BUILDING ARCHITECTURE

Using sticks, stones and computer visualisation

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Abstract. This work explores the transformation process from drawings to buildings by inserting unusual representation techniques between traditional orthographic drawings and actual buildings. The aim has been to explore the links and gaps between architecture as drawn and as built to gain a better understanding of the translation from idea to building. Computer modelling techniques enable designs to be ‘built’ at full scale and resolved in great detail. This type of representation was compared with built models, also at full scale, but using a mix of model making and real materials. At one school students interpreted actual working drawings from architects and at the other school, students worked from theoretical designs. By exploring the translation from idea to building using a range of representational interventions, this research creates a nexus between current issues of representation and design/construction research.

1. Introduction

Prior to the Renaissance, the use of orthographic drawings was rare. Since the nineteenth century, architects have had an implicit trust in the accuracy of orthographic projections (Perez-Gomez & Pelletier, 1997). But recent theorists into representation such as Evans (1995) and Sekula (1989) have argued that shifts in interpretation invariably occur between an object, its representation and the viewer.

This research builds on current thinking across several fields. O'Shea (1997), Trumbo (1997) and Spender (1993) compare the differences between multimedia and print media for the storage and dissemination of information. Evans (1997) and Perez-Gomez & Pelletier (1997) reveal an invisible perspectival hinge that is
always at work between drawings and the realisation of architecture. Ford (1990) looks at a range of twentieth century architecture and uses cut-away axonometric models to reveal conflicts between design styles professed by architects and their construction styles.

The work referred to in this paper has been undertaken using students from two schools of architecture. At one school students have interpreted working drawings of actual buildings while at the other school students have explored hypothetical scenarios based on student designs. Both groups are tackling the issue of translation between the representation of ‘idea’ to its realisation as ‘building’ but from opposite angles. One group is working backwards (through analysis) from the construction of real buildings while the other is working forward (through synthesis) with the design of theoretical buildings. By comparing and contrasting two distinct approaches to understanding the relationship between ideas and constructions of ideas through design, a powerful dialectic results: analysis versus synthesis. This dialectic serves to show that conventional representations of constructions alone serve a peculiar principle, one of abstraction. ‘Conventional’ representations are loaded with implicit meaning – the viewer is obliged to extrapolate from representative samples. The consequences of this in terms of site working relationships between architects and building contractors are obvious. The consequences too for architectural construction pedagogy are also clear. The work reported here therefore considers the paradigm shift between abstractions and virtual representations made possible through the use of the computer.

2. Method and significance

By inserting unusual representation techniques between the traditional orthographic drawings and an actual building, it has been possible to study aspects of the transformation from drawing to building. In the space between the working drawings and the built form, up to five types of intervention were placed:

- Computer models composed for plotting at various scales
- Computer models composed for plotting at 1:1 scale
- Orthographic projections at 1:1 scale
- ‘Built’ models at 1:10 scale using model making materials
- ‘Built’ models of details at 1:1 scale using model-making and ‘real’ materials

The questions we were asking dealt with issues of scale, materials, view and process but some unexpected outcomes were also revealed.
Do details get drawn differently if it is known they will be plotted at full scale?

How does the ‘building’ of a computer model at full-scale differ from building a full-scale solid model?

What interpretive shifts occur when the designer is not the builder?

Computers allow buildings to be detailed at full scale and viewed from many angles. Does this ability help close the gap between what is drawn and what is built?

The building process is largely concealed when a building is completed. Computer models can be used to reveal aspects of the construction process. In twentieth century architecture, there are often contradictions between what architects profess to do and the resulting construction. If the statement that “God is in the details” is true (attributed to Mies van der Rohe), then one could conclude that God was a liar? In the Barcelona Pavilion, the marble and onyx walls which appear as solid are often thin veneers. In the same building, a complex structural kit of steel and bolts was carefully concealed behind thin sheaths of chrome. Cut-away axonometric drawings by Ford (1990) reveal the Barcelona Pavilion to be a measured representation of structure and construction.

The appearance of a building can be at odds with its construction. In the two examples below, students developed cut-away models from the architects’ working drawings. These revealed layered and lightweight construction methods.
that were not consistent with the appearance of mass. As layered facades become more common, so does this confusion.

