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Design Research and Design Participation

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Abstract: This paper brings together some key research issues in design participation: Is it possible to develop a computer-based architectural design application which can be used by completely untutored lay participants in a meaningful design process? How can the designs created by the participants be objectively compared with other building designs created to the same brief by professional architects? What are the implication of design participation as an expression of a wider social and political process of 'democratisation'? The research described here is based on a pioneering project called 'Computer Aids for Design Participation' conducted in the 1970's. While the computing facilities used in this project would be considered incredibly primitive by today's standard, the research methodology, including software design and empirical studies with participants is still relevant today.

Keywords: Participation; Architecture; Human-Computer-Interaction:

Introduction

In 1971 the Design Research Society under the leadership of Nigel Cross organised a conference called 'Design Participation' which brought together leading policy experts, design theorists and software developers (Cross 1972). It had already been shown that CAD systems could be developed for use by professional designers such as architects, but it was also proposed that the emerging fields of computer aided design and human computer interaction could be potentially combined to create a computational design system for design participation.

This idea was pursued by Nigel Cross and Tom Maver (head of the ABACUS research unit at the University of Strathclyde) in an article published in the Architects Journal (Cross and Maver 1973). This idea was further supported by John Lansdown, who was the chair of the civil engineering subcommittee of the UK Science Research Council. As a result of these discussions a research project into 'Computer Aids for Design Participation' was started at

the ABACUS research unit in 1975. The objectives of this research were three fold: first, to develop a suitable CAD system for use by lay participants, second to test the usability of this system with participants and third, to objectively evaluate the quality of the designs produced by the participants in comparison to equivalent buildings designed by professional architects.

This project represented a unique empirical study in the field of Design Research, but we should remember that this work was executed with incredibly primitive interactive computing systems and before computing became a ubiquitous 'user experience'. Indeed for the lay participants who used these design tools, this was most probably their first experience of computing.

Historical Context

The 1971 Design Research Society's conference on Design Participation reflected a growing interest during the preceding decade in a number of key precursors to design participation. Within this period, the year 1964 emerges as a pivotal moment with the publication of four seminal texts.

First, the publication of 'Architecture without Architects' by Bernard Rudofsky (Rudofsky 1964), which explored the history of vernacular architecture. This suggested that convenient, adaptable and in many cases highly aesthetic buildings and urban forms could emerged from an untutored vernacular design process.

Second, in the 1960's, there were a number of significant architectural practitioners and theoreticians who articulated what they considered to be the practical, social and political imperatives for community architecture. This included John Turner, working in Peru between 1957-1965 (Turner 1972). The advocates of community architecture recognised that architecture intersects with social policy and therefore inevitably with ideology. However, they rejected conventional highly interventionist urban (re)development and associated community disruption. Instead community architects emphasised local activism, focussing on incremental improvement, building on existing community organisations and vernacular architectural traditions via self-help initiatives. These ideas were often characterised as being counter culture, non-conformist and represented a dimension of idealism and social action which was completely orthogonal to the prevailing architectural and political ideologies.

Third, the publication of 'Notes on the Synthesis of Form', by Christopher Alexander (Alexander 1964) in which he makes the distinction between 'unselfconscious' and 'self-conscious' designing. While we don't know if Alexander, Rudofsky and Turner were aware of each other's work, it certainly appears that Alexander supports the contention of Rudofsky and associated unselfconscious design with societies that design and build their own buildings, which are often transient or are frequently re-built. He suggested that because the builder is the building user, the resulting architecture is 'unselfconsciously' adapted and 'fits' the needs of the user. On the other hand, he associated self-conscious design with the

establishment of a distinct specialist profession of architects, who develop their own system of ideas, discourse and criticism. For Alexander, architecture became the self-conscious expression of the architect. Alexander suggests that these academic and professional preoccupation are overlaid on and potentially masked the need of the building user.

