and thirty four sets of questionnaires were sent to UK participants and another forty three to Malaysia participants. A total response for Malaysian industrial designers and design consultants was 88.6% and of 29.1% for UK study. The questionnaire was subjected to descriptive and inferential analysis using SPSS software. Based on the resultant findings, the first

aim of this research (to investigate the role that the industrial designer currently plays in the process of NPD both in Malaysian and UK companies) was established. The key statistical findings of the questionnaire survey were then utilised to form the basic theoretical background for the case studies in Phase Three of this research. To extract the nature of significance the role of industrial designers in the process of NPD in both countries, the results from Malaysia and UK studies were combined and compared. Based on this comparison, the researcher found that there was sufficient evidence to suggest that similarities and differences did exist. The key similarities of the selected best practice Malaysian and UK respondents with regard to the role of industrial designers in the process of NPD were found to be:

1. They are involved from the beginning of the design project (first stage) to the commercialisation stage.
2. They are skilled in creating new design concepts and representing design solutions.
3. They have a working knowledge of presentation techniques, relevant computer techniques and the knowledge of anthropometrics.
4. They are preferred by engineers, marketers and industrial design consultants to contribute to the quality of consumer goods.
5. They are 'aesthetic specialists' and work in consultation with other specialists.
6. They viewed the most preferred skills as being the creation of new design concepts, representation of alternative design solutions, knowledge of presentation and computer techniques.

The key differences between the Malaysian and UK respondents with regard to the role of industrial designers in the process of NPD were that:

1. Malaysian industrial designers have between two to four years of experience in product design while UK industrial designers tend to have more than fifteen years.

2. In Malaysia new products are designed and developed by a team of qualified engineering and industrial designers, or may be made by industrial designers who completed the product through to commercialisation. However, in the UK close interaction between customers/users in the design and development stages and replacement of old products are important.

3. The design team in Malaysian SMIs comprises of industrial designers and engineers while in UK, the design team is made up of multi-disciplines of people.

4. In Malaysia, industrial designers are employed by companies as permanent staff within R&D departments, while in the UK they work in a Design/Industrial Design Department or an R&D department.

5. Most of the UK companies co-opted a professional industrial designer into the design team for the period of the project. In Malaysian SMIs, this did not take place.

6. In Malaysia, industrial designers function in order to provide creative thinking and re-designing while in the UK industrial designers function in order to collaborate, to act as process communicators or facilitators in a design team as well as to provide creative thinking.

The comparative study findings also have enabled the researcher to identify differences between the two countries in terms of NPD. These are that:

1. In Malaysia, the appearance/shape of products is important to help increase sales while operational performance of products were favoured by UK companies. In both cases sale price was, however, an important similarity.

2. UK companies introduce new products into specific market-sectors to create new business while in Malaysia, companies introduce new products in response to competitive pressure in order to protect existing products.

3. Malaysian SMIs follow 'improvement' (incremental innovation leading to minor changes in the existing product) as a design strategy. By contrast, UK companies follow a 'major innovation' strategy (innovation leading to major changes in, or more addition to an existing product).

4. Malaysian companies rely on the existing manufacturing processes and the suitability of existing manufacturing processes (e.g. for design purpose). However, in the UK most companies attempt to reduce the number of components and try to make use of various materials which act as important design/manufacture interface considerations.

Although statistical analysis enabled the researcher to determine the important issues regarding industrial designers and NPD in both Malaysia and UK companies, that by itself was considered to be insufficient. As well as the similarities and differences between Malaysia and the UK (in quantitative terms), a number of key areas were found to require a qualitative approach (i.e. through case studies). To do this, any quantitative similarities and differences were clarified with reference to Malaysian and UK Product Development Managers themselves.

Thus a third phase (Phase Three) case studies (involving four companies in Malaysia and four in the UK) were conducted. The main aim of these case studies was to provide a clear understanding of the actual conditions of best practice in NPD for both countries. Case studies were selected from companies based on notable, successful design projects and the general perception of reputation for design leadership. This was made with particular reference to the consumer durable product market sector. The companies included SMIs/SMEs, Design Companies working as

an independent R&D section of a larger manufacturing company and design consultancies.

From the analysis of case studies interviews, documentary reviews and direct observations at the four companies studied in Malaysia, four important observations contributing to this study were noted:

1. Most Malaysian SMIs rely on existing products and foreign technology to develop new products. Product development activity is still based on 'reverse engineering', 'modification' and 'localisation' to suit local needs. The design of products is based on influences from foreign sources such as catalogues, magazines and trade exhibitions. These may have been visually or materially improved in order to give more choice to their customers.

2. Most of the companies have not conducted market surveys since they claim to have sufficient business experience in order to determine customer requirements.

3. Malaysian SMIs are currently in the process of adopting a formal quality system.

4. Most of the Malaysian SMIs have not implemented CE or other similar methods.

Phase Three also compared the results of the two nation case studies in order to discover whether there were any significant differences and similarities between Malaysia and the UK. The comparison was based on the four core factors which were adopted as guidance for best practice evaluation. From this comparison, the researcher has identified distinct similarities between the countries regarding their approach to the NPD process. The findings show that both Malaysian and UK companies have:

1. Excluded customers and end-users from the NPD process.

2. Employed industrial designers as 'aesthetic specialists' or 'visualisers' in order to 'give a uniqueness to the design' in the NPD process.

3. Not employed the services of industrial design consultants or external expertise.

5. Not adopted any particular design process model while carrying out design development.

In order to illustrate the main conclusions of the research, the findings from comparative analysis were correlated with the proposed model of best practice derived from previous literature. From the results of the correlation, some generalisations, discussed below, emerged which explain the patterns and relationships that exist between the 'actual practice' of Malaysian and UK companies with the proposed model of best practice.

1. No elements of best practice of customer and marketing factors (company product, customer expectations and responses, marketing knowledge and proficiency) outlined by the model of best practice correlate with the Malaysian model of best practice. However, most of these elements do correlate with the UK model of best practice (except for the involvement of customers in the NPD process).

2. Results show that no elements of best practice of product design and development factors (new product design, design consultants and external expertise) outlined by the model of best practice correlate with the Malaysian model. However, regarding the issues of R&D and the role of industrial designers in the NPD process, the latter model does have similarities with the model of best practice. Although the UK model agrees in most areas with the best practice model, it disagrees in areas concerning design consultants and external expertise.

3. The results of correlation also show that no elements of best practice of technical factors (i.e. models of process and CE) outlined by the model of best practice match with the Malaysian model. However, the Malaysia model does match the model of best practice where multi-disciplinary teamwork is the factor. Unlike the Malaysian model, the UK model matches the model of best practice in two areas (multidisciplinary teamwork and CE). However, elements of best practice in the 'model of process' factor outlined in the UK model are congruent with the elements of best practice outlined in the model of best practice.

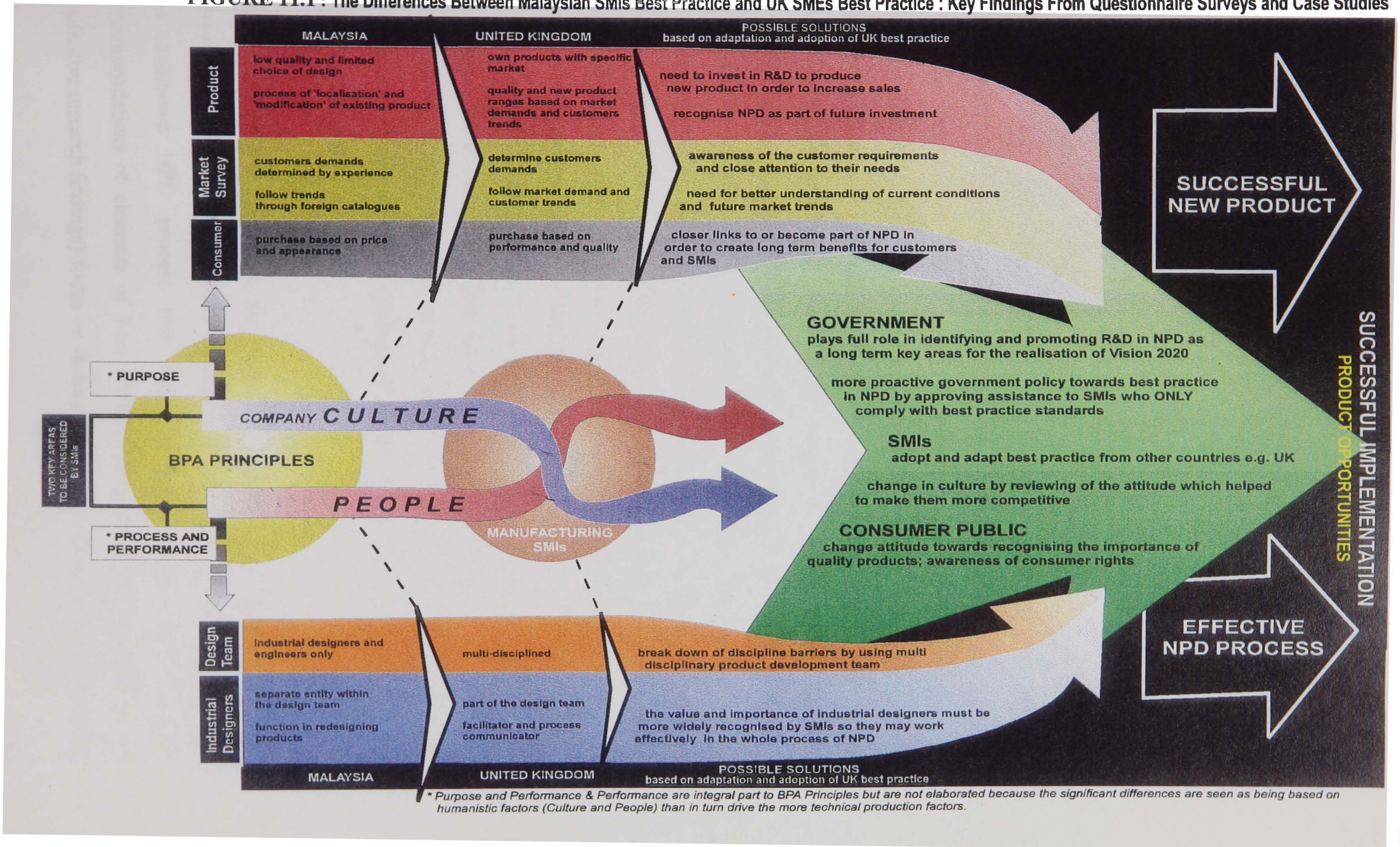
4. No elements of best practice of management factors (management style and top management) correlate in the Malaysian and UK models of best practice. However, both of the models share similarities with the model of best practice regarding the issues of 'the role of the Product Development Manager'.

The results of the correlation discussed above form a valuable framework to show how the elements of best practice might be redefined and combined in order to make them applicable as best practice guidelines to the Malaysian SMIs context.

The questionnaires and case study findings from the current research have been placed into such a framework in Figure 11.1. This demonstrates how Business Process Analysis (BPA) principles impinge and interact in a milieu that incorporates company culture and people.

Based on the UK best practice, the next section (11.3) outlines the salient recommendations that the researcher has revealed concerning best practice in the Malaysian context.

FIGURE 11.1 : The Differences Between Malaysian SMIs Best Practice and UK SMEs Best Practice : Key Findings From Questionnaire Surveys and Case Studies



** Purpose and Performance & Performance are integral part to BPA Principles but are not elaborated because the significant differences are seen as being based on humanistic factors (Culture and People) than in turn drive the more technical production factors.*

11.3 Recommendations

The purpose of this section is to review the major themes that have been developed in the thesis and to provide a brief outline of how the line of this investigation might be drawn-out in further studies.

NPD in Malaysian SMIs has been successfully undertaken through the utilisation of existing products and foreign technology. Most of the products produced by Malaysian SMIs go through 'instant processes' known as 'localisation', 'modification' and 'reverse engineering' in order to be made suitable for local market conditions. Through this 'instant process', some products have been visually or materially improved in order to give more choice to customers. Another way of developing product is through 'copying', 'imitating' or 'adopt' and 'adapt' techniques to suit local needs. This process is made by copying foreign products (especially those of Japan and Europe) via product catalogues, magazines or through visits to national and international trade exhibitions and shows. As a result, most of the products produced by SMIs have failed to meet customers requirements either because they are of very low quality or because they offer a limited choice of design. It is important to be aware that although these types of processes are claimed by most SMIs to be the best way of producing new products, this activity is unlikely to last into the future with other countries emerging in the ASEAN region and the implementation of the ASEAN Free Trade and Agreement (AFTA) in the year 2003. Thus, the Malaysian SMIs need to find possible ways of solving future problems by improving their NPD process in order to compete in the competitive national and international market.

Based on the above discussion, the researcher believes that further considerations should be added to the current NPD process so that Malaysian SMIs might reform the traditional NPD process that they currently employ. The following recommendations of elements of best practice (formulated via quantitative and qualitative research findings) focus on factors identified in Chapter Ten (10.8.1) are

possible guidelines for Malaysian SMIs in the improvement of their NPD process. Moreover, they fulfil aim three of this study which relates to the guidelines of elements of best practice for SMIs in Malaysia [see 1.3 pp.5-6].

11.3.1 SMIs Products and Brand Names

The results in Phase Two and Phase Three of this study have identified that Malaysian SMIs are still reliant on existing products and foreign technology to develop new products. These have been largely produced under licensing arrangements and have gone through a process of 'localisation' and 'modification' in order to make them suitable for local market conditions. As a result, most Malaysian SMIs have produced outdated and low quality products with a limited choice of design.

It is therefore recommended that Malaysian product manufacturer SMIs produce their own products with their own design and brand name that aim to meet international standards. Addressing the First International Industrial Design Conference in Kuala Lumpur, Lord Caldecote (1991) suggested to Malaysian companies that 'any country aspiring to industrialise cannot rely totally upon imported manufactured products. It needs its own range of indigenous products which have the competitive edge'. In the inaugural address at the same conference, Abdul Ghafar Baba, former Deputy Prime Minister of Malaysia urged Malaysian companies to place greater emphasis on the development of new products. He further stated that, although Malaysia is beginning to see a small number of companies embarking on product design and development, the large majority of companies have yet to incorporate product development and design into their business strategies. The Malaysian Minister of International Trade and Industry, Dato' Seri Rafidah Aziz, suggests that companies 'need to strengthen efforts in the promotion of Malaysian brands and designs to gain a greater market niche. They should be more sensitive and responsive to developments in the global market' (Star

28th May 1996). As well as this she indicates that 'it is important for Malaysians to have the ability to design products from scratch as innovation can improve the design of certain products' (Star 20th August 1996).

From these considerations, the researcher believes that the success of Malaysian SMIs will greatly depend on the SMIs capability to design and produce products that can compete in both the local and global markets. It is thus now appropriate for Malaysian SMIs to make extra effort and commitment to create their own products. For example, company brands could be trademarked to stimulate an image of quality and design (Turner 1985) [see Kim 1989 pg. 353]. This is being helped by Malaysian government schemes and incentives that encourage SMIs to design and produce their own products to compete in international markets. Furthermore, the importance of design and brand names, has been widely discussed in many Malaysian newspapers and has helped the public and companies to understand the issue. For example the New Straits Times (22nd May 1997) reports that:

> 'The time has come for more Malaysian companies to create, design and produce our own brand names. There is no reason why we cannot market products with our brand names if the quality is the same and the price is competitive'.

It is hoped that by creating their own products and brand names, the wish put forward by Sickinger (1992 pg.11) that 'the day will come when 'Designed and Made in Malaysia' is appreciated and spoken in the same breadth as made in Italy, Scandinavia, Germany...' will become a reality for Malaysian SMIs.

11.3.2 Model of the Product Development Process

The results of Phase Three (Chapter Ten) show that Malaysian SMIs have not adopted any particular product development design process models. This practice contradicts the element of best practice outlined in the model of best practice [see

Chapter Nine] which suggests that companies should have a proper model of the design process with each function having an input at all stages of the process. Thus, it is suggested here that Malaysian SMIs need to develop a 'definitive' model of the product development process because it is an effective and popular way of organising product development in most successful companies. According to the DTI (1994) without a model, it is impossible to identify where excessive time is consumed, or where more efficient planning and management could provide a more cost-effective and rapid response to the market and customer needs. This report suggests that companies should adopt BS 5750, or BS 7000 in order to have a clear view of their current processes.

11.3.3 Concurrent Engineering

Phase Three findings confirmed that Malaysian SMIs have not implemented CE but rather stick to the traditional '*throw it over the wall*' working practice. Therefore, the NPD process in most Malaysian SMIs is essentially linear and segmented, with clear divisions between phases such as design and engineering, manufacturing and marketing.

In order to help departments in Malaysian SMIs work in a more integrated manner, CE is recommended. It is hoped that by implementing this modern approach, Malaysian SMIs improve the quality of early design decisions as well as having a positive impact on the life-cycle cost of the product. According to Allen (1993) almost all successful product programmes today use some form of this parallel approach. The success of CE is highlighted by Blau (1994) who claims that it cuts product development time from 20% to 70% and boosts white collar productivity from between 20% and 100%. Similarly, Salomone (1995) reports of 30% - 70% reductions in total development time whilst Gatenby (1994) shows that time to market improvements of 30% - 60% are typical.

11.3.4 The Role of the Industrial Designers in NPD Process

Findings from the quantitative (Phase Two) and qualitative (Phase Three) research confirmed that the role of industrial designers in Malaysian SMIs is mainly that of 'aesthetic specialists', 'visualisers', 're-design for improvement' and to 'give a uniqueness to the design' in NPD process. Since Malaysian SMIs do not understand the 'actual' roles can be played by industrial designers in the NPD process, they underestimate the contributions made by their designers and demotivate them. Industrial designers are thus used by SMIs as 'stylists', or 'artists', and not as persons who can play a catalytic role in the NPD process. Consequently, most Malaysian industrial designers feel they are not valued by their companies and tend to 'jump' from one company to another to find a better working environment (Manan 1991).

Although the roles discussed above are part of the industrial designer's role, the researcher believes that they are too narrow and only cover part of the NPD process. These roles should be redefined by SMIs so that industrial designers can be effectively involved in the whole process. Furthermore, as part of the design team in product development, industrial designers should be given a 'multi tasking role' of activities not only related to design but also manufacturing and marketing. Pilditch (1976) suggests that a good industrial designer is one who is technically minded and is practical and imaginative, and stands somewhere between the factory and the consumer. He adds that industrial designers should have extensive knowledge of the four 'M's'- *Materials, Machinery* and *Methods of Manufacture*. With this knowledge, industrial designers cannot only produce functional and attractive designs, but can also select the right materials and enable economically viable manufacturing. Similarly, Harkins (1994) believes that industrial designers are trained to be 'holistic thinkers'. This is because industrial designers draw their strength from a diverse view of markets that may cross-fertilise ideas to create new features in products. They are familiar with a broad range of manufacturing processes, and combine the best attributes to create innovative and cost-competitive products.

In line with the ideas above, the researcher strongly recommends that Malaysian SMIs redefine the role of industrial designers in NPD. Malaysian SMIs need to understand that the NPD concerns the total process of idea generation, development and successful marketing of a new product. Therefore, industrial designers should not only deal with aesthetic ideas, shapes or colours, but also with technical and marketing aspects. As suggested by Thornton (1987) industrial designers should be made an integral part of the project team and encouraged to play an active role in product development team where their role is to create the important product definitions: how the product works, interface with the user, and manufacturing. Thornton further suggests that the industrial designer can act with dual roles. He acts as a 'concepts creator' and 'facilitator' when questions about executing the product definition are raised, and as a 'buyer's' or 'end-user's' representative when problems about the product's use and operation arise. Thus, industrial designers 'bridge the gap' between marketing and engineering. This idea is supported by Fraser (1990) who focuses on product improvement for consumers.

11.3.5 Design Awareness

The study has revealed that there is a lack of awareness of good design and the importance of design in daily life by Malaysian consumers. In order to elevate the level of design in Malaysia, it is necessary that design awareness be widely promoted by the Malaysian government through all types of media and not just through schools. Although the government, through Malaysian Design Council (MDC), have organised a range of design promotional activities including 'Concept Car Competition', 'The Malaysian Young Designers Award' and 'The Malaysia Good Design Mark' to create design awareness among the public and manufacturing industry, it seems to be insufficient and more needs to be done. For example, there is a need to propagate design and industrial design activities including design innovation, design trends, consumer lifestyle and other related activities. This design awareness need not only be highlighted by the Malaysian government. Other parties

involved directly (and indirectly) in design and product development such as trade associations, higher educational institutions, R&D institutions and development agencies must also be encouraged to play an important role in promoting design awareness to the public.

11.3.6 Design Consultants Services

The results in Phase 2 and Phase 3 of this study show that most Malaysian companies have not employed the services of industrial design consultants to help them design new products. Although most Malaysian companies show that industrial design consultant services are limited in Malaysia, the researcher believes that this is not the case. This is because, Malaysian SMIs have made little opportunity for such services and may not realise the benefits that they can offer. According to Eustace (1985) as the demands from customers increase, companies have to ask design consultants to help them design their products in order to maintain their position in the changing market. Design consultants can offer companies the skill they need to realise this and at the same time give them advice based on their experience working with other companies. Research by Roy (1987) shows that companies who employ the services of design consultants to help develop new products show that 90% of implemented services are commercially successful.

Since many successful companies (e.g. Sony, Olivetti, Wilkinson Sword) use design consultants to assist developing new products, it is suggested that Malaysian SMIs do similarly. Malaysian SMIs should thus send staff to countries where companies employ industrial design consultant services or other external expertise to help them design new products. There are a number of UK design consultants that have been helping their clients to formulate appropriate product strategies (Chung 1989) and it may be thus beneficial for Malaysian SMIs to come to the United Kingdom to see such work in situ. Moreover, the UK has one of the worlds leading design

consultancy industries (Cooper et al 1995). It is hoped that by doing this, SMIs will learn how and why UK companies employ industrial design consultants services and see the effectiveness of these services to their companies. The practice could then be evaluated and possibly adopted in the Malaysian environment.

11.3.7 Consumer Requirements

Phase Two and Phase Three identified that most products made by Malaysian companies do not suit market needs due to the lack of market research on consumer requirements. Most Malaysian SMIs claim to have sufficient business experience to determine customer requirements. Most SMIs products are not based on consumer requirements, but rather on 'aesthetic' or 'price' appeal. Therefore, it is suggested that Malaysian SMIs focus more sharply on consumer requirements when introducing new products to the market and not merely on profits. In other words, Malaysian SMIs need to base production on consumer and market requirements rather than trying to sell what they can produce. In this way, SMIs will be able to maintain their position in the contemporary competitive market. In order to achieve this, SMIs should carry out adequate market research, develop products with a clearer market strategy and pay more attention to the customer. 'Concept engineering' (a well known element of best practice) for example, could be adopted by Malaysian SMIs with the voice of customers (VOC) being translated into a product that is desired by customers. (For a discussion on VOC see Chapter Nine pp.190-191).

However in Malaysia, this may encounter problems since consumers have not formed or organised powerful consumer associations (Wah 1976) [see Bajuri 1988]. Thus a suggestion by Kim (1989 pg. 350) that a 'Consumer Protection Body could be established to protect consumers by assessing products in the market in terms of consumer requirements' should be taken seriously by the Malaysian consumer public. By doing this, product improvement via bodies such as the Association for

Consumer Research and the magazine 'Which?' could be made possible in Malaysia as has happened in the UK.

11.3.8 Design Education

From the results of the questionnaire survey in Chapter Six, it was found that industrial designers in Malaysian SMIs are mostly skilled in creating new design concepts and representing design solutions. As well as these they have working knowledge of relevant computer and presentation techniques, knowledge of anthropometrics and current market trends. These findings show that industrial designers are lacking in technical areas such as basic knowledge of engineering, materials or processes. At present, in Malaysia, industrial design education concentrates on 'aesthetics' and art based knowledge rather than industrial reality. This may need to be revised. Design education needs to focus more on the technical and engineering knowledge since much of industrial designers work is related to highly engineered product design work. In order to achieve this, design education should employ experts from a variety of backgrounds including electronics, production and marketing. In this way, a bridge between technology, marketing and design may be formed. Training courses for industrial designers and engineering designers are also recommended as part of this revision of design education. Roles of the respective designers and their limitations can be clearly defined in this way. Kim (1989 pg. 354) suggests that 'to enable this and to transfer knowledge between them, that training courses for design education staff might be organised to transfer up-to-date trends of design and bridge between technology and design, such as teaching design to engineers and teaching engineering to designers'

11.3.9 Management Style

This study has shown that top managers (i.e. Chairman, CEO, Director, General Manager) have authority and power in most of the Malaysian companies. Although

the management style differs from one country to another and from one company to another, this study has shown that the Malaysian management style is far from the one outlined in the model of best practice [see Table 9.2 pg.241]. Thus a change in management style in order to realize more efficient ways of management is required. Malaysian SMIs are thus urged to change their authoritarian styles to more flatter and less hierarchical ones that include flexible leadership. By adopting such ideas, it is hoped that middle management may function more effectively. As discussed in Chapter Nine, new styles could be considered by Malaysian SMIs in order to create systematic management and become part of best practice in managing NPD process (Johne and Snelson 1990).

11.4 Receptivity Test

In order to gauge the suitability of the recommendations formulated to help Malaysian SMIs improve their NPD process, a receptivity test was carried out with respondents involved directly and indirectly in NPD. Twenty six participants were included in this test representing companies, design consultants, higher design education institutions, consumer associations and government agencies [see **Appendix 12**]. Respondents were asked to indicate their opinions to nine proposed recommendations using a five point scale (1 = low probability, and 5 = high probability). As well as learning about respondents views on the applicability of the recommendations to their organisation, the scales showed how they might be employed. At the end of the test, the respondents were presented with six open-ended questions to show how they would turn these recommendation into a working strategy. This includes issues such as finance, staff retraining and whether these recommendations influence the 'culture' or policy of practice in their organisation.

The selection of respondents for the test was based on a judgement sample [see 5.3.1 pg.103] taken from a mailing list of companies who replied to the questionnaire survey. In order to obtain a good response rate, all procedures adopted in the

questionnaire survey were followed [see 5.4.1 pg.106]. From twenty six participants, twelve (46%) respondents completed and returned the questionnaires. The researcher considered this response rate as satisfactory and believes that the number of responses were sufficient for generalisation.

To obtain an objective quantitative analysis, all the data collected were subjected to descriptive statistics including frequency distributions and means, using SPSS software. Frequency distributions were used in order to organise the data into a more readable form; the means procedure revealed the degree of preference given by respondents [for details and discussion of descriptive analysis, please refer to section 6.2 pg.123].

Based on the means output, the results of the receptivity test have been summarised below in 11.4.1-11.4.3. For a more detailed presentation of these recommendations see **Appendix 11**.

11.4.1 Applicability

Overall, results appear to suggest that 'recommendation four' (The Role of the Industrial Designers in NPD Process) was the highest priority with a mean score of 4.33 (Table 11.1), followed by 'Design Education' (4.08), 'Design Awareness' (4.08) and 'Concurrent Engineering' (4.00).

11.4.2 Ease of Implementation

In terms of the ease of implementation of the recommendations in the Malaysian environment, it was found that 'recommendation eight' (Design Education) exhibited the highest mean score (3.75), 'Design Awareness' (3.67) and 'The Role of the Industrial Designer in NPD Process' (3.67) were also important [see Table 11.2].

This result also shows that the least easy to implement was 'SMIs Products and Brand Names' (2.92).

TABLE 11.1 : Applicability of Recommendations

	Recommendations	Means
4	**The Role of the ID in NPD Process**	**4.33**
8	**Design Education**	**4.08**
5	**Design Awareness**	**4.08**
3	**Concurrent Engineering**	**4.00**
2	Model of Product Dev. Process	3.75
9	Management Style	3.58
7	Consumer Requirements	3.58
6	Design Consultants Services	3.58
1	SMIs Products and Brand Names	3.58

TABLE 11.2 : Ease of Implementing Recommendations

	Recommendations	Means
8	**Design Education**	**3.75**
5	**Design Awareness**	**3.67**
4	**The Role of the ID in NPD Process**	**3.67**
7	Consumer Requirements	3.42
3	Concurrent Engineering	3.42
6	Design Consultants Services	3.25
9	Management Style	3.17
2	Model of Product Dev. Process	3.00
1	*SMIs Products and Brand Names*	*2.92*

11.4.3 Expected Benefits

The most 'expected benefits' for the Malaysian SMIs from adoption of any recommendations were 'recommendation four' (The Role of the Industrial Designer

in NPD Process) (mean = 4.67) and 'recommendation five' (Design Awareness) (4.50) [see Table 11.3]. The least 'expected benefits' are those from 'recommendation six' (Design Consultants Services) and 'recommendation one' (SMIs Products and Brand Names) (both 3.83).

TABLE 11.3 : Expected Benefits of Recommendations

	Recommendations	Means
4	**The Role of the ID in NPD Process**	**4.67**
5	**Design Awareness**	**4.50**
8	Design Education	4.17
3	Concurrent Engineering	4.17
2	Model of Product Dev. Process	4.17
9	Management Style	4.08
7	Consumer Requirements	4.08
6	*Design Consultants Services*	*3.83*
1	*SMIs Products and Brand Names*	*3.83*

11.4.4 Adoption of Recommendations

This section summarises the respondents comments on the issues raised in the open-ended questions regarding the adoption of any of the recommendations to their organisation. Each of the following sub-sections relates to questions 1-6 in the adoption of recommendations [see **Appendix 11**].

11.4.4.1 Working Strategy

Most of the respondents believe that most of the proposed recommendations can be turned into a working strategy. However, managers indicated that they are often restricted by organisation profit targets. Therefore, a change of attitude that does not sacrifice and compromise productivity and profitability must be first overcome. The respondents also suggest that companies should be aware of their deficiencies and

make efforts to correct them. For example more emphasis on R&D, improving quality and increasing know how may be beneficial.

11.4.4.2 Financing

Most of the respondents suggest that they should have their own special budget in order to adopt the recommendations satisfactorily. To do this most of the respondents believe that financial loans from the government or commercial banks are needed. Some of the respondents suggest that partnerships with other organisations maybe a means to solve financial problems and may help to create bigger markets.

11.4.4.3 Staff Retraining and New Expertise

In order to implement the recommendations, most of the respondents believe that staff retraining and new expertise are required.

11.4.4.4 Culture and Policy of the Organisation

Most of the respondents agree that culture or policy of practice within organisations is the main obstacle to adopting the recommendations. They suggest that culture or policy depends more on top management thinking and vision than on other management or staff levels. They did note, however, that once formulated, a company vision or policy is very simple to implement amongst a motivated workforce.

11.4.4.5 The Role of Malaysian Government

All of the respondents agree that the Malaysian government has a large role to play in formulating any of the proposed recommendations. Although the government have

set up and given various incentives and funds, these seem insufficient. Most respondents suggest that the government should enhance existing policies, diagnose the SMIs problem, co-ordinate the network and add on smart partnerships (i.e. collaboration between government agencies such as the Ministry of International Trade and Industry and SMIs) to produce new products.

11.4.5 Summary of the Results

The results from the receptivity test show there are three recommendations that appear to have a very high mean score and significance on applicability, ease of implementation and expected benefits. These recommendations are:

1. The Role of the Industrial Designers in NPD Process
2. Design Education
3. Design Awareness

Most of the respondents agree that the role of industrial designers should be redefined by Malaysian SMIs so that they can be effectively involved in the whole NPD process. Some of the respondents also suggest that academic institutions that are currently offering industrial design courses, should also add to their knowledge base on the *contemporary* role of industrial designers in NPD process.

All the respondents from higher learning institutions agree that design education needs to focus more on engineering and marketing knowledge rather than concentrate on aesthetics and art based knowledge. Universiti Malaysia Sarawak (UNIMAS), for example, is now applying the concept of integration with experts from outside including design consultants. Similarly, Universiti Teknologi Malaysia (UTM) courses include a 30% input in engineering and 20% in marketing. This helps to bridge the gap between design, technology and marketing. Furthermore, Universiti Putra Malaysia (UPM) are upgrading staff knowledge in marketing and engineering aspects. By doing this, UPM hopes to produce students experienced in marketing

and engineering aspects and will thus become industrial designers who can involve themselves in the *whole* NPD process.

In terms of design awareness, most of the respondents believe that although the Malaysian Design Council (MDC) and Malaysian Invention and Design Society (MINDS) have aggressively promoted design awareness to the public, it seems to have not been achieved. Therefore respondents suggest that the government should promote design awareness at the grass roots level.

As well as these three recommendations, the receptivity test has revealed that 'recommendation one' (SMIs Products and Brand Names) appear to have low mean scores in each of the three areas (applicability, ease of implementation and expected benefits). For 'ease of implementation' the score is especially low (2.92). The reasons given by most of the respondents for such low scores are that Malaysian SMIs have relied on existing products and foreign technology. It is thus very hard to change their attitude towards producing their own designs and brand names since it may jeopardise their position in the market they are currently located in. Most of the respondents believe that SMIs are not willing to create their own products with their own design and brand name since this process requires a huge investment and particularly so in R&D.

In conclusion, the researcher believes that most of the proposed recommendations are suitable to be adopted and employed in Malaysian organisations involved directly and indirectly in NPD process. This is because all of the recommendations (except recommendation one) have high means scores, i.e. more than 3.0. However, the adoption and implementation of these recommendations depends entirely on the organisations themselves. It is hoped that they can consider and possibly take on board the recommendations made here in order to improve their NPD and to profit the nation overall.

11.5 Suggestions for Further Research

This research project has established an example of advanced academic research which illustrates that case studies combined with a questionnaire survey and literature search and review can provide qualitative and quantitative data of necessary depth and complexity for analysis of the NPD process. Some possible problems of the use of case study interviews and questionnaire surveys as research methods have been tackled by maximising the respondent's understanding of the objectives of this research, minimising bias through careful formulations of questions for questionnaire survey and interviews, and cross examinations of results. In addition, in order to validate the contents of the data collected through case studies, draft reports containing sources of evidence from interviews, documentary sources and direct observations were sent to the interviewees for their content approval. By doing this, the content of the case studies report were as accurate and precise as possible.

It is hoped that the detail and discussion in this thesis will provide knowledge furthering industrial design and NPD. The motivation of the research is to find and adopt a sophisticated approach to the process of NPD and to apply it to help boost Malaysia's economic performance. A wider aspiration is for the work to be utilised by all manufacturing industries in Malaysia, and other emergent industries elsewhere. Furthermore, it may help direct product development strategies and assist Malaysia in achieving the status of a modern industrialised nation by the year 2020.

Despite it's depth, the current research is not exhaustive and future work could explore and detail, more finely, some of the ideas and techniques adopted here. For example, the present study focused on small and medium sized companies in Malaysia and the UK, although discrete R&D sections of larger manufacturers were consulted. The focus was necessary to provide a focal point for the research. A future useful study could concentrate on larger or multi national companies in order to relate the elements of best practice in these companies with the findings from

small and medium sized companies. Since the elements of best practice of NPD in larger or multi national companies are widely recognised and they are 'the source of many of the general recommendations of the literature on best practice' (Maffin 1996 pg. 302), it is hoped that such research could benefit other companies, especially SMIs in adopting such elements of best practice into their operations. Alternatively, a comparison of the elements of best practice in larger companies with the element of best practice found in small and medium companies could be made.

As well as these possible directions for research, future work could focus on industrial sectors not covered in this research. Whereas this study examined consumer durables such as domestic electrical appliances, office furniture and plastic products, future researchers may find value in extending the range of manufacturing industry and product development categories i.e. agriculture, wood-based products or the footwear industries as the basis of research.

In this study, the UK has been chosen for comparison because there is a considerable body of literature of best practice relating to product development, which recognises the importance of design to business success. Further research does however, seem necessary so that the Malaysian situation may be compared with other countries than the UK. In particular, a comparison of Malaysian SMIs to companies in Japan, America, Germany, Italy, or even an emergent country like Korea may help to benchmark their product development process.

Specific products could also form a focus. By looking at those items already in the market and measuring the extent to which the selling of such products can contribute to the success of the companies concerned, research can provide ideas on market trends, consumer requirements and the background to market success.

The industrial designers' contribution towards the success and failure of the product in the market place areas was not examined in great detail here and is one that would provide a wide range of salient commentary. Moreover, a study of the elements of 'poor practice' of product development in Malaysian SMIs compared to the elements of best practice but using substantially different research methods to those used could give a new methodological focus to the study of industrial design.

As a tool for development, Business Process Analysis (BPA) has been mostly concerned with engineering aspects of NPD. The researcher recommends that future NPD assessments in design should employ similar BPA considerations to those utilised by engineers. In this respect, a new direction in the 'culture' of BPA in it's application to 'people' may result and would be beneficial to the NPD process overall.

Consideration and focus on specific issues would also be beneficial. Studies of the importance of ideas and the creativity of designers to product innovation; the impact of design in marketing new products; design trends and style; the role of marketers and engineers in NPD process could all help to form an extensive body of literature and empirical data for industry and academia to draw upon.

It is hoped that this research is beneficial to the field of industrial design and that it has made some positive contribution towards the strategy for improvement of the NPD process amongst Malaysian SMIs. It is also hoped that it enables Product Development Managers to adopt new strategies and working practices in order to achieve improvements in contemporary measures of performance, such as cost, quality, service and speed. As well as these important attributes, it is hoped that it helps them to create long-term competitive advantages to further their respective businesses effectiveness .

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The Role of the Industrial Designer in Malaysian Small and Medium Industries

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A thesis submitted to the University of Northumbria at Newcastle
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DOCTOR OF PHILOSOPHY

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July 1999

Vol.II (Appendices)

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SURVEY QUESTIONNAIRE
(INDUSTRIAL DESIGNER)

This survey is designed to investigate the role that the industrial designer currently plays in the process of new product development. It focuses on different aspects of design. The results may well highlight any mismatches in understanding and could prove informative and useful to all concerned. Complete confidentiality is assured and the survey will be used strictly for academic purposes.

Name : _____

Position : _____

Department : _____

Company/establishment : _____

_____

_____

Telephone no. : _____ Fax no. : _____

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QUESTIONS Q.1 - Q.9

Please tick the boxes on the right as appropriate

Q.1 How long have been involved in industrial design/product design?

Less than 2 years	[ ]	8 - 9 years	[ ]
2 - 4 years	[ ]	More than 10 years	[ ]
5 - 7 years	[ ]	More than 15 years	[✓]

Q.2 How many new product development projects have you been involved in?

2 - 4 [ ] 5 - 9 [ ] More than 10 [ ] More than 15 [✓]

Q.3 How many industrial designers, engineering designers and marketers are employed in your company? (Please write in number)

Industrial designers	[ ]	2
Engineering designers	[ ]	6
Marketers	[ ]	5

Q.4 To what extent are industrial designers, engineers and marketers involved in the process of new product development ?

