Assessing the Effectiveness of Architectural Design Communication through Public Participation Methods

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INTRODUCTION

There has been an increase in competition between architectural practices over recent years due to numerous factors, including: a reduction in design fees; added complexity of the architect's role; and the increasing importance to deliver quality projects in an efficient manner that meets stakeholder expectations. There is also pressure on the architectural profession to adapt its marketing and management strategies as traditional work has declined (Robinson *et al*. 2011). As a result, a greater understanding of user interaction is invaluable for architects in order to assess specific requirements and produce design solutions.

The abolishment of compulsory and recommended professional fee scales due to orders by the UK Monolopies and Mergers Commission and the Office of Fair Trading (Brindley and Perry 2009) has resulted in the reduction in architects fees in the UK. Studies by Tilley and McFallan (Nelson 2006) reveal the disparity between design fees required to provide a proper service, produce quality design and documentation, and the fee levels needing to be submitted to win work, declined on average by 24% from 1985 to 2000. Fee reduction is suggested to have the following impact on the architectural profession and resulting project delivery according to studies by Tilley and McFallan (Nelson, 2006, 175):

- A reduction in proper examination of design proposals and innovation
- A reduction in quality of service being provided
- Insufficient personnel to carry out work, causing an overload on those available
- A greater use of junior and inexperienced staff
- A lack of profit, leading directly to a reduction in the levels of in-house training and research and development

The reduction in time available for design development due to lower professional fees is compounded by the increased complexity of the architect's responsibilities. Due to advances in society's demand for building quality, the expectations in terms of structural safety, fire protection, acoustic provision, thermal insulation and accessibility by disabled persons are all developing in conjunction with increasing numbers of regulatory texts by organisations such as the National Health Service (2008) and the Ministry of Defence (2008) prescribing basic conditions (ACE 2003). The Accelerating Change agenda (Strategic Forum for Construction 2002, 10) is "for the UK construction industry to realise maximum value for all clients, end users and stakeholders and exceed their expectations through the consistent delivery of world class products and services".

The architectural design process is vibrant and creative in nature with evidence of high rates of iteration by design teams (Austin *et al*. 2001). Although iteration can be helpful in refining designs, too much can result in negative effects on project delivery. Costa and Sobek (2003) recognised that understanding iteration is important to improve the design process on cost, time and quality of the delivery of a construction project. They classify iterations in the design process as: rework; design; and behavioural; in order to recognise areas for improvement. Rework iteration is defined as repeating an activity where the concept and scope has not changed-this is usually to correct an error. Design iteration is described as looking at the same design problem but defining and refining a solution while moving from the initial concept to the detailed design. Finally behavioural iteration is the design team performing similar activities but on different areas of the project, resulting in repetition of activity. In a typical project, much of the rework iteration is a result of changes to designs throughout the process as stakeholders respond to design communication methods presenting the architect's design.

It is accepted that some iteration, such as design iteration, should be welcomed in refining design solutions, however, other categories (rework and behavioural) have a negative effect resulting in the schedule delays and cost overruns that persist in design and construction projects (Park and Peña-Mora 2003). Previous research efforts have also pointed to non-value adding activities (NVAAs), defined as wasted efforts that consume time and/or resources but do not directly or indirectly add value or progress to the project requirements (Koskela 1992), was a major contributor to project delays. An example would include the misinterpretation of a building component by stakeholders during design consultation leading to remedial work after construction. Studies reveal that such activities can take up 26–40% of the overall project time (Ireland 1995; Han et al. 2007), with reports that 40–60% of a typical construction day is wasted on non-productive activities (Jergeas et al. 2002). It is also reported that 37.6% of rework and 51.6% of variations (change orders) that occur on construction projects are reported to be due to design or documentation deficiencies according to Tilley and McFallan (Nelson 2006). Studies by Westerdahl, *et al*. (2006) propose that the effectiveness of communication methods helps to identify errors that can be corrected prior to construction, early in a project. Therefore, improvements in design communication are beneficial in the reduction of both negative iteration during the design phase and remedial work to buildings after construction.

Stakeholders are any individuals, groups, or organisations that have a direct or indirect interest or impact on the building project. In the context of this paper, they often consist of building end users. Stakeholder value judgements are influenced by a number of issues that frame their decisions (Köhler 1966; Griseri 1998; Keeney 1998) including: religious and political beliefs, expectations (Thomas *et al*. 2003), cognition of surroundings (Vickers 1968), and the object's exchange, use and esteem values (Best and De Valance 1999). It is reported that stakeholders responding collectively may help to articulate their values, as they are often not aware of them (Fischhoff 1991). As a result, a greater understanding of stakeholder interaction is invaluable for architects in order to assess specific requirements and produce design solutions. Stakeholder involvement in the design process allows the values relevant to each construction project to be identified and understood by architects and defers from assumptions. The importance of this is emphasised by Saxon (2002, 335):

> "What society does not want from its built environment is repetitive, context-ignoring tackiness. However buildings are produced, cultural expectations (Impact Values) will control the acceptability of buildings. Therefore, an improved understanding of cultural and social expectations is vital if the built environment is to have enhanced 'fit' and value."