Fourth, the publication of 'Plug-in City' by Peter Cook and the Archigram group (Cook 1964), which explored the idea of a technological urban service and support structure for flexible housing units which could be reconfigured to adapt to the changing, even transient needs of the occupants. The implication was that the occupants would be able to design and customise their individual units, within the defined constraints of the support system, so that the overall architectural effect would be the aggregation of the occupants' designs. While 'Plug-in City' represents a delightfully playful combination of science fiction, architectural fantasy and cartoon like illustration, it effectively questioned how new construction technologies combined with new architectural thinking might transform the social, technical and professional status quo.

Fifth, in 1972 John Harbraken published 'Supports: an Alternative to Mass Housing' (Harbraken 1972) in which he advocated building public housing structures with continuous internal spans so that the spatial arrangement of housing units could be customised to suit the needs of the individual occupants and potentially allow for reconfiguration for subsequent occupants. In the UK, architects at the GLC used the ideas of Harbraken in the PSSHAK project (Rabeneck 1975). PSSHAK stood for "Primary Support Structures and Housing Assembly Kits". This was used by the GLC in the design of public housing at Stamford Hill, Hackney and at Adelaide Road, Camden.

PSSHAK was a system of prefabrication devised by Nick Wilkinson and Nabeel Hamdi, based on the writings of the Dutch architect Nicholas Habraken and designed for mass housing. PSSHAK:

> "also aimed to demonstrate the feasibility and benefits of participatory design methods in the public sector, the designer acting as 'skilled enabler' instead of the 'expert architect', approaches that Hamdi and Wilkinson have pursued ever since. "(Rabeneck 1975)

Sixth, during the 1970's and 80's the 'self-build' movement developed in the UK, in part by leading architectural pioneers such as Walter Segal. As Colin Ward has suggested (Ward), Walter Segal ideas challenged

> "the assumption of both regulatory authorities and providers of finance, that a house should be a full-finished product right from the start, rather than a simple basic structure that grows over time as needs grow and as labour and income can be spared. Segal's achievement was to devise a way of simplifying the process of building so that it could be undertaken by anyone, cheaply and quickly. He insisted that his was an approach, not a system, and he made no claims for originality or patents."

The historical context and pre-cursor research all contribute to the argument for Design Participation which can be summarised as: First, that the most important aspect of any building is the satisfaction of the people who use that building. Second, if the role of

architecture is to balance technical, functional, economic, social and cultural concerns then the people who use the building are best place to determine this balance.

The key issue is 'user satisfaction' or conversely the issue of 'user dissatisfaction'. We can further decompose this as:

- For most people, the building is not an end in itself, but is an intermediate object which indirectly may be satisfying because it enables other primary activities.
- The lack of user control over the immediate built environment creates a sense of powerlessness (hence user dissatisfaction).

In summary, it is generally recognised that the value of design participation comes from the process of participation (the sense of involvement and control) and from intangible aspects of the building rather than from measurable attributes of the physical building (Broome, 2005, quoting Turner, 1991 and Ward, 1985).

Political Context

What is the political context for 'design participation'? These is a recognised distinction between 'direct' democracy such as referenda where there is direct participation in a specific political decision and 'representative' democracy where a level of indirection is introduced [the representatives] between the participants and executive decision making.

Both types of democracy have limitations. On the one hand, Plato criticised the direct Athenian democracy because he suggested that it followed the citizens' impulses rather than pursuing the common good and did not allow for the emergence of an effective and consistent executive. On the other hand, the limitation of representative democracy is that the decisions of the representative may be influenced by lobbying outside the normal democratic processes. While participation in a representative democracy is 'bottom-up', once the executive is in place all subsequent decisions can appear to be imposed 'top-down'. This may create a feeling of remoteness and powerlessness which is exactly opposite to the sense of empowerment which democracy is supposed to offer. This is reflected in attitudes and participation, for example, the Pew Research Center [Pew, 2013] reported that "Trust in the US federal government" has dropped from 71% in 1958 to 19% in 2013. In the UK participation in general elections has declined from 83.9% in 1950 to 59.4% in 2001 [Hawkins, Keen and Nakatudde, 2015]. Participation in UK local elections in 2012 was 31.3%.