	Extremely Involved	Very Involved	Involved	Slightly Involved
Industrial Designers	[✓]	[ ]	[ ]	[ ]
Engineers	[✓]	[ ]	[ ]	[ ]
Marketers	[✓]	[ ]	[ ]	[ ]

Q.5 In the process of new product development, at which stage are you involved in? (Please tick all which apply)

- First stage (idea generation and drawing) [✓]
- Middle stage (development of prototype) [ ]
- Last stage (production) [ ]
- Commercialisation stage (after product has been launched) [ ]
- Throughout all stages [ ]

Q.6 The design of the new products is determined by

- Customer pull [✓]
- Management [ ]
- Technology push [✓]

Others (Please specify) : MARKET / PURPOSE

Q.7 Under which management level is the design function located (Please tick one only)

- Top management [✓]
- Middle management [ ]
- Lower management [ ]

Q.8 Who is responsible for managing product development in your company? (Please tick all which apply)

- Managing Director [✓]
- Marketing Director [ ]
- Production Director [ ]
- Industrial Design Director [ ]
- Purchasing Director [ ]
- Financial Director [ ]
- Research and Development (R&D) Director [ ]
- Technical Director [ ]

Others (Please write in)
GENERAL MANAGER

Q.9 Which one of the following systems best describes the design/manufacture relationship in your company? (Please tick one only)

Design team hands over the prototype to production to produce and marketing to sell [ ]

Design team sees the new product design through production [ ]

Design team sees the new product design through to commercialisation [ ]

Design team monitors the performance feedback of the new product design throughout commercialisation and beyond [✓]

Others (Please write in)

_____

QUESTIONS Q.10 - Q.12

Please circle the appropriate number according to your degree of preference.

Q.10 How do you see the **ROLE** of industrial designers in the process of the new product development?

	Lowest Role		**Medium**		**Highest Role**
Aesthetic specialist	1	2	3	4	5
Generalist/jack-of-all-trades	1	2	3	4	5
Work in consultation with other specialist	1	2	3	4	5
Mediator between the multi-discipline team	1	2	3	4	5
Project co-ordinator	1	2	3	4	5
Others (Please write in and rank order) _____	1	2	3	4	5

Q.11 How do you rate the following **design considerations** in the design of new products?

	Lowest Priority		**Medium**		**Highest Priority**
Functionality	1	2	3	4	5
Aesthetic value	1	2	3	4	5
Ergonomic factors	1	2	3	4	5
Ease of use	1	2	3	4	5
Low maintenance cost	1	2	3	4	5
Safety	1	2	3	4	5
Others (Please write in and rank order) _____	1	2	3	4	5

Q.12 Listed below are factors which may lead to a successful new product. How significant do you consider each factor to be in the successful development of new products ?

	Very Important				**Not important at all**
Process directed by an individual with outstanding authority and power	1	2	3	4	5
Early recognition of market needs	1	2	3	4	5
Close interaction with customers/users in design and development stages	1	2	3	4	5
Replacement of old products	1	2	3	4	5
A higher technological content that rival product offerings	1	2	3	4	5
Made more use of new and improved manufacturing techniques	1	2	3	4	5
Rationalisation of production process leading to better price/value ration	1	2	3	4	5
Product designed and developed by a team of qualified engineering and industrial designers	1	2	3	4	5
Designer(s) saw the product through to commercialisation	1	2	3	4	5
Others (Please write in and rank order) _____	1	2	3	4	5

QUESTIONS Q.13, Q.14, Q.15

Each question has 5 numbers and you are asked to **circle** these 5 numbers according to your degree of preference. These 5 numbers will correspond to;

1- Not acquired 2- Least acquired 3- Less acquired 4- More acquired 5- Most acquired

Q.13 In your company, INDUSTRIAL DESIGNER is **skilled** in .....

	Not acquired				**Most acquired**
Understanding and developing a client's brief	1	2	3	4	5
Creating new design concepts	1	2	3	4	5
Representing alternative design solutions	1	2	3	4	5

Q.13 (Continued .....)

	Not acquired				Most acquired
Presenting work visually	1	2	3	4	5
Selecting colours/textures/forms	1	2	3	4	5
Constructing model(s)/prototype(s)	1	2	3	4	5
Using computers to aid design (CAD)	1	2	3	4	5
Selecting materials	1	2	3	4	5
Selecting joining and assembling methods	1	2	3	4	5
Mechanical/engineering drawing	1	2	3	4	5
Manufacturing techniques	1	2	3	4	5
Managing a project	1	2	3	4	5
Deriving basic market data	1	2	3	4	5
Assessing customer feedback	1	2	3	4	5
Others (Please write in and rank order) _____	1	2	3	4	5

Q.14 In your company, INDUSTRIAL DESIGNER should have a **working knowledge** of .....

	Not acquired				Most acquired
Design history and theory	1	2	3	4	5
Art history/aesthetics	1	2	3	4	5
General technical knowledge	1	2	3	4	5
Mechanical engineering	1	2	3	4	5
Relevant computer techniques	1	2	3	4	5
Presentation techniques	1	2	3	4	5
Anthropometrics/ergonomics	1	2	3	4	5
Current market trends	1	2	3	4	5
Consumer behaviour	1	2	3	4	5
Relevant volume production processes	1	2	3	4	5
Workshop practices	1	2	3	4	5
Quality control methods	1	2	3	4	5
Design practice and management	1	2	3	4	5
Others (Please write in and rank order) _____	1	2	3	4	5

Q.15 In your company, INDUSTRIAL DESIGNER **functions** in order to .....

	Not acquired				**Most acquired**
Create a new product concept	1	2	3	4	5
Redesign for improvement	1	2	3	4	5
Work well with other designers	1	2	3	4	5
Collaborate in a design team	1	2	3	4	5
Collaborate with experts from other areas	1	2	3	4	5
Work successfully to deadlines	1	2	3	4	5
Have creative or original thinking	1	2	3	4	5
Pay attention to detail	1	2	3	4	5
Reduce product and production costs	1	2	3	4	5
Others (Please write in and rank order) _____	1	2	3	4	5

==========

QUESTIONS Q.16, Q.17, Q.18

Questions **Q.16, Q.17, Q.18** are designed to find out which skills, competencies, and attitudes industrial designers **NEED** in order to perform their functions or tasks effectively in the process of new product development.

Each question has 5 numbers and you are asked to **circle** these 5 numbers according to your degree of preference. These 5 numbers will correspond to;

1- Not needed 2- Least needed 3- Less needed 4- More needed 5- Most needed

==========

THE IDEAL SITUATION

Q.16 The INDUSTRIAL DESIGNER should be **skilled** in .....

	Not needed				**Most needed**
Understanding and developing a client's brief	1	2	3	4	5
Creating new design concepts	1	2	3	4	5
Representing alternative design solutions	1	2	3	4	5
Presenting work visually	1	2	3	4	5
Selecting colours/textures/forms	1	2	3	4	5

Q.16 (Continued .....)

	Not needed				Most needed
Constructing model(s)/prototype(s)	1	2	3	4	5
Using computers to aid design (CAD)	1	2	3	4	5
Selecting materials	1	2	3	4	5
Selecting joining and assembling methods	1	2	3	4	5
Mechanical/engineering drawing	1	2	3	4	5
Manufacturing techniques	1	2	3	4	5
Managing a project	1	2	3	4	5
Deriving basic market data	1	2	3	4	5
Assessing customer feedback	1	2	3	4	5
Others (Please write in and rank order) _____	1	2	3	4	5

Q.17 The INDUSTRIAL DESIGNER should have a **working knowledge** of .....

	Not needed				Most needed
Design history and theory	1	2	3	4	5
Art history/aesthetics	1	2	3	4	5
General technical knowledge	1	2	3	4	5
Mechanical engineering	1	2	3	4	5
Relevant computer techniques	1	2	3	4	5
Presentation techniques	1	2	3	4	5
Anthropometrics/ergonomics	1	2	3	4	5
Current market trends	1	2	3	4	5
Consumer behaviour	1	2	3	4	5
Relevant volume production processes	1	2	3	4	5
Workshop practices	1	2	3	4	5
Quality control methods	1	2	3	4	5
Design practice and management	1	2	3	4	5
Others (Please write in and rank order) _____	1	2	3	4	5

Q.18 The INDUSTRIAL DESIGNER should **function** to .....

	Not needed				**Most needed**
Create a new product concept	1	2	3	4	5
Redesign for improvement	1	2	3	4	5
Work well with other designers	1	2	3	4	5
Collaborate in a design team	1	2	3	4	5
Collaborate with experts from other areas	1	2	3	4	5
Work successfully to deadlines	1	2	3	4	5
Have creative or original thinking	1	2	3	4	5
Pay attention to detail	1	2	3	4	5
Reduce product and production costs	1	2	3	4	5
Others (Please write in and rank order) _____	1	2	3	4	5

==========

Q.19 Available evidence suggests that design is often neglected in many British industries and when effectively managed may lead to better design and higher quality products. Drawing on your experience, please briefly suggest ways in which, in your view, the management of design can be improved.

Integrating design as part of the development team.
Starting and involving designers early in the project.
Using qualified staff.

THIS IS THE END
THANK YOU VERY MUCH FOR ANSWERING THIS QUESTIONNAIRE

SURVEY QUESTIONNAIRE
(MARKETER)

This survey is designed to investigate the role that the industrial designer currently plays in the process of new product development. It focuses on different aspects of design and you are asked to answer some questions. The results may well highlight any mismatches in understanding and could prove informative and useful to all concerned. Complete confidentiality is assured and the survey will be used strictly for academic purposes.

Name : _____

Position : _____

Department : _____

Company/establishment : _____

_____

_____

Telephone no. : _____ Fax no. : _____

==========

QUESTIONS Q.1 - Q.7

Please tick the boxes on the right as appropriate

Q.1 Please tick **ONE** to indicate the number of employees in your company:

0 - 9 employees (micro industry)	[ ]
10 - 99 employees (small industry)	[ ]
100 - 499 employees (medium industry)	[x]

Q.2 Does your organisation:

Employ industrial designers on your staff	[ ]
Employ outside design consultants and/or freelance designers	[x]
Expect design to be part of the service given to you by the contractors, agents, suppliers of materials, etc.	[ ]
Have a Research & Development Department	[x]
Have a Design/Industrial Design Department	[x]

Q.3 How many industrial designers, engineers, and marketers are employed in your company? (Please write in number)

Industrial designers	[4]
Engineers	[4]
Marketers	[3] *

* Marketers cooperate with 4 locations.

Q.4 To what extent are industrial designers, engineers and marketers involved in the process of new product development ?

	Extremely Involved	Very Involved	Involved	Slightly Involved
Industrial designer	[ ]	[X]	[ ]	[ ]
Engineers	[ ]	[ ]	[X]	[ ]
Marketers	[X]	[ ]	[ ]	[ ]
Significantly others (Please state) _____	[ ]	[ ]	[ ]	[ ]

Q.5 Who is responsible for managing product development in your company? (Please tick all which apply)

Managing Director	[ ]
Marketing Director	[X]
Production Director	[X]
Industrial Design Director	[ ]
Purchasing Director	[ ]
Financial Director	[ ]
Research and Development (R&D) Director	[X]
Technical Director	[X]

Others (Please write in)

_____

Q.6 Under which management level is the design function located (Please tick one only)

Top management	[ ]
Middle management	[X]
Lower management	[ ]

Q.7 In your company, industrial design functions to:

Evaluate a market opportunity	[ ]
Create a new product concept	[X]
Represent alternative design solutions	[X]
Redesign for improvement	[ ]
Select materials	[ ]
Carry out ergonomics	[ ]

Q.7 (Continued .....)

Mechanical drawings for production	[ ]
Construct prototypes	[X]
Develop a product strategy	[ ]
Analyse product failure/success	[ ]
Adapt the technology to local needs	[ ]
Reduce product and production costs	[ ]
Undertake detailed design	[ ]

Others (please specify) :

_____

QUESTIONS Q.8 - Q.14

Please circle the appropriate number according to your degree of preference.

Q.8 How do you foresee the **ROLE** of the industrial designer in the process of the new product development?

	Lowest Role		**Medium**		**Highest Role**
Aesthetic specialist	1	2	3	4	5
Generalist/jack-of-all-trades	1	2	3	4	5
Work in consultation with other specialists	1	2	3	4	5
Mediator between the multi-discipline team	1	2	3	4	5
Project co-ordinator	1	2	3	4	5
Others (Please write in and rank order) _____	1	2	3	4	5

Q.9 In your opinion, which of the following do industrial designers contribute to in your organisation?

	Lowest				**Highest**
Improving the quality of capital goods/consumer goods	1	2	3	4	5
Cutting production cost	1	2	3	4	5
Making products easier to use	1	2	3	4	5
Packaging and sales appeal	1	2	3	4	5
Advertising and publicity	1	2	3	4	5
Increasing sales	1	2	3	4	5
Others (Please write and rank order) _____	1	2	3	4	5

Q.10 How does your company rate the use of the following industrial design services arrangements?

	Very satisfied				Not satisfied at all
Co-opt a professional industrial designer into the design team for the period of the project	1	2	3	4	5
Employ a visiting industrial designer on a part-time consulting basis (e.g. to provide advice and contribute to design proposals)	1	2	3	4	5
Employ external consultants with basic industrial design work carried out in their own design offices	1	2	3	4	5
Draw on the knowledge of a member (engineer) of the design team who is experienced in industrial design techniques	1	2	3	4	5
Employ industrial designers on a permanent basis	1	2	3	4	5
Employ engineers with knowledge of industrial design	1	2	3	4	5
Others (Please write in and rank order) _____	1	2	3	4	5

Q.11 Which one of the following systems best describes the design/manufacture relationship in your company? (Please tick one only)

Design team hands over the prototype to production for manufacture and marketing to sell [ ]

Design team sees the new product design through to production [ ]

Design team sees the new product design through to commercialisation [ ]

Design team monitors the performance feedback of the new product design throughout commercialisation and beyond [X]

Others (Please write in)

_____

Q.12 Listed below are factors which may lead to successful new product. How significant do you consider each factor to be in the successful development of a new product ?

	Very Important				Not important at all
Process directed by an individual with outstanding authority and power	1	2	3	4	5
A higher technological content that rival product offerings	1	2	3	4	5

Q.12 (Continued.....)

	Very Important				Not important at all
Close interaction with customers/users in design and development stages	1	2	3	4	5
Made more use of new and improved manufacturing techniques	1	2	3	4	5
Product designed and developed by a team of qualified engineering and industrial designers	1	2	3	4	5
Designer(s) saw the product through to commercialisation	1	2	3	4	5

Q.13 In general, when taking product design decisions, how important are the following design/manufacture interface considerations?

	Very important				Not important at all
Existing manufacturing processes	1	2	3	4	5
Suitability of existing manufacturing processes (e.g. for design purpose)	1	2	3	4	5
Choice of materials (e.g. strength of materials)	1	2	3	4	5
Reduction in rather than addition to the number of components	1	2	3	4	5
Range of colours (e.g. for production reasons)	1	2	3	4	5
Others (Please write in and rate) _____	1	2	3	4	5

Q.14 Listed below are characteristics that can make one product more attractive than the other in the marketplace. Using the scale provided, please indicate the extent to which you believe each factor has influenced the sale of your products against those of your competitors in the markets.

	Very influential				Not influential at all
Sale price	1	2	3	4	5
Style/fashion	1	2	3	4	5
Durability	1	2	3	4	5
Flexibility and adaptability in use	1	2	3	4	5
Parts availability	1	2	3	4	5

Q.14 (Continued .....)

	Very influential				Not influential at all
Attractive appearance/shape	1	2	3	4	5
Technical sophistication	1	2	3	4	5
Performance in operation	1	2	3	4	5
Easy to use	1	2	3	4	5
Safe to use	1	2	3	4	5
Reliability	1	2	3	4	5
Easy to maintain	1	2	3	4	5
Quality of after-sales service	1	2	3	4	5
Efficient delivery	1	2	3	4	5
Advertising and promotion	1	2	3	4	5
Operator comfort	1	2	3	4	5
Others (Please write in and rank order) _____	1	2	3	4	5

QUESTIONS Q.15 & Q.16

If more than one please rank order (1,2,3 etc.) in order of importance

Q.15 Which of the following types of strategies for new product development does your company follow?.

Introduce new products in response to competitive pressure [4]
Protect existing products via process innovation [3]
(e.g. cutting manufacturing costs)

Introduce new products into specific market-sectors [1]
Introduce new products into related market segments [2]

Others (Please write in)
_____

Q.16 Which of the following types of design strategy does your company follow?

Radical breakthrough (innovation leading to entirely new technology [ ]
Major innovation (innovation leading to major changes in, or more addition to an existing product) [X]

Improvements (incremental innovation leading to minor changes in the existing product) [ ]

Others (Please write in)
_____

QUESTIONS Q.17, Q.18, Q.19

Questions **Q.17, Q.18, Q.19** are designed to find out which skills, competencies, and attitudes industrial designers NEED in order to perform their functions or tasks effectively in the process of new product development in your company.

Each question has 5 numbers and you are asked to **circle** these 5 numbers according to your degree of preference. These 5 numbers will correspond to;

1- Not needed 2- Least needed 3- Less needed 4- More needed 5- Most needed

==========

Q.17 The INDUSTRIAL DESIGNER should be **skilled** in .....

	Not needed				**Most needed**
Understanding and developing a client's brief	1		3	(4)	5
Creating new design concepts	1	2	(3)	4	5
Representing alternative design solutions	1		3	(4)	5
Presenting work visually		2	3	4	(5)
Selecting colours/textures/forms	1	2	(3)	4	5
Constructing model(s)/prototype(s)	1	2	(3)	4	5
Using computers to aid design (CAD)		2	3	(4)	5
Selecting materials	1	(2)	3		5
Selecting joining and assembling methods	1	(2)	3		5
Mechanical/engineering drawing	(1)	2	3	4	5
Manufacturing techniques	1	2	3	(4)	5
Managing a project	1	(2)	3	4	5
Deriving basic market data	1	(2)	3	4	5
Assessing customer feedback	1	2	3	(4)	5
Others (Please write in and rank order) _____	1	2	3	4	5

Q.18 The INDUSTRIAL DESIGNER should have a **working knowledge** of .....

	Not needed				**Most needed**
Design history and theory	1	2	3	(4)	5
Art history/aesthetics	1	2	3	(4)	5
General technical knowledge	1	2	3	(4)	5

Q.18 (Continued .....)

	Not needed				Most needed
Mechanical engineering	1	2	3	4	5
Relevant computer techniques	1	2	3	4	5
Presentation techniques	1	2	3	4	5
Anthropometrics/ergonomics	1	2	3	4	5
Current market trends	1	2	3	4	5
Consumer behaviour	1	2	3	4	5
Relevant volume production processes	1	2	3	4	5
Workshop practices	1	2	3	4	5
Quality control methods	1	2	3	4	5
Design practice and management	1	2	3	4	5
Others (Please write in and rank order) _____	1	2	3	4	5

Q.19 The INDUSTRIAL DESIGNER should function to .....

	Not needed				Most needed
Create a new product concept	1	2	3	4	5
Redesign for improvement	1	2	3	4	5
Work well with other designers	1	2	3	4	5
Collaborate in a design team	1	2	3	4	5
Collaborate with experts from other areas	1	2	3	4	5
Work successfully to deadlines	1	2	3	4	5
Have creative or original thinking	1	2	3	4	5
Pay attention to detail	1	2	3	4	5
Reduce product and production costs	1	2	3	4	5
Others (Please write in and rank order) _____	1	2	3	4	5

Q.20 Available evidence suggests that design is often neglected in many British industries and when effectively managed may lead to better design and higher quality products. Drawing on your experience, please briefly suggest ways in which, in your view, the management of design can be improved.

- Design brings fresh ideas and should not be governed by internal constraints like manufacturing facilities.
- Extensive briefing of the designer(s) in terms of product application, users, buyers and decision makers and competitive environment is crucial.
- Permanent contact between designer(s), marketers and industrial designers is important.

THIS IS THE END
THANK YOU VERY MUCH FOR ANSWERING THIS QUESTIONNAIRE

SURVEY QUESTIONNAIRE
(DESIGN CONSULTANTS)

This survey is designed to investigate the role that the industrial designer currently plays in the process of new product development. It focuses on different aspects of design and you are asked to answer some questions. The results may well highlight any mismatches in understanding and could prove informative and useful to all concerned. Complete confidentiality is assured and the survey will be used strictly for academic purposes.

Name : _____

Position : _____

Department : _____

Company/establishment : _____

_____

_____

Telephone no. : _____ Fax no. : _____

==========

QUESTIONS Q.1 - Q.3

Please tick the boxes on the right as appropriate

Q.1 Who are the people that comprise the design team in your company?

Industrial Designers	[3]
Ergonomist	[ ]
Mechanical Engineers	[1]
Electrical Engineers	[ ]
Production Engineers	[ ]
Market Analysts	[ ]
Others (Please write in) MODELMAKER	1
ADMIN	1

Q.2 At what stage in your client's operation are design considerations brought in?

First stage (idea generation and drawing)	[ ]
Middle stage (development of prototype)	[ ]
Last stage (production)	[ ]
Commercialisation stage (after product has been launched)	[ ]
Throughout all stages	[✓]

Sometimes all stages others at a particular stage. Generally the ticked option applies.

Others (Please specify)

_____

Q.3 What do you think is the nature of the work/task of the industrial designer in designing new products? (Tick all boxes that apply)

Evaluate a market opportunity	[✓]
Create a new product concept	[✓]
Visualise the product concept	[✓]
Represent alternative design solutions	[✓]
Redesign for improvement	[✓]
Select materials	[✓]
Select a final design	[✓]
Carry out ergonomic studies	[✓]
Mechanical drawings for production	[✓]
Assist with production engineering and tooling	[✓]
Construct prototypes	[✓]
Test prototypes(s)	[✓]
Develop a selling strategy	[?]
Analyse product failure/success	[✓]
Adapt the technology to local needs	[ ]
Reduce product cost	[✓]
Reduce production costs	[✓]
Undertake detailed design	[✓]

Others (please specify) :

_____

QUESTIONS Q.4 - Q.7

Please circle the appropriate number according to your degree of preference.

Q.4 What criteria do you think your client(s) use when selecting design consultant(s)?

	Least Considered				**Most Considered**
Reputation	1	2	(3)	4	5
Service fees	1	2	(3)	4	5
Previous work experience	1	2	3	4	(5)
Market knowledge	1	2	3	(4)	5
Quality of work	1	2	3	(4)	5
Professionalism	1	2	3	(4)	5
Creativity	1	2	3	(4)	5
Others (Please write in and rank order) _____	1	2	3	4	5

Q.5 How do you rate the following **design considerations** in the design of new products?

	Lowest Priority		**Medium**		**Highest Priority**
Functionality	1	2	3	4	5
Aesthetic value	1	2	3	4	5
Ergonomic factors	1	2	3	4	5
Ease of use	1	2	3	4	5
Low maintenance cost	1	2	3	4	5
Safety	1	2	3	4	5
Others (Please write in and rank order) _____	1	2	3	4	5

Q.6 How do you foresee the **ROLE** of the industrial designer in the process of the new product development in your company?

	Lowest Role		**Medium**		**Highest Role**
Aesthetic specialist	1	2	3	4	5
Generalist/jack-of-all-trades	1	2	3	4	5
Work in consultation with other specialist	1	2	3	4	5
Mediator between the multi-discipline team	1	2	3	4	5
Project co-ordinator	1	2	3	4	5
Others (Please write in and rank order) _____	1	2	3	4	5

Q.7 In your opinion, which of the following do you/your designer(s) contribute to in your clients' organisation?

	Lowest				**Highest**
Improving the quality of capital goods/consumer goods	1	2	3	4	5
Cutting production cost	1	2	3	4	5
Making products easier to use	1	2	3	4	5
Packaging and sales appeal	1	2	3	4	5
Advertising and publicity	1	2	3	4	5
Increasing sales	1	2	3	4	5
Others (Please write and rank order) _____	1	2	3	4	5

QUESTIONS Q.8 - Q.10

Questions **Q.8** - **Q.10** are designed to find out which skills, competencies, and attitudes industrial designers **NEED** in order to perform their functions or tasks effectively in the process of new product development in your company.

Each question has 5 numbers and you are asked to **circle** these 5 numbers according to your degree of preference. These 5 numbers will correspond to;

1- Not needed 2- Least needed 3- Less needed 4- More needed 5- Most needed

==========

Q.8 The INDUSTRIAL DESIGNER should be **skilled** in .....

	Not needed				**Most needed**
Creating new design concepts	1	2	3	4	5
Representing alternative design solutions	1	2	3	4	5
Presentation drawing/airbrush etc.	1	2	3	4	5
Selling the design concept to the client	1	2	3	4	5
Presenting work visually	1	2	3	4	5
Presenting design concepts verbally	1	2	3	4	5
Selecting colours/textures/forms	1	2	3	4	5
Constructing model(s)/prototype(s)	1	2	3	4	5
Selecting a final design	1	2	3	4	5
Photography	1	2	3	4	5
Using computers to aid design (CAD)	1	2	3	4	5
Selecting materials	1	2	3	4	5
Selecting joining and assembling methods	1	2	3	4	5
Mechanical/engineering drawing	1	2	3	4	5
Manufacturing techniques	1	2	3	4	5
Deriving basic market data	1	2	3	4	5
Assessing market trends	1	2	3	4	5
Marketing techniques/selling strategy	1	2	3	4	5
Recognising maintainability/ reliability constraints	1	2	3	4	5
Working to deadlines	1	2	3	4	5
Assessing customer feedback	1	2	3	4	5
Others (Please write in and rank order) _____	1	2	3	4	5

Q.9 The INDUSTRIAL DESIGNER should have a **working knowledge** of .....

	Not needed				**Most needed**
Design history and theory	1	2	3	4	5
Art history/aesthetics	1	2	3	4	5
General technical knowledge	1	2	3	4	5
Mechanical engineering	1	2	3	4	5
Electronics/electrical engineering	1	2	3	4	5
Behavioural sciences (e.g. psychology, sociology)	1	2	3	4	5
Relevant computer techniques	1	2	3	4	5
Presentation techniques	1	2	3	4	5
Anthropometrics/ergonomics	1	2	3	4	5
Current market trends	1	2	3	4	5
Standards and trade regulations	1	2	3	4	5
Relevant volume production processes	1	2	3	4	5
Workshop practices	1	2	3	4	5
Quality control methods	1	2	3	4	5
Design practice and management	1	2	3	4	5
Design protection	1	2	3	4	5
Others (Please write in and rank order) _____	1	2	3	4	5

Q.10 The INDUSTRIAL DESIGNER should function to .....

	Not needed				**Most needed**
Evaluate a market opportunity	1	2	3	4	5
Create a new product concept	1	2	3	4	5
Redesign for improvement	1	2	3	4	5
Work well with other designers	1	2	3	4	5
Collaborate in a design team	1	2	3	4	5
Collaborate with experts from other areas	1	2	3	4	5
Work successfully to deadlines	1	2	3	4	5
Have creative or original thinking	1	2	3	4	5

Q.10 (Continued .....)

	Not needed				Most needed
Pay attention to detail	1	2	3	4	5
Analyse product failure/success	1	2	3	4	5
Reduce product and production costs	1	2	3	4	5
Develop a product strategy	1	2	3	4	5

Others (Please write in and rank order)

_____	1	2	3	4	5

Q.11 Available evidence suggests that design is often neglected in many British industries and when effectively managed may lead to better design and higher quality products. Drawing on your experience, please briefly suggest ways in which, in your view, the management of design can be improved.

· Better more appropriate education of fewer more talented industrial designers. Far too many are submitted courses teaching no talent kid to practice badly

· Ditto separate design management courses.

· Government backed initiatives, backed by international examples of the process working successfully in large/small companies. (Telling will do nothing there has to be a scheme which actively encourages by example)

Etc Etc sorry no more time

THIS IS THE END
THANK YOU VERY MUCH FOR ANSWERING THIS QUESTIONNAIRE

APPENDIX 2
(List of Malaysia Design Consultants and Companies Involved in Questionnaire Survey)

Design Consultants

1 Orcadesign Consultants Sendirian Berhad
2 Panel-Link Sendirian Berhad
3 Radiustech Sendirian Berhad
4 SIRIM Berhad
5 Sulik Design Consultants

Companies

1 BFS Group of Companies
2 Bristol Industries Sendirian Berhad
3 Cenzin Woods (Malaysia) Sendirian Berhad
4 Chungwa Picture Tubes (Malaysia) Sendirian Berhad
5 Cable Vision Technologies (Malaysia) Sendirian Berhad
6 EP Mould and Die (Malaysia) Sendirian Berhad
7 Faber Group Berhad
8 Furniture Industry Technology Centre
9 Goh Ban Huat Berhad
10 Guthrie Furniture Sendirian Berhad
11 H&R Johnson (Malaysia) Sendirian Berhad
12 Hasro Furniture (Malaysia) Sendirian Berhad
13 Hitachi Airconditioning Products (Malaysia) Sendirian Berhad
14 J.K. Digital Technology (Malaysia) Sendirian Berhad
15 Kee Huat Industries Berhad
16 Loyal Works (Malaysia) Sendirian Berhad
17 Malpro Industri (Malaysia) Sendirian Berhad
18 Mara Shipyard and Engineering (Terengganu) Sendirian Berhad
19 Markas Sendirian Berhad
20 Matsushita Electric Co. (Malaysia) Berhad
21 MEC Home Appliances Sendirian Berhad
22 Miracle Equipment Sendirian Berhad
23 Modenas Sendirian Berhad
24 Motorola Penang Malaysia
25 Naga Furniture Choicewood Sendirian Berhad
26 Perabot Matang Industries (Malaysia) Sendirian Berhad
27 Perodua Manufacturing Sendirian Berhad
28 Perusahaan Otomobil Nasional Berhad
29 Prisinar Sendirian Berhad
30 PKNS Federal Furniture International (Malaysia) Sendirian Berhad

31 Plastictecnic (Malaysia) Sendirian Berhad
32 Ralco Plastic Sendirian Berhad
33 Safire Plastics Sendirian Berhad
34 Sapura Research Sendirian Berhad
35 Sharp Electronics (Malaysia) Sendirian Berhad
36 The Merryfair Chair System Sendirian Berhad
37 Tiga Mutiara Industries Sendirian Berhad
38 Usra Sendirian Berhad

APPENDIX 3
(List of UK Design Consultants and Companies Involved in Questionnaire Survey)

Design Consultants

1. Addison Design Consultants Limited
2. ASA Designers Limited
3. Atkinson Design Associates Limited
4. Atlantic Design
5. BIB Design Consultants Limited
6. Buxton Wall McPeake
7. Cambridge Consultants Limited
8. Cambridge Design
9. Colin Cheetham Design Partnership
10. David Crisp
11. David Morgan Associates
12. DCA Design Consultants
13. Design Matters
14. Fitch
15. FM Design Limited
16. Forth Product Design Limited
17. Frazer Designers
18. Glenelg Product Design
19. Greaves Best Design
20. Grey Matter Design Consultants Plc
21. GX Design Engineers
22. Heights Design Group Limited
23. Hodges and Drake Design
24. Hollington
25. Hop Studios (International Limited)
26. IDEO Product Development
27. International Automotive Design
28. Jones Garrard Limited
29. Kinneir Dufort Design Limited
30. Level Six Design Limited
31. London Associates
32. Madison Limited
33. MRDC Limited
34. Ogle Design Limited
35. Paul Usher Design
36. Pemberton Dear
37. Pentagram Design Limited
38. Product First
39. PSD Associates Limited
40. Queensbury Hunt Levien
41. Raffo Design Associates
42. Rainford Design

43. Random Product Design Limited
44. Sadler Associates
45. Satherley Design Associates
46. Seymour Powell Limited
47. Tangerine
48. Team Consulting Limited
49. The Product Group
50. Therefore Limited
51. TKO Product Design
52. Toucan Product Design

Companies

1. ACF International Limited
2. Addis Limited
3. Aiwa UK Limited
4. Antocks Lairn Limited
5. Asher Systems Furniture
6. Audus Noble Limited
7. Belling & Company Limited
8. Bisley Office Furniture
9. Bissel Appliances Limited
10. Black & Decker
11. Braun Electric UK Limited
12. Candy Holdings Limited
13. Canon UK Limited
14. Cannon Rubber Limited
15. Caplan Furniture
16. Comet Group Plc
17. Creda Limited
18. Currys Group Plc
19. Curver Consumer Products Limited
20. Dauphin Plc
21. Deanes Furniture Limited
22. Dyson Appliances Holdings Limited
23. Electrolux
24. Ercol Furniture Limited
25. Eurotek Office Furniture Limited
26. Flexiform Business Furniture Limited
27. GEC Marconi (Projects) Limited
28. GKK Plastics Limited
29. Godfrey Syrett Limited
30. Hille Ltd
31. Hills Industries Limited
32. Hitachi Consumer Products UK Limited
33. Hotpoint Limited
34. Hozelock Group Plc

35. Hoover Limited
36. IBM UK Limited
37. Intercraft Designs Limited
38. Jackel International Limited
39. K&N International (Office Systems) Limited
40. Kenwood Limited
41. Kinnarps UK Limited
42. LG Electronics UK Limited
43. Linn Products Limited
44. Linpak Plastics Limited
45. Matsushita Electric UK Limited
46. Midland Industrial Plastics Limited
47. Morphy Richards Limited
48. Moulinex Swan Holding Limited
49. Myson Group Plc
50. Ness Furniture Limited
51. Newman Tonks Group Plc
52. New World (Group) Limited
53. Panasonic UK Limited
54. Phillips Electronics UK Limited
55. Pifco Manufacturing Limited
56. Pioneer High Fidelity (GB) Limited
57. Plasplugs Limited
58. Plastic Omnium Limited
59. Plysu Plc
60. Polypipe Plc
61. President Office Furniture Limited
62. Probus Mayfair Plc
63. Quad Electro Acoustics Limited
64. Redring Electric Limited
65. Russel Hobbs Tower Limited
66. Samas Roneo Limited
67. Sharp Electronics UK Limited
68. Samsung Electronics Manufacturing UK Limited
69. Sanyo Industries UK Limited
70. Sanyo Electric Manufacturing UK Limited
71. Silentnight Holdings Plc
72. Sony UK Limited
73. Thermos Limited
74. Thorn EMI Electronics UK Limited
75. Thorn Lighting Limited
76. Toshiba Consumer Products UK Limited
77. Vector Seating Limited
78. Vent-Axia Limited
79. Verco Office Furniture Limited
80. Wharfedale International Limited
81. Xpelair Limited
82. Yale & Valour

APPENDIX 4 : QUESTIONNAIRE SURVEY: ANALYSIS AND FINDINGS

1.1 MALAYSIA RESPONDENTS

1.1.1 SINGLE VARIABLE

1.1.1.1 Industrial Designer's Frequencies and Descriptive Results

The data from the single variables were subjected to frequency and descriptive procedures enabling the researcher to examine the data in a more condensed form. Altogether twenty three single variables from 3 different groups were used (industrial designers, engineers and marketers, and industrial design consultants). From twenty three single variables, twelve were subjected to a frequency and descriptive procedure while another eleven were subjected to a mean procedure. For each of the variables, frequency distribution or frequency table indicate the number of cases in each category. From the frequency output, the researcher was able to gain results from three different groups of respondents with regard to the process of new product development in Malaysian SMIs.

The variable 'YEAR' was used to identify how long the respondents had been involved in industrial/product design . The findings (Table 1) show that 38.2% of the respondents recorded 2-4 years, 23.5% respondents showed less than 2 years, 17.6% between 5-7 years, 14.7% between 8-9 years and only 2.9% of the total sample had more than 10 and 15 years experience in industrial/product design.

Table 1 : Involvement in Industrial/Product Design.

Value Label	*Frequency*	*Percent*	*Valid Percent*	*Cum Percent*
less than 2 years	8	23.5	23.5	23.5
2-4 years	**13**	**38.2**	**38.2**	**61.8**
5-7 years	6	17.6	17.6	79.4
8-9 years	5	14.7	14.7	94.1
more than 10 years	*1*	*2.9*	*2.9*	*97.1*
more than 15 years	*1*	*2.9*	*2.9*	*100.0*

The 'NOPROJ' variable was used to find out how many new product development projects companies had been involved in. The results show that 29.4% of total respondents had been involved in more than 15 projects, 26.5% between 2-4 projects, 23.5% involved in more than 10 projects, a further 20.6% of the respondents were involved in between 5-9 projects.

Table 2 : No. of New Projects Involved

Value Label	*Frequency*	*Percent*	*Valid Percent*	*Cum Percent*
2-4	9	26.5	26.5	26.5
5-9	7	20.6	20.6	47.1
more than 10	8	23.5	23.5	70.6
more than 15	**10**	**29.4**	**29.4**	**100.0**

From the frequency output of the variable 'STAGE' (stage they are involved in the process of new product development), the results show that 38.2% or thirteen out of thirty four of respondents were involved throughout all stages and 17.6% were involved at the first and middle stage. Only 5.9% were involved at the middle stage (development of prototype) and the last stage (production), whilst 2.9% of the respondents were involved at the first stage (idea generation and drawing).

Table 3
Stage at Which Industrial Designers are Involved

Value Label	*Frequency*	*Percent*	*Valid Percent*	*Cum Percent*
first stage	1	2.9	2.9	2.9
middle stage	2	5.9	5.9	8.8
last stage	2	5.9	5.9	14.7
throughout all stage	**13**	**38.2**	**38.2**	**52.9**
first and middle stage	6	17.6	17.6	70.6
first, middle and last	3	8.8	8.8	79.4
first, middle and comm.	4	11.8	11.8	91.2
others	3	8.8	8.8	100.0

The variable 'NPDETER' was used in order to identify the factor which determined the design of new products. It is clear from Table 4 that the design of the new products was mostly determined by customer pull (33.3%) and management (29.2%). It was also indicated that 14.6% of new products were determined by all of the factors; customer pull, management and technology push.

Table 4:
Factor Which Determined the Design of the New Products

Value Label	*Frequency*	*Percent*	*Valid Percent*	*Cum Percent*
customer pull	**16**	**33.3**	**33.3**	**33.3**
management	**14**	**29.2**	**29.2**	**62.5**
technology push	11	22.9	22.9	85.4
all of them	7	14.6	14.6	100.0

1.1.1.2 Engineer and Marketer's Frequencies and Descriptive Results

The 'TYPE' variable was used to find out the number of employees in the company. The findings (Table 5) show that, eight companies or 61.5% were medium (100 - 499 employees) sized, 23.1% (10 - 99 employees) were small, the remaining 15.4% were large companies (more than 499 employees).

Table 5 : Type of Company

Value Label	*Frequency*	*Percent*	*Valid Percent*	*Cum Percent*
small	3	23.1	23.1	23.1
medium	**8**	**61.5**	**61.5**	**84.6**
large	2	15.4	15.4	100.0

The variable 'ORGANI' was used to find out on the background of the company. (i.e., how they get industrial design *services* and whether they have a design or Research and Development department). The 'ORGANI' variable result (Table 6). shows that twelve or 44.5% of the companies employed industrial designers on their staff and eight or 29.6% have a Research and Development department. In marked contrast, only one or 3.7% expected design to be part of the service given to them by the contractors, agents or suppliers of materials. From these results, it can be concluded that most of the companies in Malaysia employed industrial designers on their staff and at the same time have their own Research and Development department.