The evidence described suggests that architects are required to make difficult decisions when selecting communication methods to use to present work at specific stages of the design process, as well as methods for capturing stakeholder values and expectations. The range of communication methods available to architects to present design development has expanded over recent years. This includes: computer aided 2D drawings, hand drawn sketches, physical models, 3D computer models and renders. The objective of this paper is to assess the effectiveness of three selected communication methods for architectural design at presenting final designs to stakeholder representatives and obtaining their understanding and critical appraisal. The design of an alteration to a UK school project carried out by a local authority architectural practice is used as a case study. Two of the current methods of communication used by the architectural practice were assessed, along with a third communication method available to use in future. The assessment aimed to test the levels of understanding by stakeholder representatives of the final design using established public participation techniques. The focus of the research was to gain their critical reflection and feedback on the final design of the proposed alteration of the school building prior to construction. This information would provide architects with critical advice to consider making suitable changes to the final design with the aim of increasing stakeholder satisfaction. It would also be used to provide information for the most effective way to make a contribution to controlling rework iteration and improving design documentation to reduce overruns to the overall project programme.

Research Methodology

The designs for the proposed alteration of an existing UK school building were used as a case study to assess the effectiveness of the understanding of communication methods by stakeholder representatives. The three methods are indicated in Table 1:

Table 1: Communication Methods and Presentation Details

	Method 1	**Method 2**	**Method 3**
Reference	**2D drawings**	**3D model**	**VR model**
Dimensions	Two	Three	Three
Image type	Static Image	Animation (fly-through)	Animation
Medium	Paper	Computer monitor	Screen and 3D glasses
Rendering	Basic labelling	Basic rendering	Detailed rendering

The first two communication methods were regularly used by the architectural practice to present designs to stakeholders, with the third potentially available for future use. Each communication method was presented to 12 stakeholder representatives and their responses recorded in a controlled manner and environment. These forms of communication were selected due to the architectural practice's interest in assessing their current design communication methods of 2D drawings and 3D model, and the available option of introducing the use of VR (virtual reality) modelling. The comments were analysed to assess the effectiveness of each communication method.

The participants were selected in order to provide a representation of end users of the proposed building. The number of participants was determined by three factors; the number of different roles of the likely building end user; the capacity of the venue used for presenting and assessing communication methods; and the manageable number of participants. A total group of 12 participants were selected and were compromised from 4 teaching staff, 4 support staff, and 4 school pupils. The participants were selected by senior school staff after the authors requested representatives from the aforementioned end user groups. The school selected the individuals based on their availability and interest in taking part in the research. The participants were divided into three groups of four to allow a mixture of age groups and role within the school (see table 2).

The methodology for the collection of participant opinion was developed in conjunction with Participatory Evaluation and Assessment (PEA) Newcastle upon Tyne, an organisation that specialise in conducting public research based at Northumbria University. The methodology used by PEA is based on the categories of participatory approach (Arnstein 1969; Hart 1992) (see fig. 1). To ensure the results were comparable, the presentations and data collection were controlled with the aim to solicit comments and to arrive at decisions collectively. This is the participatory approach defined as *Deciding Together*.

Table 2: Communication Methods Presentation Groups and Stakeholder Representative's Role in School

Group A	**Role within Organisation**
Representative 1	Head Teacher
Representative 2	Pupil
Representative 3	Pupil
Representative 4	Area Catering Manager
Group B	
Representative 5	Deputy Head Teacher
Representative 6	Pupil
Representative 7	Teaching Assistant
Representative 8	Senior Lunch Supervisor
Group C	
Representative 9	School Business Manager
Representative 10	Pupil
Representative 11	Teaching Assistant
Representative 12	School Catering Manager

- **Learning and Acting Together**- The participants have the power and responsibility for solving problems that they chose to tackle.

- **Deciding Together**- Facilitators control the consultation process and decide the forms of recording participation responses.

- **Consulting**- Facilitators are given a controlled set of opinions that they are asked to gain from participants e.g. questionnaire.

- **Informing**- Methods of questioning controlled with limited options for participants to respond.

Figure 1: Participatory Approach (Arnstein 1969; Hart 1992)

PEA (Mowbray & Butcher 2010) has also developed the Participatory Community Appraisal Process (see fig. 2) that allowed the research to be planned in stages. A pilot exercise, with the participants divided into their peer groups, was used to familiarise the participants with the methodology. Finally, the design was presented in a controlled manner using the three communication methods. Once completed, the process moved to the final stage where the priority of comments was established through an overall group vote; all participants' comments were given equal weighting. The responses provided the architects with information to potentially make changes to the design.

