I propose to consider how added value for professionals, and the consumers of their buildings and students of these processes might be attained. Through the vehicle of new technologies including the humble 'CAD' system a fuller collaboration in design decision-making is aided through representation of 3 dimensional design ideas and their comprehension from different 'vantage' points. Thus computing may enhance opportunity for more informed dialogue involving verbal and visual responses between the intentions of the architect and client and promise to open up more of the architectural design process to participation by the building consumers, bringing 'advantage' to all actors in the design process. More liberated sketching at the system is becoming evident as programmers, and users' skills adapt to the search for more enabling, creative and easier tools, procedures and interfaces freeing responsiveness to consumer wishes. Reflection from clients and practitioners brings hope that a more informed dialogue is enabled through computer supported designing. The beginnings of CAAD support to community groups acts as a facilitator. Contacting and working with community groups follows effective 'Community Development' precedents established in the Liverpool of the sixties; to contact, activate, enable and provide necessary skill supports for community-driven striving for resolution of housing problems. Results of this, ploughed back into CAD teaching for Environmental Planners, brings increased awareness and visualisation of environmental, architectural and human issues and promises to begin a new cycle of more informed participation for citizens, architects, planners and consultants.
C AD vantage for Professionals, Consumers & Students

Introduction

The main focus of this paper is on the particular advantage which CAAD may bring for effective informed, involvement of the consumer in design decision-making with the architect. The use of the term consumer is used to highlight the fact that architects design a product for people to own, use and observe. The term is also used to infer a right of choice in the design and accountability of the designer. Earlier papers define and discuss participation more fully. (Kokosalakis, 1996a & b). The author has held a professional interest in participation since the sixties as a town planner working with architect/planners. A process of documenting the role of CAAD as a vehicle to assist informed involvement of the client in the building design, began in the context of documentation for courseware, as an appointed Teaching Fellow. This paper describes continuing investigation to extend suitable case studies for further documentation. Many of the case studies follow up practices known, studied and informally monitored for periods of up to 25 years. Others constitute new contacts. The cases explore client perspectives on their dialogue with the designer regarding ability to elucidate their own wishes and to comprehend the designers' ideas. They also focus on the architect's perspective of the dialogue. Action research and participant observation are being considered to promote procedures and programs advisedly and explore their potential to serve effective participation. Advantages through computing enhancements (C AD vantage) can be gained for the professional architect in freeing design potential. Architects present variety in methods for CAAD-based dialogue to achieve consumer satisfaction. The more this dialogue is based in intent to illustrate ideas early in the design process, continuing informed involvement and input through to the finished design, the less likely failure to meet the clients' intentions will become, bringing added value to them. Educational activity is enriched through case studies, particularly where consumers viewpoints can be appreciated. Ultimately C AD may AD vantage all concerned.

Professional liberation to design more freely with improved computing

A continuum of approaches to computer facilitation of consumer/designer dialogue

Computing enhancements are gradually freeing up opportunity for increased flexibility to respond to consumer demands within the architect's CAADesign. A continuum of consumer-serving approaches may be considered. Improved & consumer-operated visualisation opportunities (such as QuickTime movies and Virtual Reality worlds, extend potential architect/consumer dialogue. This technological end of the continuum involves greater time in preparation of the material, but
facilitates distant negotiations. Next on the technological scale, hidden line and colour printed visualisations are helpful to the client, particularly when the architect is able to sketch new consumers' suggestions over them. Simply, cheaper on hard copy costs, but taking time in the consumer dialogue, is the approach of seating the client at the system to view, comment, request changes and see them implemented for further consideration. This end of the continuum tends to be time-saving in preparation and clarity of what is agreed, but time-consuming during the meeting. The more traditional approach of CAD based 2D plans and elevations are cheaper, in the short term, but may bring the costs of failure (to explain successfully to the consumer what is intended, thus bringing costs at the extreme of demolition e.g. Southgate, Runcorn (Morton, 1994) and Netherley, Liverpool (Kokosalakis, 1996a &b)).

Software facilitation

The limitations of CAD systems to facilitate modelling of complex 3D forms has been lamented in CAAD literature for perhaps 2 decades. It appears now that acceptance amongst researchers and programmers, has brought a new determination to positively seek to resolve these limitations through enhancing computer support. Relatively simple processes are being enhanced and more complex processes are being simplified, e.g. Triforma developed by the Bentley programmers, Visual GDL from the GraphiSoft stable, etc., potentially announce this tendency to bring greater ease and flexibility. For the consumer this trend suggests the future may also enable the architect to be more responsive therefore, to client design requests which might otherwise have met a technical difficulty from the CAAD aspect. Thus more liberated sketching at the system is becoming evident as programmers, and users' skills adapt to the search for more enabling, creative and easier tools, procedures and interfaces in preference to slavish use of limiting software.