Table 6: Organisation

Value Label	*Frequency*	*Percent*
Employ industrial designers on your staff	**12**	**44.5**
Employ outside design consultants and/or freelance designers	2	7.4
Expect design to be part of the service given to you by the contractors, agents, suppliers of materials, etc.	1	3.7
Have a Research & Development Department	8	29.6
Have a Design/Industrial Design Department	4	14.8

The functions of industrial design to the company according to engineers and marketers were identified through the 'IDFUNC' variable. The overall results (Table 7) appear to suggest that the functions of industrial design in Malaysia companies were to 'redesign for improvement' (20%), 'create a new product concept' (17.5) and 'represent alternative design solutions' (15.0%).

Table 7: Functions of Industrial Design

Value Label	*Frequency*	*Percent*
Evaluate a market opportunity	2	5.0
Create a new product concept	7	17.5
Represent alternative design solutions	6	15.0
Redesign for improvement	**8**	**20.0**
Select materials	3	7.5
Carry out ergonomics	2	5.0
Mechanical drawings for production	4	10.0
Construct prototypes	1	2.5
Develop a product strategy	1	2.5
Analyse product failure/success	1	2.5
Adapt the technology to local needs	1	2.5
Reduce product and production costs	2	5.0
Undertake detailed design	2	5.0

The results of the variable 'PROSTRA' in Table 8 (the types of strategies for new product development) show that 32.1% of respondents indicated 'introduce new products in response to competitive pressure' and 'protect existing products via process innovation' were the most preferred types of strategies for new product development.

Table 8 : Strategies for New Product Development

Value Label	*Frequency*	*Percent*
Introduce new products in response to competitive pressure	**9**	**32.1**
Protect existing products via process innovation	**9**	**32.1**
Introduce new products into specific market-sectors	4	14.3
Introduce new products into related market segments	6	21.5

In order to identify the types of design strategy followed in the company, the variable 'DESSTRA' was used. As can be seen in Table 9, the results appear to

suggest that most of the Malaysian companies followed 'improvements' (incremental innovation leading to minor changes in the existing product) as a design strategy in their company.

Table 9 : Design Strategy

Value Label	*Frequency*	*Percent*	*Valid Percent*	*Cum Percent*
radical breakthrough	1	7.7	7.7	7.7
major innovation	3	23.1	23.1	30.8
improvements	**9**	**69.2**	**69.2**	**100.0**

1.1.1.3 Industrial Design Consultants's Frequencies and Descriptive Results

The variable 'TEAM' was used to identify who are the people that comprise the design team. The frequency output in Table 10 shows that the design team comprised of industrial designers (33.3%) and engineers of (66.7% (25% mechanical engineers, 25% production engineers and 16.7% electrical engineers). There were no ergonomists or market analysts recorded.

Table 10 : Design Team

Value Label	*Frequency*	*Percent*	*Valid Percent*	*Cum Percent*
Industrial Designers	**4**	**33.3**	**33.3**	**33.3**
Ergonomist	-	-	-	-
Mechanical Engineers	3	25.0	25.0	58.3
Electrical Engineers	2	16.7	16.7	75.0
Production Engineers	3	25.0	25.0	100.0
Market Analysts	-	-	-	-

In terms of the stage of the design considerations brought in, the results of variable STAGE show that about half or 50% of the respondents indicated that they have

been involved throughout all stages. In contrast there was no frequency for 'commercialisation stage' and only 16.7% for the first, middle and last stages.

Table 11 : Stage at Which Design Considerations are Brought In

Value Label	*Frequency*	*Percent*	*Valid Percent*	*Cum Percent*
First stage (idea generation and drawing)	1	16.7	16.7	16.7
Middle stage (development of prototype)	1	16.7	16.7	33.3
Last stage (production)	1	16.7	16.7	50.0
Commercialisation stage	-	-	-	-
Throughout all stages	**3**	**50.0**	**50.0**	100.0

The variable 'IDETASK' was used in order to identify the nature of the work/task of the industrial designer in designing new products. As can be seen in Table 12, 18 items were listed. The results suggest that the most preferred work/task of the industrial designer in designing new products was to 'create a new product concept', 'visualise the product concept' and 'select a final design' (all have the same percentage of 11.1%). The least preferred items (with a zero frequency) were 'develop a selling strategy' and 'reduce product cost'.

1.1.1.4 Industrial Designer's MEAN Results

In the second stage of statistical analysis of the Malaysia study, all the single variables were subjected to a mean procedure. From the means output, the researcher was able to compare the degree of importance given to each variable by the respondents. As has been stressed by Cohen and Holliday (1996 pp 22-28), the mean reflects the value of each score in a distribution and allows other advanced statistical techniques to be considered.

Table 12 : The Nature of the Work/Task of the Industrial Designer

Value Label	*Frequency*	*Percent*	*Valid Percent*	*Cum Percent*
Evaluate a market opportunity	2	5.6	5.6	5.6
Create a new product concept	**4**	**11.1**	**11.1**	**16.7**
Visualise the product concept	**4**	**11.1**	**11.1**	**27.8**
Represent alternative design solutions	3	8.3	8.3	36.1
Redesign for improvement	3	8.3	8.3	44.4
Select materials	2	5.5	5.5	49.9
Select a final design	**4**	**11.1**	**11.1**	**61.0**
Carry out ergonomic studies	2	5.6	5.6	66.6
Mechanical drawings for production	1	2.8	2.8	69.4
Assist with production eng. and tooling	3	8.3	8.3	77.7
Construct prototypes	1	2.8	2.8	80.5
Test prototypes(s)	1	2.8	2.8	83.3
Develop a selling strategy	-	-	-	-
Analyse product failure/success	1	2.8	2.8	86.1
Adapt the technology to local needs	2	5.5	5.5	91.6
Reduce product cost	-	-	-	-
Reduce production costs	1	2.8	2.8	94.4
Undertake detailed design	2	5.6	5.6	100.0

Through the variable 'DESCONS', respondents were asked to rate the design consideration factors in the design of new products. Overall results appear to suggest that 'functionality' was the highest priority with mean scores of 4.50 (Table 13), followed by 'safety (4.21) and ergonomic factors (4.18).

Table 13 : Design Considerations

Variable	*Mean*	*Std Dev*	*Min*	*Max*	*Total*
Functionality	**4.50**	**.66**	**3**	**5**	**34**
Aesthetic value	4.00	1.02	1	5	34
Ergonomic factors	4.18	.83	2	5	34
Ease of use	4.09	.83	3	5	34
Low maintenance cost	4.03	.83	2	5	34
Safety	4.21	.81	2	5	34

The skills of industrial designers were identified by the variable 'SKILL'. Table 14 presents the results. It is clear from the results that 'creating new design concepts' and 'representing design solutions' were among the 'SKILL' items (mean scores greater than 4.20). In contrast, 'deriving basic market data', 'manufacturing techniques', and 'assessing customer feedback' had mean scores less than 3.62.

Table 14 : Skills of Industrial Designers

Variable	*Mean*	*Std Dev*	*Min*	*Max*	*Total*
Understanding a client's brief	3.88	1.17	1	5	34
Creating new design concepts	**4.26**	**1.05**	**1**	**5**	**34**
Representing design solutions	**4.24**	**.82**	**2**	**5**	**34**
Presenting work visually	4.00	.85	2	5	34
Selecting colours/textures/forms	4.03	.80	2	5	34
Constructing model(s)	4.03	1.00	2	5	34
Using computers	3.91	1.06	1	5	34
Selecting materials	3.68	1.09	1	5	34
Selecting joining/assembling	3.94	.98	2	5	34
Engineering drawing	3.76	1.07	2	5	34
Manufacturing techniques	3.62	1.07	1	5	34
Managing a project	3.79	.95	1	5	34
Deriving basic market data	3.32	1.04	1	5	34
Assessing customer feedback	3.62	1.10	1	5	34

From the variable 'WORKNO' (working knowledge of industrial designers) , (Table 15) results suggest that the most preferred working knowledge that Malaysian industrial designers acquire are; 'relevant computer techniques' (mean = 4.29), 'presentation techniques' (4.24), 'anthropometrics' (4.18) and 'current market trends' (4.18)

Table 15 : Working Knowledge of Industrial Designers

Variable	*Mean*	*Std Dev*	*Min*	*Max*	*Total*
Design history and theory	3.00	1.15	1	5	34
Art history/aesthetics	3.24	1.07	1	5	34
General technical knowledge	4.06	.92	1	5	34
Mechanical engineering	3.71	.87	1	5	34
Relevant computer techniques	**4.29**	**.87**	**1**	**5**	**34**
Presentation techniques	**4.24**	**.92**	**2**	**5**	**34**
Knowledge of anthropometrics	4.18	.90	2	5	34
Current market trends	4.18	.80	2	5	34
Consumer behaviour	4.00	.78	2	5	34
Relevant volume prod. processes	3.65	1.04	1	5	34
Workshop practices	3.56	.89	2	5	34
Quality control methods	3.47	1.08	1	5	34
Design practice and management	4.06	.89	2	5	34

In terms of the functions that industrial designers acquire most in the process of the new product development, it was found from the variable 'FUNCT' that 'have creative thinking' displays the highest mean score of 4.62, 'work successfully to deadlines' (4.59) was second and 'redesign for improvement' (4.56) was third in the list. (see Table 16)

Table 16 : Functions of Industrial Designers

Variable	*Mean*	*Std Dev*	*Min*	*Max*	*Total*
Create a new product concept	4.47	.83	2	5	34
Redesign for improvement	**4.56**	**.61**	**3**	**5**	**34**
Work well with other designers	4.32	.73	3	5	34
Collaborate in a design team	4.44	.66	3	5	34
Collaborate with experts	4.03	.76	2	5	34
Work successfully to deadlines	**4.59**	**.70**	**2**	**5**	**34**
Have a creative thinking	**4.62**	**.70**	**2**	**5**	**34**
Pay attention to detail	4.41	.78	2	5	34
Reduce product/production costs	4.12	.95	2	5	34

1.1.1.5 Engineer and Marketer's MEAN Results

The variable 'IDECONT' (see Table 17) was used to find out the contributions made by the industrial designers in the company. According to Malaysian engineers and marketers, the contributions of the industrial designers in the company were; 'making products easier to use' (mean = 3.54) and 'improving the quality of consumer goods' (3.46). The rest of the contributions (in order of preferences) were; 'packaging and sales appeal' (3.38), 'increasing sales' (3.23), 'cutting production cost' (3.15) and 'advertising and publicity' (3.08)

Table 17: Contributions of Industrial Designers

Variable	*Mean*	*Std Dev*	*Min*	*Max*	*Total*
Improving the quality of consumer goods	**3.46**	**1.39**	**1**	**5**	**13**
Cutting production cost	3.15	1.52	1	5	13
Making products easier to use	**3.54**	**.97**	**2**	**5**	**13**
Packaging and sales appeal	3.38	1.33	1	5	13
Advertising and publicity	3.08	1.26	1	5	13
Increasing sales	3.23	1.24	1	5	13

The industrial design services arrangement was identified via the variable 'ARRANG'. The respondents were asked to rate according to their degree of preference (1 = very satisfied and 5= not satisfied at all). The results in Table 18 show that most of the respondents preferred 'employ industrial designers on a permanent basis' (mean = 2.23) and 'employ engineers with knowledge of industrial design' (2.54). In contrast, most of the respondents did not specify 'employ a visiting industrial designer on a part-time consulting basis' and 'employ external consultants with basic industrial design work carried out in their own design offices' (both = 4.15) in their choices.

Table 18 : Industrial Design Services Arrangement

Variable	*Mean*	*Std Dev*	*Min*	*Max*	*Total*
Co-opt a professional industrial designer into the design team for the period of the project	3.23	1.17	2	5	13
Employ a visiting industrial designer on a part-time consulting basis	4.15	.90	3	5	13
Employ external consultants with basic industrial design work carried out in their own design offices	4.15	1.21	1	5	13
Draw on the knowledge of a member (engineer) of the design team who is experienced in industrial design techniques	3.31	1.38	1	5	13
Employ industrial designers on a permanent basis	**2.23**	**1.36**	**1**	**5**	**13**
Employ engineers with knowledge of industrial design	**2.54**	**1.33**	**1**	**5**	**13**

The variable 'INTERF' was used to identify the importance of the design/manufacture interface considerations when taking product design decisions. Again, the respondents were asked to rate according to their degree of preference (1 = very important and 5= not important at all). The results in **Table 19** show that 'existing manufacturing processes' was very important (mean = 1.77). 'Suitability of existing manufacturing processes' was second (2.00) and 'choice of materials' (2.46) third.

Table 19 : Design/Manufacture Interface Consideration

Variable	*Mean*	*Std Dev*	*Min*	*Max*	*Total*
Existing manufacturing processes	**1.77**	**.73**	**1**	**3**	**13**
Suitability of existing manufacturing processes	2.00	.82	1	3	13
Choice of materials	2.46	1.27	1	5	13
Reduction in the number of components	2.54	1.39	1	5	13
Range of colours (e.g. for production reasons)	2.54	.88	1	4	13

The 'SALEFACT' variable was used to identify the characteristics that can make one product more attractive than an other in the market place. By using the scale provided (1 = very influential and 5 = not influential at all), respondents were asked to indicate the extent to which they believed each factor influenced the sale of their products against those of their competitors in the markets. Based on the mean scores in Table 20, the five 'very influential' factors were 'sale price' (mean = 1.54), 'attractive appearance/shape'(1.46), 'reliability' (1.77), 'style/fashion' (1.85) and 'performance in operation', 'easy to use' (both 1.85)

Table 20 : Factors Which Have Influenced the Sale of the Products

Variable	*Mean*	*Std Dev*	*Min*	*Max*	*Total*
Sale price	**1.54**	**.66**	**1**	**3**	**13**
Style/fashion	1.85	.69	1	3	13
Durability	2.31	.85	1	4	13
Flexibility and adaptability in use	2.08	.76	1	3	13
Parts availability	2.23	.83	1	4	13
Attractive appearance/shape	**1.46**	**.52**	**1**	**2**	**13**
Technical sophistication	2.62	1.19	1	5	13
Performance in operation	1.85	.80	1	3	13
Easy to use	1.85	.80	1	3	13
Safe to use	1.92	.76	1	3	13
Reliability	1.77	.73	1	3	13
Easy to maintain	2.15	.55	1	3	13
Quality of after-sales service	2.31	1.03	1	5	13
Efficient delivery	2.15	.90	1	4	13
Advertising and promotion	2.31	.75	1	4	13
Operator comfort	2.15	.80	1	3	13

1.1.1.6 Industrial Design Consultants's MEAN Results

In order to find out the criteria that clients use when selecting design consultants, the variable 'CRITERIA' was used. The results show that 'previous work experience'

has the highest mean scores (mean = 5.00), followed by 'reputation' (4.75), 'quality of work' (4.75) and 'professionalism' (4.75).

Table 21 : Criteria for Selecting Design Consultants

Variable	*Mean*	*Std Dev*	*Min*	*Max*	*Total*
Reputation	4.75	.50	4	5	4
Service fees	*3.75*	*1.50*	*2*	*5*	*4*
Previous work experience	**5.00**	**.00**	**5**	**5**	**4**
Market knowledge	*3.75*	*.50*	*3*	*4*	*4*
Quality of work	4.75	.50	4	5	4
Professionalism	4.75	.50	4	5	4
Creativity	4.00	1.41	2	5	4

Respondents were also asked to rate design consideration factors in the design of new products through the variable 'DESCONS' (Table 22). Overall results appear to suggest that 'functionality' was the highest priority with a total mean of 5.00, followed by 'low maintenance cost' and 'safety' (both 4.50).

Table 22 : Design Considerations

Variable	*Mean*	*Std Dev*	*Min*	*Max*	*Total*
Functionality	**5.00**	**.00**	**5**	**5**	**4**
Aesthetic value	4.00	1.41	2	5	4
Ergonomic factors	*3.25*	*.96*	*2*	*4*	*4*
Ease of use	4.00	.82	3	5	4
Low maintenance cost	4.50	.58	4	5	4
Safety	4.50	.58	4	5	4

From the variable 'IDECONT' (the contributions made by the industrial designers to the clients' organisation), it was found that 'improving the quality of capital goods/consumer goods' had the highest mean score (4.75), followed by 'cutting production cost' and 'making products easier to use' (both 4.25).

Table 23 : Designers Contributions

Variable	*Mean*	*Std Dev*	*Min*	*Max*	*Total*
Improving the quality	**4.75**	**.50**	**4**	**5**	**4**
Cutting production cost	4.25	.50	4	5	4
Making products easier to use	4.25	.50	4	5	4
Packaging and sales appeal	3.25	.50	3	4	4
Advertising and publicity	*2.75*	*.50*	*2*	*3*	*4*
Increasing sales	3.75	.96	3	5	4

1.1.2 COMBINED VARIABLES

(Industrial Designers + Engineers and Marketers)

1.1.2.1 Frequencies and Descriptive Results for Combined Variables

As stated earlier that 'combined variables' are the combination of industrial designer's variables with engineers and marketer's. The data from the combined variables (variable labels in *italic*) were subjected to a frequency and descriptive procedures. From six combined variables five were subjected to frequency and descriptive procedure and one was subjected to a mean procedures. From the frequency output, the researcher was able to further investigate relationships existing between the two groups of respondents with regard to the process of new product development in Malaysia SMIs.

The number of staff (industrial designers, engineering designers and marketers) that are employed companies was identified through the variable '*NOSTAF*'. From the frequency output in Table 24, a total of 131 industrial designers were employed in 34 selected companies in Malaysia compared to 278 engineering designers and 203 marketers. Industrial designers thus represented around 21% of the total workforce in the 34 companies, whilst engineering designers represented 45.4% the remaining 33.2% were marketers. This calculates to a ratio of 2: 5 : 3. Thus for every five engineering designers employed in a company, a further two were industrial designers and another three were marketers.

Table 24 : No. of Staff Employed

Value Label	*Frequency*	*Percent*
Industrial Designers	131	21.4%
Engineering designers	**278**	**45.4%**
Marketers	203	33.2%

The variable '*STAFIN*' was used to identify the extent to which industrial designers, engineers and marketers were involved in the process of new product development. It was evident from the frequency output in Table 25 that industrial designers were very much involved in the process of new product development (72.3%), engineers were very involved (51.1%) and (38.3%) marketers were only involved in that process.

Table 25 : Involvement in the Process of New Product Development

	Extremely Involved	**Very Involved**	**Involved**	**Slightly Involved**
Value Label	*Frequency [%]*	*Frequency [%]*	*Frequency [%]*	*Frequency [%]*
Industrial Designers	**34 [72.3]**	11 [23.4]	2 [4.3]	0 [-]
Engineers	16 [34.0]	**24 [51.1]**	7 [14.9]	0 [-]
Marketers	8 [17.0]	17 [36.2]	**18 [38.3]**	4 [8.5]

From the variable '*LEVDES*' (the management level where the design function is located), results in Table 26 show that twenty nine or 61.7% of the respondents indicated the design function as being located at the top management whilst a further eighteen or 38.3 indicated it was at the 'middle management' level.

Table 26 : Design Locations

Value Label	*Frequency*	*Percent*	*Valid Percent*	*Cum Percent*
top management	**29**	**61.7**	**61.7**	**61.7**
middle management	18	38.3	38.3	100.0
lower management	-	-	-	-

The variable '*RESP*' was used to identify the person who is responsible for managing product development in the company. Table 27 suggests that this person was a 'Managing Director' (33.0%). 'Research and Development Director' (25%) or 'Marketing Director' (13.9%) in most cases.

Table 27 : The Person Who is Responsible for Managing Product Development

Value Label	*Frequency*	*Valid Percent*	*Cum Percent*
Managing Director	**33**	**33.0**	**33.0**
Marketing Director	14	13.9	46.9
Production Director	10	10.0	56.9
Industrial Design Director	10	10.0	66.9
Purchasing Director	-	-	-
Financial Director	*1*	*0.1*	*67.0*
R&D Director	**25**	**25.0**	**92.0**
Technical Director	8	8.0	100.0

Respondents were further asked to choose the system which best describes the design/manufacture relationship in their company through the variable '*RELATION*'. The overall results in Table 28 appear to suggest that 'design team monitors the performance feedback of the new product design throughout commercialisation and beyond' (37.7%) and 'design team hands over the prototype to production for manufacture and marketing to sell' (34.0%) were the best systems applied in most of the Malaysian companies.

Table 28 : Design/Manufacture Relationship

Value Label	*Frequency*	*Valid Percent*	*Cum Percent*
Design team hands over the prototype to production to produce and marketing to sell	18	34.0	34.0
Design team sees the new product design through to production	6	11.3	45.3
Design team sees the new product design through to commercialisation	9	17.0	62.3
Design team monitors the performance feedback of the new product design throughout commercialisation and beyond	**20**	**37.7**	**100.0**

1.1.2.2 MEAN Results for Combined Variables

For the combined variables, only one variable was subjected to mean statistical procedures. From the mean results of the combined variables, the researcher was able to combine the degree of preference given by the two groups of respondents in terms of their choice of answers. The results from mean helped the researcher to investigate the relationship between the two groups.

The '*FACTSUC*' variable was used to identify the factors leading to successful new product. Using the scale provided (1 = very important and 5 = not important at all), the respondents were asked to consider how significant each factor was in the successful development of new products. Based on the mean scores in Table 29, the most 'important' factors were; 'product designed and developed by a team of qualified engineering and industrial designers (mean = 1.74) and 'designer(s) saw the product through to commercialisation' (1.98).

Table 29 : Factors Which May Lead to a Successful New Product

Variable	*Mean*	*Std Dev*	*Min*	*Max*	*Total*
Process directed by an individual with outstanding authority and power	2.94	1.05	1	5	47
Early recognition of market needs	2.04	.95	1	5	47
Close interaction with customers/users in design and development stages	2.02	.92	1	5	47
Replacement of old products	2.00	.88	1	4	47
Product designed and developed by a team of qualified engineering and industrial designers	**1.74**	**1.05**	**1**	**5**	**47**
Designer(s) saw the product through to commercialisation	**1.98**	**.90**	**1**	**4**	**47**

1.1.2.3 Cross Tabulation and Significance (X^2) Test Results for Combined Variables

All the data from the combined variables were subjected to the Crosstabulation in order to identify how a variable's value changes from one subgroup to another. In this case, the subgroup for combined variables were industrial designers against engineers and marketers group. In order to define whether variables are statistically independent or not, Pearson Chi-Square (X^2) test was used as the main statistical test. Chi-Square (X^2) test is a useful first step in studying the relationship between the two variables or testing of that relationship (Norusis 1993 pg 206). Therefore, in this study, Chi-Square (X^2) was applied in order to find whether any systematic relationships existed between the two groups (industrial designers and engineers and marketers) in Malaysian SMIs.

In this study, all the combined variables from both groups were combined and crosstabulated. From crosstabulation and Chi-Square (X^2) test, the researcher could identified relationships between the two group by referring to the value of the chi-square and significance level. As shown in Table 30, there were fifteen variables in

total. From the fifteen variables, eleven variables (73.3%) are not significant at the 0.05 or the 95% confidence level. Only four of the fifteen (26.7%) variables were significant at the 0.05 level. Based on Finks ideas (1985), the researcher believes the 0.05 significance level to be appropriate for this study. Variables have thus been considered at this level.

Table 30:
Crosstabulation/Chi-Square (X^2) Output for Malaysia *COMBINED VARIABLES*
(Industrial Designers + Engineers and Marketers)

Variables		Chi-Square	D.F	Significance
1. *NOSTAF1*	*Industrial Designers*	2.14597	5	.82860
2. *NOSTAF2*	*Engineers*	8.01765	8	.43175
3. *NOSTAF3*	*Marketers*	6.01855	9	.73806
4. *STAFIN1*	*Industrial Designers*	.52371	2	.76962
5. *STAFIN2*	*Engineers*	9.56159	2	**.00839**
6. *STAFIN3*	*Marketers*	1.31807	3	.72485
7. *LEVDES*	*Design locations*	4.10754	1	**.04269**
8. *RESP*	*Person who responsible for NPD*	37.17112	22	**.02265**
9. *RELATION*	*Relation of design/manufacture*	13.58884	6	**.03458**
10. *FACSUCT1*	*Individual with power*	3.21412	4	.52265
11. *FACSUCT2*	*Higher technology*	4.13479	4	.38807
12. *FACSUCT3*	*Interaction with customers*	4.26772	4	.37098
13. *FACSUCT4*	*New manufacturing techniques*	3.01991	3	.38857
14. *FACSUCT5*	*Developed by a team*	3.15318	4	.53253
15. *FACSUCT6*	*Designer's idea*	3.29902	3	.34778

Table 31 below illustrates a crosstabulation of variable '*STAFIN2*' (to what extent are engineers involved in the process of new product development) by 'RESPOND' (type of respondent). Based on this output, it can be observed that the Chi Square value of 9.56159 was significant (.00839) since it is less than 0.05 (95% confidence level). This is an indication that the observation does not occur by chance and it

actually reflects a pattern of characteristics within Malaysia SMIs. From this variable, there seems to be an agreement between the groups about the involvement of engineers in the process of new product development , with 32.4% of the industrial designers and 38.5% of the engineers and marketers both agreeing that engineers were 'extremely involved' in that process. However, the result also shows a significant difference of the respondent's preference with 61.8% of industrial designers indicating that engineers were 'very involved' while engineers and marketers recorded 23.1%. In contrast, 38.5% of engineers and marketers indicated that engineers were 'involved' in the process of new product development in Malaysia SMIs, while only 5.5% of the industrial designers referred to this.

Table 31 : Crosstabulation output for variable '*STAFIN2*' by 'RESPOND'

Exp Val / Row Pct / Col Pct / Tot Pct	**RESPOND** ind.des (1)	eng+mkt (2)	Row Total
STAFIN2			
1 Extremely involved	11.6 68.8% 32.4% 23.4%	4.4 31.3% 38.5% 10.6%	16 34.0%
2 Very involved	17.4 87.5% 61.8% 44.7%	6.6 12.5% 23.1% 6.4%	24 51.1%
3 Involved	5.1 28.6% 5.9% 4.3%	1.9 71.4% 38.5% 10.6%	7 14.9%
Column Total	34 72.3%	13 27.7%	47 100.0%

Chi-Square	Value	DF	Significance
Pearson	9.56159	2	.00839

Number of Missing Observations: 0

The *'LEVDES'* variable was used to identify under which management level the design function is located. As shown in Table 32, this variable records a significance of 0.04269. From the crosstabulation output, there is a difference between the two groups of respondents against this variable. 70.6% of the industrial designers indicated that design function is located at the 'top management' while only 38.5% of the engineers and marketers indicated this. However, more than half the numbers of the engineers and marketers indicated that the design function is located at 'middle management' (61.5%) while this was only 29.4% for industrial designers.

Table 32 : Crosstabulation output for variable *'LEVDES'* by 'RESPOND'

	Exp Val / Row Pct / Col Pct / Tot Pct	**RESPOND** ind.des (1)	eng+mkt (2)	Row Total
LEVDES	1 Top management	21.0 82.8% 70.6% 51.1%	8.0 17.2% 38.5% 10.6%	29 61.7%
	2 Middle management	13.0 55.6% 29.4% 21.3%	5.0 44.4% 61.5% 17.0%	18 38.3%
	Column Total	34 72.3%	13 27.7%	47 100.0%

Chi-Square	Value	DF	Significance
Pearson	4.10754	1	.04269

Number of Missing Observations: 0

Table 33 : Crosstabulation output for variable *'RESP'* by 'RESPOND'

RESP	Exp Val / Row Pct / Col Pct / Tot Pct	RESPOND ind.des 1	RESPOND eng+mkt 2	Row Total
Managing director	1	7.2 100.0% 29.4% 21.3%	2.8 .0% .0% .0%	10 21.3%
Marketing director	2	.7 100.0% 2.9% 2.1%	.3 .0% .0% .0%	1 2.1%
Production director	3	.7 100.0% 2.9% 2.1%	.3 .0% .0% .0%	1 2.1%
Industrial design	4	1.4 50.0% 2.9% 2.1%	.6 50.0% 7.7% 2.1%	2 4.3%
R&D director	7	3.6 80.0% 11.8% 8.5%	1.4 20.0% 7.7% 2.1%	5 10.6%
Technical director	8	.7 100.0% 2.9% 2.1%	.3 .0% .0% .0%	1 2.1%
OTHERS (mixed answers)				14 40.4%
	Column Total	34 72.3%	13 27.7%	47 100.0%

Chi-Square	Value	DF	Significance
Pearson	37.17112	22	.02265

Number of Missing Observations: 0

The result of variable *'RESP'* (Table 33) shows that 29.4% of engineers and marketers indicated that the 'Managing Director' was the person responsible for managing product development in their company. No industrial designers indicated this. Similar results (29.0% against 0%) were also found in 'Marketing Director' , 'Production Director' and 'Technical Director' responses. However, industrial designers indicated that 'industrial design director' was the person responsible for managing product development in their company. 7% of them indicated this while only 2.9% from the engineers and marketers did so. Interestingly, the results of this variable shows that there seems to be an agreement between the groups with both groups recording a high percentage for 'Research and Development Director'. The result shows that 11.8% of industrial designers and 7.7% of the engineers and marketers indicated this.

Table 34 illustrates crosstabulation output on the variable *'RELATION'* -the design/manufacture relationship. Based on this output, it can be seen that, for this variable, the Chi-Square value of 13.58884 was significant recording 0.03458. This is an indication that the observation reflects a pattern within the Malaysia SMIs. As shown in Table 34, it can be concluded that there was significant difference on the respondent's opinion regarding the relationshiop of design and manufacture in their company. For example, engineers and marketers indicated that there was no close relationship between design and manufacture in their company. The design/manufacture relationship can be desribed as 'over the wall'. This is shown by the relatively high value to *'RELATION1'* compared to industrial designers (23.5%). Contrastingly, 41.2% of the industrial designers claimed that 'design team monitors the performance feedback of the new product design throughout commercialisation and beyond' whereas only 7.7% of the engineers and marketers did the same. Furthermore, 30.8% of engineers and marketers indicated that 'design team sees the new product design through production', whilst for industrial designers this figure was only 2.9%.

Table 34 : Crosstabulation output for variable *'RELATION'* by 'RESPOND'

RELATION	Exp Val / Row Pct / Col Pct / Tot Pct	RESPOND ind.des 1	RESPOND eng+mkt 2	Row Total
Design team hands over the prototype to production to produce and marketing to sell	1	9.4 61.5% 23.5% 17.0%	3.6 38.5% 38.5% 10.6%	13 27.7%
Design team sees the new product design through production	2	3.6 20.0% 2.9% 2.1%	1.4 80.0% 30.8% 8.5%	5 10.6%
Design team sees the new product design through to commercialisation	3	5.8 62.5% 14.7% 10.6%	2.2 37.5% 23.1% 6.4%	8 17.0%
Design team monitors the performance feedback of the new product design throughout commercialisation and beyond	4	10.9 93.3% 41.2% 29.8%	4.1 6.7% 7.7% 2.1%	15 31.9%
Relation 1 and 2	12	.7 100.0% 2.9% 2.1%	.3 .0% .0% .0%	1 2.1%
Relation 1 and 4	14	2.9 100.0% 11.8% 8.5%	1.1 .0% .0% .0%	4 8.5%
Relation 3 and 4	34	.7 100.0% 2.9% 2.1%	. 3 .0% .0% .0%	1 2.1%
	Column Total	34 72.3%	13 27.7%	47 100.0%

Chi-Square	Value	DF	Significance
Pearson	13.58884	6	.03458

1.1.3 COMMON VARIABLES

(Industrial Designers + Engineers and Marketers + Industrial Design Consultants)

Since all questions used for common variables (variable labels in **bold**) were based on the interval scale, all the variables were only subjected to means statistical analysis. The interval scale measures the magnitude of the differences in the preferences among the individuals and measures the arithmetic mean. In this study, there were four combined variables with regard to the role, skill, working knowledge and functions of industrial designers in the process of new product development in Malaysia SMIs. From the means output the researcher was able to establish how a variable's value changes from one subgroup to another. This allowed the study of the relationship among variables. In addition, this procedure was also used to test whether a given observation reflects actual patterns in the population or whether it had occurred by chance.

1.1.3.1 MEANS Results for Common Variables

In order to find out which role industrial designers need in order to perform their functions or tasks effectively in the process of new product development, the variable '**IDEROLE**' was used. From the results (Table 35), it was found that the item 'aesthetic specialist' has the highest mean scores of 3.82. Other roles (in order of preference) were: 'work in consultation with other specialist' (mean = 3.75), 'project co-ordinator' (3.73), 'mediator between the multi-discipline team' (3.49) and 'generalist/jack-of-all-trades'
(3.18).

Table : 35 The Most Preferred Role of Industrial Designers

Variable	*Mean*	*Std Dev*	*Min*	*Max*	*N*
Aesthetic specialist	**3.82**	**1.14**	**1**	**5**	**51**
Generalist/jack-of-all-trades	3.18	1.03	1	5	51
Work in consultation with other specialist	**3.75**	**.91**	**1**	**5**	**51**
Mediator between the multi-discipline team	3.49	.97	2	5	51
Project co-ordinator	**3.73**	**1.02**	**2**	**5**	**51**

The '**IDESKI**' variable was used to identify which skills industrial designers need in order to perform their functions or tasks effectively in the process of new product development. Based on the results in Table 36, it was found that the 5 preferred aspects of skills that industrial designers should acquire were; 'creating new design concepts' (mean = 4.53), 'representing alternative design solutions' (4.45), 'using computers to aid design (CAD)' (4.29), 'presenting work visually' (4.22) and 'understanding and developing a client's brief' (4.18).

Table 36 : The Most Preferred Skills of Industrial Designers

Variable	*Mean*	*Std Dev*	*Min*	*Max*	*N*
Understanding and developing a client's brief	4.18	.99	1	5	51
Creating new design concepts	**4.53**	**.70**	**2**	**5**	**51**
Representing alternative design solutions	**4.45**	**.61**	**3**	**5**	**51**
Presenting work visually	4.22	.73	2	5	51
Selecting colours/textures/forms	4.08	.82	2	5	51
Constructing model(s)/prototype(s)	3.80	1.11	1	5	51
Using computers to aid design (CAD)	**4.29**	**.78**	**2**	**5**	**51**
Selecting materials	3.75	.96	2	5	51
Selecting joining and assembling methods	3.76	.99	2	5	51
Mechanical/engineering drawing	3.75	1.06	1	5	51
Manufacturing techniques	3.57	1.04	1	5	51
Managing a project	3.63	1.06	1	5	51
Deriving basic market data	3.24	.93	1	5	51
Assessing customer feedback	3.45	.97	1	5	51

From the variable **'IDEWOR'** (which working knowledge industrial designers need in order to perform their functions or tasks effectively in the process of new product development), Table 37 shows that most Malaysian respondents gave a high rating for 'presentation techniques' (mean = 4.31), 'relevant computer techniques' (4.29), 'anthropometrics/ergonomics' (4.25) and 'current market trends' (4.20). Three less prioritized items included 'design history and theory' (3.51), 'art history/aesthetics' (3.49) and ' quality control methods' (3.39).

Table 37 : The Most Preferred Working Knowledge of Industrial Designers

Variable	*Mean*	*Std Dev*	*Min*	*Max*	*N*
Design history and theory	3.51	1.07	2	5	51
Art history/aesthetics	3.49	1.10	1	5	51
General technical knowledge	4.10	.83	2	5	51
Mechanical engineering	3.78	.97	2	5	51
Relevant computer techniques	**4.29**	**.83**	**2**	**5**	**51**
Presentation techniques	**4.31**	**.76**	**2**	**5**	**51**
Knowledge of anthropometrics	**4.25**	**.74**	**3**	**5**	**51**
Current market trends	4.20	.78	2	5	51
Consumer behaviour	3.92	.72	2	5	51
Relevant volume prod.processes	3.65	.80	2	5	51
Workshop practices	3.59	.83	2	5	51
Quality control methods	3.39	.98	1	5	51
Design practice and management	4.00	.94	2	5	51

Lastly, the results of the variable **'IDEFUN'** (which functions industrial designers need in order to help improve the process of new product development), show that the most preferred functions that Malaysian industrial designers should acquire were regarded as: 'create a new product concept' (mean = 4.69), 'have creative or original thinking' (4.65), 'redesign for improvement' (4.57), 'collaborate in a design team' (4.51) and 'work successfully to deadlines' (4.49)

Table 38 : The Most Preferred Functions of Industrial Designers

Variable	*Mean*	*Std Dev*	*Min*	*Max*	*N*
Create a new product concept	**4.69**	**.62**	**2**	**5**	**51**
Redesign for improvement	**4.57**	**.57**	**3**	**5**	**51**
Work well with other designers	4.35	.74	2	5	51
Collaborate in a design team	**4.51**	**.58**	**3**	**5**	**51**
Collaborate with experts from other areas	4.24	.71	3	5	51
Work successfully to deadlines	4.49	.76	2	5	51
Have a creative or original thinking	**4.65**	**.63**	**2**	**5**	**51**
Pay attention to detail	4.39	.80	2	5	51
Reduce product and production costs	4.10	.96	1	5	51

1.1.3.2 Cross Tabulation and Significance (X^2) Test Results for Common Variables

As in the combined variables, the cross-tabulations procedure was used for the common variables. The aims of the cross-tabulation were to reveal how a variable's value changes from one subgroup to another and to study and test this relationship. The subgroup for the Malaysian common variables were industrial designers, engineers, marketers and industrial design consultants groups. Chi-Square (X^2) test was used as the main statistical test in order to define whether or not the variables were statistically independent and to reveal whether a systematic relationship existed between the four subgroups.

In this study, all four category of variables (**'IDEROLE', 'IDESKI', 'IDEWOR'** and **'IDEFUN'**) with were cross-tabulated (Table 39) with forty one common variables from four subgroups. From this cross-tabulation, the researcher could identify whether the relationship between the subgroup occurs by chance or represents an actual pattern where the 'significance values' of Chi Square were less than 0.05 (i.e. the 95% confidence level), the researcher could conclude that the observations reflect a true patterns within Malaysian SMIs. For reasons clarify and data interpretation, the researcher considers response '1' of the interval scale as the

lowest point, '3' as the middle point (indicating the medium advantage ranking) and '5' as the highest point of the response. As shown in Table 39, sixteen variables were isolated as having high Chi-Square values of 0.05 or less. In these sixteen variables observations did thus not occur by chance and reflect a true patterns within Malaysian SMIs.

Table 40 illustrates a cross-tabulation output on the variable '**IDEROLE**' - the role of the industrial designer in the process of new product development. Based on the output, it could be concluded that the variable **'IDEROLE4'**, (Chi-Square value 17..22396 0.04532 value). reflects a true pattern within the Malaysia SMIs and that there is a positive association between the variable 'mediator between the multi-discipline team' with the role of the industrial designer in the process of new product development in their company. With reference to Table 40, 35.3% of all the respondents considered this role as 'high', 31.4% indicated it was 'medium' and only 17.6% of them indicated it as a 'low'. However, the result also shows a significant difference of the subgroup's preference with 50.0% of the industrial design consultants respondents indicating this role as 'highest' while 41.2% of the industrial designers and 50.0% of the engineers regarded this as a 'high' role. By contrast, 60.0% of the marketers indicated it as a 'low' role.