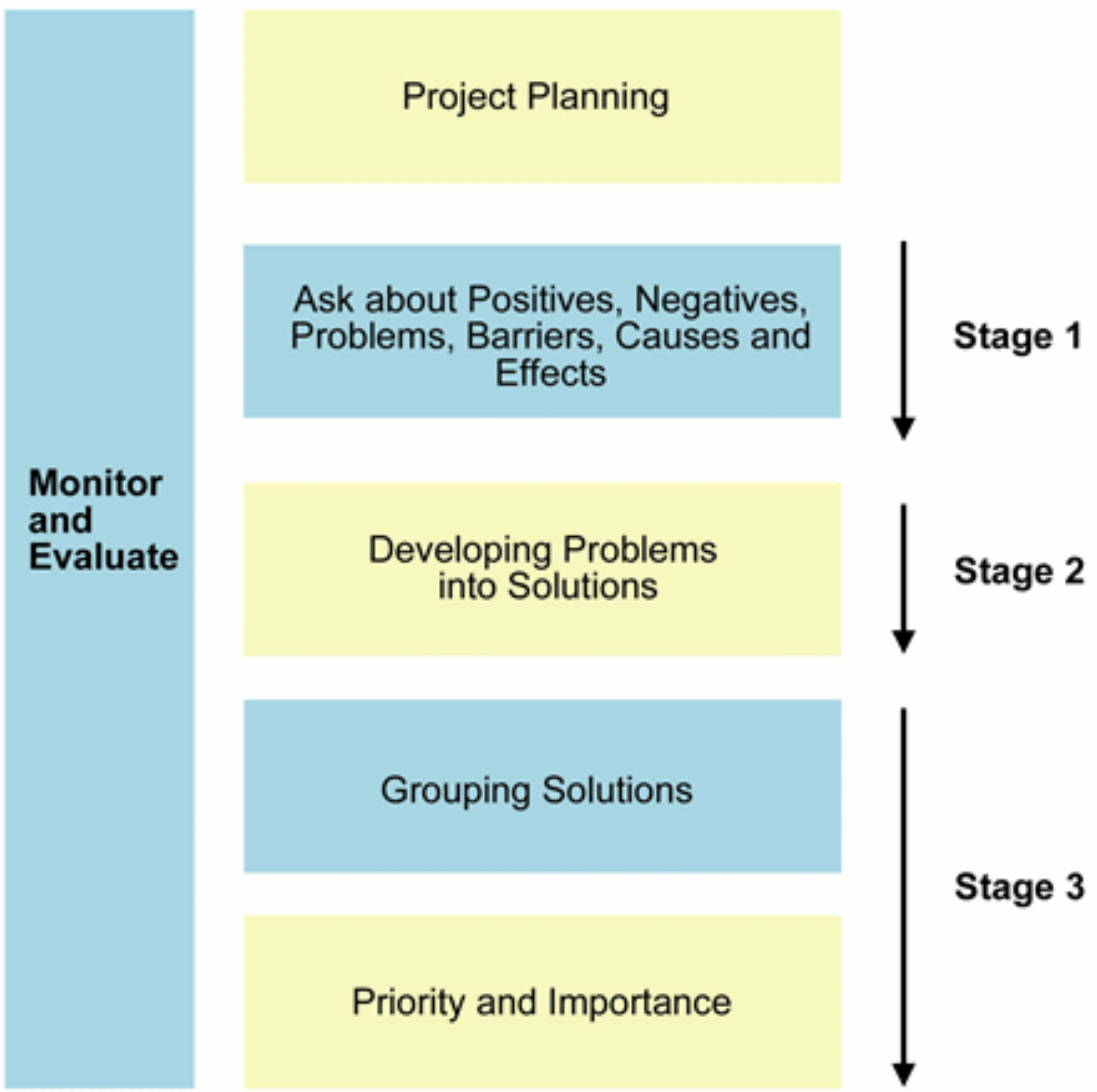

Figure 2: Participatory Community Appraisal Process (Adapted from Mowbray & Butcher 2010, 21)

To allow each group to view each presentation, a carousel approach was used. This method allowed each group to comment on each presentation in a difference sequence to analyse if previously viewed presentations had influenced comments. Organising presentations in this manner is said to be advantageous in maintaining energy levels among the participants as they are required to walk from each presentation as opposed to remaining in the same place for a prolonged period (Mowbray & Butcher 2010, 41). To maintain a fair comparison, each group had an equal time of 15 minutes to view the presentation and record comments. The length of the 3D model and VR model presentations were equal and replayed to the group twice and remained on a still image to the end as the participants made comments. The 2D drawings presentation allowed the drawings to be presented throughout; however the facilitator instructed the group when the presentation period was complete and that the group could proceed to record comments.

Each presentation was delivered in separate spaces for two reasons; firstly to reduce participant distraction to allow a level of discussion that can promote decision making and comments to be recorded; and secondly, to prevent groups from gaining previews of the other presentations that may influence their opinions or comments. Each presentation space had a table and set of chairs available with the participants provided with a comment sheet (see fig. 3) and individual pads of post-it notes and pens to allow equal contribution. The 3D model was presented on two computer monitors, with adequate view for all 4 participants. The VR model presentation required specific facilities therefore used a separate room with a large back-lit screen. Each space would also have a spare table to allow the facilitators to store stationary and completed comment sheets. After careful consideration, the larger presentation space was chosen as the base for the event, where the participants would gather and instructions be given, with tables and chairs provided for the 12 participants and facilitators.

Each presentation had a facilitator who introduced the presentation using a script, and was not permitted to answer any questions regarding the presentation, other than how to complete the comments sheet and inform the group of the time remaining. This ensured that each presentation had the same rules and level of interaction. The main role of the facilitator was to record observations of group behaviour and any discussions that occurred but not placed on the sheet, or record any comments that had a specific meaning or required further explanation than provided on the post-it note. The facilitator would also observe the group behaviour and clarify any comments made that may be confusing or interpreted in different ways. To avoid any differences between the presentations, each facilitator was provided with an identical script to read to each group. Part of the script explained how each facilitator would not answer any specific questions regarding the presentations or design and that any queries regarding the design or presentation were to be written down and added to the comments sheets.

As the presentations were planned to start and finish at the same time, an interval of 2 minutes was factored-in to allow for participants to move between venues. At the conclusion of each session, the facilitator instructed each group where their next presentation would take place. Once all comments had been recorded, the facilitator took a photographic record and marked each comment with the group and presentation number. To allow comments to be traced, each group used a specific colour post-it note. A summary of the research schedule is explained in Table 3.

Table 3: Summary of Research Schedule

Number	**Task**	**Duration (minutes)**
1	Registration	15
2	Welcome	05
3	Introduction to Methodology	05
4	Pilot Exercise	10
5	Communication Methods Presentations	15 x 3 = 45
6	Interval between Presentations	2 x 3 = 6
7	Refreshment Break	10
8	Vote	10
9	Question and Answer Session	05

A variety of tools are available to gather participant comments during and after their observations of presentations. Mowbray and Butcher (2010) have established the most suitable use for each tool. Due to the time restriction of the event because of school commitments of the participants, it was important to gain comments from all participants in a short space of time, including the level of importance each comment holds. To achieve this task, the Participant Positive and Negative Comment Record Sheet (see fig. 3) was selected after consultation with PEA Newcastle upon Tyne.