Software user skilling

As CAAD users become more informed about the full potential and background programming of even the CAAD systems they use at present, this has a tendency to be less constrained and more innovative. This in turn can reduce anxieties in their response to demanding clients, assisting participation to flourish. A paper in preparation deals with a change of policy regarding CAAD education at LJMU. One aspect of this, was to introduce new parametric library object creation and manipulation through simple Geometric Description Language programming commands within version 4.12 of ArchiCAD. This appeared to establish a better conception of the nature and potential of the system and freed up a range of design opportunities not otherwise possible through the normal plan-generation of 3D objects. The development of 3D forms by this group became far more ambitious, creative and dynamic.

Sketching with clients

Two recent observations relate particularly to freehand sketching as a medium for participation of clients: One emerged from a video-documented interview by Jon Moorhouse (1996) of architect Richard
Dudzieki demonstrating how he combines fish eye views of 3D interiors initiated in AutoCAD with a digitising pad to sketch in modifications and colour during dialogue with clients about the design. The other was referred to in a video conference organised by the CTI Cardif. A new virtual whiteboard program\(^1\) - distant parties are able to interact and draw on the board. Video conference computer interfaces and cameras to physical whiteboards were also presented. Again, (though presently expensive), these devices enable increased and more effective intervention by the consumer during design development.

**Initial Case Studies**

Considering the potential and actual role of CAAD as a vehicle for participation of the consumer in the design decision-making process, I have interviewed various practitioners and clients. Some constitute new case studies, some revisit cases to reflect on the role played by computing for consumer participation, others continuing monitoring of client/CAAD experience.

**Case 1. Nick Spalton - Client for the Aldham Robarts Learning Resource Centre - JMU**

The architects, Austin - Smith:Lord were major Intergraph users. I had provided ArchiCAD support to Nick Spalton to assist his participation in this project. An earlier co-authored paper (Kokosalakis, Farrow and Spalton, 1993) had related the CAAD processes involved to some extent, but had not really weighed the value of the contribution of CAAD from the consumer's perspective. This paper presents Nick Spalton's reflection on this issue retrospectively. Both Nick and I are users of the building now - he as an information management professional and I as a user of the resources housed there. The whole of his account of his participation in the design, is italicised and in quotes, with my comments in parenthesis.

"How CAAD facilitated the design

The original design for the building was presented to us by the architects on 1:50 scale plans". (The architects mainly presented plotted working drawings from their Intergraph system. They also had some pc based MicroStation systems). “My (Nick Spalton) task was to see what were the possible internal arrangements which we could adopt and which of these led to the greatest ease of use.

Despite some familiarity with plans of this kind and also with an architects' scale rule, it was difficult to envisage what it would be like to 'walk' around the building either in the guise of a user of the building, or as a service provider". (Some visualisations of the exterior and context had been made available).

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\(^1\) The whiteboard software is named EMBONE and uses Internet Protocol. See Jeff Constable and Dr. Mark Retcliffe of Aberystwyth, on the NEAT project (Network Expertise Advice & Tuition) within JTAP subcommittee of Joint Information Services Committee.
"What flexibility was there, in terms of the arrangement of the shelving bays? Could they be aligned on a N-S axis as well as an E-W axis? What was the spacing between tiers of shelving? Was this the same for all shelving bays throughout the building? How did this spacing compare with national standards? Could the shelving bays be arranged in such a way as to minimise noise? Was there enough space for the material we had to store? What was the lighting going to be like? How would the lighting of the building be affected by different arrangements? How would people move through the building? Where could queues be expected? Where would streams of traffic cut across each other? Could anything be done about this? These were the sort of questions we asked ourselves.

The original response to these questions was to cut out the objects we wanted to place in the building, using graph paper, scissors and glue".  
(Here, Nick was taking photocopies of the rather traditional CAD working drawings the architects had drawn and plotted. Whilst the CAD was accurate, the cut outs were incrementally enlarged by the copier).

"This worked fine for a while, but it was slow and not particularly accurate when working with small objects. The errors involved and the tedium of working through the number of different arrangements eventually led us to the use of CAD".

(For ease of comprehension and use by Nick, I translated the proposed building data for each floor to ArchiCAD. Thereafter, we sat in front of the screen and Nick described what he wanted and I drove the system in response).

"We were then able to fairly speedily work out a number of 'ideal' solutions to the internal arrangement of the building and report our findings back to the architects and the other participants on the design team." (User Group)

"A number of problems arose at this stage. The internal arrangement adopted by the architects we discovered were guided by the combined lighting/ceiling units. The placement of these was in turn guided by the modular grid of the building. Yes we could move the shelving bays to an 'ideal' arrangement but if we did so they would be out of phase with the light fittings. They would also clash with pillars. The only possible way of arranging the shelving bays was that which had been initially proposed by the architects.