Cross-tabulation output on variables **'IDESKI'**, **'IDEWOR'** and **'IDEFUN'** by 'RESPOND' (type of respondent) identified any relationships in the respondent's opinion on the skills, competencies and attitudes industrial designers NEED in order to perform their functions or tasks effectively in the process of new product development. For these variables, a scale of 1 to 5 was adopted where: 1= Not needed, 2 = Least needed, 3 = Less needed, 4 = More needed and 5 = Most needed.

From the cross-tabulation output on '**IDESKI**' in Tables 41-45, it can be seen that the most significant variable was **'IDESKI2'** (creating new design concepts) with a Chi-Square value of 27.59406 (value 0.00111). From the cross-tabulation of variable

'IDESKI2' in Table 41, it shows that there seems to be agreement between the three respondents. 64.7% of the industrial designers, 75.0% of the engineers and 75.0% of the industrial design consultants respondents indicated that 'creating new design concepts' is the 'most needed' skill for industrial designers. By contrast, only 20.0% of the marketers indicated this.

The second variable with a high significance level was **'IDESKI6'** - constructing model(s)/prototype(s), (Chi-Square value 27.40653 value 0.00675 level (Table 42). The result from this variable shows the difference between the four subgroups against this variable. 41.0% of the industrial designers and 50.0% of the industrial design consultants respondents indicated that 'constructing model(s)/prototype(s)' as 'most needed', while only 12.5% the engineers indicated this. It shows that the industrial designers and industrial design consultants believe that this skill is very important and needed by industrial designers in order to perform their functions effectively in the process of new product development. In addition, engineers have showed a positive response with 50.0% indicating this skill as 'more needed' in industrial designers. This is in contrast to marketers (60.0% of them indicated this skill as 'least needed').

The third variable with a high significance was **'IDESKI5'** - selecting colours / textures / forms. From the cross-tabulation of **'IDESKI5'** (Table 43), there seems to be an agreement

Table: 39

Cross-tabulation/Chi-Square (X^2) Output for Malaysia COMMON VARIABLES

(Industrial Designers + Engineers + Marketers + Industrial Design Consultants)

Variables		Chi-Square	D.F	Significance
1. **IDEROLE1**	Aesthetic specialist	14.10241	12	.29422
2. **IDEROLE2**	Jack-of-all-trades	15.92479	12	.19471
3. **IDEROLE3**	Work with others	15.51463	12	.21449
4. **IDEROLE4**	Mediator	17.22396	9	**.04532**
5. **IDEROLE5**	Project co-ordinator	10.86603	9	.28500
6. **IDESKI1**	Understanding a client's brief	11.69900	12	.47015
7. **IDESKI2**	Creating new design concepts	27.59406	9	**.00111**
8. **IDESKI3**	Representing design solutions	14.97579	6	**.02045**
9. **IDESKI4**	Presenting work visually	16.23932	9	.06205
10. **IDESKI5**	Selecting colours/textures/forms	21.82046	9	**.00947**
11. **IDESKI6**	Constructing model(s)	27.40653	12	**.00675**
12. **IDESKI7**	Using computers	11.56151	9	.23917
13. **IDESKI8**	Selecting materials	7.08731	9	.62803
14. **IDESKI9**	Selecting joining/assembling	12.63624	9	.17977
15. **IDESKI10**	Engineering drawing	16.16875	12	.18363
16. **IDESKI11**	Manufacturing techniques	8.76392	12	.72295
17. **IDESKI12**	Managing a project	11.62203	12	.47649
18. **IDESKI13**	Deriving basic market data	6.53062	12	.88701
19. **IDESKI14**	Assessing customer feedback	22.44643	12	**.03281**
20. **IDEWOR1**	Design history and theory	9.49754	9	.39267
21. **IDEWOR2**	Art history/aesthetics	5.43159	12	.94199
22. **IDEWOR3**	General technical knowledge	6.60164	9	.67852
23. **IDEWOR4**	Mechanical engineering	11.29284	9	.25617
24. **IDEWOR5**	Relevant computer techniques	10.93000	9	.28054
25. **IDEWOR6**	Presentation techniques	14.37125	9	.10972
26. **IDEWOR7**	Anthropometrics	7.66443	6	.26373
27. **IDEWOR8**	Current market trends	11.97665	9	.21463
28. **IDEWOR9**	Consumer behaviour	18.61696	9	**.02865**
29. **IDEWOR10**	Relevant production processes	10.04277	9	.34703
30. **IDEWOR11**	Workshop practices	9.57321	9	.38613
31. **IDEWOR12**	Quality control methods	8.85197	12	.71552
32. **IDEWOR13**	Design practice	11.60877	9	.23627
33. **IDEFUN1**	Create a new product concept	16.72536	9	**.05319**
34. **IDEFUN2**	Redesign for improvement	12.32863	6	**.05503**
35. **IDEFUN3**	Work well with other designers	18.33000	9	**.03153**
36. **IDEFUN4**	Collaborate in a design team	22.67321	6	**.00091**
37. **IDEFUN5**	Collaborate with experts	17.87609	6	**.00655**
38. **IDEFUN6**	Work successfully to deadlines	17.30549	9	**.04414**
39. **IDEFUN7**	Have a creative thinking	21.85946	9	**.00934**
40. **IDEFUN8**	Pay attention to detail	19.27722	9	**.02294**
41. **IDEFUN9**	Reduce product/production costs	27.56964	12	**.00639**

Table 40

IDEROLE4	Exp Val Row Pct Col Pct Tot Pct	RESPOND ind.des 1.00	engr 2.00	mktr 3.00	const 4.00	Row Total
	2	6.0 55.6% 14.7% 9.8%	1.4 .0% .0% .0%	.9 33.3% 60.0% 5.9%	.7 11.1% 25.0% 2.0%	9 17.6%
	3	10.7 56.3% 26.5% 17.6%	2.5 25.0% 50.0% 7.8%	1.6 12.5% 40.0% 3.9%	1.3 6.3% 25.0% 2.0%	16 31.4%
	4	12.0 77.8% 41.2% 27.5%	2.8 22.2% 50.0% 7.8%	1.8 .0% .0% .0%	1.4 .0% .0% .0%	18 35.3%
	5	5.3 75.0% 17.6% 11.8%	1.3 .0% .0% .0%	.8 .0% .0% .0%	.6 25.0% 50.0% 3.9%	8 15.7%
	Column Total	34 66.7%	8 15.7%	5 9.8%	4 7.8%	51 100.0%

Table 41

IDESKI2	Exp Val Row Pct Col Pct Tot Pct	RESPOND ind.des 1.00	engr 2.00	mktr 3.00	const 4.00	Row Total
	2	.7 .0% .0% .0%	.2 .0% .0% .0%	.1 100.0% 20.0% 2.0%	.1 .0% .0% .0%	1 2.0%
	3	2.0 .0% .0% .0%	.5 .0% .0% .0%	.3 66.7% 40.0% 3.9%	.2 33.3% 25.0% 2.0%	3 5.9%
	4	10.0 80.0% 35.3% 23.5%	2.4 13.3% 25.0% 3.9%	1.5 6.7% 20.0% 2.0%	1.2 .0% .0% .0%	15 29.4%
	5	21.3 68.8% 64.7% 43.1%	5.0 18.8% 75.0% 11.8%	3.1 3.1% 20.0% 2.0%	2.5 9.4% 75.0% 5.9%	32 62.7%
	Column Total	34 66.7%	8 15.7%	5 9.8%	4 7.8%	51 100.0%

Table 42

IDESKI6

Exp Val / Row Pct / Col Pct / Tot Pct	RESPOND ind.des 1.00	engr 2.00	mktr 3.00	const 4.00	Row Total
1	.7 .0% .0% .0%	.2 .0% .0% .0%	.1 100.0% 20.0% 2.0%	.1 .0% .0% .0%	1 2.0%
2	4.7 42.9% 8.8% 5.9%	1.1 .0% .0% .0%	.7 42.9% 60.0% 5.9%	.5 14.3% 25.0% 2.0%	7 13.7%
3	6.7 60.0% 17.6% 11.8%	1.6 30.0% 37.5% 5.9%	1.0 10.0% 20.0% 2.0%	.8 .0% .0% .0%	10 19.6%
4	10.7 68.8% 32.4% 21.6%	2.5 25.0% 50.0% 7.8%	1.6 .0% .0% .0%	1.3 6.3% 25.0% 2.0%	16 31.4%
5	11.3 82.4% 41.2% 27.5%	2.7 5.9% 12.5% 2.0%	1.7 .0% .0% .0%	1.3 11.8% 50.0% 3.9%	17 33.3%
Column Total	34 66.7%	8 15.7%	5 9.8%	4 7.8%	51 100.0%

Table 43

IDESKI5

Exp Val / Row Pct / Col Pct / Tot Pct	RESPOND ind.des 1.00	engr 2.00	mktr 3.00	const 4.00	Row Total
2	1.3 .0% .0% .0%	.3 .0% .0% .0%	.2 100.0% 40.0% 3.9%	.2 .0% .0% .0%	2 3.9%
3	6.0 55.6% 14.7% 9.8%	1.4 22.2% 25.0% 3.9%	.9 11.1% 20.0% 2.0%	.7 11.1% 25.0% 2.0%	9 17.6%
4	15.3 69.6% 47.1% 31.4%	3.6 17.4% 50.0% 7.8%	2.3 8.7% 40.0% 3.9%	1.8 4.3% 25.0% 2.0%	23 45.1%
5	11.3 76.5% 38.2% 25.5%	2.7 11.8% 25.0% 3.9%	1.7 .0% .0% .0%	1.3 11.8% 50.0% 3.9%	17 33.3%
Column Total	34 66.7%	8 15.7%	5 9.8%	4 7.8%	51 100.0%

between the three subgroups. 47.1% of the industrial designers, 50.0% of the engineers and 40.0% of the marketers indicated this skill as 'more needed' in industrial designers. Moreover, 50.0% of the industrial design consultants respondents believe that this skill is 'most needed' in industrial designers to effectively perform their functions in the process of new product development.

Another variable with a high significance level was **'IDESKI3'** -representing alternative design solutions. From the results (Table 44), it can be observed that there is a relationship between the industrial designers and the industrial design consultants respondents opinion and again between the engineers and the marketers. The results show that 55.9% of the industrial designers and 75.0% of the industrial design consultants respondents indicated that representing design solutions is the 'most needed' skill for industrial designers in order to perform their functions effectively in the process of new product development. Positively, both of the engineers (50.0%) and marketers (40.0%) referred to this skill as 'more needed' for industrial designers.

The last variable for **'IDESKI'** which fell with the 95% confidence level was **'IDESKI14'** (assessing customer feedback). As shown in Table 45, this variable has a significance of 0.03281. The cross-tabulation output, shows that there was a significant difference in all of the respondents' preference. For instance, 75.0% of the industrial design consultants respondents indicated that assessing customer feedback is the 'most needed' skill for industrial designers, whereas 44.1% of the industrial designers indicated this skill as *'more needed'* and 60.0% of the marketers indicated as ***'less needed'*** for industrial designers.

In terms of the working knowledge that can be made by industrial designers in order to perform their functions or tasks effectively in the process of new product development in Malaysia SMIs, the results of variables **'IDEWOR1'** to **'IDEWOR13'** show that there is only one variable which is statistically significant

at the 95% level. This variable is **'IDEWOR9'** - consumer behaviour, (0.02865). From this variable (Table 46), we can see that there seems to be an agreement in the subgroup about the working knowledge of industrial designers. For example 87.0% of engineers, 80.0% of the marketers and 47.1% of the industrial designers agreed that the 'consumer behaviour' is the 'more needed' working knowledge for industrial designers.

In order to reveal the function of industrial designers in the process of new product development in Malaysia SMIs, variables **'IDEFUN1'** to **'IDEFUN9'** were used. These variables were cross-tabulated with the variable 'RESPOND' (type of respondent) in order to identify any similarities or differences of respondents' preference regarding each of these task variables. From the cross-tabulation output results (Table 47 to 48), There were four variables (**'IDEFUN4', 'IDEFUN5', 'IDEFUN7', 'IDEFUN9'**) which had a significance at the 95% confidence level.

From the cross-tabulation output result on **'IDEFUN4'** (collaborate in a design team) there seems to be an agreement between the subgroup regarding the function of industrial designers. Table 47 shows shows that almost 62.0% of the industrial designers, 50.0% of the engineers and 75.0% of the industrial design consultants respondents indicated that the function of collaborating in a design team was the 'highest' or the 'most needed' function for industrial designers. Equally though at slightly lower priority 60.0% of the marketers indicated this function as *'more needed'*.

The next variable with a high significance level was **'IDEFUN9'** (reduce product/production costs) (0.00639). The result from this variable shows that there was a significant difference in opinions about product coat reduction. From the cross-tabulation output on **'IDEFUN9'** (Table 48), 50.0% of the industrial designers and 37.5% of the engineers indicate that the function of reducing product and production costs is the 'most needed' function. Some 60.0% of the marketers

considered this function as 'more needed' however 75.0% of the industrial design consultants respondents indicated it as 'less needed'.

Table 44

IDESKI3	Exp Val / Row Pct / Col Pct / Tot Pct	RESPOND ind.des 1.00	engr 2.00	mktr 3.00	const 4.00	Row Total
	3	2.0 .0% .0% .0%	.5 33.3% 12.5% 2.0%	.3 66.7% 40.0% 3.9%	.2 .0% .0% .0%	3 5.9%
	4	14.7 68.2% 44.1% 29.4%	3.5 18.2% 50.0% 7.8%	2.2 9.1% 40.0% 3.9%	1.7 4.5% 25.0% 2.0%	22 43.1%
	5	17.3 73.1% 55.9% 37.3%	4.1 11.5% 37.5% 5.9%	2.5 3.8% 20.0% 2.0%	2.0 11.5% 75.0% 5.9%	26 51.0%
	Column Total	34 66.7%	8 15.7%	5 9.8%	4 7.8%	51 100.0%

Table 45

IDESKI14	Exp Val / Row Pct / Col Pct / Tot Pct	RESPOND ind.des 1.00	engr 2.00	mktr 3.00	const 4.00	Row Total
	1	.7 100.0% 2.9% 2.0%	.2 .0% .0% .0%	.1 .0% .0% .0%	.1 .0% .0% .0%	1 2.0%
	2	4.7 42.9% 8.8% 5.9%	1.1 14.3% 12.5% 2.0%	.7 28.6% 40.0% 3.9%	.5 14.3% 25.0% 2.0%	7 13.7%
	3	12.0 66.7% 35.3% 23.5%	2.8 16.7% 37.5% 5.9%	1.8 16.7% 60.0% 5.9%	1.4 .0% .0% .0%	18 35.3%
	4	12.0 83.3% 44.1% 29.4%	2.8 16.7% 37.5% 5.9%	1.8 .0% .0% .0%	1.4 .0% .0% .0%	18 35.3%
	5	4.7 42.9% 8.8% 5.9%	1.1 14.3% 12.5% 2.0%	.7 .0% .0% .0%	.5 42.9% 75.0% 5.9%	7 13.7%
	Column Total	34 66.7%	8 15.7%	5 9.8%	4 7.8%	51 100.0%

Table 46

IDEWOR9	Exp Val / Row Pct / Col Pct / Tot Pct	RESPOND ind.des 1.00	engr 2.00	mktr 3.00	const 4.00	Row Total
	2	.7 .0% .0% .0%	.2 .0% .0% .0%	.1 100.0% 20.0% 2.0%	.1 .0% .0% .0%	1 2.0%
	3	8.0 83.3% 29.4% 19.6%	1.9 .0% .0% .0%	1.2 .0% .0% .0%	.9 16.7% 50.0% 3.9%	12 23.5%
	4	18.7 57.1% 47.1% 31.4%	4.4 25.0% 87.5% 13.7%	2.7 14.3% 80.0% 7.8%	2.2 3.6% 25.0% 2.0%	28 54.9%
	5	6.7 80.0% 23.5% 15.7%	1.6 10.0% 12.5% 2.0%	1.0 .0% .0% .0%	.8 10.0% 25.0% 2.0%	10 19.6%
	Column Total	34 66.7%	8 15.7%	5 9.8%	4 7.8%	51 100.0%

Table 47

IDEFUN4	Exp Val / Row Pct / Col Pct / Tot Pct	RESPOND ind.des 1.00	engr 2.00	mktr 3.00	const 4.00	Row Total
	3	1.3 .0% .0% .0%	.3 .0% .0% .0%	.2 100.0% 40.0% 3.9%	.2 .0% .0% .0%	2 3.9%
	4	14.0 61.9% 38.2% 25.5%	3.3 19.0% 50.0% 7.8%	2.1 14.3% 60.0% 5.9%	1.6 4.8% 25.0% 2.0%	21 41.2%
	5	18.7 75.0% 61.8% 41.2%	4.4 14.3% 50.0% 7.8%	2.7 .0% .0% .0%	2.2 10.7% 75.0% 5.9%	28 54.9%
	Column Total	34 66.7%	8 15.7%	5 9.8%	4 7.8%	51 100.0%

Another variable with a high significance level was **'IDEFUN5'** - collaborate with experts from other areas (0.00655). As can be seen in Table 49, the results shows that 100.0% of the industrial design consultants and 50.0% of the engineers indicated that the function of collaborating with experts from other areas is 'most needed'. While 55.5% of the industrial designers indicated this as 'more needed' some significantly 60.0% of the marketers referred to it as *'less needed'*.

The result of variables **'IDEFUN7'**, **'IDEFUN8'**, **'IDEFUN3'**, **'IDEFUN6'**, **'IDEFUN1'** and **'IDEFUN2'** in Tables 50 to 55 all show that there seems to be an agreement between the three subgroups; the industrial designers, the engineers and the industrial design consultants respondents regarding the function of industrial designers in order to perform their tasks effectively in the process of new product development in Malaysia SMIs

For example, variable **'IDEFUN7'** - 'have creative or original thinking' (Table 50) shows that 79.4% of the industrial designers, 62.5% of the engineers and 75.0% of the industrial design consultants respondents indicated this function as 'most needed' in industrial designers. Marketers also showed a positive answer with 40.0% of them indicating this function as 'more needed'.

In Table 51 (**'IDEFUN8'** - 'pay attention to detail'), the result shows that almost 68.0% of the industrial designers, 50.0% of the engineers and 50.0% of the industrial design consultants respondents suggest that paying attention to detail is the 'most needed' function for industrial designers. On the other hand, 40.0% of marketers indicated this function as 'more needed' and another 20.0% regarded this function as 'least needed'.

Similarly, for the **'IDEFUN3'** variable - 'work well with other designers', (Table 52) shows that 55.9% of the industrial designers, 50.0% the engineers and 50.0% of the

industrial design consultants respondents indicated this function as 'most needed'. 40.0% of the marketers referred this skill as 'more needed' for industrial designers.

For the **'IDEFUN6'** variable (0.04414 significance), 67.6% of the industrial designers, 62.5% of the engineers and 75.0% of the industrial design consultants respondents indicated that working successfully to deadlines is the 'most needed' function for industrial designers (Table 53).

The result of variable **'IDEFUN1'** - 'create a new product concept' (Table 54) shows that 79.4% of industrial designers, 75.0% of engineers and 100.0% of the industrial design consultants respondents indicated that this function is the 'most needed' function for industrial designers. In contrast, only 20.0% of the marketers indicated this.

Lastly, the cross-tabulation output of variable **'IDEFUN2'** (Table 55) shows that almost 65.0% of the industrial designers, 62.5% of the engineers and 100.0% of the industrial design consultants respondents indicated that re-designing for improvement is the 'most needed' function for industrial designers in order to perform their tasks effectively in the process of new product development in Malaysia SMIs. 80.0% of marketers indicated this function as 'more needed' and another 20.0% regarded this function as 'least needed'.

Table 48

IDEFUN9	Exp Val Row Pct Col Pct Tot Pct	RESPOND ind.des 1.00	engr 2.00	mktr 3.00	const 4.00	Row Total
	1	.7 .0% .0% .0%	.2 .0% .0% .0%	.1 100.0% 20.0% 2.0%	.1 .0% .0% .0%	1 2.0%
	2	1.3 50.0% 2.9% 2.0%	.3 .0% .0% .0%	.2 50.0% 20.0% 2.0%	.2 .0% .0% .0%	2 3.9%
	3	6.0 44.4% 11.8% 7.8%	1.4 22.2% 25.0% 3.9%	.9 .0% .0% .0%	.7 33.3% 75.0% 5.9%	9 17.6%
	4	12.0 66.7% 35.3% 23.5%	2.8 16.7% 37.5% 5.9%	1.8 16.7% 60.0% 5.9%	1.4 .0% .0% .0%	18 35.3%
	5	14.0 81.0% 50.0% 33.3%	3.3 14.3% 37.5% 5.9%	2.1 .0% .0% .0%	1.6 4.8% 25.0% 2.0%	21 41.2%
	Column Total	34 66.7%	8 15.7%	5 9.8%	4 7.8%	51 100.0%

Table 49

IDEFUN5	Exp Val Row Pct Col Pct Tot Pct	RESPOND ind.des 1.00	engr 2.00	mktr 3.00	const 4.00	Row Total
	3	5.3 37.5% 8.8% 5.9%	1.3 25.0% 25.0% 3.9%	.8 37.5% 60.0% 5.9%	.6 .0% .0% .0%	8 15.7%
	4	15.3 82.6% 55.9% 37.3%	3.6 8.7% 25.0% 3.9%	2.3 8.7% 40.0% 3.9%	1.8 .0% .0% .0%	23 45.1%
	5	13.3 60.0% 35.3% 23.5%	3.1 20.0% 50.0% 7.8%	2.0 .0% .0% .0%	1.6 20.0% 100.0% 7.8%	20 39.2%
	Column Total	34 66.7%	8 15.7%	5 9.8%	4 7.8%	51 100.0%

Table 50

IDEFUN7	Exp Val Row Pct Col Pct Tot Pct	RESPOND ind.des 1.00	engr 2.00	mktr 3.00	const 4.00	Row Total
	2	.7 .0% .0% .0%	.2 .0% .0% .0%	.1 100.0% 20.0% 2.0%	.1 .0% .0% .0%	1 2.0%
	3	.7 .0% .0% .0%	.2 .0% .0% .0%	.1 100.0% 20.0% 2.0%	.1 .0% .0% .0%	1 2.0%
	4	8.7 53.8% 20.6% 13.7%	2.0 23.1% 37.5% 5.9%	1.3 15.4% 40.0% 3.9%	1.0 7.7% 25.0% 2.0%	13 25.5%
	5	24.0 75.0% 79.4% 52.9%	5.6 13.9% 62.5% 9.8%	3.5 2.8% 20.0% 2.0%	2.8 8.3% 75.0% 5.9%	36 70.6%
	Column Total	34 66.7%	8 15.7%	5 9.8%	4 7.8%	51 100.0%

Table 51

IDEFUN8	Exp Val Row Pct Col Pct Tot Pct	RESPOND ind.des 1.00	engr 2.00	mktr 3.00	const 4.00	Row Total
	2	.7 .0% .0% .0%	.2 .0% .0% .0%	.1 100.0% 20.0% 2.0%	.1 .0% .0% .0%	1 2.0%
	3	4.7 57.1% 11.8% 7.8%	1.1 .0% .0% .0%	.7 28.6% 40.0% 3.9%	.5 14.3% 25.0% 2.0%	7 13.7%
	4	9.3 50.0% 20.6% 13.7%	2.2 28.6% 50.0% 7.8%	1.4 14.3% 40.0% 3.9%	1.1 7.1% 25.0% 2.0%	14 27.5%
	5	19.3 79.3% 67.6% 45.1%	4.5 13.8% 50.0% 7.8%	2.8 .0% .0% .0%	2.3 6.9% 50.0% 3.9%	29 56.9%
	Column Total	34 66.7%	8 15.7%	5 9.8%	4 7.8%	51 100.0%

Table 52

IDEFUN3	Exp Val Row Pct Col Pct Tot Pct	RESPOND ind.des 1.00	engr 2.00	mktr 3.00	const 4.00	Row Total
	2	.7 .0% .0% .0%	.2 .0% .0% .0%	.1 100.0% 20.0% 2.0%	.1 .0% .0% .0%	1 2.0%
	3	3.3 60.0% 8.8% 5.9%	.8 .0% .0% .0%	.5 40.0% 40.0% 3.9%	.4 .0% .0% .0%	5 9.8%
	4	13.3 60.0% 35.3% 23.5%	3.1 20.0% 50.0% 7.8%	2.0 10.0% 40.0% 3.9%	1.6 10.0% 50.0% 3.9%	20 39.2%
	5	16.7 76.0% 55.9% 37.3%	3.9 16.0% 50.0% 7.8%	2.5 .0% .0% .0%	2.0 8.0% 50.0% 3.9%	25 49.0%
	Column Total	34 66.7%	8 15.7%	5 9.8%	4 7.8%	51 100.0%

Table 53

IDEFUN6	Exp Val Row Pct Col Pct Tot Pct	RESPOND ind.des 1.00	engr 2.00	mktr 3.00	const 4.00	Row Total
	2	.7 .0% .0% .0%	.2 .0% .0% .0%	.1 100.0% 20.0% 2.0%	.1 .0% .0% .0%	1 2.0%
	3	3.3 60.0% 8.8% 5.9%	.8 .0% .0% .0%	.5 40.0% 40.0% 3.9%	.4 .0% .0% .0%	5 9.8%
	4	8.7 61.5% 23.5% 15.7%	2.0 23.1% 37.5% 5.9%	1.3 7.7% 20.0% 2.0%	1.0 7.7% 25.0% 2.0%	13 25.5%
	5	21.3 71.9% 67.6% 45.1%	5.0 15.6% 62.5% 9.8%	3.1 3.1% 20.0% 2.0%	2.5 9.4% 75.0% 5.9%	32 62.7%
	Column Total	34 66.7%	8 15.7%	5 9.8%	4 7.8%	51 100.0%

Table 54

IDEFUN1	Exp Val / Row Pct / Col Pct / Tot Pct	RESPOND: ind.des 1.00	engr 2.00	mktr 3.00	const 4.00	Row Total
	2	.7 100.0% 2.9% 2.0%	.2 .0% .0% .0%	.1 .0% .0% .0%	.1 .0% .0% .0%	1 2.0%
	3	.7 .0% .0% .0%	.2 .0% .0% .0%	.1 100.0% 20.0% 2.0%	.1 .0% .0% .0%	1 2.0%
	4	7.3 54.5% 17.6% 11.8%	1.7 18.2% 25.0% 3.9%	1.1 27.3% 60.0% 5.9%	.9 .0% .0% .0%	11 21.6%
	5	25.3 71.1% 79.4% 52.9%	6.0 15.8% 75.0% 11.8%	3.7 2.6% 20.0% 2.0%	3.0 10.5% 100.0% 7.8%	38 74.5%
	Column Total	34 66.7%	8 15.7%	5 9.8%	4 7.8%	51 100.0%

Table 55

IDEFUN2	Exp Val / Row Pct / Col Pct / Tot Pct	RESPOND: ind.des 1.00	engr 2.00	mktr 3.00	const 4.00	Row Total
	3	1.3 50.0% 2.9% 2.0%	.3 .0% .0% .0%	.2 50.0% 20.0% 2.0%	.2 .0% .0% .0%	2 3.9%
	4	12.0 61.1% 32.4% 21.6%	2.8 16.7% 37.5% 5.9%	1.8 22.2% 80.0% 7.8%	1.4 .0% .0% .0%	18 35.3%
	5	20.7 71.0% 64.7% 43.1%	4.9 16.1% 62.5% 9.8%	3.0 .0% .0% .0%	2.4 12.9% 100.0% 7.8%	31 60.8%
	Column Total	34 66.7%	8 15.7%	5 9.8%	4 7.8%	51 100.0%

1.2 UK RESPONDENTS

1.2.1 SINGLE VARIABLE

1.2.1.1 Industrial Designer's Frequencies and Descriptive Results

The data from the single variables were subjected to frequency and descriptive procedures using the SPSS software in order to be examined in a more comprehensive and condensed form. From twenty three single variables (as in the Malaysian studies section 1.1.1) twelve were subjected to frequency and descriptive procedures the other eleven were subjected to the mean procedure. The researcher also was able to gain results from three groups of respondents (industrial designers, engineers and marketers and industrial design consultants) with regard to process of new product development in UK industry.

The variable 'YEAR' was used to identify how long the respondents had been involved in industrial/product design. The findings (Table 56) show that most of the respondents had more than 15 years experience in industrial/product design (77.8%). Surprisingly, there was no frequency for the item '7 years and less'.

Table 56 : Involvement in Industrial/Product Design.

Value Label	*Frequency*	*Percent*	*Valid Percent*	*Cum Percent*
less than 2 years	-	-	-	-
2-4 years	-	-	-	-
5-7 years	-	-	-	-
8-9 years	1	11.1	11.1	11.1
more than 10 years	1	11.1	11.1	22.2
more than 15 years	**7**	**77.8**	**77.8**	**100.0**

The 'NOPROJ' variable was used to find out how many new product development projects respondents had been involved in. The results show that more than half, or 66.7% of the total respondents had been involved in more than 15 projects. 22.2%

'more than 10' and 11.1% involved in between 5-9 projects. There was a zero frequency for the item marked '2 - 4' projects.

Table 57 : Number of New Projects Involved

Value Label	*Frequency*	*Percent*	*Valid Percent*	*Cum Percent*
2-4	-	-	-	-
5-9	1	11.1	11.1	11.1
more than 10	2	22.2	22.2	33.3
more than 15	**6**	**66.7**	**66.7**	**100.0**

From the frequencies output of the variable 'STAGE' (stage they are involved in the process of new product development), results (Table 58) show that more than half (55.6%) of the respondents were involved throughout all stages and 22.2% were involved at the first, middle and last stage. The results also revealed that 11.1% were involved at the first stage (idea generation and drawing) whilst a further 11.1% of the respondents were involved at the first and middle stage.

Table 58
Stage at Which Industrial Designers are Involved

Value Label	*Frequency*	*Percent*	*Valid Percent*	*Cum Percent*
first stage	1	11.1	11.1	11.1
throughout all stage	**5**	**55.6**	**55.6**	**66.7**
first and middle stage	1	11.1	11.1	77.8
first, middle and last	2	22.2	22.2	100.0

The variable 'NPDETER' was used in order to identify the factors which determined the design of new products. It is clear from the results in Table 59 that the design of the new products was mostly determined by customer pull (36.4%). As well as this

it shows that 36.4% of new products were determined by all of the factors (customer pull, technology push and management).

Table 59
Factors Which Determined the Design of the New Products

Value Label	*Frequency*	*Percent*	*Valid Percent*	*Cum Percent*
customer pull	**4**	**36.4**	**36.4**	**36.4**
technology push	1	9.0	9.0	45.4
management	2	18.2	18.2	63.6
all of them	**4**	**36.4**	**36.4**	**100.0**

1.2.1.2 Engineer and Marketer's Frequencies and Descriptive Results

The 'TYPE' variable was used to find out the number of employees in the company. The findings (Table 60) show that more than 90% of the UK companies were medium sized (100 - 499 employees) and only 9.1% were small (10 - 99 employees). There were no large companies involved.

Table 60 : Type of Company

Value Label	*Frequency*	*Percent*	*Valid Percent*	*Cum Percent*
small	1	9.1	9.1	9.1
medium	**10**	**90.9**	**90.9**	**100.0**
large	-	-	-	-

The variable 'ORGANI' was used to find out the background of the company, (i.e., how they get industrial design services and whether they have a design or Research and Development department). The 'ORGANI' variable result (Table 61), shows that nine (28.1%) of the respondents have a Research and Development department and a design/industrial design department. A further 25.0% 'employ industrial

designers on their staff'. In marked contrast, only one (3.1%) expected design to be part of the service given to them by the contractors, agents and suppliers of materials. From these results, it can be concluded that most of the companies in UK employed industrial designers on their staff and have their own Research and Development or a design/industrial department.

Table 61 : Organisation

Value Label	*Frequency*	*Percent*
Employ industrial designers on your staff	**8**	**25.0**
Employ outside design consultants and/or freelance designers	5	15.7
Expect design to be part of the service given to you by the contractors, agents, suppliers of materials, etc.	1	3.1
Have a Research & Development Department	**9**	**28.1**
Have a Design/Industrial Design Department	**9**	**28.1**

The function of industrial design to the company was identified through the 'IDFUNC' variable. The overall output results in Table 62 suggest that the main functions of industrial design in UK companies were 'redesign for improvement' (20%), 'create a new product concept' (17.5) and 'represent alternative design solutions' (15.0%).

Table 62 : Functions of Industrial Design

Value Label	*Frequency*	*Percent*
Evaluate a market opportunity	4	11.8
Create a new product concept	**7**	**20.6**
Represent alternative design solutions	6	17.7
Redesign for improvement	**8**	**23.5**
Select materials	-	-
Carry out ergonomics	1	3.0
Mechanical drawings for production	1	3.0
Construct prototypes	2	5.8
Develop a product strategy	-	-
Analyse product failure/success	-	-
Adapt the technology to local needs	1	3.0
Reduce product and production costs	2	5.8
Undertake detailed design	2	5.8

The results of the variable 'PROSTRA' in Table 63 (the types of strategies for new product development) shows that 28.9% of respondents indicated 'introduce new products into specific market-sectors' was the most preferred strategy for new product development. The three other factors shared the same frequency score (23.7%).

Table 63 : Strategies for New Product Development

Value Label	*Frequency*	*Percent*
Introduce new products in response to competitive pressure	9	23.7
Protect existing products via process innovation	9	23.7
Introduce new products into specific market-sectors	**11**	**28.9**
Introduce new products into related market segments	9	23.7

In order to identify the types of design strategy followed in companies, the variable 'DESSTRA' was used. As can be seen in Table 64, the results suggest that 40% of the UK companies followed 'major innovation' (innovation leading to major changes

in, or more addition to an existing products) as their design strategy. Other important strategies were 'improvements' (incremental innovation leading to minor changes in the existing product) (35%) and radical breakthrough (innovation leading to entirely new technology)
(25%).

Table 64 : Design Strategy

Value Label	*Frequency*	*Percent*	*Valid Percent*	*Cum Percent*
radical breakthrough	5	25.0	25.0	25.0
major innovation	**8**	**40.0**	**40.0**	**65.0**
improvements	7	35.0	35.0	100.0

1.2.1.3 Industrial Design Consultants's Frequencies and Descriptive Results

The variable 'TEAM' was used to identify the people comprising the design team. The frequency output in Table 65 shows that these design teams were made up of industrial designers (38.2%) and engineers of 49% (27% mechanical engineers, 11% production engineers and 11% electrical engineers). Only 7.3% were ergonomists and a smaller 5.5% were market analysts.

Table 65 : Design Team

Value Label	*Frequency*	*Percent*	*Valid Percent*	*Cum Percent*
Industrial Designers	**21**	**38.2**	**38.2**	**38.2**
Ergonomist	4	7.3	7.3	45.5
Mechanical Engineers	**15**	**27.0**	**27.0**	**72.5**
Electrical Engineers	6	11.0	11.0	83.5
Production Engineers	6	11.0	11.0	94.5
Market Analysts	*3*	*5.5*	*5.5*	100.0

In terms of the stage at which design considerations are brought in, the results of variable 'STAGE' show that more than half (57.7%) of the respondents indicated that they have been involved throughout all stages. In contrast there was no frequency for 'commercialisation stage' and only 7.7% for the 'last stage' (production).

Table 66 : Stage at Which Design Considerations are Brought In

Value Label	*Frequency*	*Percent*	*Valid Percent*	*Cum Percent*
First stage (idea generation and drawing)	6	23.1	23.1	23.1
Middle stage (development of prototype)	3	11.5	11.5	34.6
Last stage (production)	2	7.7	7.7	42.3
Commercialisation stage	-	-	-	-
Throughout all stages	**15**	**57.7**	**57.7**	100.0

The variable 'IDETASK' was used in order to identify the nature of the work/task of the industrial designer in designing new products. As can be seen in Table 67, 18 items were listed. The results suggest that the five most preferred work/task of the industrial designer in designing new products were 'create a new product concept', 'visualise the product concept', 'redesign for improvement', 'reduce product cost' and 'undertake detailed design' (all have the same percentage of 6.6%). The least preferred item in the list was 'develop a selling strategy' (1.3%).

Table 67 : The Nature of the Work/Task of the Industrial Designer

Value Label	*Frequency*	*Percent*	*Valid Percent*	*Cum Percent*
Evaluate a market opportunity	16	5.1	5.1	5.1
Create a new product concept	**21**	**6.6**	**6.6**	**11.7**
Visualise the product concept	**21**	**6.6**	**6.6**	**18.3**
Represent alternative design solutions	20	6.3	6.3	24.6
Redesign for improvement	**21**	**6.6**	**6.6**	**31.2**
Select materials	20	6.3	6.3	37.5
Select a final design	15	4.7	4.7	42.2
Carry out ergonomic studies	20	6.3	6.3	48.5
Mechanical drawings for production	20	6.3	6.3	54.8
Assist with production eng. and tooling	18	5.7	5.7	60.5
Construct prototypes	19	6.0	6.0	66.5
Test prototypes(s)	16	5.1	5.1	71.6
Develop a selling strategy	*4*	*1.3*	*1.3*	*72.9*
Analyse product failure/success	10	3.2	3.2	76.1
Adapt the technology to local needs	14	4.4	4.4	80.5
Reduce product cost	**21**	**6.6**	**6.6**	**87.1**
Reduce production costs	20	6.3	6.3	93.4
Undertake detailed design	**21**	**6.6**	**6.6**	100.0

1.2.1.4 Industrial Designer's MEAN Results

At the second stage of statistical analysis in the UK study, all the single variables were subjected to a MEAN procedure. Since the mean is a useful measure of and is simple to calculate, easily understood and it takes into account all of cases it was employed here to help the researcher compare the degree of importance given to each variable by the respondents with regard to the process of new product development in the UK industry.

Through the variable 'DESCONS', respondents were asked to rate the design considerations factors in the design of new products. Overall results suggest that 'safety' was the highest priority with the mean scores of 4.67 (Table 68), followed by 'aesthetic value' (4.44) and 'functionality' (4.33).

Table 68 : Design Considerations

Variable	*Mean*	*Std Dev*	*Min*	*Max*	*Total*
Functionality	4.33	.87	3	5	9
Aesthetic value	**4.44**	**.73**	**3**	**5**	**9**
Ergonomic factors	4.00	.71	3	5	9
Ease of use	4.22	1.09	2	5	9
Low maintenance cost	3.56	1.13	2	5	9
Safety	**4.67**	**.71**	**3**	**5**	**9**

The skills of industrial designers were identified by the variable 'SKILL'. It is clear from table 69 that 'presenting work visually', 'creating new design concepts' and 'representing design solutions' were among the 'SKILL' items which had high mean score (greater than 4.20). In contrast, items such as 'deriving basic market data', and 'assessing customer feedback' had the lowest mean scores (less than 2.56).