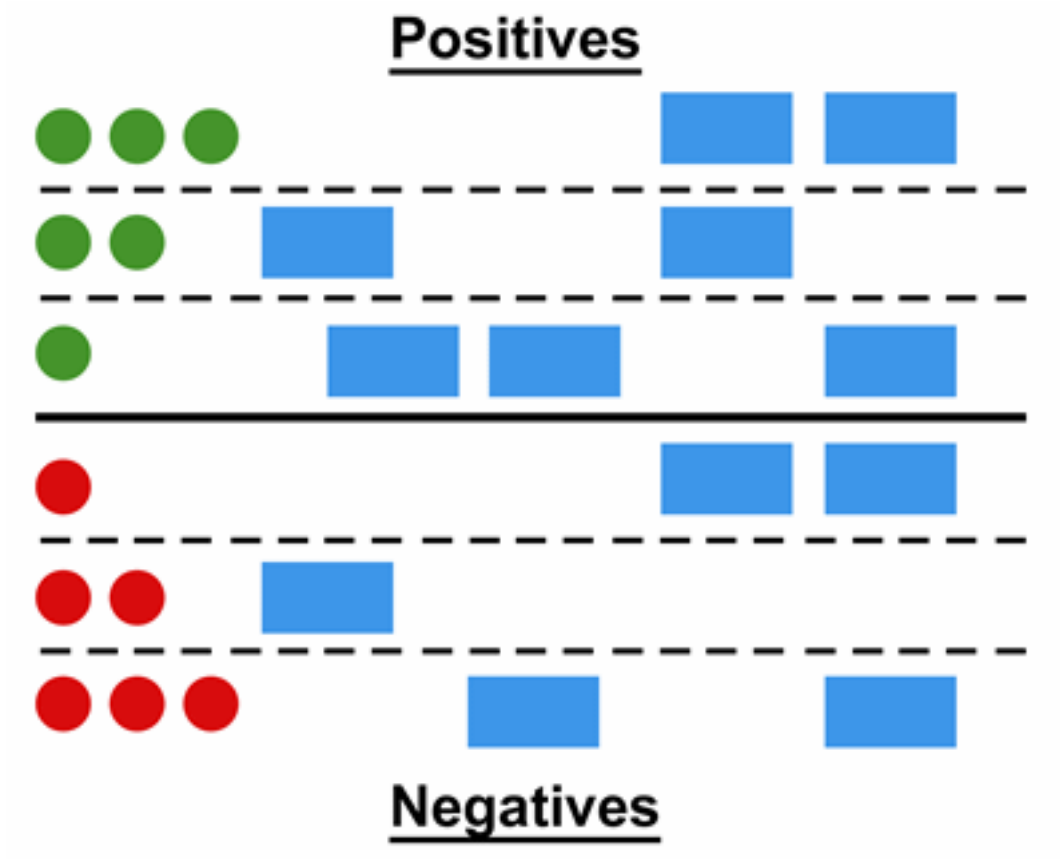

Figure 3: Participant Positive and Negative Comment Record Sheet with Priority Levels (Adapted from Mowbray & Butcher 2010)

The participants' positive and negative comments are recorded on the sheet (see fig. 3) which also ranks the importance of comments. On completion of the presentations, the event proceeded to establish the importance of the comments provided through an overall vote. The tool to evaluate comment priority organises similar comments together and allows each individual to vote for their top three comments in both the negative and positive categories (see fig. 4). Two separate grids were built up using the highest priority positive comments (labelled *likes x 3*) and the highest priority negative comments (*dislikes x 3*). Each participant was provided with six circular stickers to use to vote in each grid (total of 12 stickers). Each participant was encouraged to vote on an individual basis. The six stickers were divided so that each individual had one sticker for their third choice; two stickers for their second; and three stickers for their first choice. This method provides a set of priorities for all the participants (Mowbray & Butcher 2010, 34).

