SSM and Technology Management: Developing Multimethodology through Practice

Adrian Small[1]
Newcastle University Business School
Newcastle University
Newcastle upon Tyne
United Kingdom
NE1 4SE
Tel: +44 (0)191 2081688
adrian.small@newcastle.ac.uk

David Wainwright
Department of Mathematics and Information Sciences
Northumbria University
Newcastle upon Tyne
United Kingdom
NE1 8ST
Tel: +44 (0)191 2437634
david.wainwright@northumbria.ac.uk

Abstract
Growing competition and economic recession is driving the need for more rapid redesign of operations enabled by innovative technologies. The acquisition, development and implementation of systems to manage customer complaints and control the quality assurance process is a critical area for engineering and manufacturing companies. Multimethodologies, and especially those that can bridge 'soft' and 'hard' OR practices, have been seen as a possible means to facilitate rapid problem structuring, the analysis of alternative process design and then the specification through to implementation of systems solutions. Despite the many 'hard' and 'soft' OR problem structuring and management methods available, there are relatively few detailed empirical research studies of how they can be combined and conducted in practice. This study examines how a multimethodology was developed, and used successfully, in an engineering company to address customer complaints/concerns, both strategically and operationally. The action research study examined and utilised emerging 'soft' OR theory to iteratively develop a new framework that encompasses problem structuring through to technology selection and adoption. This was based on combining Soft Systems Methodology (SSM) for problem exploration and structuring, learning theories and methods for problem diagnosis, and technology management for selecting between alternatives and implementing the solution. The results show that, through the use of action research and the development of a contextualised multimethodology, stakeholders within organisations can participate in the design of new systems and more rapidly adopt technology to address the operational problems of customer complaints in more systemic, innovative and informed ways.

Keywords: Problem Structuring; Multimethodologies; Soft Systems Methodology; Technology Management; Soft Operational Research; IT Management

1. Introduction

The theoretical legitimacy and operational practicality of combining 'soft' methods for problem structuring with 'hard' methods for information systems specification,

[1] Corresponding author

design and development, has always remained a challenge for the Operations Research (OR) and Information Systems (IS) communities (Mingers, 2011; Ackermann, 2012). The development and use of multimethodologies, considered a type of ‘soft’ Operations Research (OR) approach, is central to this debate. Theoretically, this often relates to the problem of jumping between ‘hard’ deterministic and ‘soft’ interpretivist paradigms. Many academics may consider these to be ontologically and epistemologically distinct or in direct philosophical contradiction. Practitioners are not so concerned with theory, but perceive and experience these problems far more pragmatically. This is where there is a need for a speedy and accurate problem diagnosis, the production of a requirements specification, and then the formulation of systems specifications as a design solution to the problem. Recent and current economic drivers and competitive environments provide a strong imperative for organisations to acquire greater competencies for rapid problem identification and resolutions often involving new information and communication technology (ICT) systems adoption and implementation. The end results are often a rapid solution of what might actually be the wrong, or an irrelevant problem, or a ‘technically well engineered’ system that does not meet the requirements of the current problem situation, or in fact meet vital stakeholders’ real needs.

This paper explores the development of a multimethodology (Mingers, 2000; 2001), describes its application in an Action Research (AR) project and examines how it works in practice. The project relates to a particular intervention undertaken as a series of four related collaborative research projects between a UK university and an engineering company that manufactures very technical, high quality and fail-safe apparatus. The problem context involved the design, development and adoption of a customer concerns and quality assurance system using collaborative groupware technology. This project was initially operational in nature but had significant strategic implications for the development of future strategies for knowledge management and also the development of the company culture as a learning organisation (Senge, 1990; Chin-Fu, 1996; Lee, et al., 2000; Small, et al., 2008). The research involved examining and explaining how problem structuring methods could be fully embraced and utilised in practice to develop a learning culture within a traditional ‘hard systems’ engineering company. The research question was therefore: *how can ‘soft’ OR methods be combined with more traditional ‘hard’ technology management methods, whilst developing a learning culture and ethos throughout the design and adoption process?* This was achieved by adopting an action research strategy. This in essence resulted in the development of a contextualised multimethodology.

Our paper responds to a call for further empirical research in the development and use of multimethodologies (Mingers & Brocklesby, 1997; Mingers, 2000; Lane & Oliva, 1998; Kotiadis & Mingers, 2006; Howick & Ackermann, 2011) and in particular their use in either series or parallel (Pollack, 2009). Our particular development of a multimethodology concerns the use of Soft Systems Methodology (SSM) (Checkland & Scholes, 1990; Checkland, 1991, 1995) combined with Technology Management (Venus, 1999; Phaal, et al., 2004a, b, c) as a new approach to developing a ‘soft’ learning based culture within a traditional ‘hard’ systems engineering company. This approach involves negotiating a paradigmatic shift that occurs between the problem appreciation, analysis and assessment phases, and the action phase of the intervention process as defined by Mingers (2001). This is where the conceptual analysis and design has to stop and the system has to be embedded into the real world practices of the organisation. This is what Mingers (2001) describes as a multi-paradigm multimethodology.

The first section of the paper examines the theoretical foundations concerning the rationale, development and use of multimethodologies (Mingers & Brocklesby, 1997) describing some of the main combinations that have been used to date. We review the literature and summarise the key learning to arise from recent studies focusing on multimethodology theory and its application in practice. The second section describes the problem context, background and action research methodology adopted and the third section then provides a case study of the problem situation and the AR intervention in the engineering company, BreathCo (not the organisations real name), that led to the developed framework. The fourth section discusses the outline framework that was initially based on Soft Systems Methodology (SSM) and adapted as a result of the AR process which identified the need to incorporate learning theory. This is what we term 'softening' and expanding SSM to provide more structure to learning about, and appreciation of, problem situations. It represents the first stage of constructing the multimethodology. Due to the context and nature of our own AR project with an engineering company the framework was then further enhanced in a second stage through the addition of methods utilised in technology management. This is what we term 'hardening' the multimethodology in order to deal with issues concerned with problem solution; in this case acquiring and implementing an information system. The fifth section draws on the lessons learnt. Finally, a discussion of how the developed framework fits, or compares against, the classification for a multimethodology that is multi-paradigmatic in nature, is presented. Conclusions for further theoretical and practical research then complete the study.

2. Multimethodology theory and practice

In the context of a problem situation where an effective solution is being sought, Mingers (2000; 2001) defines a multimethodology as employing more than one method or methodology and provides examples such as using Soft Systems Methodology (Checkland, 1991) to identify and gain agreement on desirable changes and then combining this with a 'hard method' such as systems dynamics or a simulation model to help implement them. Mingers and Rosenhead (2004 p543) in their review of problem structuring methods in action, add to this definition: *"In use, multimethodology is a creative process of design, based on competence in a range of methods. Each project or intervention is seen as a unique situation…for which a particular combination of methods, or parts of methods, needs to be constructed. This is an on-going process throughout the project, as events occur and the situation evolves".* It should be noted at this stage however that Mingers and Brocklesby (1997) are reluctant to use the term method as it is seen to be interchangeable and confusing with the term methodology. Howick and Ackermann (2011) clarify the use of this terminology to reiterate that method is often used interchangeably with the term technique and there is some academic disagreement over the precise use of the terms methodology, method and techniques. For the purposes of our paper we use the term methodology to include the term methods, whereupon a technique refers to 'how work is carried out' and both method and methodology refer to 'what types of activities are required and when'; whilst considerations as to 'why the methodology and techniques are being adopted' remains more of a philosophical discussion concerning issues of commensurability and fitness for purpose (Howick & Ackermann, 2011). Mingers (2001) states that one can use several whole methodologies to address different parts of problem situations where "*the most ambitious approach is to link together different parts from several methodologies, creating a design specific to the particular situation*" (Mingers, 2001 p289). Mingers (2001) also identifies three main arguments in favour of multimethodology. The first that real world problems situations are multi-dimensional and that there will be physical or material aspects, social and political aspects, as well as personal ones; secondly that an intervention is not usually a discrete event but proceeds through a number of phases that pose different tasks and problems for practitioners; and thirdly, that combining different methods can provide triangulation on situations generating new insights and providing possibilities for validating results.

If you adopt an individual paradigm you will only be able to have a limited view of that situation (Mingers, 2001). Mingers (2001) draws on the work of Habermas (1984) to explore the relationship into, as well as our interactions with, three worlds – as shown in Figure 1.

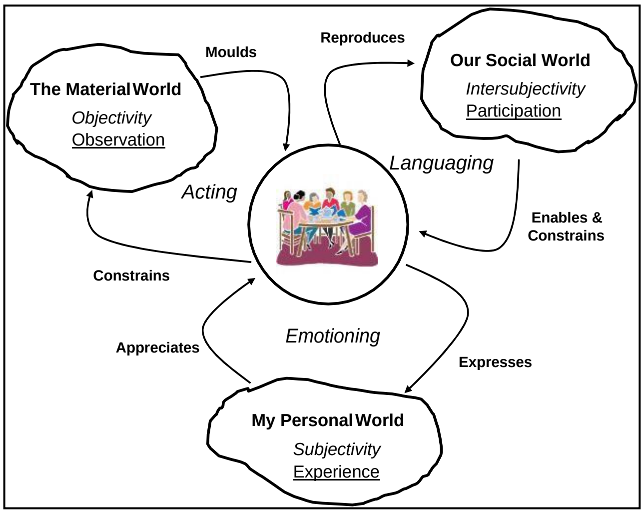

Figure 1
Habermas' Three Worlds
Interpreted by: Mingers (2001 P291)

It is proposed that through looking at the three worlds, comprising:

The Material World – independent of humans, observation is only possible;
The Personal World – can only be experienced by ourselves and consists of our thoughts, emotions, experiences;
The Social World – the world in which we interact within.

we can better observe and model real world situations that are perceived as problematical (Mingers, 2001).