Table 69 : Skills of Industrial Designers

Variable	*Mean*	*Std Dev*	*Min*	*Max*	*Total*
Understanding a client's brief	4.00	1.41	1	5	9
Creating new design concepts	**4.22**	**.83**	**3**	**5**	**9**
Representing design solutions	**4.22**	**.67**	**3**	**5**	**9**
Presenting work visually	**4.33**	**.71**	**3**	**5**	**9**
Selecting colours/textures/forms	3.89	1.05	2	5	9
Constructing model(s)	3.56	1.13	2	5	9
Using computers	4.11	1.54	1	5	9
Selecting materials	3.11	1.17	1	5	9
Selecting joining/assembling	2.78	1.30	1	4	9
Engineering drawing	3.33	1.50	1	5	9
Manufacturing techniques	3.22	1.30	1	5	9
Managing a project	2.78	1.39	1	5	9
Deriving basic market data	2.56	1.13	1	4	9
Assessing customer feedback	2.56	1.42	1	5	9

From the variable 'WORKNO' (working knowledge of industrial designers) , the results (Table 70) suggest that the most preferred working knowledge that UK

industrial designers acquire were; presentation techniques (mean = 4.11), 'relevant computer techniques' (4.00), and 'anthropometrics' (4.00).

Table 70 : Working Knowledge of Industrial Designers

Variable	*Mean*	*Std Dev*	*Min*	*Max*	*Total*
Design history and theory	3.11	1.05	2	5	9
Art history/aesthetics	3.33	1.41	1	5	9
General technical knowledge	3.78	.44	3	4	9
Mechanical engineering	3.33	.87	2	4	9
Relevant computer techniques	**4.00**	**.87**	**2**	**5**	**9**
Presentation techniques	**4.11**	**.93**	**2**	**5**	**9**
Knowledge of anthropometrics	**4.00**	**.50**	**3**	**5**	**9**
Current market trends	3.67	1.22	1	5	9
Consumer behaviour	3.78	.97	2	5	9
Relevant volume prod. processes	3.67	.71	2	4	9
Workshop practices	2.67	1.12	1	4	9
Quality control methods	2.67	1.12	1	4	9
Design practice and management	3.33	1.32	1	5	9

In terms of the functions that industrial designers most acquire in the process of the new product development, the variable 'FUNCT' found that 'collaborate in a design team' had the highest mean score (4.67), 'have creative thinking' (4.56) was second and 'redesign for improvement', 'work well with other designers', 'work successfully to deadlines', and 'pay attention to detail' all items shared the same mean scores of 4.44 (see Table 71)

Table 71 : Functions of Industrial Designers

Variable	*Mean*	*Std Dev*	*Min*	*Max*	*Total*
Create a new product concept	4.33	.50	4	5	9
Redesign for improvement	4.44	.73	3	5	9
Work well with other designers	4.44	.88	3	5	9
Collaborate in a design team	**4.67**	**.50**	**4**	**5**	**9**
Collaborate with experts	4.22	.83	3	5	9
Work successfully to deadlines	4.44	.73	3	5	9
Have a creative thinking	**4.56**	**.53**	**4**	**5**	**9**
Pay attention to detail	4.44	.73	3	5	9
Reduce product/production costs	3.33	1.50	1	5	9

1.2.1.5 Engineer and Marketer's MEAN Results

The variable 'IDECONT' was used to find out the contribution made by the industrial designers in companies. According to UK engineers and marketers, the most important contribution made by the industrial designers were; 'improving the quality of consumer goods', 'increasing sales' (both = 3.64) and 'making products easier to use' (3.55) (see Table 72).

Table 72 : Contributions of Industrial Designers

Variable	*Mean*	*Std Dev*	*Min*	*Max*	*Total*
Improving the quality of consumer goods	**3.64**	**1.03**	**2**	**5**	**11**
Cutting production cost	2.73	.79	1	4	11
Making products easier to use	3.55	.52	3	4	11
Packaging and sales appeal	2.73	1.27	1	4	11
Advertising and publicity	2.36	.67	1	3	11
Increasing sales	**3.64**	**.92**	**2**	**5**	**11**

The industrial design services arrangement was identified through the variable 'ARRANG'. The respondents were asked to rate according to their degree of preference (1 = very satisfied and 5= not satisfied at all). The results in Table 73

show that most of the UK engineers and marketers preferred 'employ engineers with knowledge of industrial design' (mean = 2.55), 'employ a visiting industrial designer on a part-time consulting basis'(2.64) and 'co-opt a professional industrial designer into the design team for the period of the project' (2.73). By contrast, most of the respondents showed less preference to 'employ external consultants with basic industrial design work carried out in their own design offices' (3.27) and 'draw on the knowledge of a member (engineer) of the design team who is experienced in industrial design techniques' (3.18).

Table 73 : Industrial Design Services Arrangement

Variable	*Mean*	*Std Dev*	*Min*	*Max*	*Total*
Co-opt a professional industrial designer into the design team for the period of the project	2.73	1.27	1	5	11
Employ a visiting industrial designer on a part-time consulting basis	2.64	1.50	1	5	11
Employ external consultants with basic industrial design work carried out in their own design offices	3.27	1.19	1	5	11
Draw on the knowledge of a member (engineer) of the design team who is experienced in industrial design techniques	3.18	1.40	1	5	11
Employ industrial designers on a permanent basis	3.09	1.70	1	5	11
Employ engineers with knowledge of industrial design	**2.55**	**1.04**	**1**	**4**	**11**

The variable 'INTERF' was used to identify the importance of design/manufacture interface considerations when making product design decisions. Again, the respondents were asked to rate according to their degree of preference (1 = very important and 5= not important at all). The results (Table 74) show that 'reduction in the number of components' (mean = 1.73) was very important. 'Choice of materials' (1.82) and 'existing manufacturing processes' (1.91) were also important.

Table 74 : Design/Manufacture Interface Consideration

Variable	*Mean*	*Std Dev*	*Min*	*Max*	*Total*
Existing manufacturing processes	1.91	1.04	1	4	11
Suitability of existing manufacturing processes	2.00	1.00	1	4	11
Choice of materials	1.82	.98	1	4	11
Reduction in the number of components	**1.73**	**.65**	**1**	**3**	**11**
Range of colours (e.g. for production reasons)	2.64	1.21	1	4	11

The 'SALEFACT' variable was used to identify the characteristics that can make one product more attractive than another in the market place. Using the scale provided (1 = very influential and 5 = not influential at all), respondents were asked to indicate the extent to which they believe each factor has influenced the sale of their products against those of their competitors in the market. Based on the mean scores in Table 75, the most 'influential' factors were: 'sale price' (1.64), 'performance in operation'(mean = 1.73), 'attractive appearance/shape' and 'easy to use' (both = 1.82). Other less important factors were; 'style/fashion', 'safe to use' and 'reliability', (all mean score of 1.91).

Table 75 : Factors Which Have Influenced the Sale of the Products

Variable	*Mean*	*Std Dev*	*Min*	*Max*	*Total*
Sale price	**1.64**	**.67**	**1**	**3**	**11**
Style/fashion	1.91	.70	1	3	11
Durability	2.18	1.08	1	4	11
Flexibility and adaptability in use	2.45	1.04	1	4	11
Parts availability	3.18	1.47	1	5	11
Attractive appearance/shape	1.82	.60	1	3	11
Technical sophistication	2.45	1.04	1	4	11
Performance in operation	**1.73**	**.90**	**1**	**3**	**11**
Easy to use	1.82	.75	1	3	11
Safe to use	1.91	1.04	1	4	11
Reliability	1.91	1.04	1	4	11
Easy to maintain	2.55	1.29	1	5	11
Quality of after-sales service	2.55	1.44	1	5	11
Efficient delivery	2.09	1.14	1	4	11
Advertising and promotion	2.27	.79	1	3	11
Operator comfort	2.45	.69	1	3	11

1.2.1.6 Industrial Design Consultants's MEAN Results

In order to find out the criteria that the clients used when selecting design consultants, the variable 'CRITERIA' was used. The results show that 'quality of work' has the highest score (mean = 4.62), followed by 'previous work experience' and 'creativity' (both = 4.33).

Table 76 : Criteria for Selecting Design Consultants

Variable	*Mean*	*Std Dev*	*Min*	*Max*	*Total*
Reputation	4.10	.89	3	5	21
Service fees	*3.52*	*.93*	*2*	*5*	*21*
Previous work experience	4.33	.80	3	5	21
Market knowledge	*3.38*	*.92*	*2*	*5*	*21*
Quality of work	**4.62**	**.74**	**3**	**5**	**21**
Professionalism	4.29	.85	3	5	21
Creativity	4.33	.91	2	5	21

Respondents were also asked to rate the design consideration factors in the design of new products through the variable 'DESCONS' (Table 77). Overall results appear to suggest that 'functionality' was the highest priority with a total mean score of 4.52. This was followed by 'ease of use' (4.43), and 'safety' (4.33).

Table 77 : Design Considerations

Variable	*Mean*	*Std Dev*	*Min*	*Max*	*Total*
Functionality	**4.52**	**.75**	**3**	**5**	**21**
Aesthetic value	4.19	1.03	1	5	21
Ergonomic factors	4.19	.81	3	5	21
Ease of use	**4.43**	**.81**	**3**	**5**	**21**
Low maintenance cost	*3.71*	*.90*	*2*	*5*	*21*
Safety	4.33	.97	2	5	21

From the variable 'IDECONT' (the contributions made by the industrial designers to the clients' organisation), it was found that 'improving the quality of capital goods/consumer goods' had the highest mean score (4.71). 'Making products easier to use' (4.52) and 'increasing sales' (4.38) were also important.

Table 78 : Designers Contributions

Variable	*Mean*	*Std Dev*	*Min*	*Max*	*Total*
Improving the quality	**4.71**	**.64**	**3**	**5**	**21**
Cutting production cost	3.90	.89	3	5	21
Making products easier to use	4.52	.60	3	5	21
Packaging and sales appeal	3.76	1.22	1	5	21
Advertising and publicity	*2.62*	*1.43*	*1*	*5*	*21*
Increasing sales	4.38	.92	2	5	21

1.2.2 COMBINED VARIABLES

(Industrial Designers + Engineers and Marketers)

1.2.2.1 Frequencies and Descriptive Results for Combined Variables

The data from the combined variables [the combination of industrial designer's variables with engineers and marketer's (variable labels in *italic*)] were subjected to frequency and descriptive procedures. Of the six combined variables, five were subjected to a frequency and descriptive procedure and one was subjected to mean procedures. The results from this statistical analysis helped the researcher to identify relationships between the two groups with regard to the process of new product development in the UK industry.

The number of staff (industrial designers, engineering designers and marketers) that are employed companies was identified through the variable '*NOSTAF*'. From the frequency output in Table 79, it can be seen that from a total of 421 staff, only 97 were industrial designers. Others were: engineering designers (243) and marketers

(81). Industrial designers thus represented about 23% of the total workforce. engineering designers 57.7% and the remaining 19.2% were marketers. This calculates to a ratio of 2: 6 : 2, meaning that for every six engineering designers employed in the company, a further two were industrial designers and another two were marketers.

Table 79 : No. of Staff Employed

Value Label	*Frequency*	*Percent*
Industrial Designers	97	23.1%
Engineering designers	**243**	**57.7%**
Marketers	81	19.2%

The variable '*STAFIN*' was used to identify the extent to which industrial designers, engineers and marketers were involved in the process of new product development. It is evident from the frequency output in Table 80 that all of them were very much involved in the process of new product development. In terms of percentage, industrial designers has recorded highest score (75.0%), followed by marketers (65.0%) and engineers (55.0%)

Table 80 : Involvement in the Process of New Product Development

	Extremely Involved	**Very Involved**	**Involved**	**Slightly Involved**
Value Label	*Frequency [%]*	*Frequency [%]*	*Frequency [%]*	*Frequency [%]*
Industrial Designers	**15 [75.0]**	4 [20.0]	1 [5.0]	0 [-]
Engineers	**11 [55.0]**	5 [25.0]	3 [15.0]	0 [-]
Marketers	**13 [65.0]**	4 [20.0]	1 [5.0]	1[5.0]

The results (Table 81) from the variable '*LEVDES*' (the management level where the design function is located), Table 81 show that sixteen or 80.0% of the respondents

indicated that the design function was located in top management whilst four (20.0%) it was indicated at the 'middle management' level.

Table 81 : Design Locations

Value Label	*Frequency*	*Percent*	*Valid Percent*	*Cum Percent*
top management	**16**	**80.0**	**80.0**	**80.0**
middle management	4	20.0	20.0	100.0
lower management	-	-	-	-

The variable '*RESP*' was used to identify the person who responsible for managing product development companies. The overall results in Table 82 suggest that it was the 'Research and Development Director' (25.0%). 'Marketing Director' (19.4%) or 'Technical Director' (16.7%) who filled this role.

Table 82 : The Person Who is Responsible for Managing Product Development

Value Label	*Frequency*	*Valid Percent*	*Cum Percent*
Managing Director	5	13.9	13.9
Marketing Director	**7**	**19.4**	**33.3**
Production Director	5	13.9	47.2
Industrial Design Director	3	8.3	55.5
Purchasing Director	-	-	-
Financial Director	1	2.8	58.3
R&D Director	**9**	**25.0**	**83.3**
Technical Director	6	16.7	100.0

As well as this respondents were asked to choose the system which best describes the design/manufacture relationship in their company via the variable '*RELATION*'. The result shows that 'design team sees the new product design through production'

(40.0%) as the most important factor in the design/manufacture relationship in most of the UK companies.

Table 83 : Design/Manufacture Relationship

Value Label	*Frequency*	*Valid Percent*	*Cum Percent*
Design team hands over the prototype to production to produce and marketing to sell	2	10.0	10.0
Design team sees the new product design through production	**8**	**40.0**	**50.0**
Design team sees the new product design through to commercialisation	5	25.0	75.0
Design team monitors the performance feedback of the new product design throughout commercialisation and beyond	5	25.0	100.0

1.2.2.2 MEAN Results for Combined Variables

There was only one variable subjected to the mean statistical procedure for the UK combined variables.

The '*FACTSUC*' variable was used to identify factors which lead to a successful new product. Using the scale provided (1 = very important and 5 = not important at all), respondents were asked to consider how significant each factor was in the successful development of new products. Based on the mean scores in Table 84, the most 'important' factors were: 'product designed and developed by a team of qualified engineering and industrial designers' (mean = 1.74) and 'designer(s) saw the product through to commercialisation' (1.98).

Table 84 : Factors Which May Lead to a Successful New Product

Variable	*Mean*	*Std Dev*	*Min*	*Max*	*Total*
Process directed by an individual with outstanding authority and power	3.05	1.23	1	5	20
Early recognition of market needs	2.30	.66	1	3	20
Close interaction with customers/users in design and development stages	**1.60**	**.88**	**1**	**4**	**20**
Replacement of old products	**1.80**	**.70**	**1**	**3**	**20**
Product designed and developed by a team of qualified engineering and industrial designers	2.00	.97	1	4	20
Designer(s) saw the product through to commercialisation	1.90	1.02	1	4	20

1.2.2.3 Cross Tabulation and Significance (X^2) Test Results for Combined Variables

In the crosstabulation procedure, all the data from the combined variables were divided into subgroups. The aim here was to identify how a variable's value changes from one subgroup to another. In this case, the subgroup for UK combined variables were industrial designers against engineers and marketers group. According to Omar (1993) the crosstabulation procedure is useful to explore two important tasks. First, to test whether a given observation reflects the true effects (actual patterns) in the population or had actually occured by chance. Second, to explore potential associations between variables in the study. In this way the Pearson Chi-Square (X^2) test is used. In this study, the Pearson Chi-Square (X^2) was applied in order to reveal whether a systematic relationships exist between two group (industrial designers and, engineers and marketers) in the UK industry.

In this study, all the combined variables from both groups were combined and crosstabulated. From the crosstabulation procedure, and by using the Chi-Square

(X^2) test, the researcher could identify any relationships between the two group by referring to the value of the chi-square and the significance value. If the related 'significance values' of the Chi Square statistic were significant, (less than 0.05 i.e. the 95% confidence level) The researcher can conclude that the observations do not occur by chance but it reflect a real pattern within the sample extendable to the whole population.

Table 85 shows the output results of Crosstabulation using Chi-Square (X^2) test. Altogether, fifteen combined variables were used in the UK study. From these fifteen variables none of were significant at the 95% confidence level. Thus the researcher also looked at those variables having significance values less than 0.1 (the 90% confidence level).

In this study, there were only three variables which fell within the stated significance value of 0.1. They are variables *'STAFIN2'* (.09033), *'FACTSUCT3'* (.19959) and *'FACTSUCT4'* (.10378).

Table 85 : Chi-Square (X^2) Output for UK COMBINED VARIABLES
(Industrial Designers + Engineers and Marketers)

Variables		Chi-Square	D.F	Significance
1. *NOSTAF1*	*Industrial Designers*	6.33959	8	.60925
2. *NOSTAF2*	*Engineers*	6.53199	8	.58786
3. *NOSTAF3*	*Marketers*	7.87879	8	.44540
4. *STAFIN1*	*Industrial Designers*	1.88552	2	.38955
5. *STAFIN2*	*Engineers*	6.48301	3	**.09033**
6. *STAFIN3*	*Marketers*	4.53768	4	.33810
7. *LEVDES*	*Design locations*	.05051	1	.82219
8. *RESP*	*Person who responsible for NPD*	13.26599	13	.42748
9. *RELATION*	*Relation of design/manufacture*	.70707	3	.87154
10. *FACSUCT1*	*Individual with power*	1.01010	4	.90826
11. *FACSUCT2*	*Higher technology*	2.72727	2	.25573
12. *FACSUCT3*	*Interaction with customers*	4.64646	3	**.19959**
13. *FACSUCT4*	*New manufacturing techniques*	4.53102	2	**.10378**
14. *FACSUCT5*	*Developed by a team*	4.31938	3	.22898
15. *FACSUCT6*	*Designer's idea*	2.26712	3	.51885

Table 86 below illustrates a crosstabulation of variable *'STAFIN2'* (to what extent are engineers involved in the process of new product development) by RESPOND (type of respondent). Based on this output, it can be observed that there seems to be a significant difference of the respondent's preference since 77.8% of industrial designers indicated that engineers were 'extremely involved' in the process while only 36.4% of engineers and marketers indicated as such. By contrast, 36.4% of the engineers and marketers indicated that engineers were 'very involved' in the process of new product development in UK industry, but only 11.1% of the industrial designers referred to this. Similarly, 27.3% of the engineers and marketers indicated that engineers were 'involved' in the process while there were none (0%) from industrial designers.

Table 86 : Crosstabulation output for variable *'STAFIN2'* by RESPOND

STAFIN2	Exp Val / Row Pct / Col Pct / Tot Pct	RESPOND ind.des 1	RESPOND eng+mkt 2	Row Total
Not applicable	0	.5	.6	1
		100.0%	.0%	5.0%
		11.1%	.0%	
		5.0%	.0%	
Extremely involved	1	5.0	6.1	11
		63.6%	36.4%	55.0%
		77.8%	36.4%	
		35.0%	20.0%	
Very involved	2	2.3	2.8	5
		20.0%	80.0%	25.0%
		11.1%	36.4%	
		5.0%	20.0%	
Involved	3	1.4	1.7	3
		.0%	100.0%	15.0%
		.0%	27.3%	
		.0%	15.0%	
	Column Total	9 45.0%	11 55.0%	20 100.0%

Chi-Square	Value	DF	Significance
Pearson	6.48301	3	.09033

Number of Missing Observations: 0

The Crosstabulation procedure was used to crosstabulate all the *'FACTSUCT'* variables by the RESPOND (type of respondent) variable. The *'FACTSUCT'* variable was used in order to identify factors which may lead to a successful new product development. From the Chi-Square (X^2) output results shown in Table 85

only two variables, (*'FACTSUCT3'* and *'FACTSUCT4')* obtained the stated significance at 0.1 level.

Table 87 illustrates a crosstabulation output on the variable *'FACTSUCT3'* - made more use of new and improved manufacturing techniques . Based on this output, it can be concluded that there was an agreement between the groups as both of the groups agreed that *'FACTSUCT3'* (made more use of new and improved manufacturing techniques) was a 'very important' factor leading to a successful new product development in UK industry. 66.7% of the industrial designers and 54.5% of the engineers and marketers indicated 'very important' as a choice of preference. The result was also showed a significant difference of the respondent's preference as 36.4% of the engineers and marketers indicated that the *'FACTSUCT3'* is an 'important' factor, while only 11.1% of industrial designers indicated this. By contrast, 22.2% of the industrial designers indicated that the *'FACTSUCT3'* was the 'least important' factor for successful new product development in UK, and 9.1% of engineers and marketers claimed this factor was 'least important'

Table 88 below illustrates the crosstabulation of variable *'FACTSUCT4'* (rationalisation of production process leading to better price/value ration) by RESPOND (type of respondent). In a similarly way to the to the previous variable, it also shows an agreement between the two groups about the factors which may lead to a successful new product development in UK industry. As shown in Table 4A, 44.4% of the industrial designers and 54.5% of the engineers and marketers agreed that *'FACTSUCT4'* is one of the 'important factors' for successful new product development. Moreover, more than half of the industrial designers (55.6%) indicated that this factor is 'very important'. However, only 18.2% of the engineers and marketers indicated this.

Table 87 : Crosstabulation output for variable *'FACTSUC3'* by RESPOND

FACTSUC3	Exp Val / Row Pct / Col Pct / Tot Pct	**RESPOND** ind.des (1)	eng+mkt (2)	Row Total
VERY IMPORTANT	1	5.4	6.6	12
		50.0%	50.0%	60.0%
		66.7%	54.5%	
		30.0%	30.0%	
IMPORTANT	2	2.3	2.8	5
		20.0%	80.0%	25.0%
		11.1%	36.4%	
		5.0%	20.0%	
LESS IMPORTANT	3	.9	1.1	2
		100.0%	.0%	10.0%
		22.2%	.0%	
		10.0%	.0%	
LEAST IMPORTANT	4	.5	.6	1
		.0%	100.0%	5.0%
		.0%	9.1%	
		.0%	5.0%	
	Column Total	9 45.0%	11 55.0%	20 100.0%

Chi-Square	Value	DF	Significance
Pearson	4.64646	3	.19959

Number of Missing Observations: 0

Table 88 : Crosstabulation output for variable *'FACTSUC4'* by RESPOND

FACTSUC4	Exp Val / Row Pct / Col Pct / Tot Pct	RESPOND ind.des (1)	RESPOND eng+mkt (2)	Row Total
VERY IMPORTANT	1	3.2	3.9	7
		71.4%	28.6%	35.0%
		55.6%	18.2%	
		25.0%	10.0%	
IMPORTANT	2	4.5	5.5	10
		40.0%	60.0%	50.0%
		44.4%	54.5%	
		20.0%	30.0%	
LESS IMPORTANT	3	1.4	1.7	3
		.0%	100.0%	15.0%
		.0%	27.3%	
		.0%	15.0%	
	Column Total	9 45.0%	11 55.0%	20 100.0%

Chi-Square	Value	DF	Significance
Pearson	4.53102	2	.10378

Number of Missing Observations: 0

1.2.3 COMMON VARIABLES

(Industrial Designers + Engineers and Marketers + Industrial Design Consultants)

As in the Malaysia study, in the UK study four combined variables (variable labels in **bold**) were subjected to means statistical analysis. This allowed the researcher to study the relationship among variables to and how the variables value changes from one subgroup to another any actual patterns in the population.

1.2.3.1 MEANS Results for Common Variables

The '**IDEROLE**' variable was used to identify which role industrial designers need in order to perform their functions or tasks effectively in the process of new product development. It was found that the 5 preferred aspects of role that industrial designers should acquire were; 'aesthetic specialist' (mean = 4.32), 'work in consultation with other specialist' (3.90), 'mediator between the multi-discipline team' (3.41), 'project co-ordinator' (3.34) and 'generalist/jack-of-all-trades' (2.85) (see Table 89).

Table : 89 The Most Preferred Role of Industrial Designers

Variable	*Mean*	*Std Dev*	*Min*	*Max*	*N*
Aesthetic specialist	**4.32**	**.99**	**1**	**5**	**41**
Generalist/jack-of-all-trades	2.85	1.24	1	5	41
Work in consultation with other specialist	3.90	.89	1	5	41
Mediator between the multi-discipline team	3.41	1.18	1	5	41
Project co-ordinator	3.34	1.44	1	5	41

In order to find out which skills industrial designers need to perform their functions or tasks effectively in the process of new product development, the variable '**IDESKI**' was used. It was found that the item 'creating new design concepts' has the highest mean scores of 4.71. The other roles (in order of preference) were: 'representing alternative design solutions' (mean = 4.44), 'presenting work visually'

(4.41), 'using computers to aid design (CAD)' (4.37), 'understanding and developing a client's brief' (4.10) and 'selecting colours/textures/forms' (4.00). See Table 90.

Table 90 : The Most Preferred Skills of Industrial Designers

Variable	*Mean*	*Std Dev*	*Min*	*Max*	*N*
Understanding and developing a client's brief	4.10	1.00	1	5	41
Creating new design concepts	**4.71**	**.60**	**3**	**5**	**41**
Representing alternative design solutions	**4.44**	**.71**	**3**	**5**	**41**
Presenting work visually	**4.41**	**.71**	**3**	**5**	**41**
Selecting colours/textures/forms	4.00	.95	2	5	41
Constructing model(s)/prototype(s)	3.37	1.24	1	5	41
Using computers to aid design (CAD)	4.37	.66	3	5	41
Selecting materials	3.49	.95	2	5	41
Selecting joining and assembling methods	3.17	1.14	1	5	41
Mechanical/engineering drawing	3.41	1.36	1	5	41
Manufacturing techniques	3.73	1.16	1	5	41
Managing a project	2.73	1.20	1	5	41
Deriving basic market data	2.59	1.16	1	5	41
Assessing customer feedback	3.39	1.24	1	5	41

From the variable **'IDEWOR'** (which working knowledge industrial designers need in order to perform their functions or tasks effectively in the process of new product development), the results (Table 91) show that most UK respondents gave a high rating for 'presentation techniques' (mean = 4.27), 'relevant computer techniques' (4.05) and 'general technical knowledge' (4.02). [The least required items were seen us 'art history/aesthetics' (3.12) and ' quality control methods' (3.07)].

Table 91 : The Most Preferred Working Knowledge of Industrial Designers

Variable	*Mean*	*Std Dev*	*Min*	*Max*	*N*
Design history and theory	3.20	1.14	1	5	41
Art history/aesthetics	3.12	1.10	1	5	41
General technical knowledge	**4.02**	**.65**	**3**	**5**	**41**
Mechanical engineering	3.63	.89	2	5	41
Relevant computer techniques	**4.05**	**.89**	**2**	**5**	**41**
Presentation techniques	**4.27**	**.81**	**2**	**5**	**41**
Anthropometrics/ergonomics	3.88	.95	2	5	41
Current market trends	3.63	1.16	1	5	41
Consumer behaviour	3.17	1.07	1	5	41
Relevant volume prod.processes	3.83	1.00	1	5	41
Workshop practices	3.24	1.02	1	5	41
Quality control methods	3.07	1.15	1	5	41
Design practice and management	3.93	.96	1	5	41

Lastly, the results of the variable '**IDEFUN**' (which functions industrial designers need in order to help improving the process of new product development) show that the most preferred functions UK industrial designers should acquire were regarded as 'work successfully to deadlines' (mean = 4.73), 'have creative or original thinking' (4.73), 'create a new product concept' (4.68), 'pay attention to detail' (4.51), 'collaborate in a design team' (4.44) and 'collaborate with experts from other areas' (4.41).

Table 92 : The Most Preferred Functions of Industrial Designers

Variable	*Mean*	*Std Dev*	*Min*	*Max*	*N*
Create a new product concept	**4.68**	**.52**	**3**	**5**	**41**
Redesign for improvement	4.37	.77	2	5	41
Work well with other designers	4.27	.87	2	5	41
Collaborate in a design team	4.44	.71	3	5	41
Collaborate with experts from other areas	4.41	.59	3	5	41
Work successfully to deadlines	**4.73**	**.55**	**3**	**5**	**41**
Have creative or original thinking	**4.73**	**.55**	**3**	**5**	**41**
Pay attention to detail	4.51	.71	3	5	41
Reduce product and production costs	3.90	.92	2	5	41

1.2.3.2 Cross Tabulation and Significance (X^2) Test Results for Common Variables

As in the Malaysian study, crosstabulation was again performed on the UK common variables. The aims of the crosstabulation was to reveal how a variable's value changes from one subgroup to another and whether or not a systematic relationship exists between the subgroups. There were four subgroup for UK common variables; industrial designers, engineers, marketers and industrial design consultants groups.

In this study, four categories of variables (**'IDEROLE', 'IDESKI', 'IDEWOR'** and **'IDEFUN')** were crosstabulated (Table 93). By using a Pearson Chi-Square (X^2) test, the researcher could identify whether the relationship between the subgroup occurs by chance or represents an actual pattern within the UK industry. In this study, the researcher chose the 0.05 significance level (the 95% confident level) as appropriate. Thus, the researcher only looked at those variables having significance values less than 0.05. For the purpose of clarify and data interpretation, the researcher considers response '1' of the interval scale as the lowest point, '3' as the middle point (indicating medium advantage ranking) and '5' as the highest point of the response.

As shown in Table 93, eleven variables were isolated as having significant Chi-Square values or at the 95% confidence level. Thus in these eleven variables observations did not occur by chance but reflect some true pattern within UK industry.

Crosstabulation output on variables **'IDESKI'**. **'IDEWOR'** and **'IDEFUN'** by RESPOND (type of respondent) were performed to identify any relationship in the respondent's opinion on the skills, competencies and attitudes industrial designers need in order to perform their functions or tasks effectively in the process of new product development in their company. For these variables. a scale of 1 to 5 was

adopted where 1= Not needed, 2 = Least needed, 3 = Less needed, 4 = More needed and 5 = Most needed.

From the crosstabulation output on '**IDESKI**' in Table 94 -104, it can be observed that the most significant variable was the '**IDESKI2**' (creating new design concepts) with a Chi-Square value of 26.38426 and a significance value of 0.00019. From the crosstabulation result of the variable '**IDESKI2**' in Table 94, there seems to be an agreement between the three respondents. Here 77.8% of the industrial designers, 60.0% of the marketers and 95.2% of the industrial design consultants respondents indicated that 'creating new design concepts' was the 'most needed' skill for industrial designers. By contrast, only 33..3% of the engineers indicated this.

The second variable with a high significance value was '**IDESKI12**' - (managing a project) , (Chi-Square value of 28.33385 significance value at 0.00494) (Table 95). For this variable, the result shows the different between the three subgroups against this variable. 50.0% of the engineers indicated this skill as 'most needed', while 33.3% of the industrial designers and 60.0% of the marketers indicated this as 'more needed'. In addition 42.9% of the industrial design consultants respondents indicated this as the 'least needed' skill for industrial designers. From this result, it can be concluded that only engineers believe that managing a project is the most important skill for industrial designers in order to perform their functions effectively in the process of new product development.

The third variable with a high significance value was '**IDESKI3**' - representing alternative design solutions. From the results in Table 96, it can be observed that there was a relationship between the industrial designers and the industrial design consultant respondents against the engineers and the marketers. The results shows that 44.4% of the industrial designers and 76.2% of the industrial design consultants indicated that representing design solutions is the 'most needed' skill for industrial designers in order to perform their functions effectively in the process of new

product development. By 80.0% of the marketer indicated this skill as 'more needed' and 50.0% of the engineers indicated as 'less needed'.

The last variable for **'IDESKI'** significant at the 95% confidence level was **'IDESKI8'** (selecting materials). As shown in Table 97, this variable has a significance value of 0.03111. From the crosstabulation output, it shows that there was a significant difference in three of the subgroups' preference. For example, 44.4% of the industrial designers indicated that selecting materials is the 'more needed' skill for industrial designers. Whereas 33.3 % of the engineers and 38.1% of the industrial design consultants respondents indicated this skill as 'less needed' and 60.0% of the marketers indicated it as 'least needed'.

In terms of the working knowledge that can be made by industrial designers in order to perform their functions or tasks effectively in the process of new product development in UK companies, the results of variables **'IDEWOR1'** to **'IDEWOR13'** show that there is only one significant variable. This variable is **'IDEWOR6'** - knowledge of presentation techniques, (significant value 0.02017). This is an indication that this result does not occur by chance and actually reflects a true pattern of characteristics within the UK companies involved in this survey. Table 98 shows that there seems to be an agreement between the subgroup about the working knowledge of industrial designers. Some 55.6% of the industrial designers, 50.0% of engineers and 80.0% of marketers agreed that agreed that 'knowledge of presentation techniques' is the 'more needed' working knowledge for industrial designers. 71.4% of industrial design consultants respondents indicated this as 'most needed'.

In order to reveal the function of industrial designers in the process of new product development in UK companies, variables **'IDEFUN1'** to **'IDEFUN9'** were used. These variables were cross-tabulated with the variable 'RESPOND' (type of respondent) in order to identify any similarities and differences on respondents'

preference regarding each of these task variables. From the cross-tabulation output results in Tables 99 to 104, we can see that there were six variables (**'IDEFUN2'**, **'IDEFUN1'**, **'IDEFUN3'**, **'IDEFUN7'**, **'IDEFUN4'**, and **'IDEFUN6'**) that were significant at the 95% confidence level.

From the cross-tabulation output on **'IDEFUN2'** variable (re-design for improvement). Table 99 shows that there seems to be an agreement between the subgroup regarding the function of industrial designers. Some 55.6% of the industrial designers, 66.7% of the engineers and 60.0% of the marketers indicated that 're-design for improvement' was the 'more needed' function for industrial designers. Equally 81.0% of the industrial design consultants respondents indicated this function as 'most needed'.

The next variable with a high significance level was **'IDEFUN1'** (create a new product concept) significance value 0.0519. The result show that there were mixed opinions from respondents regarding this variable. From the cross-tabulation output on **'IDEFUN1'** (Table 100), 88.9% of the industrial designers and 85.7% of the industrial design consultants respondents indicated that the function of creating a new product concept is the 'most needed' function for industrial designers. At a lower frequency 80.0% of the marketers and 50.0% of engineers would consider this function as 'more needed' function for industrial designers.

Table 101 (**'IDEFUN3'** - work well with other designers), results show that almost 45.0% of the industrial designers, 33.3% of the engineers and 66.7% of the industrial design consultants respondents indicated that working well with other designers is the 'most needed' function for industrial designers. By contrast, only 20.0% of marketers indicated this function as 'most needed' with a majority of them (80.0%) regarding it as 'less needed'.

'IDEFUN7' - have a creative thinking, (Table 102) results show that all respondents (55.6% of the industrial designers, 50.0% of the engineers, 60.0% of the marketers and 100.0% of the industrial design consultants respondents) agreed that having creative thinking was a 'most needed' function for industrial designers in the new product development process.

To contrast **'IDEFUN7'**, the results of **'IDEFUN4'** (collaborate in a design team) show mixed opinions by most of the respondents regarding the function of industrial designers. Table 103 shows that, 55.6% of the industrial designers and 71.4% of the industrial design consultants agreed that collaborating in a design team is a 'most needed' function for industrial designers. However, 50.0% of the engineers indicated this function as 'most needed' and 60.0% of marketers indicated it as *'less needed'*.

Finally, the **'IDEFUN6'** variable (work successfully to deadline) (significance value 0.03789) shows that all the respondents agreed that working successfully to deadline is the 'most needed' function of industrial designers in the product development process. As shown in Table 104, 77.8% of the industrial designers, 50.0% of the engineers, 80.0% of the marketers and 85.7% of the industrial design consultants respondents have gave high priority mark to this variable.