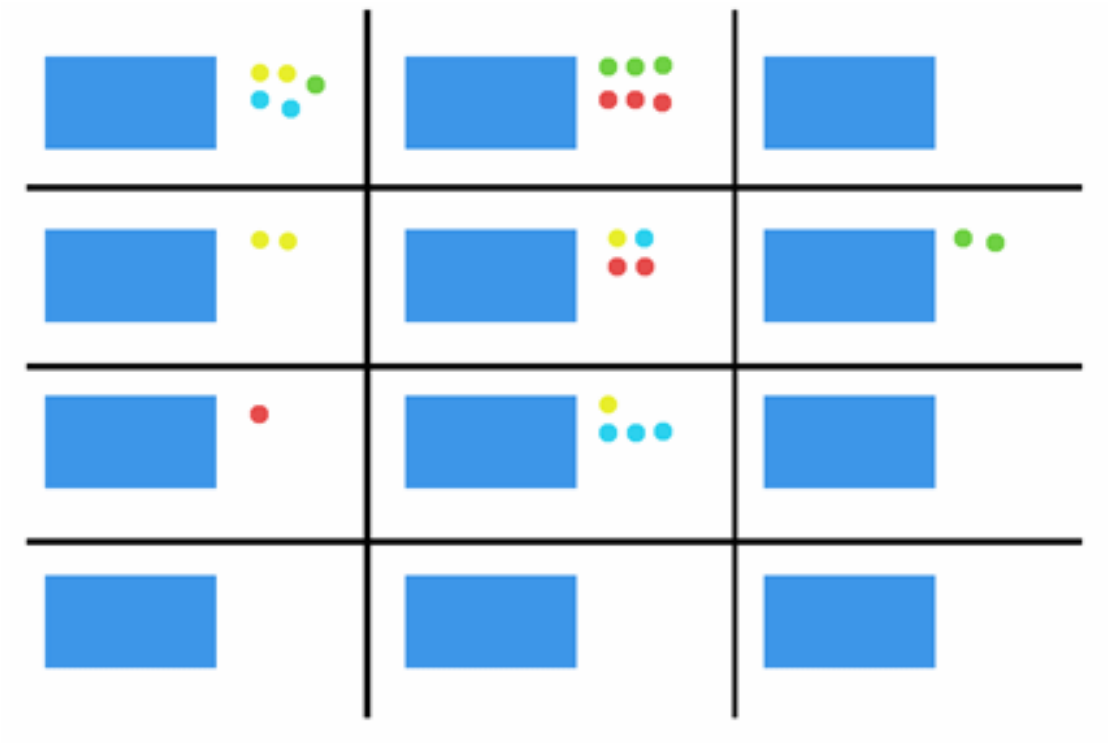

Figure 4: Tool for Evaluating Comment Priority (Adapted from Mowbray & Butcher 2010)

Findings and Discussion

Pilot Exercise

The pilot exercise using the three peer groups produced a wide variety of positive and negative comments. The majority of positive comments were related to staff and food rather than the environment itself. Negative comments focussed on the lack of facilities, space, poor access to the dining space and temperature. Although the comments were useful to the architects, they were not analysed further for the purpose of this paper as the results were not comparable with the participant's responses to the communication methods presentations.

2D Drawings Presentation

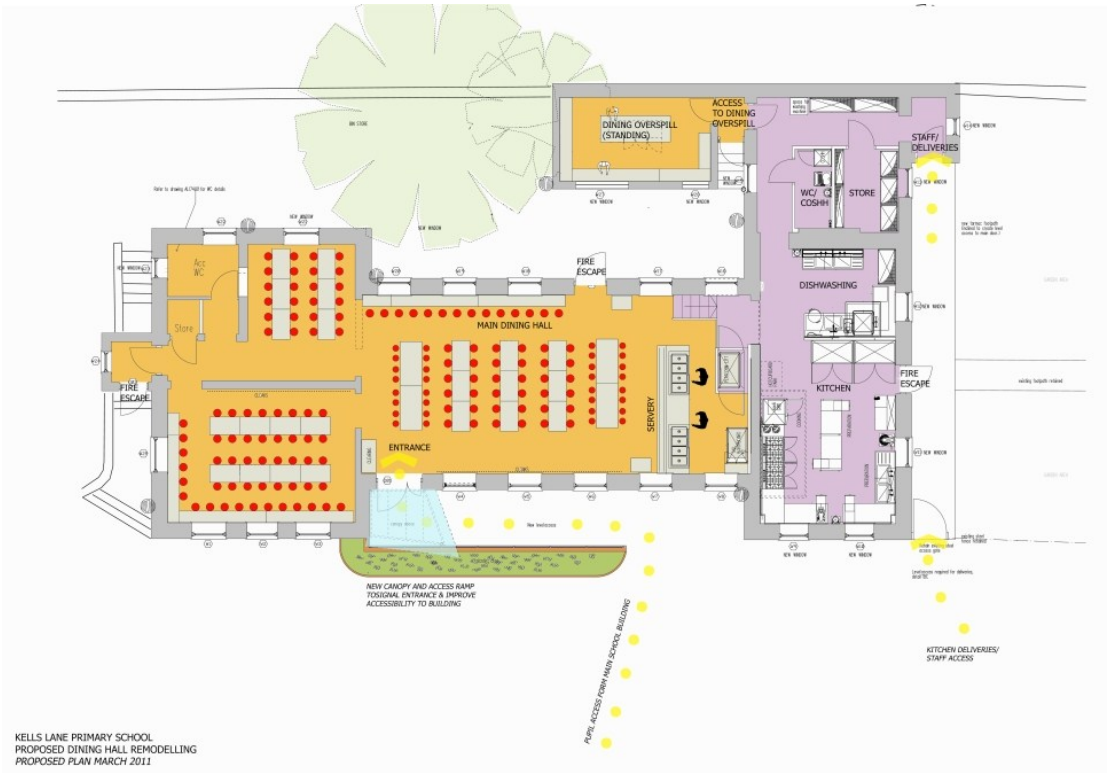

Figure 5: 2D Plan used for Presentation at 1:50 Scale at A1

Figure 6: Participants with Facilitator during 2D Presentation (Mowbray 2011a)

Responses and Observations

Presentation 1: Group A

The first group to view the 2D presentation were observed to have a different interpretation of the function of a room to that intended by the architect. The architect used colours to represent zones of space, but this was interpreted by the group as the actual flooring colour. There were generally a low proportion of negative comments.

Presentation 2: Group B

An increased number of comments were observed in comparison to Group A. The group also had a different interpretation of the function of the same room. Again, a negative comment on the flooring colour was recorded as the group interpreted the colour representation of the dining zone as literally the flooring colour.

Presentation 3: Group C

The final group to view the 2D drawings presentation made mainly negative comments. Having viewed two previous presentations, this group interpreted the function of the room as was intended by the architect. The negative comments that were recorded focused on spatial and circulation issues. It should be noted that the group misinterpreted drainage drawing components for garbage bins.