Against this backdrop of a general decline in political engagement what potential basis might there be for design participation. One approach is the idea of 'subsidiarity'. This is:

> "an organizing principle that matters ought to be handled by the smallest, lowest or least centralized competent authority. Political decisions should be taken at a local level if possible, rather than by a central authority. The Oxford English Dictionary defines subsidiarity as the idea that a central authority should have a subsidiary function, performing only those tasks which cannot be performed effectively at a more immediate or local level" [Subsidiarity, Wikipedia, 2016].

The operation of the principle of subsidiarity in early 19th century America was studied by Alexis de Tocqueville in his book “Democracy in America” [Tocqueville 1835, 1840]. He wrote that:

> "Decentralization has, not only an administrative value, but also a civic dimension, since it increases the opportunities for citizens to take interest in public affairs; it makes them get accustomed to using freedom. And from the accumulation of these local, active, pernickety freedoms, is born the most efficient counterweight against the claims of the central government, even if it were supported by an impersonal, collective will."

If we replace ‘political decisions’ by ‘design decisions’ then design participation is effectively the logical application of the principle of subsidiarity to architecture. So how can processes and institutions be adapted to allow different types of participation for different types or scope of decisions?

For society to prosper, it has to adapt and adaptation implies change and change may differentially benefit different stake holders. Uniquely in architecture and other forms of design we can use computer based modelling and simulation tools to predict many aspects of such changes in ways which are directly accessible to the stake holders. Giving direct access to these modelling and simulation tools to those who advocate change and those who feel disadvantaged by such changes would make two contribution. First, it would help to resolve specific design decisions by ensuring that the advocates of change had to demonstrate the benefits to those affected and second, it would extend the democratic process down to a local level, potentially demonstrating the benefits of participation and thereby encouraging further participation in other democratic institutions. Therefore developing the computational technologies for design participation is a key enabler of the democratisation of design and ‘positive feedback’ from the democratisation of design may become a way to re-invigorate a boarder engagement with democratic participation.

Design criteria for a software system for design participation

The primary objective of the ‘Computer aids for Design Participation’ project was to create a computer system to support practical participation. Rather than focusing directly or exclusively on these practical considerations, it was decided to implement this objective within the broader goal of creating a computer-based research tool which could be used to explore how participants design.

We concluded that what was being researched was more than a participant simply drawing or modelling of a building, but a process of decision making and trade-offs in a highly complex multi-variate solution space, combining both visual building geometry and other representations of building requirements and building performance.

Within the overall theme of design participation there is a very important educational sub-theme. Essentially, the participatory design software must not only provide an opportunity for the building users to express their own design intent, the software must in ‘very short order’ educate the participants how to make design decisions, specifically how to make

suitable trade-offs between design and performance variables. Therefore, there is an important educational challenge within the design of participatory software application, that of guiding the building users to understand design and the consequences of their design decisions.

Indeed, the conclusion from the Harbraken/Supports research and the Segal/self-build projects, was that both these approaches offered opportunity for the participant to explore what we might call 'design freedom'. Therefore, it was essential that the computer based participatory design tool presented similar opportunities to explore design freedoms but additionally also communicated the limits to this freedom. The objective was that the participants would be able to express their ideas, but not in a way which could be rejected as unrealistic.

The design of the participatory tools brought together existing research interests in performance based architectural computing and human computer interaction, namely:

From existing research into the development of computer based architectural design tools:

- The advantage of a computer graphic representation of a building is that it provides facilities for the user to create drawings and models, which require less manual drafting skills and can be easily edited to create pristine alternative designs. This enables designers [both professional and lay participants] to experiment with different layout configurations and to explore trade-offs and the consequence of different design decisions. There are many additional benefits by representing a design in a computational form as it provides a direct links to performance analysis software.
- In the design of functional building such as hospitals and schools there may be complex space allocation rules or circulation requirements. In the design of these functional building there are other types of trade-offs which have to be made in addition to the layout issues [mentioned previously]. Certainly for professional architects [and also by implication for lay participants] there is a need for 'decision support' tools to help the designers make these trade-offs and decisions. Often this involves dynamically re-computing space related measures as the consequences of design decisions. This type of instantaneous background re-computation is simply not possible with manual design method.
- Using a computer based participatory design tools, the participant's design can be continually evaluated for energy based building performance measures, and these measures provide important feedback to the participant in a way which is not possible with conventional design media and 'manual' design methods.
- As a by-product of the computer graphics system used, both existing professionally designed buildings and the participants' designs could be represented in the same stylised graphical representation. This removed visual cues from the professionally designs that might otherwise had indicated their original and authorship. This allowed the professional designs and the participants' design to be compared completely 'blind'.

From existing research in human computer interaction:

- A computer graphics representation of architecture is an important 'transitional' representation between 'man and machine'. It is 'human-readable' in that it can be view and edited as graphics by the designer [professional or lay participant] and it is 'machine-readable' in that it can be interrogated and analysed by other software.
- A computer based interaction system can provide an adaptive learning environment, where the participants can develop their skills completely at their own pace, not forced as might be the case with a conventional tutor-student learning situation.
- Simple design rules can be encoded into the system in a form of computerised expert tutor. The participants can be given advice about the viability or suitability of their design which they may accept or not without being under any inter-personal pressure, which might be the case with the presence of profession expert.
- The participant's design activity can be instrumented, for subsequent playback and analysis.

The PARTIAL design research application

The development of the 'PARTIAL' design research application represented the convergence of on-going research at ABACUS into the development and deployment of professionally oriented CAD and architectural decision support systems and contemporary research in human-computer interaction to create task oriented adaptive learning environments (Aish 1977). PARTIAL stood for **PART**icipation **I**n **A**rchitectural **L**ayout. PARTIAL assumed that there would be two users. First, a design researcher would define the participatory design task and who would review and interpret the results of the participants' design and second, a number of participants who would create the designs. To support this research workflow, PARTIAL was in fact organised as a suite of three programs.

PARTIAL 1: this program was used by the researcher to define the design problem, including the space budget [or architectural program] and any fixed building geometry, for example if the design task was a conversion or extension to an existing building. The researcher could also select the different performance measures that would be displayed to the participants, including the visual characteristics of the performance display, its datum and scale. In addition the research could select which tutorial and advice options would be available to the participant.

PARTIAL 2: this program was used by the participant within the context established by the researcher using PARTIAL 1. The design activity of the participant, how the architectural layout was created and revised was recorded in a transaction or history file.

PARTIAL 3: this program was used by the researcher to analyse the transaction file, including being able to display the state of the participant's design at any moment in the design history.

Choice of Building type and Participant

One of the critical decisions in this research project was the choice of building for the participants to design, and therefore the choice of participants. Many previous examples of design participation had focussed on housing, but in this project we wanted to move away from domestic buildings and the associated issues of subjectivity and apply design participation to a functional building where there is a professional relationship between the participant and the building owner or institution. At the time of this research and in the immediate context [the city of Glasgow] there was an ongoing local government program to build nursery schools. It was therefore decided to use nursery schools as the building type and nursery school teachers as the design participants. The ensuing design participatory design sessions harnessed the very immediate and practical concerns of the teachers about the design of new schools which they might have to teach in. Also the researchers had access to a set of architect designed schools to act as a reference for the participants' designs.

In practical terms, the design of a nursey school had to fulfil complex space allocation rules or 'space budget' [this is often called the 'architectural program']. Within this 'space budget' there were a defined number of rooms of different types. Individual rooms of a particular type had to be within a defined minimum and maximum area and the total area of all rooms of a particular type had to be with a defined minimum and maximum area. It was anticipated that as the participant was designing his building, it would be important to continuously re-compute the remaining space 'budget' yet to be allocated. This was not a task that the participant could be expected to complete using paper and pencil calculations. The participant's space allocation task could be more effectively support by a computer based recalculation method operating in the background.