Table: 93 Crosstabulation/Chi-Square (X^2) Output for UK COMMON VARIABLES
(Industrial Designers + Engineers + Marketers + Industrial Design Consultants)

Variables		Chi-Square	D.F	Significanc
1. **IDEROLE1**	Aesthetic specialist	14.99820	12	.24153
2. **IDEROLE2**	Jack-of-all-trades	12.86053	12	.37926
3. **IDEROLE3**	Work with others	14.51003	9	.10530
4. **IDEROLE4**	Mediator	10.02698	12	.61359
5. **IDEROLE5**	Project co-ordinator	14.84824	12	.24984
6. **IDESKI1**	Understanding a client's brief	10.01661	12	.61450
7. **IDESKI2**	Creating new design concepts	26.38426	6	**.00019**
8. **IDESKI3**	Representing design solutions	17.67416	6	**.00710**
9. **IDESKI4**	Presenting work visually	3.54978	6	.73733
10. **IDESKI5**	Selecting colours/textures/forms	15.49974	9	.07809
11. **IDESKI6**	Constructing model(s)	14.14314	12	.29166
12. **IDESKI7**	Using computers	3.79934	6	.70381
13. **IDESKI8**	Selecting materials	18.37098	9	**.03111**
14. **IDESKI9**	Selecting joining/assembling	13.73397	12	.31802
15. **IDESKI10**	Engineering drawing	11.79376	12	.46238
16. **IDESKI11**	Manufacturing techniques	15.25635	12	.22772
17. **IDESKI12**	Managing a project	28.33385	12	**.00494**
18. **IDESKI13**	Deriving basic market data	12.36383	12	.41692
19. **IDESKI14**	Assessing customer feedback	12.51964	12	.40490
20. **IDEWOR1**	Design history and theory	8.92596	12	.70924
21. **IDEWOR2**	Art history/aesthetics	10.41159	12	.57990
22. **IDEWOR3**	General technical knowledge	8.90141	6	.17920
23. **IDEWOR4**	Mechanical engineering	11.11846	9	.26768
24. **IDEWOR5**	Relevant computer techniques	11.98328	9	.21425
25. **IDEWOR6**	Presentation techniques	19.65488	9	**.02017**
26. **IDEWOR7**	Anthropometrics	14.95324	9	.09223
27. **IDEWOR8**	Current market trends	12.74858	12	.38758
28. **IDEWOR9**	Consumer behaviour	12.20594	12	.42928
29. **IDEWOR10**	Relevant production processes	16.48293	12	.17010
30. **IDEWOR11**	Workshop practices	8.64254	12	.73312
31. **IDEWOR12**	Quality control methods	15.89256	12	.19621
32. **IDEWOR13**	Design practice	17.03952	12	.14812
33. **IDEFUN1**	Create a new product concept	18.45479	6	**.00519**
34. **IDEFUN2**	Redesign for improvement	24.07115	9	**.00419**
35. **IDEFUN3**	Work well with other designers	21.59624	9	**.01025**
36. **IDEFUN4**	Collaborate in a design team	15.55575	6	**.01635**
37. **IDEFUN5**	Collaborate with experts	8.42195	6	.20879
38. **IDEFUN6**	Work successfully to deadlines	13.34388	6	**.03789**
39. **IDEFUN7**	Have a creative thinking	15.88547	6	**.01438**
40. **IDEFUN8**	Pay attention to detail	10.51733	6	.10449
41. **IDEFUN9**	Reduce product/production costs	3.77162	9	.92579

Table 94

IDESKI2

Exp Val Row Pct Col Pct Tot Pct	RESPOND ind.des 1.00	engr 2.00	mktr 3.00	const 4.00	Row Total
3	.7 .0% .0% .0%	.4 .0% .0% .0%	.4 66.7% 40.0% 4.9%	1.5 33.3% 4.8% 2.4%	3 7.3%
4	1.3 33.3% 22.2% 4.9%	.9 66.7% 66.7% 9.8%	.7 .0% .0% .0%	3.1 .0% .0% .0%	6 14.6%
5	7.0 21.9% 77.8% 17.1%	4.7 6.3% 33.3% 4.9%	3.9 9.4% 60.0% 7.3%	16.4 62.5% 95.2% 48.8%	32 78.0%
Column Total	9 22.0%	6 14.6%	5 12.2%	21 51.2%	41 100.0%

Table 95

IDESKI12

Exp Val Row Pct Col Pct Tot Pct	RESPOND ind.des 1.00	engr 2.00	mktr 3.00	const 4.00	Row Total
1	1.3 33.3% 22.2% 4.9%	.9 .0% .0% .0%	.7 .0% .0% .0%	3.1 66.7% 19.0% 9.8%	6 14.6%
2	3.1 7.1% 11.1% 2.4%	2.0 21.4% 50.0% 7.3%	1.7 7.1% 20.0% 2.4%	7.2 64.3% 42.9% 22.0%	14 34.1%
3	2.2 30.0% 33.3% 7.3%	1.5 .0% .0% .0%	1.2 10.0% 20.0% 2.4%	5.1 60.0% 28.6% 14.6%	10 24.4%
4	1.5 42.9% 33.3% 7.3%	1.0 .0% .0% .0%	.9 42.9% 60.0% 7.3%	3.6 14.3% 4.8% 2.4%	7 17.1%
5	.9 .0% .0% .0%	.6 75.0% 50.0% 7.3%	.5 .0% .0% .0%	2.0 25.0% 4.8% 2.4%	4 9.8%
Column Total	9 22.0%	6 14.6%	5 12.2%	21 51.2%	41 100.0%

Table 96

IDESKI3

Exp Val / Row Pct / Col Pct / Tot Pct	RESPOND ind.des 1.00	engr 2.00	mktr 3.00	const 4.00	Row Total
3	1.1 20.0% 11.1% 2.4%	.7 60.0% 50.0% 7.3%	.6 .0% .0% .0%	2.6 20.0% 4.8% 2.4%	5 12.2%
4	2.9 30.8% 44.4% 9.8%	1.9 7.7% 16.7% 2.4%	1.6 30.8% 80.0% 9.8%	6.7 30.8% 19.0% 9.8%	13 31.7%
5	5.0 17.4% 44.4% 9.8%	3.4 8.7% 33.3% 4.9%	2.8 4.3% 20.0% 2.4%	11.8 69.6% 76.2% 39.0%	23 56.1%
Column Total	9 22.0%	6 14.6%	5 12.2%	21 51.2%	41 100.0%

Table 97

IDESKI8

Exp Val / Row Pct / Col Pct / Tot Pct	RESPOND ind.des 1.00	engr 2.00	mktr 3.00	const 4.00	Row Total
2	1.3 16.7% 11.1% 2.4%	.9 33.3% 33.3% 4.9%	.7 50.0% 60.0% 7.3%	3.1 .0% .0% .0%	6 14.6%
3	3.5 25.0% 44.4% 9.8%	2.3 12.5% 33.3% 4.9%	2.0 12.5% 40.0% 4.9%	8.2 50.0% 38.1% 19.5%	16 39.0%
4	2.6 33.3% 44.4% 9.8%	1.8 8.3% 16.7% 2.4%	1.5 .0% .0% .0%	6.1 58.3% 33.3% 17.1%	12 29.3%
5	1.5 .0% .0% .0%	1.0 14.3% 16.7% 2.4%	.9 .0% .0% .0%	3.6 85.7% 28.6% 14.6%	7 17.1%
Column Total	9 22.0%	6 14.6%	5 12.2%	21 51.2%	41 100.0%

Table 98

IDEWOR6

Exp Val Row Pct Col Pct Tot Pct	RESPOND ind.des 1.00	engr 2.00	mktr 3.00	const 4.00	Row Total
2	.2 100.0% 11.1% 2.4%	.1 .0% .0% .0%	.1 .0% .0% .0%	.5 .0% .0% .0%	1 2.4%
3	1.3 .0% .0% .0%	.9 33.3% 33.3% 4.9%	.7 16.7% 20.0% 2.4%	3.1 50.0% 14.3% 7.3%	6 14.6%
4	3.3 33.3% 55.6% 12.2%	2.2 20.0% 50.0% 7.3%	1.8 26.7% 80.0% 9.8%	7.7 20.0% 14.3% 7.3%	15 36.6%
5	4.2 15.8% 33.3% 7.3%	2.8 5.3% 16.7% 2.4%	2.3 .0% .0% .0%	9.7 78.9% 71.4% 36.6%	19 46.3%
Column Total	9 22.0%	6 14.6%	5 12.2%	21 51.2%	41 100.0%

Table 99

IDEFUN2

Exp Val Row Pct Col Pct Tot Pct	RESPOND ind.des 1.00	engr 2.00	mktr 3.00	const 4.00	Row Total
2	.2 100.0% 11.1% 2.4%	.1 .0% .0% .0%	.1 .0% .0% .0%	.5 .0% .0% .0%	1 2.4%
3	.9 .0% .0% .0%	.6 25.0% 16.7% 2.4%	.5 50.0% 40.0% 4.9%	2.0 25.0% 4.8% 2.4%	4 9.8%
4	3.3 33.3% 55.6% 12.2%	2.2 26.7% 66.7% 9.8%	1.8 20.0% 60.0% 7.3%	7.7 20.0% 14.3% 7.3%	15 36.6%
5	4.6 14.3% 33.3% 7.3%	3.1 4.8% 16.7% 2.4%	2.6 .0% .0% .0%	10.8 81.0% 81.0% 41.5%	21 51.2%
Column Total	9 22.0%	6 14.6%	5 12.2%	21 51.2%	41 100.0%

Table 100

IDEFUN1	Exp Val Row Pct Col Pct Tot Pct	RESPOND ind.des 1.00	engr 2.00	mktr 3.00	const 4.00	Row Total
	3	.2 .0% .0% .0%	.1 100.0% 16.7% 2.4%	.1 .0% .0% .0%	.5 .0% .0% .0%	1 2.4%
	4	2.4 9.1% 11.1% 2.4%	1.6 27.3% 50.0% 7.3%	1.3 36.4% 80.0% 9.8%	5.6 27.3% 14.3% 7.3%	11 26.8%
	5	6.4 27.6% 88.9% 19.5%	4.2 6.9% 33.3% 4.9%	3.5 3.4% 20.0% 2.4%	14.9 62.1% 85.7% 43.9%	29 70.7%
	Column Total	9 22.0%	6 14.6%	5 12.2%	21 51.2%	41 100.0%

Table 101

IDEFUN3	Exp Val Row Pct Col Pct Tot Pct	RESPOND ind.des 1.00	engr 2.00	mktr 3.00	const 4.00	Row Total
	2	.2 .0% .0% .0%	.1 100.0% 16.7% 2.4%	.1 .0% .0% .0%	.5 .0% .0% .0%	1 2.4%
	3	1.8 25.0% 22.2% 4.9%	1.2 12.5% 16.7% 2.4%	1.0 50.0% 80.0% 9.8%	4.1 12.5% 4.8% 2.4%	8 19.5%
	4	2.4 27.3% 33.3% 7.3%	1.6 18.2% 33.3% 4.9%	1.3 .0% .0% .0%	5.6 54.5% 28.6% 14.6%	11 26.8%
	5	4.6 19.0% 44.4% 9.8%	3.1 9.5% 33.3% 4.9%	2.6 4.8% 20.0% 2.4%	10.8 66.7% 66.7% 34.1%	21 51.2%
	Column Total	9 22.0%	6 14.6%	5 12.2%	21 51.2%	41 100.0%

Table 102

IDEFUN7	Exp Val / Row Pct / Col Pct / Tot Pct	RESPOND ind.des 1.00	engr 2.00	mktr 3.00	const 4.00	Row Total
	3	.4 50.0% 11.1% 2.4%	.3 .0% .0% .0%	.2 50.0% 20.0% 2.4%	1.0 .0% .0% .0%	2 4.9%
	4	1.5 42.9% 33.3% 7.3%	1.0 42.9% 50.0% 7.3%	.9 14.3% 20.0% 2.4%	3.6 .0% .0% .0%	7 17.1%
	5	7.0 15.6% 55.6% 12.2%	4.7 9.4% 50.0% 7.3%	3.9 9.4% 60.0% 7.3%	16.4 65.6% 100.0% 51.2%	32 78.0%
	Column Total	9 22.0%	6 14.6%	5 12.2%	21 51.2%	41 100.0%

Table 103

IDEFUN4	Exp Val / Row Pct / Col Pct / Tot Pct	RESPOND ind.des 1.00	engr 2.00	mktr 3.00	const 4.00	Row Total
	3	1.1 20.0% 11.1% 2.4%	.7 20.0% 16.7% 2.4%	.6 60.0% 60.0% 7.3%	2.6 .0% .0% .0%	5 12.2%
	4	2.9 23.1% 33.3% 7.3%	1.9 23.1% 50.0% 7.3%	1.6 7.7% 20.0% 2.4%	6.7 46.2% 28.6% 14.6%	13 31.7%
	5	5.0 21.7% 55.6% 12.2%	3.4 8.7% 33.3% 4.9%	2.8 4.3% 20.0% 2.4%	11.8 65.2% 71.4% 36.6%	23 56.1%
	Column Total	9 22.0%	6 14.6%	5 12.2%	21 51.2%	41 100.0%

Table 104

IDEFUN6	Exp Val Row Pct Col Pct Tot Pct	RESPOND ind.des 1.00	engr 2.00	mktr 3.00	const 4.00	Row Total
	3	.4 100.0% 22.2% 4.9%	.3 .0% .0% .0%	.2 .0% .0% .0%	1.0 .0% .0% .0%	2 4.9%
	4	1.5 .0% .0% .0%	1.0 42.9% 50.0% 7.3%	.9 14.3% 20.0% 2.4%	3.6 42.9% 14.3% 7.3%	7 17.1%
	5	7.0 21.9% 77.8% 17.1%	4.7 9.4% 50.0% 7.3%	3.9 12.5% 80.0% 9.8%	16.4 56.3% 85.7% 43.9%	32 78.0%
	Column Total	9 22.0%	6 14.6%	5 12.2%	21 51.2%	41 100.0%

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6 July 1998

Dear Mr Brown

Re: Improving the Process of New Product Development in Malaysian Small and Medium Sized Industry (SMI) through an Investigation of the role played by the Industrial Designer

I would like to draw your attention to the letter which I sent to your colleague, Ingelise Neilson, Head of Marketing, in March 1997, regarding my first phase of study (mail survey) about the above topic. For your information, the result of this study has been assembled in the form of a report which includes some interesting findings for you to review.

As mentioned in my previous letter, this research is concerned specifically with the role of the industrial designer in the process of new product development amongst selected Malaysian companies and this will be contrasted with aspects of best practice in UK based companies. This research will end with conclusions and recommendations for the transfer of best practice guidelines to Malaysian small and medium industry (SMI's).

I am now in the second phase of collecting data which involves case studies with selected companies in the UK. The same method has already been successfully done with Malaysian companies several months ago. For the UK study, I have carefully selected several companies, including your own which I have picked based on its commercial success and a high reputation for good product development.

I order to carry out the case study in your company, I would very much like to meet you (or another appropriate person) to discuss the principles and elements of best practice in your product development process. The discussion will be in the form of case study interview and it will take approximately 30-45 minutes.

I would like to visit your company some time in August, but if this is inconvenient perhaps we can change and arrange another date. My Director of Studies, Dr R A Young will contact you in about a week's time to discuss the acceptability of this proposal.

Finally, a summary of the results of my first phase of study (mail survey) will be mailed to you after the case study interview with you is completed. In this way, it is hoped that the case study interview which I have planned with you will not be biased with the contents and findings from the mail survey results.

I hope you will be able to help and look forward to hearing from you.

Yours sincerely

MARZUKI

Marzuki Ibrahim
Research Fellow

APPENDIX 6
(A Sample of Standard Set of Open-Ended Questions Used in Case Study Interview [Malaysia and UK])

CASE STUDY INTERVIEW QUESTIONS

INTERVIEWS WITH MALAYSIAN/UK COMPANY

CHECKLIST OF QUESTIONS

The general aim of this interview is to obtain a description of the elements and principles of best practice in your product development process.

PURPOSE

Business Structure and Strategy

1. Could you please describe the background, current organisational structure and the mission statements of your company?

2. Does your company have a vision/strategy for the future? Could you describe it briefly.

COMPANY'S CULTURE

Product

1. How often do you upgrade or replace your products? How do you decide which to do? How far ahead do you plan new products (years and generations)?

2. Does your company have a product development plan based on the strategic direction for future product development? How are these targets set in relationship to this plan?

Customer

1. How do you determine what your customers (both existing and potential) want? [e.g. by conducting formal or informal market research survey]

2. Do you involve your customers in the new product development process? If YES, to what extent are they involved? (If NO, how does your staff learn about what your customers want?

Leadership

1. How are you and other senior managers involved in the process of business policy and the formulation of business culture for your organisation?

2. What roles do you and other senior managers play in managing product development?

PROCESS AND PERFORMANCE

Research and Development

1. Does your company have a centralised R&D department? (If YES, does this department control the pace of the new product development or does it only assist and advise?

2. Who are the members in this department and does your company have a special budget for R&D?

Product Development Process

1. Could you please describe how the product development process works in this company (Draw a flowchart showing the process/discuss the main sequence of activities, i.e. from idea generation to commercialisation) [*Who is responsible for the product development process in your company? How does your company select this person?*]

2. Are there any particular models for the product development process which your company have been adopted?

Role of the Industrial Designer

1. At what stage in the product development process are industrial designers normally involved? How do they play their role in this process? (e.g.: aesthetic specialist, project co-ordinator, mediator between the different-disciplines, generalist, etc.)

2. To what extent are other members of the team, i.e., engineers and marketers involved in the process of new product development ?

Design Consultants and Other Collaborations

1. Over the last 2-3 years, have you employed the services of industrial design consultants?

   (If YES);
   - What were the main reasons behind your decision to commission industrial design consultancies?
   - What criteria do you use when selecting them? (quality of work, creativity, fees, experience, etc.)
   - Are you satisfied that the consultant's advice was tailored to the particular circumstances of your organisation? (If NO); what are the problems?

   (If NO);
   - Why you have not used these services?

2. Have you collaborated with other bodies (i.e. university, research organisations, competitors, design council/society, regulatory bodies)? [If YES, what was the nature of the collaboration?]

Concurrent Engineering and Other Similar Methods

1. Does your company practice concurrent engineering (simultaneous engineering) or any other similar methods? (i.e. Taguchi, Just in Time)

   - (If YES)
   - Since when? and,
   - What was your company's early justification in introducing this method and on what basis was the choice of the present method made.
   - How much has this present method met the company's expectations and are there any limitations/constraints encountered in practising this method?

Quality

1. In terms of quality, does your company have a formal quality system? (i.e. ISO 9000/BS 5750 or equivalent)? (If NO, does the company have a policy towards TQM, continuous improvement, quality circle)?

Computer Aided Design

1. Do your designers use CAD?. If YES, can you indicate what type of computer systems (hardware and software) are they using within the new product development process? What is their purpose and at what stage are they used?

PEOPLE

People

1. How is personnel planning (human resource) derived from your strategic plans?

2. What methods of communication exist between staff? Do you feel staff consider themselves well informed?

3. Are regular surveys conducted (through questionnaires, focus group etc.) of the perceptions of the staff on various aspects of the organisation such as; the working environment, communication, training, their manager, pay etc.?

Design Teamwork

1. Do you encounter problems arising from conflicts between different functions in your new product development team?

2. Do new product development projects have leaders other than the Product Development Manager? Is so, how are they selected?

3. Does the company use any methods to foster teamwork? What are these?

4. Could you please give one example of your company's products that have been successfully developed by this team?

Would you like to add or make any further points or comments that you think are valuable to describe your company's context?

APPENDIX 7 (i)
MALAYSIAN COMPANY CASE STUDY INTERVIEW REPORT SAMPLE

RUSLEE HJ. HASHIM
Managing Director
MALPRO INDUSTRI SDN. BHD.
Wisma Malpro, Lot 1042, Batu 1
Jalan Sungai Buaya, Sungai Choh
48000 Rawang
Selangor Darul Ehsan
MALAYSIA

Date : 21 st June 1997 / 30th October 1998
Time/Venue : 1 p.m. / 5 p.m. Malpro Industri Selayang & Rawang

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CHECKLIST OF QUESTIONS

PURPOSE

Business Structure and Strategy

- **Does your company have a vision/strategy for the future? Could you describe it briefly.**

Yes, we do. We want to develop our company to become bigger. I mean I want my company to have complete departments like other companies have. Indeed, we have moved from our old factory in Selayang a few months ago in order to expand our operations. Also we want to compete not only in Malaysian market, but also in the global one. Foe example, I have just come back from Dubai to market our product and we have now got some contracts. On top of these things, I hope in the future we can come out with wide range of new products which are reasonable in price, very stylish and very high quality.

COMPANY'S CULTURE

Product

- **How often do you upgrade or replace your products? How do you decide which to do? How far ahead do you plan new products (years and generations)?**

  We actually decide it in order to compete with others. Usually we have to replace our product at least once a year, but now because of the economic slow down, we are talking about 2 years, at least. We have a wide range of products, from chairs to sofas, and we have to develop at least 6 products per year.

  In terms of planning, we plan about three years ahead but of course our design normally lasts about 5 years in the market. In Malaysia, design awareness has just started but is not as advanced as Europe, particularly in the UK. That is why in Malaysia design can last longer compared to other advanced countries in the world.

- **Does your company have a product development plan based on the strategic direction for future product development? How are these targets set in relationship to this plan?**

  Yes we have a plan based on the direction of the current and future product development. I think that if we do not follow current trends, then I don't think any people will buy our product. What we did here is to send our people, especially R&D people to furniture shows or exhibitions both national and international. From these shows and exhibitions we study then what the future trend of the furniture is likely to be and we use this as our basis when designing.

Customer

- **How do you determine what your customers (both existing and potential) want? [e.g. by conducting formal or informal market research survey]**

We have two categories of product here. One which we sell and offer to our clients, the other is where clients come to us and ask us specifically to design something for them. For our company's products, we determine customer trends by visiting exhibition or shows to get information and ideas about new product as I said before. The idea of new products is not limited to marketing people. It can come from general workers, administration or anybody in the company. We appreciate everybody's idea to upgrade our capabilities in developing new products.

Also, for products which we specifically design for clients, we do not need to conduct market survey. The reason is that we know our client need based on our experience in business. In Malaysia, price comes first then design. There are of course clients like banks, hotels and large companies who focus on design since their budget are basically unlimited and at the same time they want to keep their reputation. However, for others when they come to us, or when we go to them, the first question that we will ask is 'how much is your budget?'. From their answer the we can judge their financial circumstances and the design they want. In Malaysia, we have 3 categories of buyers, low end, middle and high end. Our company has prepared for these requirements and we offer our product design and quality based on these three categories.

- **Do you involve your customers in the new product development process? If YES, to what extent are they involved? (If NO, how does your staff learn about what your customers want?**

Yes, we involve them and sometimes we have to make presentations to them. They are normally involved from the start of the project until the end. They will feed us with their requirements and we will work on design and development based on

these requirements. Basically they will advise us on colour, comfort of the product and sometimes design, but will not advise us on matters of production.

We do not involve end users because most of the companies who purchase goods from us have their own 'Purchasing Departments'. This department represents the end user of the product they are purchasing from us. So this representative will come to us or sometimes we send them a product to be tested.

Leadership

- **How are you and other senior managers involved in the process of business policy and the formulation of business culture for your organisation?**

As a second man, I am involved in the process of business policy and also the formulation of business culture in this company. But, because senior management are so close to each other, we usually do it together. My self and the Chairman will invite all managers and heads of department to discuss business policy and other related issues regarding our business.

- **What roles do you and other senior managers play in managing product development?**

My role as a whole is to look after all my managers under me. In terms of product development, I act as a marketer as well. I will look at the market in Malaysia and abroad since the company is about to embark on marketing our design outside Malaysia, I am the one who responsible for this. I also have authority to approve any design and development in this company. I have to report to the Chairman since he is not involved in managing product development in this company.

PROCESS AND PERFORMANCE

Research and Development

- **Does your company have a centralised R&D department? (If YES, does this department control the pace of the new product development or does it only assist and advise?**

  Yes we have a centralised R&D department and as you said it controls the pace of product development in this company. We have our own department to look after research and development. R&D is the heart of our company and I can say it controls more than 70% of the total product development in this company.

- **Who are the members in this department and does your company have a special budget for R&D?**

  The members are the head of R&D including his assistant, myself, the general manager, the marketing manager, the finance manager and the export market manager. These are all the important people who will talk and discuss about product development. In terms of budget, we have a special budget for R&D and the allocation is based on needs and reports from R&D about the project. It is up to the top management to decide how much money goes to particular project, perhaps 50%, 70% or even 100%.

Product Development Process

- **Could you please describe how the product development process works in this company (Draw a flowchart showing the process/discuss the main sequence of activities, i.e. from idea generation to commercialisation) [*Who is responsible for the product development process in your company? How does your company select this person?*]**

  First of all our R&D manager will see the current and the future trends by visiting shows or looking at catalogues, especially from other countries like Japan and Europe. From these ideas then we will consult our marketing manager

concerning cost and with production staff regarding tools and production cost. Because most of the ideas are foreign, we have to think about how to use our technology and how to 'localise' them using our own technology. We then agree on a time frame which is normally 2-3 months. The allocation of time for idea sketches will be around two weeks where designers will produce around 5 to 6 ideas to be considered. After further discussion with technical staff involved in tooling and machining we will then come out with a mock-up. Then we'll study the mock up in terms of production, durability, aesthetics, comfortness and sale price. If we feel this design has the potential to be marketed, then we will produce a prototype. This prototype is then be sent to FRIM for testing. After this we study the testing results and try to improve any part which is failing. After re-testing and satisfaction with the result, we will start producing it.

Normally, the production manager will be responsible for the production of our product since he is experienced and capable.

- **Are there any particular models for the product development process which your company have been adopted?**

  No, we don't have any particular model. But we have taken 'Kursus Amalan Peningkatan Kualiti' (Business Excellence Through Quality Course) with SIRIM. All Malaysian SMIs are encouraged to take this course. Through this course you are taught how to upgrade your design, production and service. Once you have taken this course, SIRIM will recommend a company for ISO certification.

Role of the Industrial Designer

- **At what stage in product development process are industrial designers normally involved? How do they play their role in this process? (e.g.: aesthetic specialist, project co-ordinator, mediator between the different-disciplines, generalist, etc.)**

  They are involved from the first stage until the marketing stage. In the first stage, they help to produce ideas and at the marketing stage they help with aspects of

packaging and advertising. As industrial designers their core function is to design new products or to improve existing ones. Besides that they also have to work on production and materials.

- **To what extent are other members of the team, i.e., engineers and marketers involved in the process of new product development ?**

Among all staff, the industrial designers have to be knowledgeable of all processes. However, engineers and marketers are involved in the first phase together with industrial designers, they are both not involved in the whole process. For instance, marketing is involved in the first phase and the end phase whilst engineering is included in the first and middle phase.

Design Consultants and Other Collaborations

1. **Over the last 2-3 years, have you employed the services of industrial design consultants?**

(If YES);

- **What were the main reasons behind your decision to commission industrial design consultancies?**
- **What criteria do you use when selecting them? (quality of work, creativity, fees, experience, etc.)**
- **Are you satisfied that the consultant's advice was tailored to the particular circumstances of your organisation? (If NO); what are the problems?**

(If NO); *No*

- **Why you have not used these services?**

We have never used design consultants. This is because there are no furniture design consultancies in this country. There are several consultants but most of them are involved in interior and product, but not in furniture. So I feel that, instead of giving them a job and money, it is better to establish our own R&D incorporating very good design capabilities.

- **Have you collaborated with other bodies (i.e. university, research organisations, competitors, design council/society, regulatory bodies)? [If YES, what was the nature of the collaboration?]**

  No, except taking students from ITM to do their practical training here.

Concurrent Engineering and Other Similar Methods

1. **Does your company practice concurrent engineering (simultaneous engineering) or any other similar methods? (i.e. Taguchi, Just in Time)**

   (If YES); *No*
   - **Since when? and,**
   - **What was your company's early justification in introducing this method and on what basis was the choice of the present method made.**
   - **How much has this present method met the company's expectations and are there any limitations/constraints encountered in practising this method?**

Quality

- **In terms of quality, does your company have a formal quality system? (i.e. ISO 9000/BS 5750 or equivalent)? (If NO, does the company have a policy towards TQM, continuous improvement, quality circle)?**

  We are in the process of getting ISO 9002.

Computer Aided Design

- **Do your designers use CAD?. If YES, can you indicate what type of computer systems (hardware and software) are they using within the new product development process? What is their purpose and at what stage are they used?**

  Yes. We have one 'Autocad', two '3-D Studio' and 3 'Pro-Engineer' software programmes. We do not use it in the early stage since we still produce sketches and make development of ideas manually. After final ideas are made, then we use the computer to add certain features to it such as colours, back ground and texture. We also found that the computer is very helpful when we are doing technical drawing and production drawing. We can add or alter almost anything very simply and it saves a lot of time and money.

PEOPLE

People

- **How is personnel planning (human resource) derived from your strategic plans?**

  We have two ways of getting people working with us. First we have our own staff and workers, and this is what I regard as the internal human resource. All of them will be kept as they are and we do not intend to sack anybody from this company. The second way involves big projects. For instance, if we have a big project for which we do not have enough manpower, then we will sub it to a selected vendor. We may supply materials or if they agree they will do everything.

- **What methods of communication exist between staff? Do you feel staff consider themselves well informed?**

  It depends on the level. We communicate through e-mail, memos, briefings and discussion. For general workers we have a morning assembly every Monday morning. I think all staff are well informed and think they are happy with our current method of communication.

- **Are regular surveys conducted (through questionnaires, focus groups etc.) of the perceptions of the staff on various aspects of the organisation such as; the working environment, communication, training, their manager, pay etc.?**

  Yes, we conduct a survey every year but now because of the economy slowdown we will reduce this to every two years for staff pay reviews. We will ask them various questions, including general knowledge questions to gauge their sensitivity. We also send our staff for training which we do continually.

Design Teamwork

- **Do you encounter problems arising from conflicts between different functions in your new product development team?**

  So far, no. In this company, we have a culture where every person respect the other. This is all about human relations. We compromise and respect each others professions. For us, nobody is perfect, and using this basis we reciprocate from each other to help the company grow and develop.

- **Do new product development projects have leaders other than the Product Development Manager? Is so, how are they selected?**

  Yes. It depends on the project and the requirements of the project. The Board have elected an export manager to lead one project at one time as well as a design manager. They are selected based on the requirement of the project, their experience and also their availability. I trust all of them, and I see no reason why they cannot deliver.

- **Does the company use any methods to foster teamwork? What are these?**

  As I said, this is about human relations. What we did here was to set up our own club. The purpose of this club is to pool all the people in a team, not only in the office but also outside the office. We have held several activities within the club. We host games, give birthday presents, visit everybody's house in the team and host a party every year. So we know everybody very well, not only in this office but also at their homes. I think, when you are so close you will respect each other and I don't think any conflict will emerge from such a close relationship.

- **Could you please give one example of your company's products that have been successfully developed by this team?**

  Multi purpose student chair.

APPENDIX 7 (ii)
UK COMPANY CASE STUDY INTERVIEW REPORT SAMPLE

PAUL ECCLES
Technical Services Manager
EVERTAUT LIMITED
Cross Street, Darwen
Lancashire, BB3 2PW
ENGLAND

Date : 13th August 1998
Time/Venue : 10 a.m. Evertaut Limited Darwen

CHECKLIST OF QUESTIONS

PURPOSE

Business Structure and Strategy

- **Does your company have a vision/strategy for the future? Could you please describe it briefly.**

Yes we do. We have a twelve month plan or idea plan in which to grow our business. We are here to make money and it doesn't really matter whether we are producing chairs or taking in sub contract work as long as it is profitable business. Because, unless you are profitable, you might as well close the door and invest the money elsewhere.

COMPANY'S CULTURE

Product

- **How often do you upgrade or replace your products? How do you decide which to do? How far ahead do you plan new products (years and generations)?**

We have a continuous programme of upgrading our product. You have to bear in mind that we sell our products to three areas. We sell to the wholesale which

obviously they sell themselves from a pitch. We have a wide booklet that comes out once a year, every September. Around January to February we have a chance to submit new chair model to them. Because you're selling from a pitch you don't have any representative going out demonstrating the chair. So the text and photograph must be very good and that is the way you sell your product. So the wholesaler doesn't like the product to be too expensive and we have to give a big discount to them.

We plan up to twelve months in advance. We would like to have a prototype change within six to nine month from the line range. We expect to upgrade product in the market and have the literature and brochure complete including a sale price.

- **Does your company have a product development plan based on the strategic direction for future product development? How are these targets set in relationship to this plan?**

We have a continuous programme looking at the seating, reception and texture. Just to make sure we analyse what the competition are doing within these fields as well. We have to see whether we can come out with something either similar in function and at a cheaper price. And then there is a chance for them to prefer our product or not because they are there to make money as well. We have a manager who is responsible for that section of the wholesale business. We are continually coaching these people and analysing their needs. You have got to be in their office continually because you can't advise them through the phone.

Customer

- **How do you determine what your customers (both existing and potential) want? [e.g. by conducting formal or informal market research survey]**

Well, all we can do is offer the product to them and show them the features and other benefits and the price indication. We analyse the catalogue and if we can

trace a weakness in certain areas or for example, if one of the products is over the price, then we will produce a similar product either with more features or at a lower price. You have always got to gauge the functionality against the price.

No, we do not conduct any formal or informal market research survey. This is because, our customers are all spread all over the UK. They actually just supplied paper envelopes and the furniture section is just a small part of their booklet. Although they used this kind of medium to sell product, they have successfully done it and have a large numbers of customers.

We do have a marketing department which has been set up now. But, over the years it has really deteriorated and we are just starting to restructure it, giving it more formal structure according to request. We have to analyse competition, look at new product and look at other prices. We should keep moving, otherwise we cannot compete with others.

- **Do you involve your customers in the new product development process? If YES, to what extent are they involved? (If NO, how does your staff learn about what your customers want?**

As we sell our products to the wholesale, we also sell direct to the end user. Their needs are changing all the time. Again, we have our representative who goes down and looks at the problems and what the requirements are. They will come back and feed the information to us, and we will then come out with new products. We will see the customer's problems and will analyse their needs. We don't invite them to come to our company, because we are the ones who should go to them and meet them. We offer that facility.

Leadership

- **How are you and other senior managers involved in the process of business policy and the formulation of business culture for your organisation?**

  That really comes from the managerial level, such as Director. But, yes, I am also involved in the process of business policy and the formulation of business culture for this company as well as other senior managers, especially our Director. But of course, as a manager, I have to manage aspects like manufacturing and the process. By setting up main board meeting, it give us a chance to look at the overall business strategy.

- **What roles do you and other senior managers play in managing product development?**

  In this company, each committee and each unit manager is like his own director. He runs his business and he will demand according to what the requirements are. This person knows what he is doing and makes his own demands for R&D resources or whatever necessary. Mainly, it is I who will actually bring the additional people to cover any demand. Normally I will meet the six committees in the company to gauge their role, their needs, what might work and what might not and how many resources they really need.

PROCESS AND PERFORMANCE

Research and Development

- **Does your company have a centralised R&D department? (If YES, does this department control pace of the new product development or does it only assist and advise?**

  Yes, we do. We centralised our R&D department since this requirement looks after a large number of sub-branches such as Evertaut Seating, Evertaut Desking, Hille, Cinema Seating and Education Furniture. We have six business

units including Technical or R&D. So, six managers are responsible for each unit. I know what is going on in each business unit. We do have a Chairman who decides what the priorities are. Because all six business units are very busy and need somebody who can give them advice in term of business they operated, then the Chairman is needed. For the six business units, we have a committee which includes two directors, one chairman and a business unit manager as well as myself. So, I sit on every unit and I know what each business unit is expecting or has made.

- **Who are the members in this department and does your company have a special budget for R&D?**

Yes, we have a special budget for R&D. All six managers are the members in this department.

Product Development Process

- **Could you please describe how does the product development process works in this company (Draw a flowchart showing the process/discuss main sequence of activities, i.e. from idea generation to commercialisation) [*Who is responsible for the product development process in your company? How does your company select this person?*]**

There are several ways that we approach new products. One way is that we may have initially been given a brief by, say, a manufacturer. From this brief we have to add some rough dimensions. We will discuss it with their ergonomist and both of us will agree on certain dimensions to work with. Then we start designing. The design will depend upon customer technical specifications and will operate under cost parameters. We then come out with the design which satisfies what they need. That is done through small committees with four people, including engineers, upholsterers and myself, we may also invite the customer. Normally we will produce a prototype, a mock up to checkout and then demonstrate that product to our customer and discuss the total cost with them. That is one of the method.

The other method concerns the wholesaler. Here we look at the current competition and see what we've got. Other areas to look out from the design point of view is to come out with something that is different and innovative. That is what we try to do, but again you have to look at what others are doing before we can come out with our innovative design.

- **Are there any particular model for product development process which your company have adopted?**

No there aren't. Every company has their own speciality, including us. So I don't think it is suitable for us to adopt any other peoples model and suit it to our environment. We are happy with our way of doing things.

Role of Industrial Designer

- **At what stage in the product development process are industrial designers normally involved? How do they play their role in this process? (e.g.: aesthetic specialist, project co-ordinator, mediator between the multi-discipline, generalist, etc.)**

In Hille, we have three industrial designers. Interestingly, we have one guy, eighty three years old, Robin Day, a very-very famous designer. He used to design a poly structure for our company. As a company that is renowned for being innovative, Hille got to have an identity along that route. What we don't want are mismatches of all different designers.

Industrial designers in Hille are involved at the beginning of the project and may be involved earlier than other people. For example, they sometimes come out with a concept design which we have not thought of it. In terms of their role, I think they are really aesthetic specialists, producing sketches etc. We cannot call them as a project 'co-ordinator' since they are not involved to a great extent.

- **To what extent are industrial designers and other members in the team, i.e., engineers and marketers involved in the process of new product development ?**

Our marketing people come in after the initial stage, or after the product has been prototyped, because we don't find any marketing people coming to us saying we need this product at the initial stage. But, we have sales persons who come to us and tell us the latest information about the current market and trends which we have to keep in mind. We work together and feed on each other.

Design Consultants and Other Collaborations

- **Over the last 2-3 years, have you employed the services of industrial design consultants?**

  (If YES); *No*
  - **What were the main reasons behind your decision to commission the industrial design consultancy?**
  - **What criteria do you use when selecting them? (quality of work, creativity, fees, experience, etc.)**
  - **Are you satisfied that the consultant's advice was tailored to the particular circumstances of your organisation? (If NO); what are the problems?**

  (If NO);

  Why you have not used these services?

Industrial design consultants knock on our door all the time and ask whether we want new products which we will value. But it is not the same as being with the customer and finding out what the customer needs. Design consultants can easily produce some ideas for new products which we have to re-value. It might be suitable for us from time to time, and if it is, that is fair enough and we may proceed. But, if not, we can lose a lot of time and money.

- **Have you collaborated with other bodies (i.e. university, research organisations, competitors, design council/society, regulatory bodies)? If YES, what was the nature of the collaboration?**

Not really, apart from becoming like a research base for a fire retardant. We are like a research resource centre that tests product to British Standard.

Concurrent Engineering and Other Similar Methods

- **Does your company practice concurrent engineering (simultaneous engineering) or any other similar methods? (i.e. Taguchi, Just in Time)**

(If YES);

- **Since when? and,**
- **What was your company's early justification in introducing this method and on what basis was the choice of the present method made.**
- **How much has this present method met the company's expectations and are there any limitations/constraints encountered in practising this method?**

We have several steps involved. Firstly, we are given a target size and we are given a brief of the product task or issue. We will then evaluate that and manufacture the prototype. Once we have got to that stage we have got to do a competitive price comparison, or as we call it, 'CPC'. This is done so when the product has gone into the market place, it will not be over priced. We have to be concerned with competitors activities and prices in the market. Then we put it to the sale cost and let them have their views on the good points, features, the benefits, disadvantages etc. In this way, you get full company involvement. At that stage it is not guaranteed to be a marketable product. From that meeting we will then have to look at the cost again and decide. The Director will decide whether or not we prepare to invest the money because it could involve a lot of capital expenditure and he decides whether we shall take that product to the market or not. At that stage when you get a green light then the marketing will prepare the literature and price list. They will working concurrently with the drawing and manufacturing and the tooling. From here then you can see the concept of

concurrent engineering appear in this company where marketing people, engineering and tooling work simultaneously in order to complete their job. We have practised this since a few years ago.

Yes, certainly this method give some advantages to us and has speeded up our job. Because time is money here, we cannot wait two years to develop or introduce new products in the market because by the time we enter the market, the design is already outdated. So, between six to nine months seems to be long enough.

In terms of limitation, I don't think I can think one except possibly the time scale. Say, if we are given a very quick project with a tight time scale, then we have to do it concurrently at the beginning of the project in order to finish it. Well, I suppose the time scale is very important to us and we need to organise it as well as possible so that we can meet the client's deadline.

Quality

- **In terms of quality, does your company have a formal quality system? (i.e. ISO 9000/BS 5750 or equivalent)? (If NO, does the company have a policy towards TQM, continuous improvement, quality circle)?**

Yes we have ISO 9002. As you can see in our catalogue, all chairs produced by us conform to BS 5459, 4875 and 5940 which relates to performance, design, strength and stability. Our product is also supplied with a 5 year structural warranty and full National After Sales Service.

Computer Aided Design

- **Do your designers use CAD?. If YES, can you indicate what type of computer systems (hardware and software) are they using within the new product development process? What is their purpose and at what stage are they used?**

Yes we use CAD. We use Autocad Release 14 for 2D drawing and for 3D drawing we use 3D Studio. We normally use it to get some concept of idea and our engineers find CAD easy for modifying certain drawings. We also use it to stimulate the drawing so that our customer can feel it to be like real. At the end of the day, we are not relying very much on the use of the computer particularly in term of comfortness or posture. It can be used from the beginning to the end of the project though the extent of use depends on the project we are undertaking.

PEOPLE

People

- **How are personnel planning (human resource) derived from your strategic plans?**

Everything is computerised. When a project is up and coming, we analyse our human resource. We currently employ about 260 people but that depends on the demand. The number might be cut by between 10 to 15 people. We have temporary contract workers and we also have a plan for double and weekend shift. Essentially, we want our workforce to be satisfied with us.

- **What method of communications exist between staffs? Do you feel staff considered themselves well informed?**

Communication between staff in this company is by memo. Although we don't have e-mail, I think this older method works very well and we considered our staff well informed.