In summary of the 2D drawings presentation, the groups developed a better overall understanding of the design when using the plan drawing. This was evident in the understanding of the building entrance, resulting in all groups commenting on the

potential overcrowding. Two of the groups noticed the WC only in the plan and only understood what the function of the overspill area once they had viewed the plan. Both groups also raised issues about access to this space and its storage. Two of the groups, both of which had yet to see the VR model up to this point, did not understand or disliked the floor colouring. This colour was only used to signify the dining space rather than be an accurate representation of the actual flooring.

An interesting observation was that two of the groups failed to use the elevation drawing that was available. The one group that observed the elevation drawing did not use any information provided to record comments. The group that had previously seen both the 3D model and VR model presentations made predominately negative comments as it appeared that they had gained an understanding of the storage and space issues. In general, each group found the 2D drawings difficult to navigate and understand all aspects. Adult participants had to help pupils understand the drawings in some cases.

3D Model Presentation

Figure 7: Static Image of 3D Model Animation Presented on Computer Monitor

Figure 8: Participants during 3D Model Presentation (Mowbray, 2011b)

Responses and Observations

Presentation 1: Group B

Group B were the first to view the 3D model presentation and made mostly positive comments. The main comments regarded the look and feel of the new dining hall, being a more spacious, modern and brighter room to have lunch. The group noted their approval of the addition of the fan extractor system (although interpreted as a heating system by the participants), the perceived improved access and circulation, and they also interpreted the function of a room as intended. Other comments questioned the levels of facilities available suggesting that the participants did not gain sufficient understanding of seating numbers, or external shelter. The group's negative comments focused on interface details such as the number of pupils' coat pegs, the level of external shelter, the amount of storage available and the location of specific facilities.

Presentation 2: Group C

The group commented most positively on the entrance to the building, storage space, fan convector system (although misinterpreted by participants as air conditioning units), as well as colour choice for furniture and finishes. The main negative comment was the disapproval of specific furniture coloured option of the side benches, although this was also mentioned as a positive comment, showing that the group did not have full consensus on this issue.

Presentation 3: Group A

As the final group to view the 3D presentation, a lack comments in comparison to the other groups suggests that sufficient information had already been delivered in the previous presentations. The only positive comments made were of medium priority, including the approval of the entrance to the building, the increase sense of space and the positioning of furniture. However, the group interpreted the function of one room differently to that intended (the initial misinterpretation occurred in the VR model presentation). The only negative comments mentioned the proximity of furniture in certain areas.

In comparison to the results of the other presentations, all groups generally gave an equal balance of positive and negative responses. Two of the three groups noticed the storage and fan convectors for the first time from the 3D model presentation. Both of the groups had yet to view the VR model presentation. Specific details were noticed including location of the servery, coat pegs, menu boards and external space issues. The two groups that had viewed the VR model presentation prior to the 3D model presentation both commented on how they understood the following aspects more clearly in the 3D model: floor detail; room function; storage; and overall layout. Two groups made their first comments on the external shelter after viewing the 3D model presentation. The group that had yet to view the 2D drawings presentation questioned if there was a WC included in the new design. The final group to see the 3D model presentation made a small number of comments on the sheet but were observed to have specific discussions on detailed aspects of the design. Two groups noted the similarity of 3D model with the VR model presentation.

VR Model Presentation

Figure 9: Static Image of dining Hall used in VR Model Presentation

Figure 10: Participants during VR Model Presentation (Mowbray, 2011c)

Responses and Observations

Presentation 1: Group C

The first group to view the VR model presentation appeared to be very impressed with the design as all but one comment was positive. The high prioritised comments regarded the approval of the facilities, external shelter, entrance improvements, the addition of fan convectors, and overall look and feel of the refurbishment. Other positive comments included the spacious feel of the building, circulation, furniture and finishes. The only negative comment was made about the coat pegs being too close together.

Presentation 2: Group A

Again, the majority of comments made by the group were positive. The high prioritised positive comments mentioned the facilities, fan convectors (again, these were misinterpreted as air conditioning units) and the clean and clear appearance. The group interpreted the function of one room differently to the architect's intention. This interpretation by Group A was recorded in the 2D presentation and continued through the VR model. Other positive comments mentioned openness of the space, the flooring finish, furniture and entrance. The only negative comment placed on the sheet was the perceived lack of storage space.

Presentation 3: Group B

All comments noted by the final group to see the presentation were positive. The high priority comments concentrated on the furniture, flooring, and the circulation between spaces. Other comments included the group's approval of the modern feel, the space to move around and addition of heaters (although the architect intended to represent the heaters as fan convectors). Comments were also received with lower priority, such as the preference for furniture finishes.

In general, all groups appeared to be very impressed with the VR model presentation based on facilitator observations. It appeared that this could have had a dramatic effect on the participants as only two negative comments were recorded throughout, with neither given high priority.

Other interesting observations were recorded, with two of the groups collectively decided on a preferred finish on specific furniture while the presentation was still playing, suggesting that quick decisions can be made using the VR model. Two of the groups noticed the fan convectors for the first time (one group had previously seen the 2D drawings presentation and one group no presentation respectfully). The same two groups also commented on their disapproval of detailed design issues (separation space between pupil coat pegs). Two of the groups also interpreted the flooring as the architect intended and recorded positive feedback. Despite only two recorded negative comments, the facilitator observed that specific queries were discussed during the presentation, such as the materiality of interface details, the building entrance, and the location of specific facilities.

Presentation Responses

Table 4 presents a comparison of the participant's group comments in each presentation.