The design process

The initial training was in the form of a tutorial where the researcher explained to the participants the key aspects of the program including drawing, the decision support tools, and the evaluative tools. Typically the researcher would explain, 'this is how you draw a room' (figure 1), 'this is how you check that rooms you have drawn form an appropriate floor layout' (figure 2), 'this is how you check that your design is within the space requirements' (figure 3), 'this is how you compare your design with other existing nursery schools' (figure 4). One participant interrupted this explanation, turned to the researcher and said "You can go away now. I am going to design my nursery school".

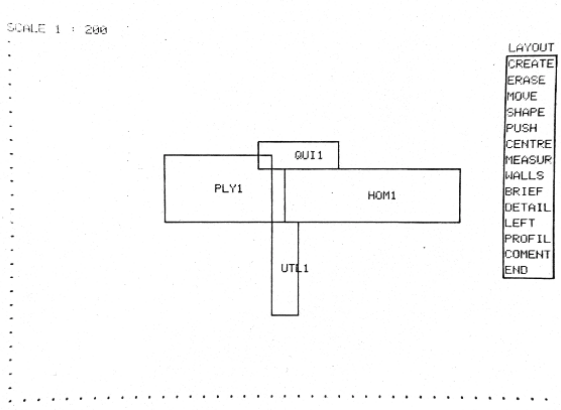


Figure 1. The participant's initial design sketch

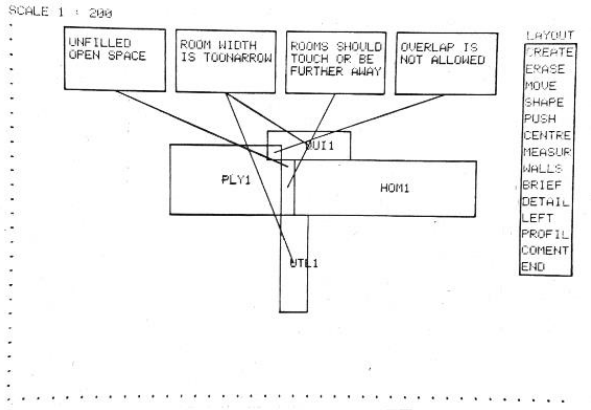
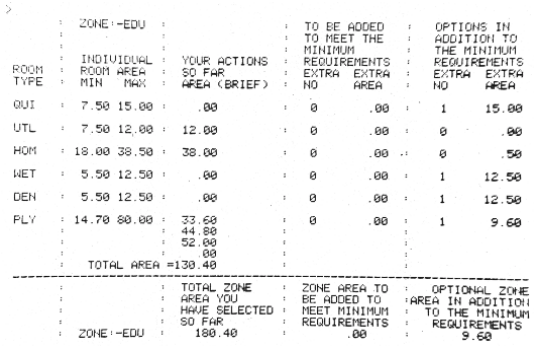


Figure 2. Advising on possible layout issues



ROOM TYPE	ZONE:-EDU INDIVIDUAL ROOM AREA MIN	MAX	YOUR ACTIONS SO FAR AREA (BRIEF)	TO BE ADDED TO MEET THE MINIMUM REQUIREMENTS EXTRA NO	EXTRA AREA	OPTIONS IN ADDITION TO THE MINIMUM REQUIREMENTS EXTRA NO	EXTRA AREA
OUI	7.50	15.00	.00	0	.00	1	15.00
UTL	7.50	12.00	12.00	0	.00	0	.00
HOM	18.00	38.50	38.00	0	.00	0	.50
WET	5.50	12.50	.00	0	.00	1	12.50
DEN	5.50	12.50	.00	0	.00	1	12.50
PLY	14.70	80.00	33.60 44.80 52.00 .00	0	.00	1	9.60
	TOTAL AREA =130.40						