As a consequence, if we are to intervene in a situation we need to be aware that they are made up of complex relationships between the three worlds. The argument for taking an informed contingency approach, selecting the best methods, tools and techniques relevant for different types, aspects and phases of problem situations is compelling both in theory and practice. However, many questions remain over the appropriate use of methods in different situations and their use by different stakeholders with varying degrees of competence, expertise, motivations and ethical practices. It is difficult in practice to achieve an appropriate balance between the subjective, social and material worlds, as seen in other research studies focused on applying the work of Habermas (1984) and Critical Social Theory (CST) in practice (Waring & Wainwright, 2002; Chiasson & Davidson, 2012). It is not the intention of this paper to focus on the CST debate, but more importantly to adopt the principle of taking a systemic view of a problem situation, incorporating elements of the 'three worlds', and then to identify a suitable combination of methods that provide both the ability to structure a problem and then provide a means to work towards an agreed solution. An overzealous or misappropriated use of multiparadigmatic methods may distort a solution towards any of these three worlds and could result in a real world technical solution that does not represent either subjective or social interests, or vice versa. The selection of methods in combination should not be a trivial or under researched activity. Research has been emerging that identifies the most common combinations of methods used for research and practice (Howick & Ackermann, 2011**)**. However, relatively few empirical studies exist of how multimethodologies are interpreted, developed and implemented in practice, but those that are published (Ormerod, 1998; Mingers & Rosenhead, 2004; Petkov, et al., 2008; Siddiqui & Tripathi, 2011; Rodriguez-Ulloal & Paucar-Caceres, 2005) are extremely informative, useful and highlight many of the issues and problems involved.

Howick and Ackermann (2011) undertook a systematic review of mixed methods research in practice. Their interpretive analysis of published action research, including case studies, identified a number of generic issues and raised several interesting research questions. They found that there were facilitator/modeller implications in terms of number of the participants involved and their collective repertoire of experience using different methods. SSM, often used as an over-arching framework, was the predominant methodology used, reiterating the importance of qualitative methods in mixed-method interventions. Forms and the nature of mixes within the interventions was important, but little rich empirical evidence was available on how to combine methods in practice with qualitative combinations being used for more strategic problem interventions. The nature, group size, types of mix, durations and forms of the interventions varied considerably with little consideration given to the impact on organisational culture. This was especially true when mixing methods and dealing with the practical problems of selling mixed methods to sponsoring clients. Value and benefits were problematic to identify and justify with little published examples of negative interventions. Finally, they found that the rationale for mixing methods was often under explored, not transparent, and that their use was often an evolutionary development within a project based on the need to overcome a real world problem. Howick and Ackermann (2011) conclude with a call for further more insightful and interpretive studies into how multimethodologies are used in practice to address the range of research questions they highlight.

In an attempt to provide more clarity on the application, use and lessons learnt arising from particular combinations of methods within a multimethodology, our own analysis, detailed in Appendix A, provides a condensed summary of relevant and recent research studies. A more systematic literature review or meta-analysis (Howick & Ackermann, 2011) of these studies, including our own will be an area for further research, but our focused literature review does highlight the range of issues related to the effective use of multimethodologies. Many of the combinations used can be seen to be context dependent and certainly vary in terms of the particular methods selected. A particular focus for our research intervention and problem structuring method was combining an accepted 'soft' OR methodology, SSM (Checkland, 1991), with what might be considered a 'hard' method for IT systems development and implementation termed technology management (Venus, 1999; Phaal, et al., 2001). This combination was underpinned with concepts taken from established learning theory (Bandura, 1977; Vygotsky, 1978; Bandura, 1986) and the learning organisation (Senge, 1990; Weick, 1995). Kotiadis and Mingers (2006) examined issues of paradigm incommensurability, cultural and cognitive difficulties by reference to both theory and a case study involving the use of SSM with discrete event simulation (soft and hard method combination). They concluded that the boundaries are blurred when we consider categorising methods, and it might be better to think in terms of a type of 'Yin and Yang' model combination where methods can be complementary to each other within a continuous interplay. Our developed theoretical framework demonstrates a similar interplay which is more closely examined and analysed in our research findings.

3. Problem Overview: Customer Concerns at BreathCo Ltd

This research is based on findings from a collaborative action research project between researchers from Tech University (TU) and BreathCo (not the organisations' real names). BreathCo are a medium sized engineering company and manufacturer of compressed air breathing apparatus and fire and gas detection products based in the UK. Initially, the team from TU were invited into the company to examine and research a problem related to a lack of strategic innovation within the organisation. The company suffered from a lack of success in utilising existing problem structuring and systems development methods to enable more rapid process and product innovations. The only method (recommended by their German parent company) utilised was a very technically and engineering orientated project management methodology, developed internally, called BEST. This was essentially a contextualised and shortened version of the PRINCE project management method. No problem structuring, information systems analysis, modelling, development or specification methods were utilised within the company; only traditional flowcharts, business cases and also brainstorming tools such as SWOT. The company, and in particular the CEO and the senior managers, were therefore highly receptive to learning about more innovative problem appreciation, analysis and systems development methods from the TU research team. The need for a new approach to enable more collaborative working within the company and the inculcation of a learning culture was very apparent. This was seen as a vital ingredient of the development of the new strategy to take the company forward supported by new information and knowledge based systems.

A first step to address this problem was the launch of a strategic planning workshop event facilitated by academics from TU. This was designed to launch the collaborative project and to provide the requisite legitimacy and formality for the research intervention. As an outcome of this workshop many strategic issues were identified and targeted for action, one being the urgent requirement to address customer complaints and serious quality concerns. The senior management team, led by the CEO, set up a cross sectional and multi-functional team comprising the Quality, Customer Services, Planning, Shipping, Technical Support, and the Repair Shop departments, to tackle this problem. This was seen as an area of strategic priority for the company and one where there was a perceived need for process innovation, knowledge management through learning, and the adoption of a new information system. It was envisaged that the project would allow customer complaints/concerns to be resolved quickly improving quality levels, customer service and customer/supplier relationships. The data that would be collected could be used to pinpoint the organisation's current weaknesses, and future improvement projects could be initiated to tackle and reduce these problems. The adoption and use of a combination of problem structuring and IT development/management methods was identified as an approach that would be useful in helping the project team structure and learn about the problem situation, as well as facilitate the management of any proposed technological solution in the form of the new IS application.

4. Research Strategy

The research strategy adopted for this work was action research as it attempts to solve practical problems, is participatory in nature, and aims to engender learning as well as contribute to knowledge (Westbrook, 1995; Baskerville & WoodHarper, 1996; Coughlan & Coghlan, 2002; Baskerville & Myers, 2004). In our case this involved developing and applying a multimethodology to a 'real world' problem based in a work place with a clear objective of documenting the learning from the outcomes. The action research cycle used to help plan, structure and enact the research followed the approach advocated by Susman and Evered (1978). Susman and Evered (1978 p588) propose their cycle to include: *Diagnosing: Identifying or defining a problem; Action Planning: Considering alternative courses of action for solving a problem; Action Taking: Selecting a course of action; Evaluating: Studying the consequences of an action; and Specifying Learning: Identifying general findings*. Baskerville and Wood-Harper (1996), in the context of information systems development, describe this as a good example of action research to follow. The research covered a period of 18 months. In that time, 41 sets of research data were collected including interviews with key informants and relevant stakeholders (30), training videos (11) and observations (a two year researcher diary). Interviews averaged 40 minutes each, were fully transcribed and analysed (using ATLAS.ti to perform thematic coding and conceptual modelling) with selected members of the project team. Transcription time varied between two to three hours per interview. The complete analysis of the data set took around eight months to complete.

The first two Action Research (AR) cycles (1 and 2) involved interviews that focused on problem appreciation to enable learning through the use of conceptual modelling. This was followed by workshops for requirements gathering to discuss and identify requirements and possible solutions to the customer concerns problems. The third cycle (AR cycle 3) again involved further interviews and workshops. These were designed to elicit views and perceptions of the methods adopted, the approach taken and the eventual solution implemented. These were more reflexive in nature and provided views and opinions on the development and use of the multimethodology itself. Details relating to interviewee roles/job functions can be seen in Table 1.