Table 4: Overall Presentation Responses Using the Tool for Evaluating COMMENT Priority. * Indicates Different Participant Interpretation to that Intended by the Architect

Category	**2D drawings**			**3D model**			**VR model**		
	A	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
Circulation			×		✓				
Coat Pegs		×			×				×
Deliveries		✓	×						
Entrance	×	✓		✓	✓	×			
External Spaces							✓		
Fan Convectors					✓*		✓*	✓*	
Flooring Colour	×	×					✓	✓	✓
Kitchen Finishes	✓					✓			
Kitchen Layout	✓	✓					✓		
Lift (Elevator)								✓	✓
Overall Appearance					✓	✓	✓	✓	✓
Packed Lunch Space		✓*	×		✓		✓*		✓
Entrance Ramp					×	✓			✓
Seating Colour						✓	✓	✓	✓
Seating Layout	✓	✓		✓	×		✓	✓	
Servery		×	✓						
Storage			✓						

Space	✓	✓	×	✓	✓			✓	✓
Tables Colour				×		×		✓	✓
Tables Layout			×						

Walls Colour					✓			✓	✓
Waste		×	×		×				
WC location	✓	✓			×				
Ventilation						✓			
Total Likes	**4**	**8**	**2**	**3**	**7**	**6**	**8**	**9**	**9**
Total Dislikes	**2**	**4**	**6**	**1**	**6**	**2**	**1**	**0**	**1**
Sub Total	**6**	**12**	**8**	**4**	**13**	**8**	**9**	**9**	**10**
Category Total	**26**			**25**			**28**		

Tool for Evaluating Comment Priority

The highest priority responses from participants were arranged using the tool for evaluating comment priority for positive and negative comments. Comments were grouped into similar responses and each participant used their opportunity to vote for their top three responses in both the positive and negative categories. The results are presented in Table 5, and were discussed with the group once voting was completed and an opportunity for questions was welcomed.

Table 5: Overall Participant Response using the Tool for Evaluating Comment Priority

Likes	Dislikes

1. *Kitchen–17*	1. *Coat pegs–17*
2. *Seats–16*	2. *Movement–14*
3. *Look–12*	3. *Colour–13*
Spacious–10	Cleaning space–11
Entrance–5	Car park–4
Movement–4	Bins outside–3
Lighting–3	Overspill (year 6 café)–3
Toilet–3	No seats (in overspill)–0
Flooring–2	Flooring–0
Overspill–0	Going outside (to get to overspill)–0
Colour–0	
Lift–0	
Storage–0	

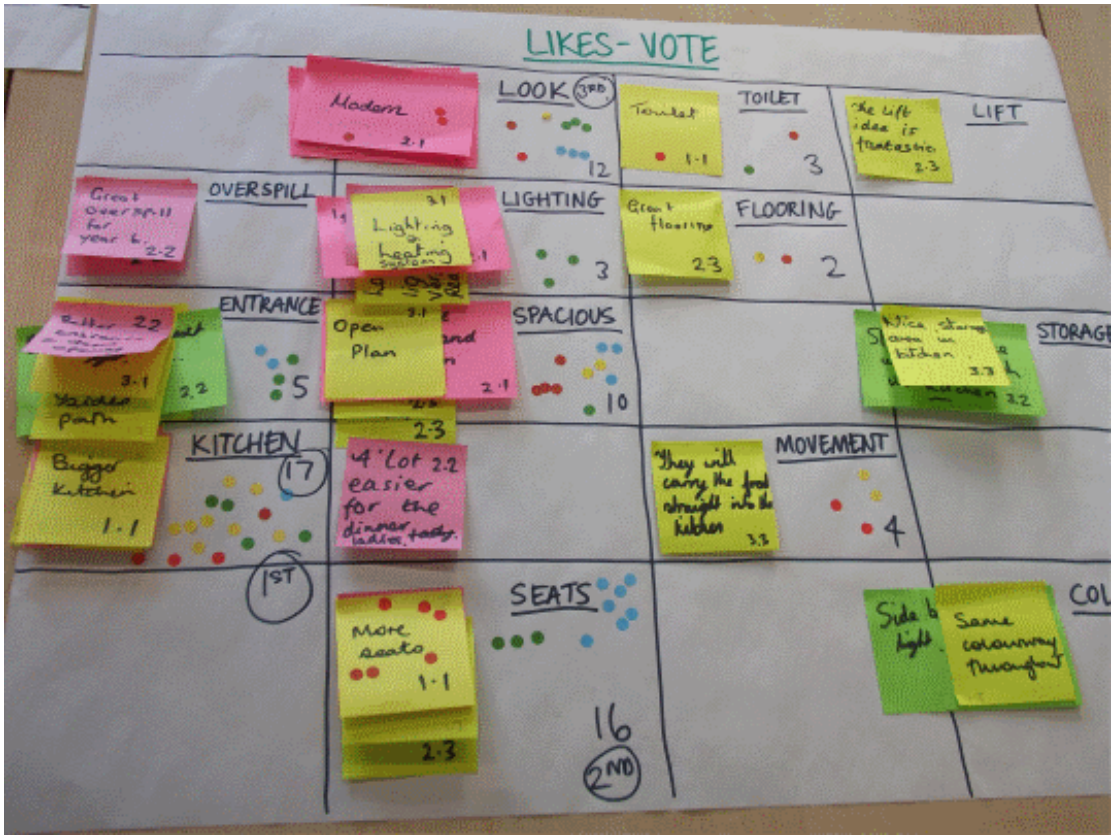

Figure 11: Completed Tool for Evaluating Comment Priority Including Top Three 'Liked' Placed Categories (Serginson 2011)

Figure 12: Completed Tool for Evaluating Comment Priority Including top Three 'Disliked' Placed Categories (Serginson 2011)