ZONE:-EDU	TOTAL ZONE AREA YOU HAVE SELECTED SO FAR	ZONE AREA TO BE ADDED TO MEET MINIMUM REQUIREMENTS	OPTIONAL ZONE AREA IN ADDITION TO THE MINIMUM REQUIREMENTS
ZONE:-EDU	180.40	.00	9.60

Figure 3. Checking the space allocation performance

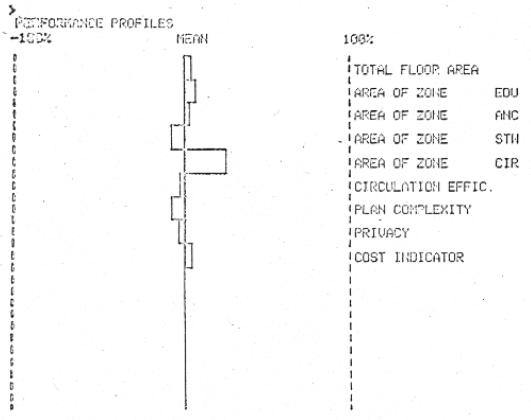


Figure 4. Displaying comparative

Using Partial 3, the researchers were able to replay the history of the participant's design process. Figure 5 and 6 show different time points in the design history as the layout of the school evolved. The initial part of the design process appears to involve the build-up of room areas, while the subsequent part of the process appears to be focussed on changing the layout of rooms to improve performance. The researcher can select different points on the time (x) axis in the design history graphs and recover the participant's design at these time points. For example in figure 5 the research has selected time A and B and the corresponding participant's designs are displayed in figures 7 and 8.