Interviewee	Month
Quality Manager (Project Leader) Int: 1 + 37	October 2003 and December 2004
Repair Co-ordinator Int: 2	October 2003
Shipping Supervisor Int: 3 + 32	October 2003 and January 2005
Receptionist Int: 4	October 2003
International Team Leader (Customer Services) Int: 5	October 2003
Product Planner Int: 6	October 2003
Customer Services Team Leader 1 (Instrument Specialist) Int: 7	October 2003
Repair Administrator Int: 8	October 2003
Product Performance Manager (Quality Department) Int: 9 + 25 + 38	October 2003, October 2004 and January 2005
Workshop Supervisor Int: 10	October 2003
Credit Control Accountant Int: 11	October 2003
Product Improvement Manager Int: 12	October 2003
Customer Services Manager Int: 13 + 39	October 2003 and January 2005
2nd Customer Services Team Leader Int: 26 + 40	October 2004 and January 2005
Research and Design Employee Int: 27	December 2004
Quality Managers PA Int: 28	December 2004
Service Co-ordinator Int: 29	December 2004
Service Co-ordinator 1 Int: 30	December 2004
Accountant Int: 31	December 2004
Gas Detection Supervisor Int: 33	December 2004
Customer Services Technical support Employee Int: 34	December 2004
Quality Employee Int: 35	December 2004
Purchasing Employee Int: 36	December 2004
IT manager Int: 41	December 2004

Table 1
Interviews Conducted by Month of Project

All participants were provided with an opportunity to verify and veto any information collected in the transcripts and project workshops. This data was combined with additional primary research materials including minutes of meetings, and numerous technology specification documents relevant to the project. Documentation from the project workshops included rich pictures, activity flow diagrams and other planning frameworks. Three action research cycles were completed, covering activities from problem definition and structuring, to systems specification, design, acquisition and training, Appendix B.

5. The Development of a Multimethodology – as a product of AR cycles

5.1 Applying SSM in Mode 2

Like many ‘Soft OR’ studies previously reported (e.g., Ormerod, 1996; Coyle & Alexander, 1997; Lane & Oliva, 1998; Ormerod, 1999; Brown, et al., 2006; Kotiadis & Mingers, 2006; Paucar-Caceres & Rodriguez-Ulloa, 2007; Kinloch, et al., 2009; Paucar-Caceres, 2009; Pollack, 2009; Siddiqui & Tripathi, 2011; Siriram, 2012), Soft Systems Methodology (SSM) was adopted to help explore the problem situation. It was originally intended to use SSM in Mode 1, following a more prescribed sequence of activities for problem structuring and identifying proposed solution alternatives. Checkland and Scholes (1999 p280) distinguish between using SSM in two subtle but important ways. Using SSM in mode 1, implies using SSM '*to do a study, or classically following the staged methodology for a problem intervention…i.e. mentally starting from SSM using it to structure what is to be done. This is in contrast to using SSM in mode 2, whereby it is acted out in the process of work and daily problem structuring, described as 'doing work using SSM…mentally starting from what is to be done and mapping it on to SSM, or making sense of it through SSM'*. Both are seen as ideal types, whereas in practice, most projects are somewhere on a spectrum between the two. This can focus on the intervention or perhaps more reflexively on the interaction. Checkland and Scholes (1999 p282) conceptualise this as a continuous 'flux' between both events and ideas explored in the problem situation and the learning or sense making about the experience itself. Our initial experiences, working with the teams in BreathCo, led us to quickly move to using SSM in Mode 2. The AR process was a journey of continuous problem structuring, modelling and discussion of alternatives using methods to hand that were easy for the stakeholders to assimilate. Hence, it was a case of working with the stakeholders to see what was to be done, and then adapting the elements of SSM to make sense of the situation. It was therefore embedded in the everyday work practice, and was not a discrete project event working through the methodology step by step.

5.2 The multimethodology and AR Framework

The project adopted SSM as an overarching framework to firstly help investigate the various issues associated with customer complaints. A guiding philosophy taken from learning organisation and social learning theories (e.g., Bandura, 1977; Argyris & Schön, 1978; Vygotsky, 1978; Bandura, 1986; Senge, 1990; Argyris & Schön, 1996) was applied to this particular problem situation. These theories were examined in order to apply a theoretical underpinning to this expanded SSM framework. Secondly, action was taken to improve the problem situation through the design and development of an information system – essentially applying 'harder' technology management methods. This essentially extended the SSM framework further. How these two sets of soft and hard OR methods fit together into this multimethodology is explored. The proposed multimethodology was designed to facilitate learning processes aiming:

- to investigate the problem situation,
- to improve the problem situation which relates to further enhancing learning activities and culture within the organisation.
- to design and develop an information system or
- to identify, procure, configure and implement a packaged information system

The process involved a heavy emphasis on using action research to define problems and potential solutions before moving into the second technology management process framework. The two frameworks, used together, provide the basis for a multimethodology that can encompass the design, implementation, and management of IS with an emphasis on learning – as smaller firms usually have limited resources and therefore cannot afford to implement an outcome that is unsuitable (Muscatello, et al., 2003). The complete framework used Soft Systems Methodology incorporating methods both for learning and the technology management processes. This multimethodology is therefore labelled as SSM^{XLTM} (Soft Systems Methodology eXpanded for Learning incorporating Technology Management). A detailed account of the three action research cycles as depicted by Susman and Evered (1978) (i.e., diagnosing, action planning, action taking, evaluating and specifying learning) is provided in Appendix B. It is important that the planned intervention is presented as a factual account of what happened within each cycle but it is also important that focus is placed on what worked in practice and what learning has come from this particular intervention. Appendix B, provides the factual account whilst the following sections discuss the development of the multimethodology, incorporate the lessons and challenges encountered, and finishes with a discussion.

6. Developing the Multimethodology

The next section describes the development of the multimethodology. The AR process was initially deductive exploring how SSM and learning theories could be utilised to solve a particular manufacturing problem related to quality control and problem reporting. This was then extended in subsequent AR cycles to explore how ‘harder’ Technology Management (TM) methods and concepts, which were readily accommodated within a traditional engineering and production culture, could be used to develop an information systems solution to the identified area of concern and resolve the organisational problems. An extensive account of these AR cycles, the research process and key research findings, can be found in Small (2007). The incorporation of TM involved a more inductive process and was developed iteratively in an evolutionary fashion over the latter stages of the project. This was a pragmatic approach to develop, prototype, project manage and implement the new Information System, in this case based on Lotus Notes technology.

6.1 Softening: Expanding SSM to incorporate Learning Theories and Methods (SSM^{XL})

It is argued that learning theories and methods can be used to inform the process of instilling a learning culture within organisations (Bandura, 1977; Vygotsky, 1978; Bandura, 1986; Lave & Wenger, 1991; Wenger, 1998). These theories take a perspective on learning as being a ‘social’ process (e.g., Ettlie, et al., 2005). Weick (1995) also believes ‘social’ issues are important in organisational sensemaking. It is argued (i.e., Argyris, 1999; Argyris & Schön, 1978) that organisations do not achieve learning; it is the individuals within the organisation who learn. Senge, et al., (1994) believe the learning organisation is an organisation that allows individuals to undertake change. Organisational learning theory and methods provides a softer and more direct focus on, and underpins, change management. Senge (1990) believes that to build a learning organisation, five disciplines need to be mastered. These disciplines include: personal mastery, mental models, shared vision, and team learning, with the fifth discipline being systems thinking. Our research proposed that, and examined how, SSM could be expanded and enhanced to take into account learning organisation disciplines, theories and methods.

SSM including its traditional methods and techniques such as rich pictures, CATWOE, root definitions and conceptual models, was used as an overarching framework and in our adaptation incorporated learning theory, methods, tools and techniques. It is labelled as SSM^{XL} (Soft Systems Methodology eXpanded for Learning). It is proposed that developing SSM^{XL}, to encompass the stages as they are displayed later in Table 2, provides a learning environment and theoretical framework that can draw on a number of 'Soft OR' tools to develop solutions to one problem, or a number of problems, contextual to our own action research project.

It is the tools and techniques adopted that allow participants to express, structure and model problem situations and enact the learning processes. As the varieties of multimethodologies that have been developed and used have shown, there is no rule in terms of which tools or techniques to use. Participants need to select the most appropriate tool or technique in terms of value and apply it at the most suitable time in order to structure the problem situation. These learning theories, tools and techniques can be used in isolation or can be joined together in different ways. Whilst learning organisation theory is incorporated into the SSM framework, it is also the dialogue, discourse, language and actions that a group of individuals create, through use of the approach, which are important. As Revans (1998 p14) articulates, "*there can be no action without learning, and no learning without action*." Utilising SSM^{XL} can provide the action to help generate learning outcomes.

Whilst learning theories and learning organisation thinking can enrich the problem identification, analysis and design phases using the developed SSM^{XL}, our own AR project still needed to identify, select, implement and manage a proposed technical artefact (IS) solution. This is a highly pragmatic exercise that often necessitates operating according to more technically orientated discourses and worldviews. This however, could be criticised for hardening a 'Soft OR' multimethodology and being paradigmatically incommensurable. These concerns are addressed later in the discussion.

6.2 Hardening: Combining SSM^{XL} with Technology Management

In the early stages of our action research project (BreathCo), the findings from the workshops and interviews indicated that there was no preferred systems selection or development method used presently within the company apart from a project management methodology, called BEST, that had been developed in-house by the German parent company. A number of alternatives were proposed and an accommodation was reached to use a Technology Management framework proposed by one of the members of the TU team. A key factor for this selection was that TM had a demonstrable track record of success with major industrial collaborative projects at Cambridge University, it was easily understood and documented, and it also suited the engineering ethos and culture of senior managers at BreathCo. Another reason was that one of the potential information systems (a collaborative groupware system using Lotus Notes) was an off-the-shelf configurable technology (with relatively little programming and coding required) and therefore more amenable to methods associated with strategic technology adoption and innovation. If more programming development was required then the decision might have been more geared to using more formal systems design and development methods such as DSDM, UML or Object modelling.