Despite the attempts of the architects to involve the clients in the design of the building the project was at too advanced a stage to contemplate any changes. It wasn't that it was impossible, it was just that we would be changing the design brief. That would cost money. There wasn't any money.

We accepted the design as provided by the architects whilst making some changes by having some shelving bays here and not there. We rotated some through ninety degrees to help baffle noise. We tried to ensure that there were clear lines of sight from the staff areas in the centre of each floor to facilitate supervision. And we looked at the ways the material could be arranged e.g. by subject, by form, by shelf number and by
academic discipline, but basically the internal design was as given to us by the architects”.

Discussion

As a key consumer, the site librarian, found ArchiCAD helpful to visualise, explore, test, clarify and communicate his requirements. He regrets that this input was not elicited at the early conceptual stage, when it would have been possible for incorporation of his ideas and professional advice. The significant differences in the early and later stages were that later:

a) the CAAD model was in front of him and accessible to him,

b) he could direct what plan or 3D data he would view

c) he could explore alternatives of his choosing (with my help)

d) direct metric data entry rather than scaling complications was easier and

e) immediate reassurance of accuracy and access to associative dimensioning was helpful.

It should be said that this was the first time the job architect had engaged in the CAD system himself rather than leaving CAD draughtsmen to enter the data. He and the LJMU consultant architect acting for the User Group found tremendous advantages in this, particularly the ease of modification of the 2D CAD drawings after each meeting, where changes were considered for acceptance and modification, even though the fundamental changes which Nick felt were relevant were not possible as he says without major additional funding. One exception was that his stock allocations to his alternative shelf planning CAAD options, did establish the need for more floor space, which was met not by modification of the new building design, but by an extension through to an adjacent existing building to be renovated.

Case 2. Tony Barrett - as client - Barclaycard

Tony Barrett echoes the librarian's mourning of missed opportunities, in a report (Stockdyk, 1996). PERA, Engineering Consultants had created an Interactive Virtual Reality model from architects' Fitzroy/Robinson's AutoCAD model. Barclaycard were able to view and respond. One change was made to the colour scheme, but Tony Barrett for Barclaycard bemoans the fact that it would have been more useful six months earlier.

Case 3. Chris Pritchard - architect at Austin - Smith:Lord, Warrington, Merseyside

An interview recently conducted by Jon Moorhouse1 with Chris Pritchard also of Austin - Smith:Lord, indicated his particular concern to capitalise on CAAD in dialogues with the client, for their extension of MOMI, Bradford. He had concentrated on maximum economy in cost/benefit of effort/design production, including rapid production of renders,

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1 CAAD research student at Liverpool John Moores University, School of the Built Environment.
innovative use of MicroStation and completion of 14 options on CD for the client. Chris Pritched named his activity with the clients "Optioneering".

Case 4. North British Housing Association - architects, Manchester

In earlier studies (Kokosalakis, Moorhouse, 1995a & Kokosalakis & Moorhouse, 1995b) of these architects, on reflection, they had perceived themselves as designing at the CAAD system. This was seen to be generally the case though it did vary between members of the team, from "almost totally", to "never". They already proclaimed the benefits of 3D CAAD in negotiating with lay people such as planners and with organisations responsible for setting housing standards.

In a more recent interview, I established that they consider that they have extended this in a number of ways. They mainly, (but not exclusively), design dwellings and residential layouts for branches of North British Housing Association throughout the country. Clients include smaller, unassociated housing associations. Design work does extend beyond housing.

NBHA are very interested in participation as involvement by relevant parties in the building design decisions. This may include some people, for whom training and experience may have covered issues about urban design, building structures, maintenance and even architecture, (for example, housing managers, housing association project development officers, planning control officers and elected local authority planning committee members). However more usually, the professionals, councillors, owners and potential clients, etc. with whom they negotiate have been almost exclusively, neither architects, designers and often not even particularly computer literate people.

They have found clients really start to understand the design and issues relating to it when they, the architects present CAAD output to them. Their clients seem "to really appreciate more realistic details being added such as brick lintels". They have moved from preference for hand rendered hidden line perspectives, to rendered images, in their more recent brochures. Generally they have extended their efforts to use ArchiCAD and associated Artlantis rendering and QuickTime Virtual Reality technology to illustrate the designs more realistically to their clients.

Several stages of consultation occurred with a recent sheltered housing scheme and chapel for ageing, infirm brothers of a Silesian Monastic Order. The Board of Trustees Steering Committee were invited into the architects’ office to explore a few QTVR movies (previously output from ArchiCAD), viewed on a 19" monitor. The committee included members of the management hierarchy, two external professionals and some elderly Silesian brothers, who would be future residents of the sheltered dwellings. (Clients are actually able to explore QTVR independently with the cursor).