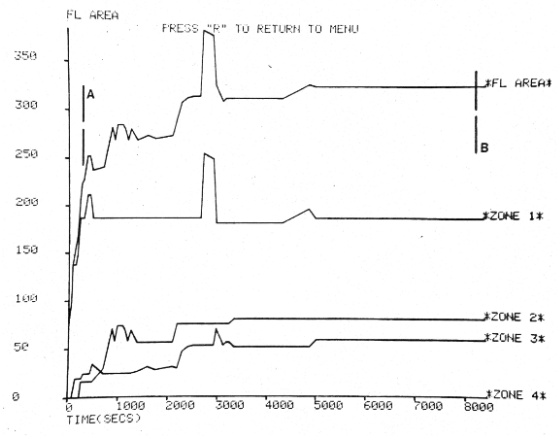


Figure 5. Space allocation during the design process

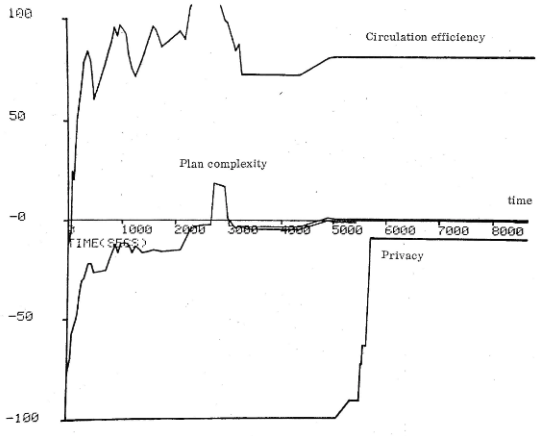


Figure 6. Changes in layout performance

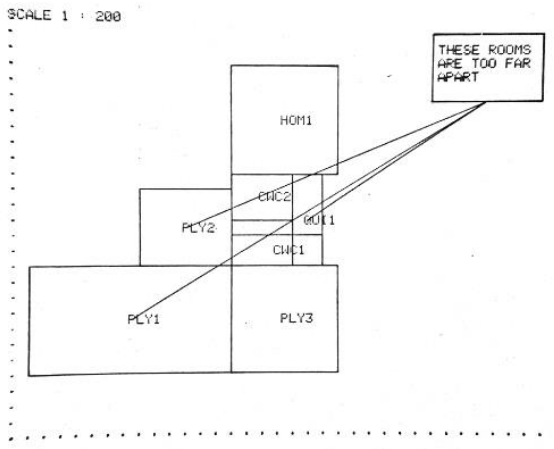


Figure 7. The participant's design at time A

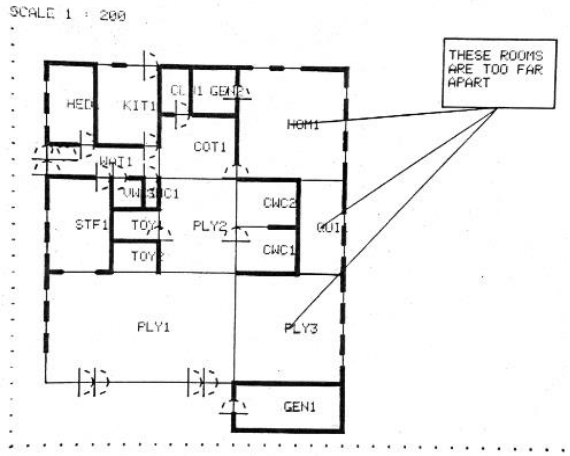


Figure 8. The participant's design at time B

Case studies

A number of case studies were carried out using PARTIAL with Nursery School teachers as the design participants (Aish 1979), (Watts and Smith 1979) and (Smith and Watts 1979) . These included:

- Asking participants to rank existing professionally designed nursery schools.
- Asking the participants to design their own nursery schools, including some very detailed recordings of the design protocol used by the participant (figure 9). These studies demonstrate the number of different design requirements and issues that the participant is able to manipulate and combine into a single coherent design solution.

- Group design sessions where a number of participants worked together to combine their individual designs into a common solution.
- Further ranking exercises where the participants ranked all the participants designs including their own. It is not surprising that in this exercise each participant ranked their own design first.
- A repeat of the ranking exercise after the group of participants had collaborated on a group design. In this second ranking task, the group design was also included in the set to be ranked, together with all the individual designs. Interestingly on the re-test, it was this group design that was consistently ranked first.

"In fact in most cases, the individual considers the eventual group design to be more acceptable than their own original. This would suggest that cooperative involvement produces a more satisfactory outcome to the participant". (Watts and Smith 1979)