Technology Management (TM) was seen as both a problem structuring and management framework that was possible to be combined with SSM^{XL} to further develop the multimethodology. This offered the potential means of adding a more objective or deterministic dimension to the use of SSM in its latter stages – identifying, choosing and developing a preferred technological that was systemically desirable and culturally feasible. At this point the requirements for the project had to be effectively frozen in order for the system to be developed and implemented within a finite timescale using the allocated financial and human resources. Subjective and social constructionist principles had now to be accommodated and translated into a real world designed system that was based on a more objective reality. We considered TM to be a hard OR method according to the criteria as defined by Checkland and Holwell (2004) where: it is positivistic, functionalist, talks of 'systems and solutions', ontologically assumes the functional and data models to be part of the real world, assumes the system can be effectively engineered and finally, is orientated to goal seeking.

Phaal, Farrukh, and Probert (Phaal, et al., 2004b p2) describe the field of technology management as "*a multifunctional and multidisciplinary field, requiring inputs from both commercial and technical functions in the firm and a synthesis of academic perspectives, such as engineering, economics, business studies, social science and psychology*". The same authors continue by adding that as of yet there are not many practical methods for undertaking technology management, with only a few conceptual models supporting technology management (2004b).

Chanaron and Jolly (1999 pp.613 – 614) quote the task force on management of technology, which is supported by the National Research Council on the definition being, "*the management of technology links engineering, science and management disciplines to plan, develop and implement technological capabilities to shape and accomplish the strategic and operational objectives of the organisation*". Chanaron and Jolly (1999) perceive the justification of the management of technology is to connect the organisation's technology portfolio to its objectives and targets.

Based on the work of Gregory (1995), Phaal, Farrukh and Probert (2001) state the technology management process framework consists of five processes. These five processes can be seen as a simple model presented in Figure 2.

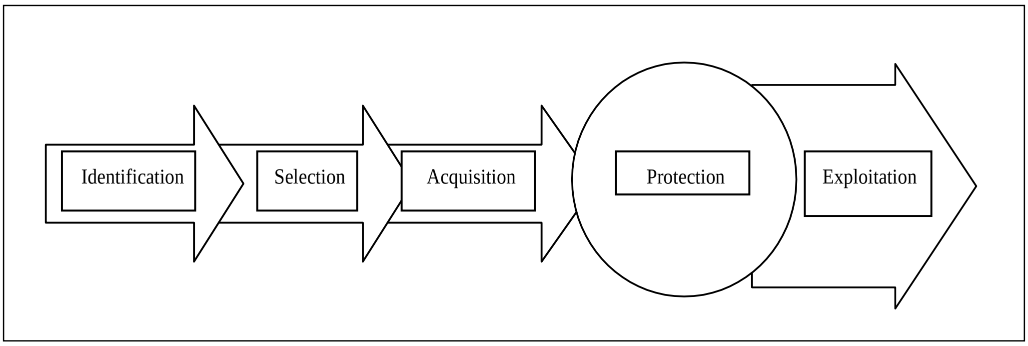

Figure 2

Technology Management Process Model

Source: Venus (1999 P14)

Figure 2 shows that the technology management process model consists of the identification, selection, acquisition, protection, and exploitation stages (ISAPE). These stages are listed by Phaal, Farrukh and Probert (2001 p117), and adapted from Gregory (1995) as:

- *Identification of technologies, which are (or may be) of importance to the business.*
- *Selection of technologies that should be supported by the organisation.*
- *Acquisition and assimilation of selected technologies.*
- *Exploitation of technologies to generate profit, or other benefits.*
- *Protection of knowledge and expertise embedded in products and manufacturing systems.*

It is argued, in fact similar to using SSM as an overarching framework that within each of the processes of ISAEP, 'Soft OR' tools and techniques could be incorporated into each phase as well as other models, if required. For example, rich pictures, flow charts or conceptual models, or the SSM^{XL} itself. Emphasis seems to be placed on the communication aspect, in terms of developing a common dialogue between stakeholders, of the framework. It is assumed that if the participants are using a specific format, within a specific process, as long as what is happening or seems to be happening can be communicated evenly, the format should be valid for that group of individuals. It is argued that communication becomes an important issue which management of technology programmes create through frameworks, language development and the effect such programmes have on performance (Zehner, 2000; Ortega, et al., 2012).

Technological management is not a mechanical methodology but a process to aid learning experiences that are flexible and can be adapted to the specific circumstance (Phaal, et al., 2004b) as well as each process benefiting from the feedback and learning that is achieved (Phaal, et al., 2004c). For example, a project team may generate or collect a variety of data and information to discuss how identification of suitable technologies can be undertaken. This may still not clarify how best a project team can identify the most suitable candidate technology and IS. Other tools, such as rich pictures, could be developed to explore this area. What is important is that whichever process is used, it can create a dialogue and build on the shared language already created. To accompany this, it is also hoped that the theories of the learning organisation can also contribute, in the form of methods, to enable participants to undertake single and double-loop learning. That is, with all stakeholders mental models being challenged along with the other learning organisation conditions that Senge (1990) argues for. It is due to the emphasis on the learning experiences generated, and the flexibility, as well as being able to start and stop anywhere, that this framework is perceived as suitable as the second phase of the multimethodology in developing a learning framework for IS planning, implementation and management.

Table 2 provides a detailed breakdown of each stage of the final developed multimethodology using SSM as the over-arching framework. The particular sequence and combination of methods evolved as a result of the learning assimilated over each of the three AR cycles.

Methodological Stage	Problem structuring or Solution Method	Perspective	Techniques	Tools
1. The problem situation: Unstructured	**SSM^{XL}**	May or may not be a problem. Adapting to change. Culture of organisation has to allow the perceived problem area to be explored. Basic dialogue around the problem area – no development of a shared language. Start of the co-operative inquiry process between all relevant stakeholders.	Facilitated workshops Round Table discussions Questionnaires Focus Groups	Structured observations Unstructured observations Field Notes
2. The problem situation: Expressed	**SSM^{XL}**	A need to adapt to the problem, hence environmental change may need to be planned for. Dialogue needs to be focussed upon the problem situation. Start of formal action process with all stakeholders.	Appreciative Inquiry Method (AIM) on the perceived problem (see West, 1995). Unstructured/semi-structured Interviews constructed around the outcomes of the AIM and SSM rich pictures. The drawing of a relevant boundary around the perceived problem area.	AIM Rich Pictures SWOT PEST Brain Storming CASE tools
3. Root definitions of relevant systems	**SSM^{XL}**	Use of a shared language developed to discuss the problem situation. Various solutions presented for discussion. The use of 'system' definitions. Allow all participants to construct systems definitions meaningful to them. Relevant system needs to be communicated that would satisfy the perceived problem.	The AIM findings and Rich Pictures could be drawn on to develop various definitions of relevant systems. Stakeholders develop system definitions and present them to other stakeholders – constructive criticisms and other debates are undertaken to refine system definitions. Hybrid definitions from numerous system definitions may form.	Root Definitions CATWOE Completed AIM Venn diagrams CASE tools
4. Conceptual Models	**SSM^{XL}**	Development of models. Systemic perspectives. More focus on the activities being designed. The use of various models to support learning.	Model development has to build on the output of the previous stage. Any modelling has to take a systems perspective from the view of the	SSM Conceptual Models Formal

			stakeholders involved in the problem situation. May or may not be formal SSM conceptual models.	System Viable Systems Model Flow Models IDEF0 Decision Tables Cognitive Mapping System Dynamics
5. Comparison of 4 with 2	**SSM^{XL}**	Important to focus upon what models were designed and how they compare to the expressed problem situation. The language developed around the perceived problem needs to be shared and used.	Compared the developed models and tools used throughout stages 2, 3 and 4. A validity check needs to be undertaken so the appropriate models relate to the problem satisfaction as perceived by the stakeholders.	A review of all tools used from stage 2.
6. Feasible, desirable changes	**SSM^{XL}**	Theoretical assumptions brought up in the model(s) provide appropriate insight. People have to 'language' together to understand the intervention. Intervention has to be justified to the individuals/organisation.	Draw out the theoretical assumptions that went into creating the models. Stakeholders need to understand and be able to justify any intervention. The identification of any further stakeholders (e.g., technology specialists, consultants) Co-opting further individuals to join the team to be able to continue to address the problem situation.	What-if analysis System Dynamics
7. Action to improve problem Situation	**SSM^{XL}**	Stakeholders need to reflect on the problem structuring process. Action comes out in 'languaging' together. Decision to implement technological solution(s) or not. If technology is to be used, a focus on selecting and acquiring a suitable technology needs to be undertaken.	Stakeholders agree to implement a project based on the models constructed at stage four and compared at stage five. Action to improve the problem situation is agreed – moving to stage 8.	Project Management
8. Identification		Technology identification is undertaken in a more unstructured ad-hoc basis.	Identify suitable technologies through accessing information both internally and	Pre-selection framework