Gordon Snape told me that the clients "got to really understand the building and were able to grasp security and access issues better". The
event seemed to trigger requests for yet more movies, as a basis for decisions, “including the interior of an individual flat”.

Another case study involved the Monsall Infill Site Scheme, Manchester, where NBHA worked on designs for the clear sites amongst the main Local Authority refurbishment. In a QuickTime movie I had developed from an interview with John Rhodes, it was already clear that virtually all his work consists of Computer Aided Architectural Designing. He had explained how he valued the opportunity to use hard copy of hidden line views from the system to improve informed discussion about the design with non-architects.

He now explained to me that he has extended this activity in his residential site layouts based on 3D animations and QuickTime VirtualReality output from ArchiCAD and further enhanced textured rendering through Artlantis. He finds the use of CAAD "infinitely better" than the traditional methods, particularly for the client. He referred to a case where CAAD figured in debate regarding concerns about the proposed development potentially causing overshadowing problems for the occupant of a neighbouring council house dwelling. In this particular case the ArchiCAD models' sunlight study facility showed there was no problem and the participant did not need to seek change of the design as a response.

In a new NBHA development, Gordon Snape is about to embark on a roadshow, using an overhead LCD panel interfaced to a PowerBook, loaded up with a PowerPoint presentation, which incorporates video clips from QTVR 360 degree movies of ArchiCAD models for 4 of their standard dwelling types.

The presentations are to new local area housing association directors, who will utilise his office's architectural service. Whilst this appears to be mainly a self-marketing exercise to non-architectural colleagues, their housing experience coupled with 3D visual exploration will provide them with a real reference point for their own informed participation in debate on the designs. The next stage will involve Gordon distributing movies (for consideration) to the computer DeskTops of these distant directors, via networking from his Manchester office.

NBHA (not unusually), rely for much of their work on competition entries. Gordon is disappointed that there is still insistence on paper entries. They do submit computer generated output, but he would be delighted to have the opportunity to use the advantage of directly viewed computer entries. This would also give them a tremendous lead over their competitors, since they became so expert.

In conclusion

Whilst much of this activity could be defined as resembling marketing, or persuasion, and is only starting to enter a fully participatory arena, nevertheless, by opening up access to CAAD for the client/consumer, empowerment begins to move more towards their grasp, even in simple terms of being able to point to something specific in the visualisation, and question, raise objections, or request an alternative which springs to
their own mind. This is particularly so in QuickTime Virtual Reality movies, where the consumer has greater control to actually explore and position the viewpoint, (even though at present constrained by the range set up initially by the architect).

Case 5. Ainsley Gommon Wood - architects, Birkenhead branch, Merseyside

Peter Gommon (of Ainsley Gommon Wood practice) is a firm believer in client participation in design. He is a member of the RIBA Community Action Group. The practice have used MicroStation for pcs for some years. 3D CAAD paper-based output is normally used for communicating with clients. Steve Vant, their CAAD technician rates CAAD highly for its "ease of production, visualisation, novelty and clarity". The partners are pleased to have now embarked on a new initiative to bring the client to the computer. Steve initiated such a meeting recently with clients of their Market Wells Foyer project. (See Fig. 1). This building will accommodate the "homeless". To a group of the clients, he flicked through a few 3D views for them, (his quiet understatement of his own effort). I sensed a tinge of disappointment in that he said it had to be rather rushed between other activities in a rather heavy present schedule. He recalled that the clients mainly talked amongst themselves about what they were observing. However, the main point is that this is now an established technique for participation, whereby, given sufficient time, the clients' views can be coaxed out of them.

Case 6. Dave King - architect, Liverpool

In contrast to NBHA's move to more time spent on high quality visualisations, Liverpool 'paperless' architect, Dave King, related to me recently that he much prefers to work with clients directly at the Mac, rather than spending time on rendered images or CAAD drawings on paper. He finds that it transforms the facility for client comprehension and architect's response.

He referred to a house design (noting that the residential client is probably the most informed in terms of potentially having the best understanding of what is wanted from the design). This suggests a tendency to accept that most clients are fairly well informed of their expectations from the design, which is rather borne out by his particular interest in responsiveness of his work to the client. He described his preferred approach to client participation. Seated in front of the CAAD system (MiniCAD with StrataVision in Dave's case), the client is in a much better position to articulate their desires, whether in reacting to a range of pre rendered and hidden line views, which Dave will always have ready in a folder to consider with them, or (as he prefers), by working through and around the MiniCAD model. Since he always holds backup copies on the optical drive, he has no anxieties about making requested modifications to explore instant investigations of the impact of client suggestions through the model. He does have some concerns about the time that visualisations take in MiniCAD. He also fears that animations and rendering may be too seductive.
Discussion

This account confirms the impressions from Nick Spalton and Tony Barrett that access to the actual CAAD system at an early stage of the design might bring greater potential for consumer interventionary dialogue and responsive design modification by the architect.