Figure 1 illustrates a house design (Thornton 1991), which used the vestigial form of a monolithic lighthouse but converted the construction to a more affordable timber frame with fibre cement sheet cladding. Domes and vaults evolved as efficient forms for masonry construction to span spaces. The expressed form and construction logic of the house are at odds. The use of fibre cement cladding can almost convince the viewer that the construction is monolithic particularly as the upper level appears to be supported on heavy columns. In fact, these are thin columns concealed within large fibre cement pipes that serve no structural purpose. Kahn’s proposition that a brick wants to speak of being a brick is called into question by an approach to architectural construction not far removed from stage set construction.

3. Architectural orthographic drawings

Unlike the sculptor working as sole-author/constructor, architects must rely on drawings to communicate the design of a building first to a large team of consultants and then to a construction team. The orthographic set that includes, plans, sections, elevations and details is a useful shorthand for representing buildings but inherently difficult for the viewer to compile into a three-dimensional form, especially on site. (Porter 1997).

![Figure 3. Arrested image from Robin Evan, 1995 (p367)](image)

The separation between drawing and building is expressed in the illustration above. The insertions made in this study occur in the zone between the orthographic projections and the designed object.
Architectural drawings influence the field of vision adopted by the architect making it easier to see some aspects while others are concealed. Its power to represent is always partial and necessarily abstract. As an ensemble they can never give an accurate and total picture of a building and, as a result, they can be read as a range of subject matter that is included alongside and opposed to all other possible subject matter that is left out or not apparent (Evans 1997). Although some architects or viewers see beyond the limited field of vision contained by the representation technique selected, orthographic drawings can still be viewed as a medium that carries and distorts information rather than being the neutral vehicle they purport to be.

4. Axonometric views

Axonometric views are useful interpretive drawings that can be compiled from the range of scales and views available within an orthographic set of working drawings. By compiling these axonometric views, one can almost step into the shoes of builders and discover how the building components fit together into a three-dimensional whole. These views are useful teaching tools. While students ‘construct’ these three-dimensional views, they become aware of discrepancies in the documentation set and feel the frustration builders must feel when they lose their way in a complex set with inadequate cross-referencing. This pedagogical approach is further explained in two papers, A 4D Multimedia Landscape (1999) and Undressing Facades (1997).

The axonometric drawings by students are sometimes strange hybrid views developed partially from the final building and partially from the working drawings. We ask that students interpret the drawings alone but where detail is lacking in the drawings or if significant changes have occurred during construction, then students may take elements from both. An example is the upper storey extension to the Faculty of Architecture, Building & Planning at the University of Melbourne. The cladding was shown on the working drawings as a composite sandwich panel with negative detailing but was changed to an aluminium sheet with lapped joints for cost reasons. Students had access to the building work and seemed to be more confident about drawing the materials and building techniques they could see and touch during construction. Perhaps the students decided it was more important to draw the ‘correct’ or built version than the view derived from working drawings even though this meant they did not comply with the assignment rule of interpreting drawings only.

5. Architectural computer models

More recently students have been ‘building’ cut-away representations from architects’ working drawings in their 3D computer modelling class. The added value of computer models has been the ability to associate layers with the process
of construction allowing short movies of the construction process to be compiled
and constructed from any view angle. These types of movies are being
incorporated into separate teaching and research tools being developed by each
author.

A possible disadvantage of computer representations is that blatantly
incorrect or incomplete drawings can be surprisingly deceptive because of their
complex and seemingly accurate line work. A third year architecture student
drew an axonometric view on computer without really understanding what was
being drawn. The initial impact of the drawing belied its content. The drawing,
developed primarily from a section, assumed background lines in elevation were
in fact section lines and so the window is strangely concealed behind layers of
apparent construction materials. Probably this outcome would not have occurred
if the view had been hand drawn.

6. ‘Built’ real and virtual full-scale models versus their 1:10 abstractions

Over three years we have experimented further with the nexus between design
and construction in fourth year studio where the students are expected to apply
knowledge in construction tectonically to their design, and to undertake this in a
group scenario. This approach was born from an earlier elective where the
relatively small number of participants were able to work as individuals on their
designs. As individuals – sole authors – they could direct their work through to a
point where they were able to represent a part of their building as a full-scale
model using, where possible, the actual construction materials. Student numbers
and the capacity of the workshop has obliged us to have the students work in
groups on a limited number of projects.