	Technology Management (TM)	The purpose of the identification phase is to correct this problem and bring together a variety of data, as well as the appropriate stakeholders. The data can then be discussed. The purpose of this phase and the others, is to challenge participants' mental models whether a technology should be identified, and if so, how, as well as further develop personal mastery, creating a shared vision, and undertake team learning. Once all appropriate technologies have been identified the most suitable needs to be selected.	externally. Consider technology vendors, specialists or off the shelf solutions. Communicate this information to all stakeholders.	Technology / market scanning Information management SSM^{XL}
9. Selection	**Technology Management (TM)**	Selecting a technology requires decisions to be made by all stakeholders. In order to do this, all the implications a technology will bring have to be drawn out. Decision criteria processes can be used to help with this phase along with the advantages and limitations of selecting a particular technology. By making these issues explicit the team hopefully can 'dialogue' the problem more effectively, so the most suitable technology will be selected.	Develop procedures to help make decisions on the most suitable technologies from the identification stage. The decision procedures need to be made explicit and include all stakeholders. Comparisons could be made with competitors or other organisations that are developing similar technologies.	Benchmarking Decision criteria and process Monitoring / improvement SSM^{XL}
10. Acquisition	**Technology Management (TM)**	Once the most suitable technology has been selected, there are various channels a team can use to acquire the technology. Whichever way a team chooses to proceed, the IS needs to be formally managed so time and budget issues are upheld. This phase can be difficult, so a team need to know support is available especially when inserting the technology alongside the organisation's other technologies. An organisation's IT department (if applicable and available) should be involved in this phase. It is at this phase that a project team also have to consider training issues and how these can be constructed and undertaken. It is important that the 'human' element of technology development is not neglected.	Acquire the selected technology by means of developing the technology from within an organisation (e.g., by an organisation's dedicated IT department). Buying a technology from 'off the shelf', or contracting the work out to a specialist developer are a couple of examples of acquisition.	Licensing and joint ventures Project management Technology insertion SSM^{XL}
11. Exploitation		Exploiting a technology is seen as the best way participants of an organisation can gain advantages and solve the perceived problem. Exploiting a technology requires a project to not only use the	Help stakeholders exploit the acquired technology by making sure the technology is performing to the desired standard.	Incremental development Product management Complementary

	Technology Management (TM)	technology to receive the benefits envisioned, it can also relate to highlighting other problems an organisation may be encountering that are not yet formally realised. This can only be achieved if the technology is functioning correctly. This is why the exploitation and protection phases are related.	Constructing short, medium and long term plans to check the technology's suitability. Performing required updates. Maintain communication channels with stakeholders so issues can be resolved quickly.	assets SSM^{XL}
12. Protection and Evaluation	**Technology Management (TM)**	To help a project team exploit a technology more effectively, the technology needs to be protected. Protection issues can relate to minimising the chances of data being deleted or eroded, or competitors obtaining the data. To accompany issues such as data loss, strategies need to be available to keep the technology running and undertake updates when required. While it is easy to draw up a list of things to do, participants have to put these into practice. Communication is required with all stakeholders.	Protect and evaluate a technology through identifying if the technology can be exploited further. Consider the requirement of replacing the current technology. Locate appropriate resources (e.g., internal expertise, support contracts, regular maintenance) to keep the technology running, Backing up a technology's data requirement's (e.g., customer details, sales). Exploitation can also be related to further training issues. If participants are fully trained they could be able to exploit the technology further.	Establish strategy Monitor effectiveness

Table 2
The multimethodology framework developed with BreathCo

7. Lessons Learnt

We argue, by building on the work of Mingers (2001), that a multimethodology can help with the design and implementation of IS applications, particularly for the actors and stakeholders involved in designing, developing and implementing a customer concerns technology in an engineering/manufacturing organisation. It was demonstrated in this research how ‘‘Soft OR’’ principles embedded in a contextualised multimethodology can be used to help explore the problem of technology identification, selection and acquisition.

In practice things did not go in such a linear fashion as Table 2 and Appendix B depicts, even though the project team did pass through the phases of Table 2 and moved through the phases of the multimethodology framework. In reality, the methodology was developed and adapted similar to how Checkland and Scholes (1999) describe the use of SSM in Mode 2, where there is a continuous flux of ideas and events throughout the project. The four key stakeholders (Quality Manager, Product Performance Manager, Customer Services Manager and 2nd Customer Services Team Leader) were briefed on why SSM^{XL} was developed and how it could be applied to this project. Whilst these key individuals identified the purpose in designing such an approach, they were more interested in the tools that could be used in order to explore the problem situation and take action – as they were seen as compatible with the current project management tools the organisation had adopted as part of its project management approach. Therefore, there was a strong symmetry which was viewed as positive. The project leaders however preferred not to communicate the SSM^{XL} approach to other members of the project team as they did not deem the time spent explaining this as useful. As a consequence, it was difficult to make SSM^{XL} fully explicit to all members of the project team. From the follow up interviews with the key stakeholders, it was identified that due to the culture of the company, the quality department was expected to lead the project, so other participants would not really be interested in any approaches as they would look for leadership from the Quality team leaders.

“*In any organisation, well certainly in any manufacturing organisation Quality is always perceived as being responsible for things that go wrong. And in [BreathCo] the Quality Department is responsible for dealing with customer and product issues. So that’s reinforced that perception but in this organisation the culture that it’s a quality issue, it’s a problem, it’s a Quality Department issue. Quality issue, Quality Department, that’s a cultural thing*” (Quality Manager, Interview 37).

If the project leaders were happy using SSM^{XL} then the other team members were happy as pointed out by the 2nd Customer Services Team Leader.

“*I think you always associate quality with continuous improvement, any continuous improvement, you know, we feel if it should be led by the quality team …so you just naturally feel that any improvement project should come as a Quality issue*” (2nd Customer Services Team Leader, Interview 40).

The project leaders looked to draw on the most appropriate methods to help move the project forward. For example, in the action taking stage of cycle 1, it was designed to move straight into using the Venn diagrams associated with the Appreciative Inquiry

Method (AIM), (see West, 1995), to help express the problem situation. A project meeting in early August 2003 however, had started to define a complaint through a brainstorming exercise. This caused a few challenges, as whilst the exercise attempted to clarify what a complaint meant to the team, confusion still remained in defining a complaint. The main problem seemed to be centred on purely finding a solution to the problem and not defining or exploring customer complaints. This required a step backwards. The team wanted to use modelling approaches they were more familiar with initially to try and explore the area of customer concerns further. The project team were traversing from phases 2 and 6. As a consequence, an early focus was placed on a technological solution to the problem. The project team created a 'wish list' or weighting scheme around the problem situation as a first attempt at systems modelling (phases 3 and 4). Some of the key features identified within the weighting scheme included: reporting functions, analysis tools, search by customer name, automatic e-mail response, calendar, ability to attach documents, remote access. Whilst no formal ranking approach was used in the end by the project team, the 'wish list' could also be argued to take the form of a decision table (cf. Stowell and West, 1994). The tools, drawn from SSM^{XL} to further collect the data to help move from phase 2 to phase 3, were the Venn diagrams used within the Appreciative Inquiry Method, semi-structured interviews to elicit project team members' perspectives, and the development of rich pictures. These were all led by the research team.

The outcome from using the Appreciative Inquiry Method and Venn diagrams provided an insight into the themes that needed to be further explored, and also provided areas for further exploration for each individual (this was the start of action research cycle two). The research team helped with this process by interviewing team members (interviews 1-13) around the themes of managing complaints, each individual's perspective of a perfect solution to customer complaints, and finally any other issues that came from the Venn diagrams that were deemed important to explore. This approach, and the other models that were constructed, were then compared to see how a solution would need to be designed to capture complaints. Whilst the models may not comprise a formal systems model (i.e., a conceptual model), it is argued that the models did take a systems perspective, due to the constructing of models based on how best a solution would tackle the problem and not just on technical issues, or what is believed to be required. To accompany these models, a complaint category matrix list was modelled. The code matrix was designed to be expanded where applicable to take account of any issues that individuals of the organisation may encounter in the future.

A small workshop was set up by the research team to explain and develop some early root definitions and conceptual models. Whilst the team found some value in the approach, participants found the approach confusing and believed more meaningful 'systems' could be modelled by drawing on their own expertise and experience and the earlier work undertaken. As a consequence, system definitions and modelling was decided to be carried out in each individual's spare time as opposed to continuing the process through workshop activities. Meetings were used to communicate the relevant activities individuals had undertaken and to discuss how the work should be refined. Modelling therefore, took what could be described as a prototyping approach. This is considered as where an individual would construct a framework or model, the work was debated by the project team, and was refined until a final model or framework emerged. This framework or model has to satisfy what was uncovered at stage 2 through the document and the other thinking that was brought out. As no formal CATWOE's were developed by the project team (see Checkland, 1993; Checkland and Scholes, 1990), the research team constructed each individuals' CATWOE perspective from the interviews (interviews undertaken and the AIM Venn diagram worksheets) in an attempt to promote further discussion and debate around relevant systems.