Regarding Dave King's sense that animations and rendering can become too seductive, there is an argument for suggesting that (whether consciously or not), the architect will probably intend animations and rendering to act as devices to persuade the client rather than to offer them full rights to modification, or rejection. Clearly changes to designs involve more work and are therefore costly, often prohibitively so. The more time, cost, effort, ownership and emotion is invested in a design, the more likelihood there is that the architect will be reluctant to make changes to it.

It is heartening to find increasing use of CAAD serving consumer involvement in design decision making, particularly in NorthWest England, where CAAD was slow to be implemented initially, possibly due to the general poverty of the region, which has now been recognised through Objective One status in the European Community.

Community CAAD

In response to requests for academic support from a local community, Dr. Rob MacDonald, Reader at the JMU Centre for Architecture in the School of the Built Environment, recently embarked on a new initiative.

Later, I was invited to introduce the committee to the potential of CAAD as a vehicle for their negotiation of urban design, environmental design, housing refurbishment and new architectural design of facilities.

Both Dr. Rob MacDonald and I had observed and been in contact with various community groups in Liverpool in the previous decades. (Kokosalakis, 1996a & 1996b), he more directly than I. Issues of the ideas or approaches to community development accepted as important in this project have been referred to by Bailey (1975) as follows: “It is the work of community development . . . to ensure that all concerned are properly represented, taken account of when decisions are made and that they compete on equal terms. . . . methods used must produce changes in people” . . . (including officials) "which will lead to increased discussion, understanding, co-operation and experimentation “ . . . (including) . . . “to produce situations, in which there is a possibility that feelings can be changed . . . Local groups are formed over particular issues. What is being asked by the community is a share in the decision-making process, . . . development of people, self-awareness, (including) . . . the process of change in one’s self ”. . . (as community worker) "modification of attitude, self examination” . . . to contain “the ideas of ‘processs’, ‘emergence’ and ‘change’”.

The community worker should never be seen to represent, only to enable representation.
With this in mind, I embarked on enablement in matters of design by assisting the community to utilise CAAD modelling as a vehicle to communicate their ideas of what is needed on the estate. It was seen as essential to establish community control from the start. Following best learning principles I started with familiar data, i.e. their dwellings, rather than considering potential new developments. Accurate architects working drawings were not found. They were assumed lost during the transfer from New Town status. The community gathered alternative, archived photographic, written and sketched material on the house plans, etc..

I supervised a voluntary CAAD placement student, giving him the estate house models as training focus. Steve Cawood proved to be an exceptional useful student. There proved to be considerable discrepancies in the archive data, as much of the estate plan material was in public exhibition format and out of scale. Data was not available for window and door positions. The residents responded by sending us dimensioned drawings from their own surveys.

A meeting was arranged with the Residents Association committee to use the trial house models for initial explanation and training introductions to CAAD usage. Armed with the PowerBook, we embarked on our first session. We met at the acting Chair lady's house. (See Fig.2.). The first item on the Agenda was the CAAD introductory session. I explained concepts of data entry, dimensions, coordinates, scale, and library objects within the context of the part complete 3D estate model. This included explanation of use of menus and palette tools. I changed role from driver to instructor early in this process to bring the residents into active participant learning mode. After orientation by reference to the scanned estate plan and the generation of 3D projections of a few house models and a sample model of an existing terrace, they soon explained slight differences in house types, which could explain discrepancies between the various estate plans to some extent. Each member then proceeded to try out a few commands and moves. Non and computer literate members all made slight changes to the models. Almost instantly the visualisations at the screen prompted design issues.

Problem 1

The main issue focused on the space created for access. The continuity of the front half of the terraced row of each house type is interrupted by the ground access area for each dwelling. The design of these building types cuts a paved area into one half of the terrace width, cutting out the front pitch right back to the ridge. (See Fig. 3, 4, 7 & 8).

Adjoining neighbours share this space roughly in the proportion of 4:1, although there is no physical indication of the line of demarcation on the ground or the back wall. (Indicated by dotted line on Fig. 3). The front door of each dwelling is positioned in the extreme left corner on the left wall and the neighbour's bin cupboard door is located (ironically) more
visibly on the extreme right corner, but on the facing back wall. (See Fig. 4).

Residents consider this to be:

i wasted space
ii insecure, dark, dangerously open to attackers and thieves
iii indefensible, space and
iv lacking clear visual or physical definition or deterrent, despite clarity of legal ownership.