- **Are regular surveys conducted (through questionnaires, focus group etc.) of the perceptions of the staff on various aspects of the organisation such as working environment, communication, training, their manager, pay etc.?**

We don't conduct any surveys, such as you mentioned, through questionnaires or focus groups, but we do have a training programme. For example, we offer training for young supervisors to bring them up and to get on within the company. Occasionally we have to employ from outside. We also offer various training for our workers and it is up to them to grab the opportunities.

Design Teamwork

- **Do you encounter problems arising from conflicts between different functions in your new product development team?**

We have some arguments, sometimes, but they argue in a professional way. I don't think everybody can have same idea or same opinion at the same time, especially when you come from different backgrounds, that is almost impossible. But, as far as I concerned, I do not encounter any serious problem or conflicts between them and so far I am happy with what this team have achieved.

- **Do new product development projects have leaders other than the Product Development Manager? Is so, how are they selected?**

No, we don't work that way. Here, each business unit manager or six different people will be responsible. They are looking at their own business. All of them have to ask me for resource, manufacturing or designing a new product. That is the way it works. I then have to report back to each meeting to say what stage are we in. In terms of the selection, our company has its own policy and of course we choose the right people and I can describe them as the best people in this company. They are normally senior and have huge work experience.

- **Does the company use any methods to foster teamwork? What are these?**

  No, we do not apply any particular methods. I think most of the people here know what they are doing and respect others. They have one attitude, that is to work together in one team. They feed each other and discuss almost anything they have done in the team in order to make sure their project is successful, not only in this company, but also in the market place.

- **Could you please give one example of your company's product that have been successfully developed by this team?**

  Most of our new products are developed by this team.

MALPRO
INDUSTRI
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Date: 10.November,1998

Mr. Marzuki Ibrahim (Phd Student)
Universiti Of Northumbria At Newcastle
Ellison Building
Ellison Place
Newcastle UponTyne
Great Britain
NE 1 1BR.

Dear **Mr. Marzuki**

Thank you for your letter of 29th October 1998 . The case study is accurate and very interesting.

I would also appreciate a copy of your final manuscript if that is possible.

I wish you luck with your PhD.

Your sincerely

.....
RUSLEE B. HASHIM
(Group Managing Director).

SHARP

SHARP ELECTRONICS (M) SDN BHD (No. 356997-H)
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UNIVERSITY OF NORTHUMBRIA AT NEWCASTLE
DESIGN DEPT. SQUIRES BUILDING
Mr. Marzuki Ibrhim

Dear Ibrhim:

I have received a report of "case study interview".

Basically, the report was well made. However, I have two things that I would like to mention.

First, I have a question our case is a good sample for the long term research like yours.

As you know, the economic situation in ASEAN countries has been changed drastically. As the result, we had to make a complete change in not only our companies plans and strategy, but also our design strategy.

On the other hand, between the first your interview and second one, there was a long interval of one year and 4 months. Therefore, I found there are some inconsistencies parts and unclear direction in your "case study interview. But there are true. I think you were also aware of it.

Again, the situation has changed every moment in the real business world. The change of our design strategy is a matter of course. I would like to ask you to understand our circumstances.

Next, I am sorry to say that it is very hard for me to find a time to help you with your research after this since I became extremely busy.

Please understand my situation and accept this letter as my last reply for you.

Finaly, I really hope you will conclude this research successfully.

Best regards,

P.S.: Regerding "case study", you will able to contact your ex-students(my staff) anytime, If you would like to do. Thank you for your understanding.

Ryu Kitagawa
General Manager / Sharp asia design center

Case Study 1 : Plastictecnic (M) Sdn Bhd

1) Company Background

Plastictecnic (M) Sdn Bhd was incorporated under the Companies Act, 1965 on 16 December 1976 as a private limited company under the name of Plastictecnic (M) Sdn Bhd. It has an authorised share capital of RM5,000,000 and an issued and paid-up share capital of RM3,500,000. In 1977 it began as a family business owned by Mr. Tan Pok Chong. The company started off in Petaling Jaya with a few injection moulding machines manufacturing plastic premium products (such as containers, cups and tumblers). In 1986, the company purchased a 2.6 acre site and relocated its premises to the Bandar Baru Bangi Industrial Estate in response to expansion in its production capacity and sales turnover.

Plastictecnic's principal activities are the manufacture and distribution of plastic products. The company's products range from industrial plastic packaging products to household plasticware and are manufactured by three major operating processes: injection stretch-blow moulding, injection moulding and direct blow moulding.

Currently, the company is concentrating on the manufacture of injection stretch-blow products, industrial packaging products and industrial plastic parts and components which use polyethylene terephthalate (PET) and polycarbonate (PC). It also continues to manufacture household plasticware products marketed under its own brand name of 'Tecnicware', which has established itself at retail outlets since 1979. All products are made according to customers' specifications and have a reputation for quality and reliability in Asia, Australia, Europe and the Middle East.

The factory is equipped with the latest manufacturing technology including machines for the finishing process. To meet the challenges of ever-growing market competition

and sophisticated demands, they are committed to continuous upgrading of their production facilities and techniques. With a workforce of about 180 workers, the factory runs 3 daily shifts throughout the year to cope with production demands.

Their team of experienced and trained Sales Personnel are an extension of their Quality Assurance programme. With the necessary technical expertise and product knowledge, they are able to respond to customers and dealers requirements. This enables benefits for end users or consumers.

They believe that what gives the company an edge over its trade competitors is the quality of its R&D programme. They have a programme headed by an R&D Manager who is assisted by a team of three highly qualified designers from ITM. Working in close association, they formulate, design and plan the necessary technical drawings for individual customer requirements. Improvement of existing products and introduction of new products is also an integral part of their R&D programme. They have installed special equipment to carry out Pressure, Strength, ESC, ASTM and other testing. In addition, they have a Mould Fabricating Division.

2) Case Study Results of Plastictecnic (M) Sdn Bhd

a) *Business Strategy*

This company has a vision of producing their our own products in the future. Currently, the company relies entirely on foreign product and technology where they purchase moulds: these are modified through the process of 'reverse engineering' to suit local needs. They have set up their own industrial design centre which is responsible for producing these products . This centre will look after design and development and will be responsible for new product and process.

b) *Product*

In terms of upgrading or replacing their products, Mr.Tan, the Managing Director (1997,1998 interview) explained that it depends on market need. He indicates that the company usually puts one product into production for a three months period but have to pull out at that point order to make way for other production. In terms of planning for new products, he believes that they cannot plan far ahead since they rely on the supply of existing products and foreign technology.

This company has a plan based on the strategic direction for future product development. Tan mentioned that end users tastes were becoming more and more sophisticated due to the influence of Malaysian modernisation. Thus, the company has to look and move in this direction to suit end-user needs. Tan added that in the future, his company will try to upgrade and give more choice to their customers by adding features such as new packaging, a range of colours, new materials and finishing.

c) *Customers*

Plastictecnic's in house marketing team has significantly contributed towards determining what their customers want by conducting market surveys. Based on this information, the process of designing and developing new product was started. Regarding involvement of customers in the process of new product development, Tan admitted that their customers only fed them with information regarding the concept of the shape of the product: other tasks are left to the company team. This is because, most of their customers were inexperienced in design and production and accepted advice given to them by the team.. Plastictecnic has not involved end-users in this process, according to Tan. They were excluded since they were seen as incapable of judging a good or poor design. Instead of this Tan suggested the company had entrusted end user requirements with the sales people in order to advise the company.

d) *Leadership*

As a Managing Director, Tan is involved in giving opinions and advising the process of business policy and the formulation of business culture in his organisation. As well as Tan other corporate managers,(i.e. Finance, Account, Human Resource and Manufacturing and the CEO) are involved in business strategy discussion. All the managers give their advice and the CEO has a right to value, judge and whether to accept ideas or not.

Tan further showed that his role was to look after Sales, R&D and Sales Operations. His duties were to gather all the information from these departments and present it to top management. It was up to CEO to decide whether or not to accept the ideas which he presents.

e) *Research and Development*

Plastictecnic has its own R&D department which has assisted the company in research and development as well as production matters. A special budget has been allocated for purchasing software and hardware for production. The members of this department, consist of industrial designers, marketing and production people. Finally there is a special committee to oversee activities within the department.

f) *Product Development Process*

Plastictecnic has not adopted or followed anyone particular model for the product development process since they have their own way of working. At Plastictecnic, the design process starts with a brief given to the designers of what their client's want made by marketing personnel. After discussion with other colleagues in the team, designers produce sketches and technical specifications. The proposal is then presented to clients. Once they (the clients) have agreed with the proposal, the drawing are then scanned into the computer to give a more detailed image. The proposed 3-dimensional design images are then presented once again to clients and after confirmation, the designers proceed

with a wooden mock-up. This mock-up is passed to the mould makers and finally to production for mass production.

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g) *Role of the Industrial Designer*

Regarding the role of industrial designers in developing new product. Tan described them as 'visualisers' and 'aesthetic specialists'. At Plastictecnic, industrial designers were involved at the very beginning as well as at the end of projects. At the beginning of a project, industrial designers give their advice on design features such as shape, form, colour and may also solve simple technical problems At the end of the project, they supervise mould making, and in the finished product they help to make arrangements on product graphics.

h) *Design Consultants and Other Collaborations*

Plastictecnic has also commissioned their design work to design consultants when their own designers were unable to cope with the volume of work. They also use the services of design consultants when they consider their design team does did not have the expertise or where new information is needed. In terms of the criteria of selecting design consultants, Tan said that it was based on quality and price of the work. Furthermore, he pointed out that they were very satisfied with design consultants work and that they have a good rapport between them.

In terms of collaboration with other bodies, Plastictecnic has worked with ITM whereby they asked ITM's design students to participate in their design competition on new concepts for a range of bottles. Plastictecnic also has close links with other higher education institutions with many of them sending their students for practical training within the company. In addition, Plastictecnic has good links with SIRIM for mould and tooling improvements.

i) *Concurrent Engineering and Other Similar Methods*

Plastictecnic has not implemented concurrent engineering or any other similar methods.

j) *Quality*

Plastictecnic is going to adopt ISO 9002 in the near future. At present, the company has completed the documentation process and is waiting for approval.

k) *Computer Aided Design*

In their design work, industrial designers used both manual and CAD design methods. Tan explained that their industrial designers visualise and sketch on paper before transferring the drawing onto CAD. 'Macintosh' software is used by their designers in producing 2D and 3D drawings, technical and presentation drawings. CAD is used throughout the design process.

l) *People*

Human resources in this company are managed by the Human Resource Department. This department is responsible for managing people through recommendations from other departments and in particular production. According to Tan, Plastictecnic has short and long term plans based on the demand and the nature of projects.

Within the company, communication between staff is highlighted by round table meetings each week with all the team members discussing issues, ranging from office work to management.

Tan pointed out that his company has not conducted any surveys of the perceptions of staff on aspects of the organisation but they have used their own procedure to gauge performance, especially for pay rises. They also offer training and short courses for selected staff interested in upgrading their capabilities.

m) *Design Teamwork*

Tan claimed that there were no conflicts arising between different functions in the new product development team since a culture of working together using

concepts of 'give' and 'take' had been adopted for some time . Moreover they did not need to use methods to foster teamwork except to discuss problems on a day to day basis. A committee had been set up to approve design and development. The function of which was to create a forum for any criticism or argument about product.

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Case Study 2 : Malpro Industri Sdn. Bhd.

1) Company Background

Malpro Industri Sdn. Bhd. (MISB) was established in April 1988 with the objective to provide comfort to people in their everyday environment. MISB is a wholly bumiputra-owned company with an authorised capital of RM150,000 and a paid-up capital of RM100,000. Renowned for office chair quality and reliability. MISB's policy is "to prepare, release products and services of quality to satisfy the needs of their customers". With the motto of "Quality", "Style", and "Comfort", MISB remains sensitive towards the needs of the consumer, primarily in areas of design, function and size. Since their establishment, MISB has developed into one of the more reputed office chair manufacturers in Malaysia.

From establishment (1988) until December 1992, the company achieved a high level of productivity with gross sales of the RM6.4 million . This figure is expected to increase at a rate of 25 to 40 percent annually in the future.

MISB primary activity is to manufacture, produce and market a variety of office chairs for the government, government-related bodies, corporations and private individuals.

MISB has enjoyed success because of its highly skilled and motivated work force. These include industrial designers, technicians, technical assistants, engineers and sales personnel. It is MISB's aim to develop and cultivate a team of employees to ensure company growth and to contribute to society.

At MISB, continuous upgrading of technology and expertise through Research and Development is followed. Their success in Research and Development is reflected in the wide range of office chairs which they produce, from secretarial to superior executive chairs. Quality, style and comfort are the basis for their product which are

designed to satisfy the needs of users at every level - including domestic applications. In 1994, in recognition of the company's continuous strive towards enhanced quality and efficiency, MISB was awarded the SIRIM National Quality Certification. This award demonstrates the company's commitment to quality through standardisation and certification.

MISB's aim for the future is to establish more production activities in order to meet the growing demands of its consumers.

2) Case Study Results of Malpro Industri Sdn. Bhd.

a) *Business Strategy*

Malpro's vision is to develop a company that can go with time.. According to Mr. Ruslee, the Managing Director (1997,1998 interview) the company requires complete departments as found in other companies. He also indicated that the company needs to compete not only in Malaysian market, but also in the global one. To reflect this the company has recently moved from an old factory in Selayang. On top of these changes, Ruslee believes, that in future, his company will release a wide range of reasonably priced, stylish, quality products.

b) *Product*

Ruslee indicated that the company usually replaces its products at least once a year, however since the economic slow down this has been reduced once every other year. Planning periods are generally around 3 years with design normally remaining 5 years in the market. The company has a product development plan based on the direction of current and future product development. Ruslee added that if they do not follow current trends products will remain unsold. The company sends staff (particularly R&D employees) to domestic and international furniture shows and exhibitions to follow future trends and to help create a product design base.

c) *Customers*

Ruslee explained that there were two types of customers for their products. One who buys directly from the company and another who ask them to design specifically. No market surveys are made for products which have these specific design characterises .This is because Malpro are aware of customer needs due to their experience in the business. Since price is more important than design, and, as Ruslee suggests there are three categories of buyer (low end, middle and top end), Malpro offers products with designs and quality based on this.

The company involves its customers at all stages of the new product development process. Customers give the company their requirements such as colour, comfort or even design of the product and the company develops based on these. End-users, Ruslee explained are not involved since most of the companies purchasing goods from them have their own 'Purchasing Departments'.

d) *Leadership*

Ruslee is involved in the process of business policy and also the formulation of business culture in the company together with other managers and heads of departments. As a Managing Director, Ruslee's role is to oversee all the managers under him. In terms of product development, he acts as a marketer interested in domestic and international markets. Ruslee has the authority to approve any design and development in the company but has to report to the Chairman who is not involved in managing product development at Malpro.

e) *Research and Development*

Malpro has a centralised R&D department which controls the pace of product development. R&D is at the heart of the company and controls more than 70% of the total product development. The company has a special R&D budget, based on needs and reports from R&D about any projects undertaken. The

members of R&D include the head of R&D and his assistant, Ruslee (the Managing Director), and other leading Malpro managers.

f) *Product Development Process*

In general, there no particular models have been adopted.. However the 'Kursus Amalan Peningkatan Kualiti' (Business Excellence Through Quality Course) with SIRIM has been utilised in order to improve design, production and service. Ruslee explained that the product development process at Malpro starts with initial ideas from the R&D manager who visits shows, or through foreign catalogues from Japan or Europe. From these ideas, the R&D manager consults the Marketing Manager and together consider production costs and how the product can be 'localised'. The next stage involves industrial designers who produce around 5 or 6 ideas to be considered. After further discussion with technical staff involved in tooling and machining, they issue a mock-up and later a prototype. This prototype is then sent to FRIM (Forest Research Institute of Malaysia) for testing. Productions begins once satisfactory results are achieved.. The Production Manager is responsible for production.

g) *Role of the Industrial Designer*

According to Ruslee industrial designers are involved from the first stage up until the marketing stage. Thus, they help to produce ideas and help with aspects of packaging and advertising. He believes that the role of industrial designers in the process is to design new products or to improve existing ones.

h) *Design Consultants and Other Collaborations*

The majority of Malpro design work is made internally without any external references since there are no furniture design consultancies in Malaysia.. Ruslee indicated that the company has not collaborated with other bodies, except for taking students from ITM to do practical training.

i) *Concurrent Engineering and Other Similar Methods*

Malpro has not implemented concurrent engineering or any other similar methods.

j) *Quality*

Malpro is in the process of getting ISO 9002 (as of September 1998)

k) *Computer Aided Design*

Ruslee stated that in-house industrial designers use both manual and CAD design methods. The company has one 'Autocad', two '3-D Studio' and 3 'Pro-Engineer' software programmes. CAD is used in later stages to add certain features such as colours, back ground and texture. The designers also use CAD to produce technical drawings and production drawings since it is economic in terms of time and money.

l) *People*

There are two ways of getting people to work with Malpro. Firstly, the company has it's own staff and workers and secondly is to sub to a selected vendor. All planning for human resources is made through the company's plans.

At Malpro staff communicate through e-mail, memos, briefings and discussion. However, for general workers communication between members is facilitated by a morning assembly each Monday. Malpro has conducted a survey every year for staff pay reviews. It also sends their staff for training which is done on a continuous basis.

m) *Design Teamwork*

Ruslee claimed that there were no problems arising from conflicts between different functions in the new product development team at Malpro because there is a culture where every person respects each other's profession. He

explained that no methods have been adopted to foster teamwork with the exception of ' human relations'. Therefore, to foster teamwork, a club was set up with the purpose of pooling all the people in a team, not only in the office but also outside the office. They have held several activities within the club (such as gift giving on birthdays or by visiting the homes of people in the team). He believes that through this interaction, all team members respect each other and that conflict between them will not arise.

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Case Study 3 : Sharp Electronics (M) Sdn. Bhd.

1) Company Background

Sharp has been at the forefront of technological innovation and manufacturing in Japan since the introduction of the Ever-Sharp Pencil in 1915, from which the present company name and trademark are derived. In Malaysia, Sharp began selling products some 40 years ago. Due to the country's potential, good work force and excellent investment incentives, Sharp now manufactures some of their products in Malaysia.

Presently, Sharp has four manufacturing plants and one sales and service company in Malaysia. They are;

1. Sharp-Roxy Corporation (Malaysia) Sdn. Bhd. (SRC)
2. Sharp-Roxy Electronics Corporation (Malaysia) Sdn. Bhd. (SREC)
3. Sharp-Roxy Appliances (Malaysia) Sdn. Bhd. (SRAC)
4. Sharp-Roxy Sales and Service Company (Malaysia) Sdn. Bhd. (SRSCC)
5. Sharp Manufacturing Corporation (Malaysia) Sdn. Bhd. (SMM)

Sharp companies in Malaysia contribute about 20 percent to the company's world wide sales. The Sharp Electric Malaysia Sdn. Bhd. alone contributed RM4.8 billion in sales for the three months, January - March 1996. This compares favourably with RM3.6 billion sales for the whole of fiscal year 1995, an increase of 134.5% .

Sharp operates on the principles of "Sincerity and Creativity". Based on these principles, design work at Sharp is not carried out simply by creating high quality designs but also considers the relationship between people and things by seeking harmony with both time and space, and by taking into account factors related to the fields of psychology and physiology.

With the motto of "Innovation and Style", Sharp believes in the philosophy that "technology should not only be, but also look, ahead of its time". With this

philosophy in mind, each Sharp product reflects a spirit of modernity and elegance that makes it both technically and aesthetically superior.

In recognition of their effort towards an enhanced quality system standard, Sharp recently gained the ISO 9002 Award for the manufacture of high performance, vacuum cleaners. Moreover, the Sharp EC-10 compact vacuum cleaner, produced in Malaysia, gained the 1996 US top ranking award. The Sharp EC-12 TWT4 upright model was also rated the best in the upright category.

In its latest development, Sharp has introduced an upgraded version of the popular 'Zaurus' series of personal information tools to the Malaysia market. The company also intends to introduce the 'Mebius' wide screen colour LCD notebook computer and the latest model of video camera known as "Viewcampfs".

2) Case Study Results of Malpro Industri Sdn. Bhd.

a) *Business Strategy*

Sharp has a vision for the future but due to the economic problems in South East Asia, this is currently under review. Mr. Kitagawa, the Chief Representative of Corporate Design Centre (1997,1998 interview) explained that the company has a plan for Asian products especially in ASEAN. The company hopes to come out with designs that can penetrate the market within Asia.

b) *Product*

Sharp Electronics replace their product once a year, but because of the economic slow down, they have had to revise this . In terms of planning for new product, one year in advance is the norm..

Sharp has a product development plan based on the strategic direction for future product development. The company has a centre known as the Corporate

Design Centre in Japan which was established in order to uniform design policy and to co-ordinate business and product strategies for the company as a whole according to Kitagawa.. Through this network all Sharp designers world-wide are able to work in close co-ordination by receiving and dispatching a wide variety of design information. Based on this information the direction of future products is decided. Kitagawa explained that, in the Asia region for instance, even he has carried out some marketing research which has gone into the centres database. The feed back from this is used as the basis for new product ideas.

c) *Customers*

Sharp Electronics has marketing people and sales people who conduct market surveys in order to determine customers needs. Sharp has not, however involved customers in the new product development process. The reason for this, Kitagawa explained is that the company can get all the information it needs from sales, and marketing people since they are experienced professionals in their own fields

d) *Leadership*

Kitagawa pointed out that the majority of Sharp Electronic's business policy and business culture has followed the Sharp Corporation in Japan. Certain things were however changed due to the differences in working practice between Japan and Malaysia. Kitagawa's role at Sharp is to be involved in business policy and the formulation of business culture. Furthermore, he gives advice and help where necessary though this role is largely top management's responsibility.

Kitagawa indicated that he is in charge of marketing and the development of new products in Asia and to look at the market in the ASEAN region and other Asian countries. Furthermore he carries out market surveys and suggests new products based on the results of these surveys. According to Kitagawa, other managers were also indirectly involved by contributing their own expertise.

e) *Research and Development*

Sharp Electronics has an R&D department but it is not centralised. The function of this department is only to assist and advise the development of new products. There is no special budget for R&D. The members in this department. include designers, marketers and production people.

f) *Product Development Process*

At Sharp Electronics, the product development process follows that of the Sharp Corporation in Japan. Traditionally, most of the ideas for product design come from Japan but not after the establishment of the SEM Asia Design Office. The function of this office is to develop market surveying and develop products based on Asian people's need. This was due to the fact that not all products from Japan can be sold in Malaysian market or the rest of Asia, claimed Kitagawa.. He added that with the helped of local designers, they now know exactly what the market trend is as well as being able to design for local market.

At Sharp the product development process. begins with marketing, proceeds to design (including the idea sketch, drawing, mock-up, prototype etc.). and finally goes to manufacturing. Kitagawa is personally responsible for new product development in the company. In addition to this, he also has to co-ordinate all the designs from other countries in Asia in order to produce one design for the whole Asia region.

g) *Role of the Industrial Designer*

Industrial designers at Sharp are involved in the product development process from the first stage until the last. In the first stage, industrial designers are involved in producing ideas through sketches and drawings. through model making and at the end of the design process by checking the tooling .

Kitagawa believes that industrial designers are not 'aesthetic specialists'. This is because to become good designers, they must equip themselves with knowledge of user image, the demands of different lifestyles, marketing knowledge and engineering. He emphasised that industrial designers are between production engineers and marketers, and are the bridge between the customer and manufacturing.

h) *Design Consultants and Other Collaborations*

Sharp Electronics has not employed the services of any industrial design consultants since they have more than 200 designers in Japan.. Kitagawa emphasised that he was sent to Malaysia to set up a Design Centre for the Asia market and claimed that this idea would not be successful if Sharp Electronics employed services from outside or a design consultancy. Furthermore Japan based designers understand company policy, he added.

In terms of collaborative ventures Sharp Electronics has a very close relation with higher learning institutions i.e. ITM and USM and have sponsored several design courses, the Malaysian Design Council and SIRIM. The company believes that transfer of technology and knowledge is very important, therefore are happy to sponsor any activities related to design and development.

i) *Concurrent Engineering and Other Similar Methods*

This company started practising concurrent engineering 4-5 years ago. According to Kitagawa, this method is a very efficient way of doing things. Although this method does not always work smoothly it has brought a lot of advantages to the company.

j) *Quality*

This company is currently waiting for approval of BS 14001.

k) *Computer Aided Design*

Kitagawa indicated that Sharp industrial designers use both manual and CAD design methods. The company has programmes such as '3D studio', 'Photoshop' and 'Adobe Illustrator' to produce 3D design and rendering. In terms of stage, CAD is used after the final ideas to add certain features such as colours, background and texture. The designers also use CAD to produce general assembly and general dimensions. Computers have saved a lot of time . Kitagawa enthused.

l) *People*

Personnel planning (human resources) at Sharp are managed by the "Human Resource Department'. This department is linked with other Sharp subsidiaries throughout Malaysia by transferring workers from one sub-company to another based on requirements and the current demand of products.

Sharp Electronics uses the full range of communication such as telephone, fax, memo, e-mail and even video conferencing for communication between staff.. They also hold regular round table meetings and a daily morning assembly.

This company has not conducted any surveys on the perceptions of the staff on the organisation since staff can express their ideas through a union which was set up for this purpose. On top of this, Kitagawa explained that the company has its own standard format for judging people vis a vis pay rises. The company also offers all staff training for future development.

m) *Design Teamwork*

Kitagawa has not encountered any serious problems or conflicts between different functions in his new product development team since they work as a mutual team.. He also stated that he doesn't use methods to foster teamwork but trusts and believes that the company needs good teamwork to achieve its goals.

He emphasised that members of his team respect each others professions, value respective knowledge and experience and believe that through teamwork they can produce better results

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Case Study 4 : Sulik Design Sdn. Bhd.

1) Company Background

This company is run by Suleiman M.Salleh a British educated Malaysian who had previous experience as an industrial designer at Reformwerke Bauer and Company Gmbh. Wels, Austria (1975), and Ogle Design Limited, Letchworth, England (1976), and also as a senior consultant at Lowey International Limited, London (1979-1981).In Malaysia, his experience includes acting as a manager of various departments at Selangor Pewter Company Sdn.Bhd. From 1986-1988 he acted as Fabrication Services Manager at the Aluminium Company of Malaysia Berhad (ALCOM), in Petaling Jaya, Selangor Darul Ehsan, Malaysia.

Sulik Design Consultants was set up in 1988, primarily as a design house in Subang Jaya, Selangor Darul Ehsan, Malaysia. The prime objective of the consultancy was to provide local companies with design solutions for the market at home and abroad. The people involved in this company are trained designers and design engineers with experience both at home and abroad. The range of expertise includes corporate graphics, desktop publishing, silk-screening, product marketing and planning, product design, and transportation design. Being a local design company, they can give appropriate support. Their design team operates in a multi disciplinary context, and is supported by expertise from different fields. Their approach is marketing oriented, and recognises the 'cultural perspective' as a valid objective. To serve their clients world-wide interests, they are now affiliated with one of the biggest design house in London - Loewy International plc.

As well as operating as a design consultancy business under the name of Sulik Design Consultants and Sulik Design Sdn. Bhd. Sulik was also a visiting lecturer at the Institut Teknologi MARA, (ITM) Shah Alam, Selangor Darul Ehsan from 1985 to 1990. He has been as external examiner and course advisor to the Department of Industrial Design, ITM Shah Alam from 1985 to 1990. Moreover, he has also been

appointed to several governmental committees and to panels of judges for national competitions.. He is also active in presenting papers for seminars and conferences throughout Malaysia. Because of his support and functions for the development of industrial design activity in Malaysia, he has now been appointed as one of the Board Members of Majlis Reka Bentuk Malaysia (Malaysia Design Council) and pro-tem Vice President for the Malaysian Industrial Design Society.

2) Case Study Results of Sulik Design Sdn. Bhd.

a) *Business Strategy*

This company does not have any mission statement. Suleiman, the Managing Director (1997,1998 interview) said that this was a profession which he wanted to do and one where he believed there was opportunity and scope.

Suleiman believes that his ideas are not going to last forever in design. Therefore, he has a strategy to involve his company in manufacturing in the near future. He believes that since everybody is looking for a product that is the best , the way to penetrate demand is through design of his own ideas.

b) *Product*

Suleiman explained that fewer than 10 new product development projects were undertaken each year. However, for graphic projects it was more than 10 per year. He indicated that he cannot take many projects on due to cost constrains.

c) *Customers*

In designing new products for clients, Sulik Design has not conducted any formal or informal surveys in order to determine clients demands. Suleiman mentioned himself that clients came to him and asked him to do something they wanted. Customers themselves were not part of his concern since his clients deal with them. Therefore, there are no marketing people working with Sulik Design.

In terms of involvement of the client's customer in the new product development process, Suleiman explained that this was never occurred He indicated that normally he was the only one involved in his client's product development. Consequently it was he who called by clients contacted to perform tasks such as 'reverse engineering', 'modification' or 'localisation'. Since most of the products in Malaysia are foreign, (i.e. Japan), it was very easy to predict the market of any particular product within Malaysia itself.

d) *Leadership*

As a managing director and propertior of the company, Suleiman is involved in all processes of business policy and the formulation of business culture. He stated that he works as a team leader who co-ordinates across all sectors. According to him, companies in Malaysia were not an 'A to Z' company, but rather specialise in one area. The companies who normally employ him, especially Chinese companies, generally take a subordinate role and merely pay money. He added that most of his clients were 'bottom line' guys who only focus on profit..

e) *Research and Development*

(Not applicable for this company)

f) *Product Development Process*

Sulik Design do not follow a process from idea to manufacturing because they deal with products for 'localisation', 'modification' and 'reverse engineering'. Based on Suleiman's experience in product development process, the design process is sometimes in the middle, sometimes towards the end and sometimes at the beginning of the project. According to him, his clients involve all the staff in their companies. Suleiman himself is only called to provide an outsiders viewpoint. Interestingly, he claims that, at the end of the day, his clients

produce products exactly as the Japanese or other foreign countries do but with a Malaysian method of manufacturing.

In terms of a model for the product development process, Suleiman explained that he is interested in the 'design process flow' method introduced by Philips of Eindhoven. He has been influenced by this model since 1975 and has adopted it as a basis for his client's product development process. According to him, this method is market orientated and reflects to his belief that at the end of the day companies have to sell products.

g) *Role of the Industrial Designer*

Suleiman suggests that industrial designers need to be involved from the first day to the last in the product development process. According to him, in Malaysia today, the realisation of the importance of the industrial designers is present since most CEO's realise that industrial designers can contribute to the idea stage or the initial stages.

h) *Clients and Collaborations*

Sulik Design Sdn.Bhd. get their clients primarily through recommendations. According to Suleiman, most of his clients know about him because his activities with other friends of theirs. He claims that his company does not have any portfolio to attract their clients that he never makes presentation for his clients because it is his clients who come to him.

To select design consultants, Suleiman admitted that it was based on track record, not experience. He added that his clients want to see how the product works and be familiar with their market. Since most of his clients started their business from a 'backyard', he suggested that they knew little about legalities or royalties.

Suleiman has close associations with higher education institutions and government bodies. For instance, he was a visiting lecturer at the Institut Teknologi MARA (ITM) from 1985 to 1990 as well as an external examiner and course advisor. In fact, his company is one of the places where students do their practical training. He has also been appointed as one of the Board Member of Malaysia Design Council and pro-tem Vice President for the Malaysian Industrial Design Society.

i) *Concurrent Engineering and Other Similar Methods*

Suleiman admitted that he has adopted the Philips working practice,(which is similar to concurrent engineering), in the companies he worked with. Most companies prefer this practice and try to work toward it, he suggested.

According to Suleiman, companies use concurrent engineering to avoid conflict between the members of teams . Suleiman could not think of any disadvantages of adopting this method. According to him, concurrent engineering speeds up their process and cuts production costs since all the obstacles have been discussed prior to implementation.

j) *Quality*

Suleiman boasted that Sulik Design Sdn.Bhd. quality started from the ground up. They eliminated all the problems from the design process by using quality control, and the 'bottom-up' method.

k) *Computer Aided Design*

Designers at Sulik used the Autocad Release 13 software systems in designing and developing their client's new product. As mentioned by Suleiman, CAD speeds up the design and development process. Although he prefers his designers to use computers, he admitted that they should not rely on them entirely. He proposed that workers should be computer and human orientated

and added that if designers are too dependent on computers, their product becomes very sterile.

l) *People*

In terms of personnel planning, Suleiman relies on his subsidiaries to take care of day- to -day requirements of personnel. In this sense, Sulik Design is just a creative house and not involved in other areas. Sulik Design have their own way of recruiting staff and operate long-term and short term planning.

To communicate, Suleiman believes face to face methods and the telephone are the best way to achieve constant feedback and rapport.

The company has made no surveys of the perceptions of staff on the organisation except for pay rises which was based on performance and portfolios.

m) *Design Teamwork*

Suleiman has encountered a lot of problems arising from conflicts between different functions in his new product development team. He also stated that there were a lot of conflicts among designers. According to him, it was very difficult to foster teamwork, especially when it involved inter human . To solve this situation he gives staff advice on teamwork and encourages them to think about the Sulik image.

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Case Study 1 : Thermos Limited

1) Company Background

The word "THERMOS" is a registered trade mark, of King-Seeley Thermos Co. and its subsidiaries Thermos Limited and Canadian Thermos Products Limited in over 80 countries around the world. Although Thermos was founded in 1904, it was not until 1906 that the name Thermos was registered. In 1905, a British company, A.E. Gutmann had obtained the UK distribution rights for the new vacuum flask but when Thermos Limited was formed in 1907, it assumed the import rights from Gutmann and registered the brand name 'Thermos' in the UK.. and many other parts of the world.

In 1908, Thermos Limited opened their first plant in Tottenham where production levels grew rapidly as consumers, in the UK and overseas recognised the benefits of the vacuum flask. At the outbreak of the 1914-18 war, Thermos was taken over by the Ministry of Munitions and in 1917 the factory was bombed. In the following year, a new plant was opened in Fontayne Road, Tottenham. In the early 1920's, the Thermos Bottle Company of America took a major share and led to the restructuring of the company as Thermos Limited.

In 1931, a plant for filler production was opened in Hackney and a metal canister factory was opened in Leyton. In 1954 the company purchased a large factory on a four and half acre site at Brentwood. In 1962, the company administration and manufacturing were centred at the Brentwood factory and the factory became one of the most modern and efficient glass factories in Europe.

With the mission to "Develop and Provide Our Consumers With Branded Innovative Portable Insulated Containers to Keep Food and Drinks Fresh, Meeting Needs for Freedom and Flexibility", Thermos continues to introduce new standards of performance and ingenuity. Thermos is seen as a company that combines performance, reliability and style for its consumers.

The company has a proud history of export achievements and in 1971, the Queen's Award to Industry was received for export achievements. Exports such as vacuum flasks, school lunch kits, cooler bags, sandwich bags, ice coolers and gas barbecues are sent to more than 100 different countries world-wide and represent over 50% of the company's production.

In the middle of 1990's Thermos began to revise their marketing strategies to capture a larger share of the youth and young adult market in the UK. To do this, the company modernised it's logo to make it more appealing, easy to read and to make it look less industrial. Thermos also introduced a sleek and modern package design for its popular beverage containers in an effort to move away from its old image of being the choice of parents and grandparents. By 1996, Thermos had completely redesigned itself and had moved away from its old image associated with trains-potters and the elderly, toward a cool look that appeals to a young market. Thermos expanded its range of licensed products to coincide with the Disney film "Mulan" released in October 1998. This range included insulated lunch boxes and novelty lunch bags.

By 1997, the company had taken another step by reducing their 27 sub-brands to only three: 'Weekend' - a simple, practical and value-for-money family range in spectral colours; 'Mondial' - a performance oriented, more serious range which comes in darker primary colours; and 'Mattino', which completes the portfolio. The company is also looking to introduce a youth line at the time of writing. In parallel to this, all product labels have been changed to look more modern, with clear icons on

the front-of-packs to tell people the product's capacity, correct temperature and use. By doing so, Thermos hope that their product will comprise a co-ordinated range which is stronger on the shelf and brings more opportunity to cross-sell other Thermos lines, such as cooler bags and carafes.

For three generations Thermos has been a leader for thermal products and currently has 80% of the £30.5m vacuumware market in the UK (around 25% of which is through grocery). Today, the company is still the premier name in thermally insulated products offering a comprehensive work/leisure range of products and remains a brand that customers reach for.

2) Case Study Results of Thermos Limited

b) *Business Strategy*

Thermos has secured the company's future for the next six years by investing in a new furnace. According to Mr. Worsley, the Project and Development Engineer (1998 interview) the idea for the future was to move their products since they have a strong competition from Far East stainless products. He also claimed that the company has to push the design and aesthetic appeal of their product forward and look to develop products that can be more specific, appealing and can be customised more quickly by specialists. By doing this it is hope that their products will be more competitive and more saleable to the customer.

b) *Product*

Thermos has two types of product. Firstly, those that it has produced for over 30 years and still produces, principally as a product which people continually use. And secondly new products, e.g. products Thermos produces for the family and the young executive. According to Worsley, these new products are replaced every five years and with new features added annually.

In terms of planning for new products, the time period is two years. Since the company out sources their design and development, they can develop their product more easily and more quickly, according to Worsley.

The company also have a product development plan based on the strategic direction for future product development. For instance, Thermos has to plan based on the market demands where the company has to gauge the trend in customer needs and requirements. He added that this needed backing from other sources such as marketing and sales people. These people provide the company with a current market and customer trends.

c) *Customers*

In Thermos the marketing team had made extensive market research in order to determine what customers want. They also hold workshops where people can view the product. Thermos has not however involved their customers in new product development but rather they make their own research to study the market which is sufficient to identify end user needs and wants.

d) *Leadership*

Worsley is not essentially involved in the process of business policy and the formulation of business culture in the organisation since he believes that it is looked at more at the Directors level. He does however presents top management future products and predictions.

Concerning his role with other senior managers in managing product development, Worsley stated that since the company has marketing and sales teams that the managers from both departments give him the latest information (i.e. the Marketing Manager gives him information regarding the market and the Sales Manager gives him information on the profit and sales of their products. He added that his role is to combine all the information in order to design a new product.

e) *Research and Development*

The is no R&D department in this company since most of their design works are outsourced using design consultants services.

f) *Product Development Process*

Thermos has not adopted any model of product development process. Worsley claimed that since they are the market leaders in thermal insulated products, they do not need to adopt any particular model. In fact, he suggested that there were many people who copied Thermos's process.

The majority of Thermos design work is made externally since there are no in-house designers. The design process starts with a design brief given to a selected design consultancy. After some discussion, the consultants create an idea and present the market features for the idea as well as the best way of manufacturing it. Thermos does however have certain limitations on selecting final design. For example, considerations on practicality and easy production design are emphasised. .