To accompany the work undertaken by the team, it was suggested by the research team that 'system' definitions could also be conducted. These definitions were designed to be further root definitions but with the language of SSM removed (cf. Lewis, 1994; Vidgen 1997). For example, this was demonstrated by drawing on the interviews conducted with the participants, to construct different participants root definitions. From the interviews three root definitions were constructed, or as was stated, 'system definitions'. These included:

"A BreathCo owned and operated system to capture external customer complaints in a cost effective manner, which can be used to make BreathCo more effective."

"A BreathCo owned and department operated system to capture external customer complaints in a cost effective manner which can be used to make BreathCo more effective."

"A senior management owned and BreathCo operated system to solve unsatisfied external customers problems by satisfying them by whatever means necessary."

When the root definitions were presented to the project team, they were able to see the value in the approach but it was observed by the research team that they would not have been able to have used the same approaches as the AIM Venn diagrams and the root definitions due to their unfamiliarity. These approaches did however provide a further useful input into the project. It is considered that due to the participants using their own tools and techniques, and adding them to a framework such as SSM[XL], with some help from the research team in the early phases, the learning that was achieved was more focused. It can be argued that more emphasis has been placed on generating learning, in comparison to working around a formal methodology. As all project team members agreed with the models as being suitable for this particular problem, it was now up to the team to try to make changes. The first step in this process was to identify and select a partner organisation to undertake the 'hard' development of the technology, now it was deemed as a requirement of the solution.

On interviewing the key stakeholders about the suitability of the tools adopted, and using SSM[XL] as a way to help with the project, it was identified that it was important that the tools and modelling approaches used were familiar to project participants and similar to those already used in the organisation, as indicated by the following comments:

"*No I think it was because there was greater focus on it [the models produced] and there was an easier end result. You could forecast the end result because you're not relying or relating to design engineers, suppliers, tools manufactured, etcetera. It was quicker, it was more concise and therefore better from our point of view*" (Product Performance Manager, Interview 38).

"*It's, [the customer concerns project] probably one of the better ones now that the whole things been completed. I mean, you were [the researchers]involved in meetings in the first place where we were just going round and round in circles and we just weren't getting any further forward*" (Customer Services Manager, Interview 39).

The project team responsible for tackling the problem of 'customer concerns' were able to explore the issue of complaints and concerns, produce feasible and desirable outcomes from the model and take this 'softer' perspective forward in order to identify what action would be needed to improve the problem situation. Through using the first part of the multimethodology, the project team were able to identify that an IS solution was required and identify what aspects the IS needed to fulfil. How the project proceeded with this was a key aspect of action research cycle two as the last phase of SSM^{XL} had been reached. It was at this point that the research team reflected on how and what frameworks could be used to help the project team complete the project. The area of technology management was identified as potentially useful due to the identification of an IS solution to the problem. The technology management framework was then joined with SSM^{XL} to further develop the multimethodology. It then needed to be seen how this would help the project team. This part of the project seemed to run more linearly through phases 8-12.

The project team obtained assistance from the organisation's computer department to identify information technology (IT) developers (*identification*) who were able to take the systems models and other outcomes of the SSM^{XL} framework to develop prototypes. Using these prototypes the team were able to visualise the proposed system and look at other issues such as features and cost. This allowed the team to select (*selection*) the best solution to the problem. Through working with the chosen IT developer on a number of prototyping revisions (on and off-site), it was possible to introduce the technology into the organisation (*acquisition*). A training programme was developed to train the other employees of the organisation on the benefits, and features, as well as how to use the technology, which would allow the benefits (*exploitation*) to be achieved (action research cycle three). The project team developed processes and procedures to enable the data the technology was collecting to be analysed. This output would allow further problem exploration to improve all parts of the organisation so that corrective actions could be implemented, or it would enable redesigning how work could be undertaken to make the organisation more effective (*protection and evaluation*). The final aspect of the research was to evaluate how the multimethodology worked in practice. Questions focused around the process that was followed in comparison to other projects the company has undertaken and the usefulness of the problem structuring methods and techniques adopted. These issues were taken up with the project leaders through follow up interviews at the end of the project (see Table 1).

"*It was enjoyable [the customer concerns project using the problem structuring methods]. I think what's nice was having yourself involved with it, it was a bit different from what we've normally had in the past…*" (2nd Customer Services Team Leader, Interview 40).

"*It definitely was. I mean I used this for explaining it to my people and it was very easy to explain as well [the output of the models and techniques adopted]. I mean the* *visuals on it were great and I wouldn't have been able to do anything like. I mean from a time point of view no one in the company had the time so that was like something great. But just from the actual input and the wording of it as well*" (Customer Services Manager, Interview 39).

"*I think this was pretty slick actually [the approach adopted to help focus and structure the project], because I'm project leader [laughter]. No, as I say there was we didn't follow any set guidelines [as* SSM^{XL} *was being used]*" (Quality Manager, Interview 37).

The quotations imply that this project adopted tools and techniques not fully familiar within the company. Through undertaking the project in this way the project leaders found value in the approaches and felt the project was a success and delivered something of value to the organisation. As the research team completed the third action research cycle and exited the company, regular meetings were planned to review how the technology was performing (*protection*) and review how the outputs could be linked to the organisations yearly business plan. This particular project was deemed a success upon completion. It was only by using the multimethodology that these phases were controlled and managed more effectively.

Table 2 demonstrates the joining of the SSM^{XL} with the ISAEP processes of technology management to create the proposed learning multimethodology. It is argued that by joining the two frameworks, a project team does not have to use the multimethodology as sequential framework (as the case study demonstrated), or use the tools and techniques highlighted. Table 2 is an 'ideal type' that has been drawn out of the action research project looking at the issue of customer complaints/concerns within BreathCo. The joining of hard and soft methods uses the problem structuring methods undertaken between phases 1 – 7 as a filter to allow appropriate technologies to be identified (see Phaal, et al., 2004c). From this filtration approach, the first part of the learning multimethodology (SSM^{XL}) has allowed a problem situation that was unstructured to be more formally structured while not viewing issues specifically related to IS. With this approach, more emphasis can be placed on tools, techniques and models that will allow purposeful action to be taken and not on technologies themselves. Starting the multimethodology from phase 8 suggests that technologies can easily be identified (in many cases at BreathCo in the past, technology selection had been far too premature and not based on a thorough analysis). It is argued therefore, that the first part of the multimethodology (phases 1 – 7) achieves the benefits that SSM espouses with the second part of the multimethodology designed to help undertake action and implement a culturally feasible and systemically desirable solution. The lessons learnt from this case are highlighted in Table 3. It is hoped these lessons can be added to Appendix A.

Problem Structuring Methods	**Application**	**Lessons Learnt**
SSM^{XL} **and** Technology Management (SSM^{XLTM})	A manufacturing company wanting to solve customer complaints/concerns.	It was found that by joining the two frameworks to create the multimethodology a project team does not have to use it as a sequential framework, or prescriptively use the tools and techniques. The joining of soft and hard methods utilises the problem structuring methods undertaken between

		phases 1 – 7 as a filter to allow appropriate technologies to be identified. More emphasis can be placed on tools, techniques and models that will allow purposeful action to be taken and not on technologies themselves. This framework may be used as a means of developing an informed learning based approach to problem structuring and IS adoption in organisations where there is a dominant engineering or scientific culture and bias.

Table 3
Lessons Learnt from using Soft Systems Methodology eXpanded for Learning incorporating Technology Management (SSM^{XLTM})

8. Discussion

Returning to the original argument concerning the development and use of multimethodologies, Mingers' (2001) argues that combining methods together can allow a practitioner to deal with the different phases as well as different aspects of any intervention. A complex problem situation was demonstrated through the AR project at BreathCo. The problem, initially in this intervention, became as Mingers (2001) so eloquently puts it – with the number of methodologies and methods available, how can you choose which ones to adopt? In our case, an examination of stakeholders' views resulted in the development of a solution orientated to developing a learning and knowledge based culture within the company. It was natural therefore, to adopt and adapt methods from learning organisation theory and combine them with methods from technology management. The culture within BreathCo, an engineering and manufacturing company, was open to this intervention approach and all stakeholders were enthusiastic to embark on a co-operative inquiry using an action research approach. Participants were willing to experiment with different methods and techniques such as appreciative inquiry and development of personal mastery and mental models, alongside the traditional SSM methods such as rich pictures and root definitions. Methods from technology management then complemented this at the appropriate stage of the project as it allowed an approach to bring forward the ideas into the organisation as a physical form.

Mingers (2001, p294) emphasises that from a multimethodology perspective it is the relationships between: *The Intervention System (people engaged in the problem content system); The Problem Content System (the perceived problem); and The Intellectual Resources System (methods that can be used)* that will be exclusive to the intervention and as a consequence will help with the selection of appropriate methodologies. This was also demonstrated through the BreathCo case. The SSM^{XL} framework, developed as part of the intellectual resource system (AR project) by the researchers, was brought to the problem content system as the customer concerns/complaints project was identified. Through a participatory action research approach the framework was used in conjunction with the project team and other stakeholders within the intervention system. As the appropriate tools were selected and iteratively applied within particular areas of the framework, the project team were able to tackle the 'wicked problem' (e.g., Rittel & Webber, 1973) of how they should address customer complaints and concerns.