Problem 2

A number of residents pointed out that structural problems are occurring at the upper joints of the ridge and the perpendicular walls

*Learning and Action*

The residents began to enter new walls to enclose these spaces on the CAAD model. This one discrete, design move, accurately positioned with the aid of the intelligent cursor, evidences the catalytic role which accessing CAAD might bring. They immediately projected the idea of two alternative solutions: first to completely build up the space by two floors of wall (Please note the inserted walls in Fig. 5), and roof and second to only introduce a ground floor structure over this existing paved area and build a terrace over the top. They experimented with introducing table and chairs and people on the terrace to consider the ergonomics of the space available.

The members were extremely well informed about their estate, housing, contacts, officials, and elected members. They had identified failures of structures and design on the estate and gave us a site tour and house tour to illustrate this. Regarding uncertainty on inaccuracy of the supplied data for the house models, they volunteered immediately to point out the various house types on site and photograph and measure controversial dimensions.

Problem 3

emerged during the site tour, when the committee members were endeavouring to obtain information about the bungalow dimensions for the CAAD modelling. The bungalows had been located in a manner which totally enclosed a small yard to each. The middle bungalow in each group had no access from the yard for bins and garden rubbish, except through their carpeted hall. This meant that council workmen refused to help them, despite their infirmities. (See Fig. 6).

Problem 4

These bungalows had deteriorating felt roofs, yet the dimensioned 3D models soon pointed up to the members visually that the roof slopes were considerable and probably suitable for tiling. This was confirmed when they discovered an archived photograph, showing one of the bungalows with a tiled roof in place.
Shortly afterwards they unearthed elevational drawings from a window replacement scheme. The accuracy of the dwelling models was improved. Committee members came into LJMU to see how the next stage of defining attributes of materials and rendering was achieved and to check the success of the visualisations. They arrived armed with photographs to match-check colouring of walls. Their comprehension of the process and its potential was rapid. Conversation moved to animations and the question of key frames and in between frames. A quick reference to well known morphed images in TV adverts was sufficient to begin to describe the inbetween frames as morphed stages and they were ahead, or in Liverpudlian, star learners!

The house type models were saved as library objects and positioned on a scanned site map. During this time the committee were busy extending the network of activity, interest and commitment. Although many are now owner occupiers, they assist the development of a Tenants Management Organisation with a Section 16 grant and they attend training courses in Community Development, committee organisation, etc. from CDS Housing Association's trainers. Though, they rightly proclaim that recognition of their skills, awareness of the need for democratic community action and decisions, and how to achieve this, have been acknowledged. In the most recent visit the flourishing of these skills was evidenced in an exhibition they mounted for fellow residents. I attended to start a wider process of involvement eventually of the whole community, starting with familiarisation with CAAD through verification of the discussion of the problems to be resolved.

**Ploughing back material for Student learning**

In preparation of the 1997 material for CAAD modules for two groups of Environmental Planning students, I decided to include the new house library objects as potential alternative dwelling types. Since they included bungalows and two and three storey flats and houses they presented a real choice for the students. (See Fig. 6, 7, & 8). (I had previously used CAAD models of another estate to teach residential estate layouts and the CAAD for this task). The project site was a difficult one, slotted in between mostly 4 and 5 storey buildings and overlooked by the Catholic cathedral. The intention was to illustrate through practice to (non architect) planners, the potential of CAAD to assist their visualisation of and assessment of suitability of alternative mixes of house types regarding scale, space, mass, height, rhythm, etc. in relation to the surrounding urban forms. Their enthusiasm, 3D visualisations and critiques of these in reports showed achievement of the objectives. They have subsequently found that this course has assisted them with the urban design course. Some of them actually requested to use CAAD for a later Urban Design project. The Residents Association have volunteered to come in and discuss design issues with them from their perspective.

**Conclusions**
Added value appears to accrue to consumers in providing a device (through CAAD), to enhance their comprehension of the design ideas and details being proposed to them by the architect. The more realistic the image the more potential for the consumer to be able to articulate their own ideas and preferences for the design with reference to the aspect of the CAAD model in view. Economy of effort and potential for satisfaction may be best served by simplicity of positioning the startpoint of the role of the CAAD model in participatory dialogue early in the design sequence. Though it can be argued that more investment in time and kit may enable much more effective client comprehension through use of attributes of materials, textures, lighting, and walkthrough effects, including QTVR. The latter approach (and any consumer-controlled viewing) brings the added value of time for reflection and possibly consultation by the client with colleagues or family members or neighbours.

Added value for the CAAD proficient architect/designer may include improved ease of: use, generation of options, modification, dialogue with the client, satisfying the client, negotiating with officials such as planners, input and output of other professional data, self appraisal of the design and in some cases development of design ideas. Much of this has not been covered in this paper, as the intention was to focus on the added value of CAAD to assist the architect in serving his client.

Added value is certainly offered by CAAD to the student, particularly to those who find 3D visualisation difficult in their mind. In terms of the exercise referred to, the added bonus was the residents' articulation of their estate design problems through reference to the CAAD model and transference of understanding of those issues to the students.