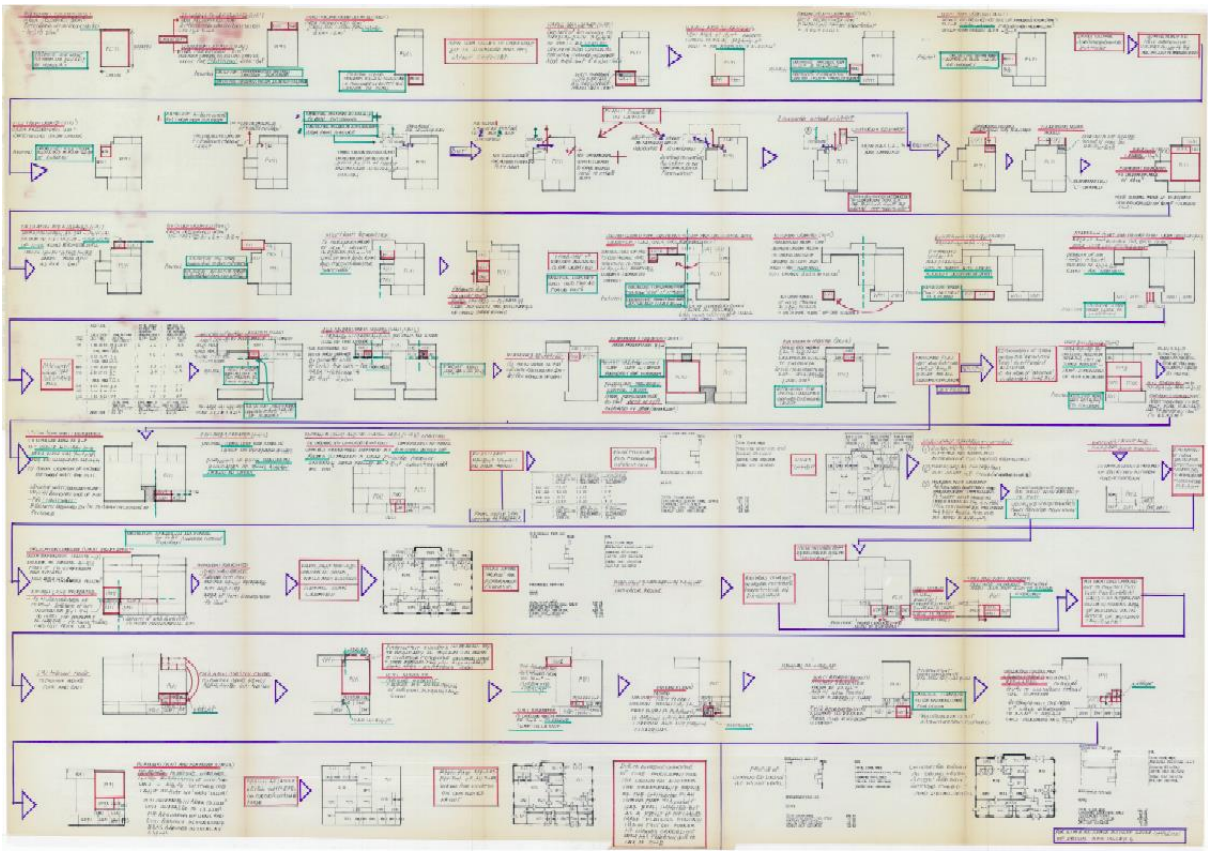


Figure 9. A detailed recording of the design protocol used by one of the participants (Watts and Smith 1979).

Watts and Smith then addressed the question of how to more objectively evaluate the participants' design. They selected six designs developed during the previous participation sessions and six professional designs. These professional designs were redrawn using PARTIAL so that all the designs were presented in the same stylised graphics as the participants' designs with no visual cue to distinguish the professional and participants'

designs. The two groups were randomly merged into a common set, thus creating a completely 'blind' ranking task.

A group of professional architects, not involved with the design projects were asked to rank these designs in order of preference and similarly a group of nursery school teachers, not involved in the participatory project, were also asked to rank the designs. The 'non-involved' architects equally ranked the architect designed schools and the participant design schools. Effectively this meant that in a completely blind test, a group of independent professional architects could not distinguish the architect designed schools from participant designed schools. In the same blind test the 'non-involved' nursery school teachers consistently ranked the participant designed schools above the architect designed schools.

> "It would appear that the participants were able to produce layout designs which were as acceptable to ['non-involved'] architects as those produced by architects using a comparable brief, and more acceptable to fellow ['non-involved'] users than those produced by architects" (Watts and Smith 1979).

Conclusions

There are two conclusions; one about the design research experiments conducted at ABACUS in the 1970's and the other about design participation as part of a user-oriented architectural process.

On the one hand the PARTIAL project at ABACUS stands out as an interesting example of design research, in that it combined some highly original developments in end-user interactive computing with the formal testing of the effectiveness of these tools in architectural design. One of the key aspects of the PARTIAL system was the 'instrumentation' of the participants' design process. As a tool for design research there are many further aspects of design participation which could be explored with this system that time and resources did not allow. For example, the potential exists to analyse the participants design strategies, how different aspects of the design layout were developed or abandoned or different measures of building performance optimised. Then there were the fascinating group design sessions, where the potential also exist to monitor negotiations between the participants and analyse how different features of the various participants' design were combined.

On the other hand design participation has been a contentious issue in architecture, open to conflicting assertions about its desirability and practicality. What is interesting about the findings from the final case study is that we have some objective evidence about the evaluation of participants' design that hopefully can raise the debate about design participation above the level of conflicting opinions.

Whatever our views on design participation it is an example of a wider social and political process of 'democratisation'. In this context the use of computational tools by lay

participants is an important example of the 'democratisation of technology', which in turn has the potential to facilitate the 'democratisation' of architectural design.

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