On attempting to take action to improve the problem situation a move took place back into the intellectual resources system to identify a second framework to help design and implement the desired technology. This framework was then applied to the problem content system with the participants in the intervention system. It was only by using a multiparadigm multimethodology, with methods that were sympathetic to the culture of the organisation and the individuals concerned, that the project team were able to philosophically move between the three 'systems' and incorporate a balance of perspectives required in a hard engineering company, recognising the 'three worlds' (subjective, social and material) as described in Figure 1.

Crossing the divide between problem identification, selecting between possible solution alternatives, and then implementation of solutions has always been difficult where the solution may be an expensive 'fixed' technology such as an IS application. Due to the use of the multimethodology this was not the case at BreathCo with this particular project. Champion and Stowell (2000) refer to interpretivist information systems design as a process where models developed intended to help implement an Information Systems (IS) solution have to be clear, as well as be understood by all participants involved (i.e., IS specialists as well as individuals that make up a department). It is this process of inquiry and systems modelling that make up what is described as a '*unifying layer*', or a bridge for focusing upon the more structured IS design and development methods (Champion & Stowell, 2000 p279).

Our multimethodology allowed this to happen by combining the two frameworks selected. If an alternative classic systems development methodology for IS development was selected (e.g., Multiview (Avison & Wood-Harper, 1990; Avison & Wood-Harper, 1995;Vidgen, 1997), or SSADM), the tools and stages would have been more structured and pre-configured. Whilst we are not arguing that these approaches are not useful – we do argue that they are not the same as a flexible multimethodology that allows a project team to have more control over particular methods available to use at each stage. The technology management framework was focused around the processes of identification, selection, acquisition, exploitation and protection of the new Lotus Notes system as opposed to prescribing how the project team would achieve this. By forcing a project team to adopt particular methods it may end up philosophically 'trapping' a team in the 'intellectual resources system' context of an intervention model. Upon entering the second part of the multimethodology (phases 8 – 12); the ISAEP processes may still present problems when trying to move through it within the problem context system. It is proposed within this multimethodology that the first 7 stages of the SSM learning framework can be used once again, perhaps in parallel and adopting a Mode 2 style of intervention, to help resolve these issues. This shows the recursiveness and flexibility of the multimethodology by allowing the techniques and methods to be used in series or parallel (e.g., Pollack, 2009). By undertaking the processes in this non-prescriptive light allows the philosophy of the learning framework to focus on the softer issues as well as take the appropriate action that each stage requires.

In entering phase 8, a logical order for technology management is presented from identification through to protection and evaluation. Even though these processes are shown to move from one to the other a team could start at any stage and move backwards and forwards with stages being re-visited if required. This is the underlying ethos for the multimethodology. This would allow a perspective of why the technology or IS was selected and may re-open a debate that can help clarify the selection issues and determine more appropriate strategies to acquire the IS more effectively, e.g., prototyping or identify a packaged IS that is easier to acquire but would still meet the requirements that would improve the problem situation. The aim of each stage is communicating key issues and learning through using suitable tools and methods. Therefore, techniques a team find useful (e.g., brainstorming, rich pictures, conceptual models, flow charts) can be used to further develop the language of the community.

Phaal, Farrukh and Probert (2004c) provide caveats however and warn that identifying a technology requires filtration techniques so only suitable technologies can be selected. If no filter is used it may provoke ‘flashes of commercial insight’, that Lubbe and Remenyi (1999) identified within IT investment processes for organisations, that are unsuitable. Lubbe and Remenyi (1999) identified most selection processes commonly involved ‘flashes of commercial insight’ (e.g., selecting the latest technology because a competitor had done so, or due to technology vendor pressure/sales expertise). This approach resulted in limited learning opportunities arising from the technology selection process and potentially the choice of the wrong technology. This is why it is argued that the multimethodology was able to be used to plan and implement an IS, such as in the BreathCo case, as a client led approach to provide this technology/solution filter in the types of IS that could be identified when phase 7 of SSM is reached. Phase 7 could be identified as the start of a strategic information systems planning process (cf. Lubbe & Remenyi, 1999), which also produces learning opportunities for all participants of a team.

9. Conclusions

This paper has contributed to a new and important body of knowledge that investigates multimethodology theory and practice. Whilst key literature and emerging theories are presented on designing and philosophically justifying multimethodologies, this paper also provides an account of how to design and use a multimethodology in action by combining SSM, learning theory and technology management methods. By drawing out, and building on, the current lessons that other researchers have identified through using multimethodologies in practice, SSM was identified as a flexible and adaptable over-arching framework. By combining a softer learning orientated and problem structuring adaptation of SSM (SSM^{XL}) with the technology management framework, a multiparadigmatic multimethodology (SSM^{XLTM} (Soft Systems Methodology eXpanded for Learning incorporating Technology Management)) was developed and applied to an engineering company who needed a rapid solution in the form of a customer complaints/concerns management IS system. The successful adoption of both the SSM^{XLTM} and a new set of learning processes and culture within the organisation was attributable to the multimethodology accommodating both hard and soft problem structuring and engineering perspectives. The use of SSM alone was not seen as sufficient or credible in engineering terms due to the dominant culture within the company. By combining a hard technology management approach SSM was then seen as a useful complement for problem definition and a means to engender discussion and participation. This was reinforced by the use of methods adapted from learning theory. ‘Talk and then action’ were then seen as mutually reinforcing towards the adoption of a successful technology and business process reengineered solution.

It is proposed that this framework may be used as a means of developing an informed learning based approach to problem structuring and IS adoption in organisations where there is a dominant engineering or scientific culture and bias. Future work will involve action research studies to use the SSM^XLTM multimethodology in similar types of organisations to further refine the methods used (selection, effective usage and sequence), examine the sociotechnical issues in more detail and provide a new means for rapid selection and adoption of Information Systems.

References

Ackermann, F. (2012). Problem Structuring Methods 'in the Dock': Arguing the Case for Soft OR. *European Journal of Operational Research, 219*, 652-658.

Argyris, C. (1999). *On Organizational Learning* (2nd ed.). Oxford: Blackwell Business.

Argyris, C., & Schön, D. A. (1978). *Organizational Learning: A Theory of Action Perspective*. Reading, Mass.: Addison-Wesley Pub. Co.

Argyris, C., & Schön, D. A. (1996). *Organizational Learning II: Theory, Method, and Practice*. Reading, Mass.: Addison-Wesley Pub. Co.

Avison, D., & Wood-Harper, T. (1995). Chapter Five Experience of Using Multiview: Some Reflections. In F. Stowell (Ed.), *Information Systems Provision The Contribution of Soft Systems Methodology* (pp. 102 – 117). London: McGraw-Hill.

Avison, D. E., & Wood-Harper, A. T. (1990). *Multiview an Exploration in Information Systems Development*. Oxford: Blackwell Scientific Publications.

Bandura, A. (1977). *Social Learning Theory*. New York: General Learning Press.

Bandura, A. (1986). *Social Foundations of Thought & Action a Social Cognitive Theory*. New Jersey: Prentice-Hall.

Baskerville, R., & Myers, M. D. (2004). Special Issue on Action Research in Information Systems: Making is Research Relevant to Practice - Foreword. *MIS Quarterly, 28*, 329-335.

Baskerville, R. L., & WoodHarper, A. T. (1996). A Critical Perspective on Action Research as a Method for Information Systems Research. *Journal of Information Technology, 11*, 235-246.

Boyd, A., Geerling, T., Gregory, W. J., Kagan, C., Midgley, G., Murray, P., & Walsh, M. P. (2007). Systemic Evaluation: A Participative, Multi-Method Approach. *Journal of the Operational Research Society, 58*, 1306-1320.

Brown, J., Cooper, C., & Pidd, M. (2006). A Taxing Problem: The Complementary use of Hard and Soft OR in the Public Sector. *European Journal of Operational Research, 172*, 666-679.

Champion, D., & Stowell, F. (2000). Chapter Thirty-One Interpretivist Discovery for Information Systems Design. In *5th Annual UKAIS Conference* (pp. 276 – 282). Cardiff.

Chanaron, J. J., & Jolly, D. (1999). Technological Management: Expanding the Perspective of Management of Technology. *Management Decision, 37*, 613-620.

Checkland, P. (1991). From Framework through Experience to Learning: The Essential Nature of Action Research. In H. E. Nissen, H. K. Klein & R. Hirschheim (Eds.), *Information Systems Research: Contemporary Approaches and Emergent Traditions* (pp. 397-403). Amsterdam: Elsevier Science Publishers.

Checkland, P. (1995). Chapter One Soft Systems Methodology and its Relevance to the Development of Information Systems. In F. Stowell (Ed.), *Information Systems Provision the Contribution of Soft Systems Methodology* (pp. 1-17). London: McGraw-Hill,.

Checkland, P., & Holwell, S. (2004). Chapter Three 'Classic OR' and 'Soft OR' - An Asymmetric Complementarity. In M. Pidd (Ed.), *Systems Modelling: Theory and Practice* (pp. 45-60). Chichester: John Wiley & Sons Ltd.

Checkland, P., & Scholes, J. (1990). *Soft Systems Methodology in Action*. Chichester: John Wiley & Sons.