For the residents it is evident that CAAD immediately enabled them to refer to potential design solutions they had in mind and to start to introduce these in the model for exploration.

Added value from CAAD as a vehicle serving participation of consumers of architectural and urban design, appears to have varying degrees of possibility. Ultimately, success in participation depends on comprehension, two directional communication, responsiveness, intention, commitment and even accountability, to name a few difficult issues. If CAAD helps with any of these, it will bring advantages to all concerned. I therefore entitle this paper - 'C AD vantage for Professionals, Consumers & Students.'

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*CAD VANTAGE for Professionals Consumers and Students*

*Fig.1 Market Wells Foyer project:* Ainsley Gommon Wood, Birkenhead

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*Photo of people with dogs.*
Testing the Benefits of Animation
This paper presents the results of an attempt to empirically test the hypothesis that expanding the range of graphic formats used in architectural communication can lead to an increase in effectiveness. To be specific, the comprehension of users was tested to measure the effectiveness of computer generated animation in comparison with still images. The dynamic functioning of a natural ventilation system was explained to two matched groups of building users. The explanation was presented in an animated video to one group and in still images to the other group. Immediately after viewing the group which viewed the animated version demonstrated a superior comprehension in a multiple-choice questionnaire test.
Testing the Benefits of Animation in Architectural Communication

Introduction

Whilst much of what is done under the title of CAAD is simply an amplification of the draughtsman’s function, one of the truly innovative functions which CAAD brings to architects is the ability to create animation. This might be compared to the quantum change which takes place when a designer shifts from plan and section, to perspective and/or axonometric representation. Eastman (1970) presented results from experiments which demonstrated that architects working with three-dimensional drawings were able solve functional problems in room layouts which were not even perceived by architects working in two dimensions. A similar enhancement of ability can be hypothesised for architects who work in four dimensions in comparison with their colleagues restricted to three dimensions.

However, little evidence exists to support such a contention. Indeed there is anecdotal evidence to the contrary. The availability of technology which makes it possible for every designer to indulge in the kind of fantasy which many associate with the medium of the moving image, appears frequently to result in the indiscriminate adoption of animation as a gimmick to demonstrate technological capability rather than as evidence of the effective communicator’s skill of selectivity.

The animation used in this experiment was created in Superscape VRT, a virtual reality creation package. Devlin and Rosenberg (1996) have warned that “Attempts to use VR … have been … problematic. In the specific domain of the construction industry the main problem is that the virtual world presents users with too much information. This makes it too difficult to abstract all, and only the information relevant to the task in hand”. It is therefore not certain that new media will always prove superior to existing solutions. They must be used selectively.

The resources available to the communicator (transmitter), the particular needs of the audience (receivers) and the nature of the material to be communicated (message) must all be considered. This experiment is made possible by the increased resource available to the architectural profession in their role as communicators. An audience of architectural students has been selected in order to ensure a basic level of interest in the message and an inherent ability to comprehend it. Finally it was decided to test the new medium with a message which previous experience led us to expect would benefit from the use of a time-based medium.

Appropriate formats for specific content

The use of more elaborate graphic representations, such as iconic formats representing the appearance of the built environment, has been recommended by McCartney (1985) in situations where the message is
complex in terms of its sensitivity to design characteristics, particularly formal variables. Iconic formats were also recommended when the audience was not completely familiar with the message and required assistance in relating the new information to previous knowledge. McCartney and Rhodes (1991) presented the argument that the difficulties faced in attempting to comprehend environmental phenomena is often due to the mismatch between the essentially dynamic nature of most environmental phenomena and the static techniques architects adopt to present them. Their comparative experiments indicated the possibility of using task based measurements to discriminate between the effectiveness of 2-D animation and still-frame based presentations in assisting designers to predict wind movements through urban environments.

Few built environment phenomena are more essentially dynamic than air movement. The students who participated in this experiment had recently moved into a new building which featured five prominent towers which were an integral constituent of the building’s natural ventilation system exploiting the convective circulation which occurs in stacks. The nature of air circulation through the studios and towers, and the techniques of controlling the flow, constituted the referent content, or message which was represented in both static and animated formats.

**Experiment Design**

A class of 79 first year architectural students were divided into two groups. Each group received a presentations explaining the design strategies for natural ventilation for the building they occupied in one of two alternative presentation formats. One group were shown a video created from a virtual reality 3-D model of a building using animated analogue elements with a tracking viewpoint. The second group were given a presentation of equal length using 13 key frame images selected from the animation. (Examples of the still-frame presentation are shown in figures 2 and 3). The duration of each presentation was equal (4 minutes), and there was no verbal commentary. A comprehension test applied to both groups was intended to test the effectiveness of the specific function of animation in communicating the ventilation strategy.