Originally students were able to build at 1:2 scale if desired. Although 1:2 is
a more convenient scale from the point of view of size – students can reach up to
heights of 5 metres building scale 2.5 metres model scale more safely – and the
volume of material is reduced to one quarter compared with full-scale modelling,
there were two distinct disadvantages: reduction in the anthropometric
association with the work in hand, and the necessity to represent artificially all
constituent materials. In retrospect, the artifice of materials, presumed to be a
loss of opportunity when we commenced with this approach, seems only to be a
practical timesaving opportunity. In fact we have observed in both schools an
advantage in the realistic manufacture of each constituent building part. To make
a cardboard brick the maker must know the x, y, and z measurements of the brick.
To abstract a steel ‘I’ section using MDF and putty the student appreciates the
exact qualities of the edges and corners of the member in question, that there are
not convenient squared arrises or perfectly formed unfilleted right-angle internal
corners.
The issue of bodily association with the stuff of building has therefore become accentuated by the distancing from the material itself through its abstraction by falsification. Even the level of the appreciation of appearance is enhanced through abstraction. Ironically “how rough is a brick?” and “what is the surface patina of mill-finished steel?” are questions answered more fully through their active representation rather than through the passive acceptance of being ‘givens’ as real material. Working therefore at 1:1 using representations of materials yields more, then, and is the ideal scenario. But the students do not commence their design thinking in this way – the opposite in fact.

The students are challenged individually by being presented by a difficult problem where the mundane functional requirements of a regular building type are challenged by an unusual and taxing location. The intention here is to distract the students immediately from tectonic issues through having an accent placed on ‘fit’. Each student will present a proposal individually during the first three-four weeks of design studio. At this stage their presentation is at a fundamentally conceptual level.

Six very different solutions to the same problem are chosen from the pool of eighty offered designs. The six are chosen on a number of criteria including structural bravado, tectonic richness, functional inventiveness, and strongly asserted individual flair. The class is divided into groups of equal numbers, and each group is divided 2:1 ‘real’ to ‘virtual’ model makers. Importantly, the author of the project is not included amongst the group who take the design through to the levels of 1:10 (for context) and 1:1.

During the following four weeks the projects migrate to different units where the group learn to document the proposal fully, and undertake a thorough technical study of the design from the perspective of environmental performance. They then return to the studio to ‘build’ part of the design at full scale with the project fully understood from a number of perspectives. The virtual modellers work in tandem with the real modellers but in essentially different environments producing the same part of the building. It would appear that few surprises are expected by both subgroups but it is clear from contact with the students during the modelling process that the implications of size only become apparent when physically confronted by the outcome as it emerges from the conventionally documented drawing set. An important difference is when the surprises take place. For the real modellers it occurs in acto. For the virtual modellers it is when they unroll their twelve metre long colour-rendered 1:1 prints and hang them adjacent to the built models, at the conclusion of the modelling process.

The program has always attracted very favourable teaching assessments from students, most of whom claim that they have had their ‘eyes opened’ not least, perhaps, by the inevitable and subtle variance of the built outcome from the previously prepared documentation. This appears to be a very powerful lesson in learning about the implications of finality and capital commitment in built
design – there will seldom be any chance for any ‘going back’. The important difference here is in the relationship between the virtual and the real modelling, discussed in a little more depth in the conclusion.

7. Conclusion

Inevitably we must conclude that there are very rich possibilities through the engagement of design and built representation both through the classroom and design studio. We have presented here two scenarios from different schools. In the classroom students engage with knowledge and judgement-calls through
analytical study and empirical investigation. In studio the participants have the opportunity to experiment in the creative application of their knowledge and their exercise of judgement. The issue here, however, is not the comparison of the two approaches each with their distinct possibilities and advantages but one of representation, and the relationship of virtual to real abstraction.

We conclude that both real and virtual abstractions of architectural tectonics have equal footing, but that their differences are important markers of our current situation and interesting indicators of future possibilities. The lessons of building at full-scale in a real medium have advantages that will not be equalled through IT until, perhaps, some future haptic holographic illusory VR environment.

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References