The top three positive aspects voted by the participants were (see fig. 11): the kitchen–the overall facility and layout; the seats–the type of seats used to allow flexibility; and the look– relating to the modern feel of the refurbishment. The top three negative aspects were (see fig. 12): coat pegs–something that appears to be an existing problem that has not been resolved based on the participant vote; movement-relating to the queuing prior to being served and access/exit before and after meals; and colour–relating to the colour of the walls, floor and chairs. The results were interesting as the comments placed on the positive and negative comment record sheets with the highest priority (x 3) by the participants during the group presentations, did not necessarily collate with overall group priority. Despite the difference, the group discussion at the end of the event agreed that this was a true reflection of their attitude after viewing all three presentations

Summary and Discussion

In summary, the results suggest several themes and areas suitable for further research. The 2D drawings appeared to be the most difficult for participants to read initially, with several examples of misinterpretation of drawing components. However, the groups generally developed a better overall understanding of the design when using the plan drawing. This was especially evident when understanding the main entrance to the dining hall, resulting in each group providing critical comments as they noticed potential for overcrowding at the beginning of the lunch break. Other specific areas of the design were also discussed in greater detail and were commented on, including the

location of the WC and the relationship between served and serviced spaces within the building. An interesting observation was that the 2D elevation drawing failed to provide any information that led to written comments or discussion by all three groups.

The results from the 3D model presentations appear to raise levels of understanding in comparison to the virtual reality model and 2D presentations. Comments received by participants identify specific details within the design that were not covered by the other two forms of presentation. It also covered the vast majority of positive issues that were mentioned by the viewers of the VR model. In addition, the facilitator observed that this presentation created high levels of debate amongst participants on detailed design. The 3D model presentation highlighted that participants have the ability to notice small scale detail design at the point where people interface with the building such as coat pegs and seating.

The results from the VR model were overwhelmingly positive with a comparatively low number of negative comments. From the point of view of an architect attempting to receive constructive feedback on a design before proceeding to the construction stage, it appears that this communication method is potentially problematic as detailed aspects of the design appear not to be recognised by the participants. This may suggest that the viewer's critical analysis is affected by the nature of the VR model and sense of immersion using the 3D glasses. This communication method could therefore be used by Architects primarily as a tool to secure work for future projects.

Some overall themes were observed during the assessment of the communication methods. It was evident that information presented to participants was often interpreted in a literal manner despite being considered representational by architects. Examples include the floor colouring on 2D drawings and the function of the fan convectors in both the 3D model and VR model presentations. There is an increasing use of computer programs as communication methods for architectural representation as they are widely believed to be better at communicating architectural forms than hand drawn alternatives (Pietsch 2000). However, the response by the participants supports suggestions that computer representations can cause misinterpretation and disagreement (Day 2002). The different perceptions of certain aspects of the presentations reinforce suggestions by Valdez (1984) that perceptual orientation of architects is considerably different from other professionals and the public. The difference in perception between architects and other professionals is also evident in the conclusion of studies into the credibility of traditional and computer generated architectural representations by Bates-Brkljac (2009).

The effect of the communication methods presentations on participant response suggests that a mixture of presentation is required in order to gain opinion and understanding of a wide range of categories of the building design. The results suggest that different communication methods may be more appropriate at different stages of the design process. Overall, the findings challenge the perception that improvements in computer technology will lead to increased participant understanding of building designs. However, it appears that critical analysis is influenced and levels of constructive criticism reduced when participants observed the virtual reality model presentation. Finally, it appears that the public participation techniques used promoted equal contribution form participants within the groups as a balance of written responses and discussion, as observed by the facilitators.

Conclusion and Further Research

This paper has presented some reflections of the increase in competition between architectural practices over recent years due to numerous factors, including: a reduction in design fees; added complexity of the architect's role; and the increasing importance to deliver quality projects in an efficient manner that meets stakeholder expectations. The effect this has on the architectural profession leads to negative forms of iteration in the design process resulting in design and documentation deficiencies that equate to 26–40% of non-value added activities on construction sites. As a result, a greater understanding of stakeholder interaction during the design process is invaluable for architects in order to assess specific requirements and produce design solutions.

The designs for the proposed alteration of an existing UK school building by a UK local authority architectural practice as a case study: the effectiveness of the understanding of three selected communication methods by stakeholder representatives. These were: 2D drawings; 3D model; and a VR model. Each communication method was presented to 12 stakeholder representatives who were divided into three groups of four of mixed age and role within the selected school. Their responses to presentations were recorded in a controlled manner and environment. The results suggest several themes and areas suitable for further research.

The 2D drawings appeared to be the most difficult for participants to read initially. There were several examples of misinterpretation of drawing components as participants tend to interpret representational colours as actual materials. However, participants found them most useful in understanding the relationship between spaces and the location specific facilities such as WCs and storage cupboards. The results from the 3D model presentations appear to raise levels of understanding in comparison to the 2D drawings presentations and VR model. Comments received by participants appear to identify specific details within the design that were not covered by the other two forms of presentation. In addition, the facilitator observed that this presentation created high levels of debate amongst participants on detailed design. This suggests that the 3D model is effective in generating critical appraisal from participants to assist the architect in making changes to the design prior to construction. The results from the VR model were overwhelmingly positive with a comparatively low number of negative comments. This may suggest that the viewer's critical analysis is affected by the nature of the VR model and sense of immersion using the 3D glasses. This communication method could therefore be used primarily by architects as a tool to secure work for future projects.

An area for further research would be to test the appropriateness of communication methods at various stages of an architectural design process with the aim of producing a theoretical model to assist architects on when to use certain communication methods at particular stages of a project.

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