**Test**

Unlike Eastman’s experiments, the effect of the means of representation on problem-solving capability has not been tested. Instead, the more fundamental condition of comprehending the nature of the built environment phenomena which are represented was the subject of test which comprised eight questions. Multiple-choice questions were used to facilitate consistency in marking the responses.
The questions were intended to test comprehension of the presentation, rather than prior knowledge. The questions are therefore highly specific, referring to information which was conveyed in the presentations. They deal with different aspects of the ventilation system which is illustrated, including questions of quantity, recognition of actions and components, identification of component position, and direction of movement.

1. What action does the automatic building management system take to induce natural ventilation within the studio spaces?
2. What action can the building users take to initiate natural ventilation within the studio spaces?
3. Where are the inlet grilles to the ducts in the studio located?
4. How many smoke dampers are positioned in the duct between the studio space and the stairwell?
5. Within the duct, how many times does the air flow change direction, before it reaches the stairwell?
6. In what direction is the airflow moving when it leaves the duct and enters the stairwell?
7. In case of fire, how would the automatic building management system prevent contaminated air passing from the studio spaces into the stairwell?
8. If the building overheats, how can the automatic building management system increase the rate of air flow after the windows have been fully opened?

Table 1 Questions used in the Comprehension Test.

Results

In seven out of eight questions used in the test, the group which had watched the animated presentation achieved higher scores than the group shown the static, key-frame presentation (fig. 1). Averaged over all eight questions the difference between the scores of each group was 13
percentage points. Statistical analysis using the Kolmogorov Smirnov test, showed that the difference in performance of the two groups was significant at a level of $\alpha = 0.05$.

Question (8) concerned the operation of two large fans at the top of the tower. It is perhaps surprising that this was the one question in which the group who received the static key-frame presentation recorded a better score. As the fan blades were shown rotating in the animation, it might have been assumed that this additional graphic cue would have drawn additional attention to them. However the difference recorded is small (81% cf 73%).

In questions (1) and (6), the differences in percentage scores were 26 and 28 respectively. Question (1) is similar to (8) in that it requires the identification of a moving component. Question (6) on the other hand concerns the identification of the direction of air movement.

The three questions which both groups found most difficult to answer correctly are (4), (5) and (6). Both groups achieved an almost equal score of about 40% for (4) which was quantitative, in that it required subjects to recall the number of smoke vents in the ductwork. (These elements had been represented as moving in the animated version, and had broken arrows to indicate movement in the still frame presentation). In both (5) and (6) the group which had watched the animated presentation scored more than twice as many correct answers than the group who had watched the still frame presentation. These questions both required respondents to recall, or infer, directional information.

**Comment on experiment design**

It is a well known problem in experiments with alternative graphic formats that it is difficult to establish conclusively that two alternative formats are equivalent. They might differ in either their ability to represent the class of formats, or in the information content. It might also be necessary to alter modes of symbolisation to suit the special needs of a specific graphic format. In this experiment, the symbol adopted for air movement in the still-frame images, is a twisting, two dimensional arrow. When it came to viewing the air movement in a three dimensional animation this symbol would disappear if viewed from certain angles. Therefore in the animation, a cone shape was substituted for the arrow to symbolise air movement and to indicate the direction of flow. It may be that the mode of symbolisation affected viewers.

However, a survey of architectural journals showed extensive use of the arrow format to represent air movement, and no use of cones. (In the year ending in July 1995, the weekly *Architects Journal* published 118 examples of different types of arrows being used to illustrate air movement through buildings Jacobs (1997)). It is not unreasonable to
assume therefore that architectural students would therefore be more accustomed to interpreting the still-frame images, and that the improved comprehension exhibited by the animation group was achieved in spite of a potential disadvantage with regard to the mode of symbolisation.

**Conclusions**

The experiment presented here demonstrates that it is possible to measure significant differences in audience comprehension when comparing alternative graphic formats, such as animation and static representations. In this case, comprehension was shown to be significantly greater in the audience which was presented with information in an animated graphic format.

However, in the experiment described here, there is considerable variation in the differences between the two test groups in answering different kinds of questions. The variation in responses reinforces the introductory comments regarding the importance of selectivity in the preparation of effective communications, and the necessity of matching the media and the message. The experiment presents evidence of the large improvements in comprehension which can be attributed to the superiority of the animated presentation used in the experiment particularly with regard to questions of direction of movement. But surprisingly, less improvement is shown in responses to questions concerned with the identification of mobile building components.

It is also difficult to draw reliable generalisations due to the difficulty in comparing both the graphic quality of the two presentations used in this experiment and the extent to which they might be claimed to represent the categories of “animated” and “static” presentations.

Animation has been shown to make significant improvements in the effectiveness of communicating specific types of information to certain types of audience. But with some types of information content, animation might actually distract some audiences from the intended message.

**References**