Worsley himself is responsible for the product development process at Thermos. His main responsibilities are to ensure that the whole system, from concept to finished product work in order and within the time scale.

g) *Role of the Industrial Designer*

Since industrial designers no longer work with Thermos, this section will discuss the role of industrial designer based on Worsley's experience working with external designers (design consultants). Industrial designers, he suggests are involved at an early stage (e.g. to produce a rough idea of products through sketches or to make a block model). The industrial designer's role in the product development process is to take the design concept and make it a reality. The industrial designer has thus to go through all the phases, from idea to production.

h) *Design Consultants and Other Collaborations*

The company has employed the services of industrial design consultants in order to cut the numbers of workers. Worsley suggests that this was not a mistake because the company needed to consider totally new design concepts. In addition, the company needed to turn their product quickly, and because of the quick turn around, the company needed to move to a design agency. Since the design agency have around ten to twelve designers, a balance between speed of design and cost can be easily reached. Worsley also believes that design agencies can produce fresh ideas of new product design for the company to consider.

In terms of criteria of selecting design consultants, experience was the main consideration rather than the cost for the company.

Regarding satisfaction, Thermos are satisfied with the services of design consultants. They added they have spent a lot of time discussing and working together with design consultants. Worsley's role in this is to be part of their team rather than part of Thermos so he can easily advise them on specific company requirements.

In terms of collaboration with other bodies, Thermos have had some linkages with universities in the past and would like to collaborate with them again in the future

i) *Concurrent Engineering and Other Similar Methods*

The company began practising concurrent engineering about 2-3 years ago. At Thermos in order to make this method work Worsley has combined the function and information of the marketing and engineering teams and has liaises between the two parties. In this way concurrent engineering meets the companies expectations and creates few limitations. The method also brings together

marketing people and engineers who through mutual exchange, a practice not seen in the past have added to each others experience.

j) *Quality*

In terms of quality, Thermos has adopted ISO 9000.

k) *Computer Aided Design*

As a designer himself, Worsley has used Autocad Release 14 at various stages of design process. For example the CAD is used in producing sketches, ideas development, the 3-D solid model, 2-D drawing for manufacturing and solid modelling. Although CAD has helped speed up the process of developing new products, Worsley indicated that he was looking for a new, faster, more economical system.

l) *People*

For undisclosed reasons, Worsley could not answer questions regarding personnel planning (human resource) at Thermos. As for communication between the staff, he did explain that they used internal and external e-mail and text phone. He suggested that since the e-mail system has a central database created within the new product development, it was very convenient. It allows all staff to view all stages of product development at any time.

Thermos has not conducted regular surveys of the perceptions of the staff on the organisation but they have monitored the way the company is working. At Thermos the system department ensures all the information moves around is correct. They are constantly looking at ways of improving it.

m) *Design Teamwork*

Thermos have encountered many problems arising from conflicts between different functions in its new product development team particularly between

engineers and marketers. However, Worsley emphasised that the team members always sit together when a problem exists. He also added that no problem yet remains unsolved in the company..

Finally, Thermos has not adopted any methods to foster teamwork. This is because they emphasis to work as a team and it is not enforced. The company believes that staff understand that if they try to work on their own, they will not achieve anything, Worsley claimed.

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Case Study 2 : Evertaut Limited.

1) Company Background

Originally, Evertaut Limited was part of the Harris and Sheldon Group of Companies under the name J.B.Brooks. This group included companies such as Antler Luggage, Desmo Car Accessories, Hardy Fishing Tackle and Evans Lifts and manufactured steel filing cabinets and personal lockers at its factory in Penny Barr, Birmingham. J.B.Brooks moved its operations to Blackburn in 1956 and occupied its present location in Darwen in April 1957, by which time manufacture of tractor seating was being carried out. By this time the company had also developed its own unique lip-seal method of seating upholstery and is still used, by the company, today. Other late 1950's developments included Brooks first office chair, the E26 typist chair. This chair incorporated a locking mechanism employing a large conduit type nut which, once locked became 'Ever Tight' and hence, the name Evertaut was born.

In the early 1960's, the company expanded and acquired a second site (Greenfield Mill) in Darwen and developed its range of products to include wooden office seating, desk products and fitted kitchen units. The installation of both wet painting and powder coating facilities on the Greenfield Mill site attracted a wide variety of new business, though it was mainly sub-contract work. This new business was mostly related to the manufacture of panels for gas fires and central heating boilers.

During the late 1970s, a third site in the town, Two Gates Mill was acquired. This was used for a variety of work such as the manufacture of supermarket trolleys and the production of domestic three piece suites upholstery until early 1981.

During 1981, the Shopfitting Division of the Harris and Sheldon Group relocated from its Midlands site to Two Gates Mill. This enabled the company to become involved with high street names such as Marks & Spencer and Woolworth. At this

site a complete manufacturing and installation service was provided. During the mid 1980's, Greenfield Mill fell into severe disrepair and was closed. As a result, manufacturing was amalgamated into the Two Gates Mill site. This amalgamation was followed by a further member of the Harris and Sheldon Group, A.S.Toones (a manufacturer of veneered panels) locating at the same site enabling Evertaut to be self sufficient in the manufacture of desking and ancillary items. In 1989 Evertaut was acquired by Wassall (Plc) and returned to being a manufacturing office seating and furniture exclusively.

In 1996 Evertaut merged with another member of Wassall (Plc), Hille Office Seating. This was perhaps the most significant development for the structure and direction of new product development at the company since Hille Office Seating was able to provide design and development (R&D) facilities. These two companies now both operate from the two remaining sites in Darwen.

2) Case Study Results of Evertaut Limited

a) *Business Strategy*

This company has a twelve month plan or idea plan in which their business grows. Mr. Eccles, the Technical Services Manager (1998 interview) described that , they were there to make money and unless they were profitable, they might as well close the business and invest the money elsewhere.

b) *Product*

This company has a continuous programme of upgrading and replacing their product in the market place. According to Eccles, they sell their products to three areas; to the wholesale, through booklets and directly to end users. Eccles explained that new products are planned up to twelve months in advance.

Evertaut Ltd. has a product development plan based on the strategic direction for future product development. Eccles explained that the company has a continuous programme looking at the features of office furniture in order to analyse competitor's products. Furthermore, he suggested that the company has to plan based on this analysis and then produce something either similar in function or at a cheaper price.

c) *Customers*

Evertaut Ltd. has not conducted market research survey to determine their customers needs and wants. Since their customers are spread all over the UK, Eccles indicated that the company only supplied them with a product catalogue. These catalogues show the features costs and benefits of the company's products. Eccles explained that their customers then analyse the catalogue and report on any weaknesses. Based on this report, the company gauge the real needs of their customers and were able to improve any weaknesses in products.

The company has set up a marketing department. It was reported that it had deteriorated considerably and was in the process of restructuring to give it more formal attributes. This department analyses competition, looks at new products and prices. Eccles suggested the need for continuous change in order to compete with others.

Evertaut has not involved customers in the new product development process since representatives of the company itself assessed their needs. In this way, customers were seen as being the ones to approach rather than being approach by them.

d) *Leadership*

According to Eccles, although the process of business policy and the formulation of business culture comes from managerial level, he and other senior managers

were involved in the process. As a manager, Eccles's duty was to manage manufacturing and the process. By setting up main board meetings, it gives managers a chance to look at the overall business strategy.

In terms of roles of other senior managers played in managing product development, Eccles emphasised that, each committee and each unit manager acts as his own director. In this way, individuals run their own business and will demand according to what the requirements are.

e) *Research and Development*

The company has a centralised R&D department which oversees a large number of branch companies such as Evertaut Seating, Evertaut Desking, Hille, Cinema Seating and Education Furniture. The company has set a special budget for R&D. All six managers act as members of the R&D department.

f) *Product Development Process*

This company has not adopted any particular model for product development process. Eccles claimed that this was because they are happy with the current way of doing things and hence there was no reason for them to adopt any other model in their environment.

There are several ways of developing new products at Evertaut. One way was to have been initially given a brief by a client such as a manufacturer. From this brief they have to add some rough dimensions. With the design depending upon the customers technical specifications and cost parameters. The team then come out with the design, prototype and finally a mock up. This is done through small committees with four people, including engineers and upholsterers. The second method concerns the wholesaler. For this method, the company look at the current competitors and will release an innovative design in order to compete with them.

g) *Role of the Industrial Designer*

According to Eccles, industrial designers are involved from the beginning to the end of the project. In terms of their role he believes that they are aesthetic specialists, producing ideas such as sketches .Eccles claims that industrial designers cannot be called project 'co-ordinators' since they are not involved to a great extent.

h) *Design Consultants and Other Collaborations*

Evertaut Ltd. has not used design consultants services for design and development although they indicated that industrial design consultants have regularly contacted them. According to Eccles it is very 'risky' to work with design consultants since consultants ideas are not always workable within. the company framework and thus can waste time and money.

In terms of collaboration, the company is not associated with other bodies. However Evertaut Ltd. Is a research base for testing (fire retardant) products to the British Standard.

i) *Concurrent Engineering and Other Similar Methods*

The company has practised concurrent engineering for a few years. This has given the company some advantages such as speeding up operations.

j) *Quality*

The company has adopted ISO 9002. In addition to this. all chairs produced conform to BS 5459, 4875 and 5940 which relate to performance. design, strength and stability respectively. Their products are also supplied with a 5 year structural warranty and full National After Sales Service.

k) *Computer Aided Design*

The designers at Evertaut use Autocad Release 14 for 2D drawing and for 3D Studio for 3D drawing. CAD was used in order to create product concept and in modifying drawings. Eccles pointed out that CAD can be used from start to finish in the project though the extent of use depends on the project undertaken.

l) *People*

All activities regarding personnel planning are computerised. The company currently employs about 260 people though this number fluctuates with demand by around 5%. They hire temporary contract workers and have plans for double and weekend shifts.

In terms of communication amongst staff, Eccles indicated that it was primarily through memo. He believes that although the company is not equipped with e-mail, the more traditional method has worked very well. He considers his staff well informed.

This company has not conducted any surveys of the perceptions of their staff on the organisation. However it does offer training programmes for staff and general workers.

m) *Design Teamwork*

To date, Eccles did not reveal any serious problems or conflicts between different disciplines in design teamwork. Although there are some arguments, but these were done in a professional way. He is happy with what the team have achieved.

Evertaut has not applied any particular methods to foster teamwork. Eccles believes that most people in the company know what they are doing and respect others work. They have one attitude, he suggested, that was to work together in

one team. The team exchange information and discuss all aspects of teamwork in order to make sure projects are successful in this company and in the market place.

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Case Study 3 : Electrolux Spennymoor

1) Company Background

The origins of Electrolux can be traced back to the introduction of the vacuum cleaner, the invention of the absorption refrigerator and a marketer named Axel Wenner-Gren who worked at Santo in Vienna before returning to Stockholm where he used his experience with colleagues and staff to create the Lux 1, the world's first household vacuum cleaner in 1912. In 1925 the first Electrolux absorption refrigerator was launched and Electrolux began its quest to be the largest household appliance producer in the world.

Today, Electrolux is the world's leading producer of household appliances for indoor and outdoor use, and of corresponding products for professional users. Each year, more than 55 million customers from more than 100 countries purchased their products. Electrolux is one of the largest industrial companies in the world and are among the top 100 largest private employers in the world with about 110,000 employees.

Electrolux is a European market leader in white goods, and is the third largest white-goods company in the U.S.A. In 1997, white goods accounted for 74% of sales in Household Appliances and for half of total Group sales. Electrolux has three pan-European white goods brands; Electrolux, AEG and Zanussi. In the U.S.A they are known as Frigidaire, Gibson, Kelvinator, Tappan and White Westinghouse.

The Group consists of more than 500 companies in 60 countries with an annual turnover of US $14 billion. It is the world's largest producer of floor-care products, absorption refrigerators for caravans and hotel rooms, and compressors for refrigerators and freezers. Electrolux is also the world's largest manufacturer of home appliances such as refrigerators, washing machines, cookers, vacuum cleaners and room-air conditioners. Furthermore it is the world leader in powered devices for

gardening and forestry products such as lawn mowers, garden tractors and chain saws. Electrolux has over 100 years experience in industrial laundry services and has manufactured food service systems and cleaning equipment since the 1920s.

Until recently, Electrolux had grown mainly through acquisitions. Their ability to make very large acquisitions and integrate them into a world-wide competitive group is a key strength. Today, they are focusing on growing organically, that is from within. They are also setting up new operations in emerging regions, such as China and Russia. In addition, Electrolux has built a strong marketing, distribution and service organisation that can satisfy it's customers.

2) Case Study Results of Electrolux Spennymoor

a) *Business Strategy*

This company has a vision to be a product leader and also to become an environmental leader. According to Mr. Carney, the Industrial Design Manager (1998 interview) they have already reached this position. However there is a lot more for the company to take care of and to take forward, he added. Moreover he indicated that new legislation has been introduced which means they are now responsible for product after life. Thus in future Electrolux products will be created through new moulding or new interface features and will have more upgradibility through 'plug in' module. In this way, there will be more rather choice from the consumers point of view in that they do not have to buy a new product but rather just upgrade it.

b) *Product*

The company has a 'generation plan' in upgrading their products. This plan is based on the business strategy, an overall plan which provides the direction for

the long term planning of product development projects. In terms of planning of new products, 3 to 10 years planning is the norm.

The company also has their own product development plan, known as 'strategic planning'. This plan is included in one of four sub-processes of their IPDP (Integrated Product Development Process) and it provides a general direction for future product development. The main purpose of this plan is to ensure the right work is done and provides guidance to help them select the appropriate projects. IPDP set targets for customers, markets, products and services and is continuously updated and reviewed.

c) *Customers*

At the Electrolux, customers needs and demands are determined by identifying retail scale and any related gaps in the retail market. This process starts with product planning at the local level with the whole company having access to the 'note information system'. According to Carney, through this note database, requests go as notes to a number of key people at brand and factory level. These people were evaluated the database and it was up to Project Planning Manager to decide on commencing the IPDP project or not.

Carney indicates that Electrolux do involve their customers in the new product development process and believed that in the near future, this involvement will increase. He added that because of customers involvement, he did not need to worry about design and development. This is because, not only does he know exactly what their customers want but also it saves time and money by eliminating the need for presentations.

d) *Leadership*

As an industrial design manager, Carney's role is to be responsible for the overall design and development project. Within IPDP there are also IPDP co-

ordinators and project managers. The IPDP co-ordinator is responsible for documenting, modifying, reviewing and updating the IPDP within the business sector or product line while the project manager, is responsible for the overall project.

e) *Research and Development*

The R&D department at Electrolux is not centralised. In terms of budget, the company has allocated a special budget for R&D. In fact, Carney pointed out that in his department, industrial design was running in a completely separate cost centre. They operate the in-house consultancy internally to these people and recover their costs based on the amount of labour expended.

f) *Product Development Process*

Electrolux has invested £1million on 'Integrated Product Development Process' or IPDP. Since its introduction as the Group standard, it has shown to be a powerful total quality management tool that has helped Electrolux achieve it's targets. IPDP maximises the use of Group resources and creates more value for its customers. This process provides both short and long term support for the strategic direction of Electrolux.

The product development process at Electrolux consists of three phases: project specification and pre-engineering ; project industrialisation and production. Each phase is then divided into sub-phases and each of these ends with a checking system. The purpose of the first phase is to identify and reduce uncertainty through analysis and evaluation of target consumers, markets, volume and customer demands. Based on this information, early design work can be done. In the second stage of the process, a production process is set up and the product is prepared for launch. The final phase involves feedback from the test markets and decisions about full market release.

At Electrolux, the project manager is responsible for the overall project. and has the appropriate authority. It his responsibility to report to the project owner or to a steering team representing the project owner.

g) *Role of the Industrial Designer*

Industrial designers are involved at the beginning of the process and in all phases of IPDP, together with other specialists to solve core problems. Their role, in this process, is to help others in developing new products by exploring the potential needs and give a uniqueness to the product.

h) *Design Consultants and Other Collaborations*

The company has not employed the services of industrial design consultants since the company focus on developing their core competence within the group itself. According to Carney, the company has more than 120 industrial designers world-wide and does not see any advantages in using external consultancy services.

Electrolux have an EPF plastic project running at Teeside. Carney is also an external examiner at the University of East London. Collaborative projects has also been made with the University of Central London and Royal College of Art. In addition, Electrolux has other academic connections across Europe and collaborative projects in America.

i) *Concurrent Engineering and Other Similar Methods*

The company does practice concurrent engineering. They integrate their process through IPDP. This has helped the company reach its targets by maximising the use of resources as well as creating more value for customers.

j) *Quality*

Electrolux have a wide portfolio of quality certification.

k) *Computer Aided Design*

Within the Industrial Design department Electrolux uses Vellum software for basic drafting and Alias software which was installed with the programme CAD Direct. This allows industrial designers to ' talk' to the main engineering tool. The entire company is now based in this programme which allows them to create workforce 2D and 3D drawings.

CAD is not used early in the design process since manual methods are employed. However, Carney admitted that they are currently considering Alias software as a 'front end' tool to replace this.

l) *People*

Activities related to human resources at Electrolux focus on achieving greater mobility for managers between countries and operations. Furthermore, the company aims to achieve greater diversity in the age, gender and nationality of the workforce. Employee recruitment is thus based on a more strategic, long term approach.

In terms of communications between staff, Carney pointed out that regular formal and informal project meetings are held at the local level. They also use a form of internet known as Lotusnet which has given transparency to activities since it provides a database accessible to everybody. Using this tool, products, marketing and specifications can be cross referenced by anybody at any time on any product.

The company conducts an Employee Attitude Survey three times a year which forms part of the administration point measurement system. This survey asks people about aspects of their work and enables achievement targets to be set.

For training, Electrolux has a comprehensive programme of staff development. For example, Electrolux University holds various training courses including leadership, project management, strategic development and quality control to help their staff in future responsibilities and new challenges.

m) *Design Teamwork*

Carney pointed out that he has encountered a lot of problems arising from conflicts between different functions in new product development team. However, he believes as a team, they should be dynamic. People should be given a voice and agree or disagree in order to create something of value. Should any conflict become unresolvable, a steering committee exists to assist.

To foster teamwork, Carney explained that lines of communication need to be well defined and everyone involved in the project should have at least some knowledge of the overall organisation structure and have a clear understanding of everybody's role. He emphasised that all the members of the project team must be fully aware that they have complete responsibility for the project work and its end product. He stressed the need to maintain the team shape and members throughout the project to ensure complete success.

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Case Study 4 : IDEO Product Development, London

1) Company Background

IDEO was formed during the summer in 1991 through a merger of Moggridge Associates, David Kelly Design and Matrix Product Design. David Kelley, a professor of engineering owns 100% of the business, although 60% of stock options devolves to the two other main partners, Bill Moggridge and Mike Nuttall. Before setting up IDEO, David Kelley had been working as an engineer at Boeing and NCR. As part of the companies' corporate engineering staff he recognised a need for a multi-disciplinary approach to product design and development. He left NCR and formed his owned firm dedicated to product engineering. An early success for David Kelley was the Apple computer mouse.

IDEO has about 300 professional staff and has offices in New York, San Francisco, Boston, Palo Alto, Chicago, Grand Rapid, London, Milan, Tokyo and Tel Aviv. It claims to be one of the world's largest integrated product development and design consultancies.

Since it's establishment in 1991, IDEO has won international acclaim. It has won more Business Week Industrial Design Excellent Awards than any other design group, 1996 Business Week survey of Product Design placed it top amongst design firms and Design Zentrum, voted it 'Design Group of the Year' in 1996. It was also the creator of more than 2000 medical, computer, telecom, industrial and consumer products and has a prestigious list of leading corporations.

IDEO believes it exists to help clients widen their point of view without losing ownership of the project. IDEO also believes that success in meeting the challenges of international competition depend on a company's ability to tap new sources of innovation within and outside the organisation.

At IDEO they believe in the philosophy that;

> " IDEO combines multi disciplinary skills and resources for the development of new products. We are dedicated to the creation of innovative function and form, from the first idea to the last detail. We balance technical invention with a strong orientation toward the end user, linking engineering solutions with consideration and concern for the customer. Product functionality is combined with and balanced by the needs and desires of people. This combination is achieved by a blend of disciplines both technical and human, as well as by a partnership between IDEO and the clients we serve".

Through this approach it combines fresh thinking and speed with in-depth knowledge and follow-through, giving companies new tools for innovation.

2) Case Study Results of IDEO Product Development

a) *Business Strategy*

This company does not really have a mission statement, however it does want to be the company that clients want to come to for innovation and for highly effective product development.

In terms of strategy for the future, the company has no definite plan. But, Mr. Brown, the Director IDEO Europe (1998 interview) explained, it may be something to do with services and to do with experiences becoming more virtual. The future will also related to moving away from being a conventional consultancy, he added.

b) *Product*

IDEO undertakes a variety of projects numbering 30-50 per annum.

c) *Customers*

The IDEO teams conduct 'user research' in order to determine what their customers want and require. According to Brown, since the whole approach of design and development was based around customers and users, most of projects embarked upon undergo 'user research' which is more empirical than market research.

IDEO does not involve their client's own customers in the new product development process because they much prefer to visit them in their own environment, Brown suggested.

d) *Leadership*

As a Director of IDEO Europe, Brown is involved in the process of business policy and the formulation of business culture for his company. Concerning the role of himself and other senior managers in managing product development projects, he showed that they have a slightly different culture to most normal design consultancies. Brown explained that the most powerful people inside their company are project leaders. Thus it is project leaders who manage the projects, not top management. Not only do they control the resources within IDEO and decide what to do, but they work for clients too.

e) *Research and Development*

(Not applicable for this company)

f) *Product Development Process*

No particular product development process model has been adopted at IDEO. Brown stressed that models are not important because they do not design a process to fit the project, but use 'process' as a guide on what they have done. He pointed out however that they do have a structure model by which they can understand, visualise, evaluate and implement product development process. The

process acts as a series of procedures and it was up to each group to apply it or not. Beyond this they attempt to build the project as it is.

In terms of product development process, Brown described that the most important tasks for all design companies are visualisation and creation of ideas using various kinds of techniques. The examples he gave of what they have achieved include 'scenario making', 'story boarding', 'improvisation' and 'making movies'. Another area was prototyping. This company is equipped with extensive prototyping facilities and are prototyping all the time it was indicated. Furthermore IDEO have very strong engineering groups with deep technical understanding. Therefore, the process does not stop at design but at the finished product. As well as this IDEO also have manufacturing groups who have sourced manufacture and managed manufacturing companies around the world.

g) *Role of the Industrial Designer*

Brown believes that industrial designers should be involved all the way through the product development process. However since the company has moved from being a multi disciplinary design company to a post-disciplinary company, it is very hard to specify their roles. He emphasised that the industrial designers role was similar to others, such as engineers and marketers.

h) *Clients and Collaborations*

IDEO is introduced to its clients through reputation and recommendation, Brown claimed. This is supported by the fact that they focus on particular industries and companies.

In terms of criteria their clients used when selecting this company, there was no common agreement. However, Brown believes that most of the companies selected IDEO because they were interested in the culture of innovation practised at the company.

As far as collaboration with outside bodies is concerned a lot of contact with universities in Europe, America and Asia through a teaching commitment is central to their corporate strategy.

i) *Concurrent Engineering and Other Similar Methods*

IDEO does practise concurrent engineering. According to Brown, company attitude and culture is built on the assumption that if they do not do it concurrently, then they were wasting their time. He added that traditional engineering processes were time consuming whilst concurrent engineering offered more interaction amongst staff..

j) *Quality*

IDEO do not have a formal quality system. They have adopted their own 'semi-formal' quality system which Brown indicated satisfied most of their clients.

k) *Computer Aided Design*

Industrial designers at IDEO use a variety of computer programmes in designing and developing new products. According to Brown, they use Unit Space Systems so that they can use Pro- Engineering and Solid Designer. They also use PC based systems, Mac based systems and some design servicing tools. Finite element analysis and mould flow analysis are some of the more sophisticated engineering tools they use.

In terms of stage, CAD is normally used from the beginning of the project. Essentially to visualise new product concepts. All of their documentation, both 2D or 3D, are made by computer, claims Brown. These tools are used for speed and quality.

l) *People*

IDEO does not have a formal way of getting people working for them. However, Brown indicated that they have the ability to develop talent through the company's own training programme.

Communication between staff, is made possible by all the normal tools such as e-mail, internet and video conferencing facilities. IDEO also hold a diary meeting every Monday morning to discuss the team, administration and other matters.

Staff surveys are conducted on the perceptions of staff on the organisation. In addition, IDEO conduct a review process in which every individual must participate by talking with their peers about goals and objectives.

m) *Design Teamwork*

Brown indicated that he has not encountered any problems arising from conflicts between different functions in his new product development team after the company moved from a multi-disciplinary to single a disciplinary teamwork style. He emphasised that, with just a disciplinary runner, staff were more conscious of the external goals of the project and less conscious of the internal goals of discipline.

To foster teamwork, the company has a culture of team, that is a culture of product to teamwork. This includes culture prototyping and willingness to take risks. These methods work well and have been very successful.

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Improving the Process of New Product Development in Malaysian Small and Medium Industry (SMI) Through an Investigation of the Role Played by the Industrial Designer

Introduction

The principal objective of this study is to assist Malaysian SMIs in improving their new product development process through the creation of design guidelines from an industrial design perspective. The focus of the study was new product development in Malaysian SMIs. The approach adopted in this study was to investigate the role of the industrial designer in the process in a selected number of Malaysian SMIs and to contrast them with theoretical knowledge and best practice in UK based companies. In this study, the data was collected through : 1) literature search and review, 2) questionnaire survey, and 3) case study.

Findings

New product development in Malaysian SMIs has been successfully undertaken through the utilisation of existing products and foreign technology. Most of the products produced by Malaysian SMIs go through *'instant processes'* known as *'localisation'*, *'modification'* and *'reverse engineering'* in order to be made suitable for local market conditions. Through this 'instant process', some products have been visually or materially improved in order to give more choice to customers. Another way of developing product is through *'copying'*, *'imitating'* or *'adopt and adapt'* techniques to suit local needs. This process is made by copying foreign products (especially those of Japan and Europe) via product catalogues, magazines or through visits to national and international trade exhibitions and shows. As a result, most of the products produced by SMIs have failed to meet customers requirements either because they are of very low quality or because they offer a limited choice of design. It is important to be aware that although these types of processes are claimed, by most SMIs, to be the best way of producing new products, this activity is unlikely to last into the future with other countries emerging in the ASEAN region. Thus, the Malaysian SMIs need to find possible ways of solving future problems by improving their new product development process in order to compete in the competitive national and international market.

Based on the above findings, further considerations should be added to the current product development process so that Malaysian SMIs might reform the traditional product development process that they currently employ. The following recommendations of elements of best practice are possible guidelines for Malaysian SMIs in the improvement of their product development process.

The research investigation now seeks to confirm the appropriateness of these recommendations by reference to Malaysian industry and government.

Recommendations

Recommendation 1 : SMIs Products and Brand Names

Research Findings

The results of this study have identified that Malaysian SMIs are still reliant on existing products and foreign technology to develop new (or OEM) products. These have been largely produced under licensing arrangements and have gone through a process of *'localisation'* and *'modification'* in order to make them suitable for local market conditions. As a result, most Malaysian SMIs have produced outdated and low quality products with a limited choice of design. The success of Malaysian SMIs will greatly depend on the SMIs capability to design and produce products that can compete in both the local and global markets.

Proposed Recommendation

It is therefore recommended that Malaysian product manufacturer SMIs produce their own products with their own design and brand name that aim to meet international standards. Malaysian government schemes and incentives now encourage SMIs to design and produce their own products to compete in international markets. It is thus now appropriate for Malaysian SMIs to make extra effort and commitment to create their own products

Please circle the appropriate number according to your degree of preference

	Low				High
Applicability	1	(2)	3	4	5
Ease of implementation	1	(2)	3	4	5
Expected benefits	1	2	(3)	4	5

Comments/Suggestions of Adoption of Recommendations (if any)

Problem of Malaysian SMI is to ~~penetr~~ compet by supporting anchor product that already long in the market (ex. ~~Proton~~ of anchor product: Proton, MEC & SMI just simply support the anchor company.

It is not to sell product but rather to sell brand first.

If we want to defy the above statement, a very big investment is required in R&D in order enjoy qui

Recommendation 2 : Model of Product Development Process

Research Findings

Models of the product development process are shown to be an effective and popular way of organising the product development in most successful companies. Without a model, it is impossible to identify where excessive time is consumed, or where more efficient planning and management could provide a more cost-effective and rapid response to the market and customer needs. The results show that Malaysian SMIs have not adopted any particular product development design process models.

Proposed Recommendation

Therefore, it is suggested that Malaysian SMIs should determine and adopt a specific model of the product development process for their company.

	Low				High
Applicability	1	2	3	(4)	5
Ease of implementation	1	2	3	(4)	5
Expected benefits	1	2	3	(4)	5

Comments/Suggestions of Adoption of Recommendations (if any)

Agreed, through my own observation. Malaysia not truly use the facility provided by government ex: Technology Park Malaysia (TPM) with their Pr. Rapid Prototyping computer system, but in contrary SIRIM with its ISO not truly comprehend its implementation of ISO 9001

Recommendation 3 : Concurrent Engineering

Research Findings

The findings confirmed that Malaysian SMIs have not implemented concurrent engineering but rather stick to the traditional *"throw it over the wall"* working practice. Research has shown that concurrent engineering improves the quality of early design decisions as well as having a positive impact on the life-cycle cost of the product.

Proposed Recommendation

In order to help departments in Malaysian SMIs work, in a more integrated manner, the adoption of concurrent engineering approaches is recommended.

	Low				High
Applicability	1	2	3	4	(5)
Ease of implementation	1	2	(3)	4	5
Expected benefits	1	2	3	(4)	5

Comments/Suggestions of Adoption of Recommendations (if any)

implementation required in adopting Engineering knowledge & know-How. Malaysia still lack of R&D.

Recommendation 4 : The Role of the Industrial Designers in NPD Process

Research Findings

Findings from the research confirmed that the role of industrial designers in Malaysian SMIs is mainly that of *'aesthetic specialists'*, *'visualisers'*, *'re-design for improvement'* and to *'give a uniqueness to the design'* in new product development process. Although these are part of the industrial designer's role, they are too narrow and only cover part of the product development process. Companies with the product development process in successful companies in the UK shows that industrial designers should be given a *'multi tasking role'* of activities not only related to design but also manufacturing and marketing. Industrial designers should not only deal with aesthetic ideas, shapes or colours, but also with technical and marketing aspects.

Proposed Recommendation

The role of the industrial designers should be redefined by Malaysian SMIs so that they can be effectively involved in the whole process.

	Low				High
Applicability	1	2	3	4	5
Ease of implementation	1	2	3	4	5
Expected benefits	1	2	3	4	5

Comments/Suggestions of Adoption of Recommendations (if any)

My understanding that industrial designer in Malaysia more dealing with the mfg. process (improving process time etc. However I believe aesthetic specialist should be understand more by Art & design team. I think engineering is more toward product feasibility but aesthetic is more toward Art & Design

Recommendation 5 : Design Awareness

Research Findings

The study has revealed that there is a lack of awareness of good design and the importance of design in daily life by Malaysian consumers. Research in the UK has revealed that a number of other parties are involved directly (and indirectly) in nurturing design and product development such as trade associations, higher educational institutions, R&D institutions and development agencies. These also play an important role in promoting design awareness to the public.

Proposed Recommendation

In order to elevate the level of design in Malaysia, it is necessary that design awareness be widely promoted by the Malaysian government through all types of media and not just through schools. For example, there is a need to propagate design and industrial design activities including design innovation, design trends, consumer lifestyle and other related activities. New organisations also need to be set up to develop design awareness.

	Low				High
Applicability	1	2	3	4	5
Ease of implementation	1	2	3	4	5
Expected benefits	1	2	3	4	5

Comments/Suggestions of Adoption of Recommendations (if any)

(except Chinese & Indians) Malaysia do have the MINDS (Malaysia Invention and Design Society) but not fully well known by invent & designers. Furthermore knowledge on patentship & trademark not fully practices by enforcer (Lawyers & MITI) Patentship normally violated by 3rd parties (Parties that have more money in improving the patent products ~~Furthermore~~ Patentship required invest. which not affordable by individual

Recommendation 6 : Design Consultants Services

Research Findings

There are a number of UK design consultants that have been helping their clients to assist developing new products and formulate appropriate product strategies. The results of this study show that most Malaysian companies have not employed the services of industrial design consultants to help them design new products.

Proposed Recommendation

Therefore, it is suggested that Malaysian SMIs send staff to countries where companies employ industrial design consultant services to help them design new products. It may be thus beneficial for Malaysian SMIs to come to the United Kingdom to see such work in situ and see the effectiveness of these services to their companies.

	Low				High
Applicability	1	2	3	4	5
Ease of implementation	1	2	3	4	5
Expected benefits	1	2	3	4	5

Comments/Suggestions of Adoption of Recommendations (if any)

Agreed, based on my understanding TPM do provide consultancy for the SMI, from formulating the design, till mold design & product prototype

Recommendation 7 : Consumer Requirements

Research Findings

This research identified that most products made by Malaysian companies do not suit market needs due to the lack of market research on consumer requirements. Most SMI products are not based on consumer requirements, but rather on *'aesthetic'* or *'price'* appeal.

Proposed Recommendation

Therefore, it is suggested that Malaysian SMIs focus more sharply on consumer requirements when introducing new products to the market and not merely on profits. Malaysian SMIs need to base production on consumer and market requirements rather than trying to sell what they can produce. In order to achieve this, SMIs should carry out adequate market research, develop products with a clearer market strategy and pay more attention to the customer. In addition, a *'Consumer Protection Body'* could be established to protect consumers by assessing products in the market in terms of consumer requirements.

	Low				High
Applicability	1	2	3	4	5
Ease of implementation	1	2	3	4	5
Expected benefits	1	2	3	4	5

Comments/Suggestions of Adoption of Recommendations (if any)

My understanding in the UK, MS SPA they do have special report/mag that do compare products & get feedback from consumer of what they want (similar to Consumer Protection body). Based on my observation, Malaysian are not so concern on this type of report.

Recommendation 8 : Design Education

Research Findings

The results of this study show that industrial designers in Malaysian SMIs are mostly skilled in creating new design concepts and lack knowledge of technical areas such as basic engineering, materials or processes. At present, in Malaysia, industrial design education concentrates on 'aesthetics' and art based knowledge rather than industrial reality.

Proposed Recommendation

Design education needs to focus more on the technical and engineering knowledge since much of industrial designers work is related to highly engineered product design work. In order to achieve this, design education should employ experts from a variety of backgrounds including electronics, production and marketing. In this way, a bridge between technology, marketing and design may be formed. Training courses for industrial designers and engineering designers in Malaysian SMIs are also recommended as part of this revision of design education.

	Low				High
Applicability	1	2	3	4	5
Ease of implementation	1	2	3	4	5
Expected benefits	1	2	3	4	5

Comments/Suggestions of Adoption of Recommendations (if any)

Normally the strong company do have their own R&D & technical science ex: Hitachi Air cond have its own technical/vocational school where supported by the Master & PhD holder from Hitachi's scholarship holders. Therefore all the expertise & experience will be return back to new scholars.

Recommendation 9 : Management Style

Research Findings

This study has shown that top managers (i.e. Chairman, CEO, Director, General Manager) have authority and power in most of the Malaysian companies. However, research shows that changing authoritarian styles to more flatter and less hierarchical ones that include flexible leadership enables middle management to function more effectively ensure best practice in managing the new product development process.

Proposed Recommendation

Thus a change in management style in Malaysian SMIs is urged to realize more efficient ways of working.

	Low				High
Applicability	1	2	3	4	5
Ease of implementation	1	2	3	4	5
Expected benefits	1	2	3	4	5

Comments/Suggestions of Adoption of Recommendations (if any)

Malaysia SMI management normally comes from holders MBA which too much concern on Profit & loss rather than understanding the importance of R&D investment, knowhow & all the engineering quality & knowledge.

ADOPTION OF RECOMMENDATIONS

1. Where recommendations apply to your organisation, how would you turn them into a *working strategy*?

For Japan company -- it is not applicable. Japan mother company emphasis more on its R&D, improving quality, increasing the know how knowledge. Malaysia just simply become their 'dumping country' in producing their R&D outcome (normally after certain years that product in their country so that they won't worry about copying & imitating by other co

2. If you were to adopt any of the recommendations, how would you expect to *finance* them (e.g. internal and external sources)

By right internally if its beneficial to the company (Business) that we work. But if we are thinking of having our own company, financial should be derived from external sources which assist new ideas to grow. My understand in overseas their have special fund or investors that willing to support new ideas from private inventors/designers (ex: Fairchild semicond in early 60's)

3. In order to implement the recommendations, would you envisage the need for *staff retraining* or the requirement for *new expertise*?

Staff retraining

4. If you were to adopt the recommendations, do you think it would influence the *'culture'* or *policy* of practice within the organisation?

Yes. Depends more by the top management vision & thinkings.

5. Do you think the *Malaysian government* has a role to play in encouraging or formulating any of the recommendations? In what way? (e.g. new initiatives, policy, funding etc.) / partnership

Very big role. Company institution should not simply comprises of MBA holders but also the Engineering & executives personal should be brought up to be the CEO, Chairman etc. Since they comprehend the importance of new technology.. not just simply 'adopt & adapt'.

6. Do you have any *other observations* about the relevance of the recommendations to your organisation's future development?

Not to my organisation's future development but more specifically I and team did submitted a paperwork to Malaysian Government (MIGA) to come-up with PV cooling company in 1997. We believe that by establishing the Anchor company, at the same time we can develop more Malaysian SMEs which at the end turned up to be a developed country. Unfortunately as (chronism & cronyism), the MED (Malaysian Entrepreneur Dept) stated

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"it's a matter of 'who you know' not what you know - "..technology

APPENDIX 12
MALAYSIAN PARTICIPANTS RECEPTIVITY TEST SAMPLE

1. BATA MARKETING SDN.BHD
2. BFS R&D (M) SDN BHD
3. CABLE-VISION TECHNOLOGIES (M) SDN BHD
4. CENZIN WOODS (M) SDN. BHD
5. CHOICEWOOD SDN. BHD.
6. GUTHRIE FURNITURE SDN.BHD
7. J.K.DIGITAL TECHNOLOGY (M) SDN BHD
8. PLASTICTECNIC (M) SDN BHD
9. RALCO PLASTIC SDN. BHD
10. THE MERRYFAIR CHAIR SYSTEM SDN. BHD
11. SAPURA RESEARCH SDN BHD
12. MALAYSIA DESIGN COUNCIL
13. SIRIM BERHAD
14. MATSUSHITA ELECTRIC CO. (M) BHD
15. HITACHI AIR CONDITIONING PRODUCTS (M) SDN. BHD
16. PROTON
17. ORCADESIGN CONSULTANTS SDN. BHD
18. RADIUSTECH SDN. BHD.
19. SULIK DESIGN CONSULTANTS
20. UNIVERSITI MALAYSIA SARAWAK (UNIMAS)
21. UNIVERSITI TEKNOLOGI MALAYSIA (UTM)
22. UNIVERSITI PUTRA MALAYSIA (UPM)
23. INSTITUT TEKNOLOGI MARA (ITM)
24. CONSUMERS' ASSOCIATION OF PENANG (CAP)
25. FEDERATION OF MALAYSIAN CONSUMER ASSOCIATIONS (FOMCA)
26. MALAYSIA INVENTION AND DESIGN SOCIETY (MINDS)