Checkland, P., & Scholes, J. (1999). *Soft Systems Methodology: A 30-year Retrospective*. Chichester: Wiley.
Chiasson, M., & Davidson, E. (2012). Reconsidering Deconstruction in Information Systems Research. *European Journal of Information Systems, 21*, 192-206.
Chin-Fu, H. (1996). Information Technology Implementation Strategies for Manufacturing Organizations: A Strategic Alignment Approach. *International Journal of Operations & Production Management, 16*, 77-100.
Coughlan, P., & Coghlan, D. (2002). Action Research for Operations Management. *International Journal of Operations & Production Management, 22*, 220-240.
Coyle, R. G., & Alexander, M. D. W. (1997). Two Approaches to Qualitative Modelling of a Nation's Drugs Trade. *System Dynamics Review, 13*, 205-222.
Ettlie, J. E., Perotti, V. J., Joseph, D. A., & Cotteleer, M. J. (2005). Strategic Predictors of Successful Enterprise System Deployment. *International Journal of Operations & Production Management, 25*, 953-972.
Gregory, M. J. (1995). Technology Management - A Process Approach. *Proceedings of the Institution of Mechanical Engineers, 209*, 347-356.
Habermas, J. (1984). *The Theory of Communicative Action*. London: Heinemann.
Howick, S., & Ackermann, F. (2011). Mixing OR methods in practice: Past, present and Future Directions. *European Journal of Operational Research, 215*, 503-511.
Kinloch, P., Francis, H., Francis, M., & Taylor, M. (2009). Supporting Crime Detection and Operational Planning with Soft Systems Methodology and Viable Systems Model. *Systems Research and Behavioral Science, 26*, 3-14.
Kotiadis, K., & Mingers, J. (2006). Combining PSMs with Hard OR Methods: The Philosophical and Practical Challenges. *Journal of the Operational Research Society, 57*, 856-867.
Lane, D. C., & Oliva, R. (1998). The Greater Whole: Towards a Synthesis of System Dynamics and Soft Systems Methodology. *European Journal of Operational Research, 107*, 214-235.
Lave, J., & Wenger, E. (1991). *Situated Learning: Legitimate Peripheral Participation*. Cambridge England: Cambridge University Press.
Lee, G., Bennett, D., & Oakes, I. (2000). Technological and Organisational Change in Small-to-Medium-Sized Manufacturing Companies - A Learning Organisation Perspective. *International Journal of Operations & Production Management, 20*, 549-572.
Lubbe, S., & Remenyi, D. (1999). Management of Information Technology Evaluation – The Development of A Managerial Thesis. *Logistics Information Management, 12*, 145 – 156.
Mingers, J. (2000). Variety is the Spice of Life: Combining Soft and Hard OR/MS Methods. *International Transactions in Operations Research, 7*, 673-691.
Mingers, J. (2001). Combining IS Research Methods: Towards a Pluralist Methodology. *Information Systems Research, 12*, 240-259.
Mingers, J. (2011). Soft OR comes of age-but not everywhere! *Omega-International Journal of Management Science, 39*, 729-741.
Mingers, J., & Brocklesby, J. (1997). Multimethodology: Towards a Framework for Mixing Methodologies. *Omega-International Journal of Management Science, 25*, 489-509.
Mingers, J., & Rosenhead, J. (2004). Problem Structuring Methods in Action. *European Journal of Operational Research, 152*, 530-554.
Muscatello, J. R., Small, M. H., & Chen, I. J. (2003). Implementing Enterprise Resource Planning (ERP) Systems in Small and Midsize Manufacturing Firms. *International Journal of Operations & Production Management, 23*, 850-871.
Ormerod, R. J. (1996). Information Systems Strategy Development at Sainsbury's Supermarkets using "Soft" OR. *Interfaces, 26*, 102-130.
Ormerod, R. J. (1998). Putting Soft OR Methods to Work: Information Systems Strategy Development at Palabora. *Omega-International Journal of Management Science, 26*, 75-98.
Ormerod, R. J. (1999). Putting Soft OR Methods to Work: The Case of the Business Improvement Project at PowerGen. *European Journal of Operational Research, 118*, 1-29.
Ortega, C. H., Garrido-Vega, P., & Machuca, J. A. D. (2012). Analysis of Interaction Fit between Manufacturing Strategy and Technology Management and its Impact on

Performance. *International Journal of Operations & Production Management, 32*, 958-981.
Paucar-Caceres, A. (2009). Measuring the Performance of a Research Strategic Plan System Using the Soft Systems Methodology's Three 'Es' and the Viable System Model's Indices of Achievement. *Systemic Practice and Action Research, 22*, 445-462.
Paucar-Caceres, A., & Rodriguez-Ulloa, R. (2007). An Application of Soft Systems Dynamics Methodology (SSDM). *Journal of the Operational Research Society, 58*, 701-713.
Petkov, D., Petkova, O., Andrew, T., & Nepal, T. (2008). On the Process of Combining Soft Systems Methodologies and other Approaches in Systemic Interventions. *Journal of Organisational Transformation & Social Change, 5*, 291-303.
Phaal, R., Farrukh, C. J. P., & Probert, D. R. (2001). Technology Management Process Assessment: A Case Study. *International Journal of Operations & Production Management, 21*, 1116-1132.
Phaal, R., Farrukh, C. J. P., & Probert, D. R. (2004a). Collaborative Technology Roadmapping: Network Development and Research prioritisation. *International Journal of Technology Intelligence and Planning, 1*, 39-55.
Phaal, R., Farrukh, C. J. P., & Probert, D. R. (2004b). A Framework for Supporting the Management of Technological Knowledge. *International Journal of Technology Management, 27*, 1-15.
Phaal, R., Farrukh, C. J. P., & Probert, D. R. (2004c). Technology Roadmapping - A planning Framework for Evolution and Revolution. *Technological Forecasting and Social Change, 71*, 5-26.
Pollack, J. (2009). Multimethodology in Series and Parallel: Strategic Planning using Hard and Soft OR. *Journal of the Operational Research Society, 60*, 156-167.
Revans, R. W. (1998). *ABC of Action Learning* (3rd Edition ed.). London: Lemos & Crane.
Rittel, H. W. J., & Webber, M. M. (1973). Dilemmas in a General Theory of Planning. *Policy Sciences, 4*, 155-169.
Rodriguez-Ulloal, R., & Paucar-Caceres, A. (2005). Soft System Dynamics Methodology (SSDM): Combining Soft Systems Methodology (SSM) and System Dynamics (SD). *Systemic Practice and Action Research, 18*, 303-334.
Senge, P. M. (1990). *The Fifth Discipline : The Art and Practice of the Learning Organization* (1st ed.). New York: Doubleday/Currency.
Senge, P. M., Kleiner, A., Roberts, C., Ross, R. B., & Smith, B. J. (1994). *The Fifth Discipline Fieldbook*. London: N. Brealey.
Shaw, D., Westcombe, M., Hodgkin, J., & Montibeller, G. (2004). Problem Structuring Methods for Large Group Interventions. *Journal of the Operational Research Society, 55*, 453-463.
Siddiqui, M. H., & Tripathi, S. N. (2011). Application of Soft Operations Research for Enhancing the Servicescape as a Facilitator. *Vikalpa: The Journal for Decision Makers, 36*, 33-49.
Siriram, R. (2012). A Soft and Hard Systems Approach to Business Process Management. *Systems Research and Behavioral Science, 29*, 87-100.
Small, A. (2007). *The Exploration and Adaptation of Soft Systems Methodology using Learning Theories to enable more Effective Development of Information Systems Applications.* Northumbria University.
Small, A., Sice, P., & Venus, T. (2008). A Framework for Promoting Learning in IS Design and Implementation. *The Learning Organization, 15*, 149-178.
Susman, G. I., & Evered, R. D. (1978). An Assessment of the Scientific Merits of Action Research. *Administrative Science Quarterly, 23*, 582-603.
Venus, T. (1999). Getting Value from Technology a Guide to Technology Management. In. Cambridge: University of Cambridge Centre for Technology Management.
Vidgen, R. (1997). Stakeholders, Soft Systems and Technology: Separation and Mediation in the Analysis of Information System Requirements. *Information Systems Journal, 7*, 21-46.
Vos, B., & Akkermans, H. (1996). Capturing the Dynamics of Facility Allocation. *International Journal of Operations & Production Management, 16*, 57-70.
Vygotsky, L. S. (1978). *Mind in Society: The Development of Higher Psychological Processes*. Cambridge: Harvard University Press.

Waring, T., & Wainwright, D. (2002). Communicating the Complexity of Computer-Integrated Operations: An innovative use of process modelling in a North East Hospital Trust. *International Journal of Operations & Production Management, 22*, 394-411.

Weick, K. E. (1995). *Sesnsemaking in Organizations*. California: Sage Publications.

Wenger, E. (1998). *Communities of Practice: Learning, Meaning, and Identity*. Cambridge, England: Cambridge University Press.

West, D. (1995). Chapter Seven The Appreciative Inquiry Method: A Systemic Approach to Information Systems Requirements Analysis. In F. Stowell (Ed.), *Information Systems Provision the Contribution of Soft Systems Methodology* (pp. 140 – 158). London: McGraw-Hill.

Westbrook, R. (1995). Action Research: A New Paradigm for Research in Production and Operations Management. *International Journal of Operations & Production Management, 15*, 6-20.

Zehner, W. B. (2000). The Management of Technology (MOT) Degree: A bridge between Technology and Strategic Management. *Technology Analysis & Strategic Management, 12*, 283-291.