Augmenting critique of lost or unbuilt works of architecture using digitally mediated techniques

Nicholas Webb¹, Andre Brown²
¹,²The Liverpool School of Architecture, University of Liverpool, UK
¹,²http://www.liv.ac.uk/lsa
¹N.J.Webb@liv.ac.uk, ²andygpb@liv.ac.uk

Abstract. The paper explores how digital techniques can be applied to lost or unbuilt works of architecture in order to enhance our understanding of a particular architect or building they designed. For example, if current knowledge of a historic design is based on surviving literature or fragmented images, the new arrangement introduced using digitally augmented techniques allows a clearer reading of these original sources. Case study examples are used to demonstrate how this is achieved.

Keywords. Virtual construction; forensic analysis; digital modelling

INTRODUCTION

In the architectural profession mediating devices are essential for describing a design, enabling ideas to be translated into finished buildings. Unlike other disciplines in the arts, the use of devices such as scale drawings, models and perspective images are crucial as in most cases it is unfeasible to make full scale physical prototypes of works of architecture. Such mediating devices have developed into the digital realm with the widespread introduction of computer aided drafting and design into the profession from the 1980s onwards. These have become increasingly complex, offering the potential to be exploited as analysis tools in a research context (Richens, 1992; Brown and Knight, 1995).

The use of digital techniques in architecture has primarily been to aid design and representation of schemes that are yet to be built. However, this paper explores how such techniques can be used to augment and enhance our understanding of lost or unbuilt works of architecture. Investigation into the lost or unbuilt has become increasingly prominent in the last thirty years for their importance in architectural history and heritage (Sky and Stone, 1983; Stamp, 2007). Digital techniques are utilised to re-analyse and re-interpret surviving mediating documents such as paper and photographic records of lost or unbuilt architecture. Previous research has shown that this process can uncover new information and enhanced understanding in relation to particular architects and buildings that they designed (Novitski, 1997; Burry, 2008).

The documentation available to construct the required digital representations is almost always incomplete; therefore interpretation of material requires parallel study into the architect, their influences and the contemporary context they operated within in order to extrapolate and fill gaps in an informed way. The construction of digital
representations enables specific questions to be investigated and in this sense it can be seen as a forensic analysis of a design similar to methods used in crime forensics; the reconstruction of events produces an investigation into what may have occurred (Harfmann and Akins, 2000; Brown, 2001). This methodology is demonstrated in figure 1.

DEVELOPMENT OF MEDIATING DEVICES
Mediating devices were used at least as early as the classical Greeks, where the role of the architect developed from being the literal ‘maker’ of a building to the person responsible for creating media enabling other parties to construct a design (Pérez-Goméz and Pelletier, 2000). This was achieved by techniques such as carving a design into stonework or using full scale drawings and models (Ackerman, 2002). Technological advances accelerated the output of design ideas with the widespread introduction of paper from the East and the printing press from Germany during the Renaissance (Chapman and Faietti, 2010). From this point onwards, it meant that records of lost or unbuilt architecture became extensive.

A search for objective truth in representing the world became prominent in the sixteenth century and can be seen in devices such as Dürer’s ‘draftsman’s net’; a design featuring a gridded glass panel between the subject and painter which literally cuts a section through the cone of vision enabling the painter to draw an image as accurately as possible (Pérez-Goméz and Pelletier, 2000). Later advancements such as the camera obscura and camera lucida objectified reality further, ultimately leading to the invention of the photographic image. This resulted in scientific experiments such as Eadweard Muybridge proving that a horse raises all four hooves off the ground when galloping by taking a series of photographs of a horse in motion.

A further example of mediating techniques augmenting knowledge is Choisy’s use of axonometric

Figure 1
Flow diagram explaining the research methodology when augmenting critique using digital techniques.
drawings in the 1870s. He adopted them as a way of visually describing the history of ancient and medieval architecture and believed they could ‘demonstrate what he assumed to be the deterministic principles according to which the great buildings of history were achieved’ (Pérez-Goméz and Pelletier, 2000). His work is a key example in demonstrating how representation techniques can be used to augment our understanding of historic architecture; revealing truths that were previously unseen.

**DIGITALLY AUGMENTED CRITIQUE**

Mitchell (1977) stated that the use of computer-aided design techniques would radically change the architectural profession. This proved to be true, and over the last thirty years the role of the computer has rapidly increased, becoming part of our daily lives. As a mediating technique, the use of computer-aided design is a direct continuation of devices in history. The use of digital modelling to reconstruct lost or unbuilt architecture has proved a successful process in augmenting our spatial understanding of such designs (Novitski, 1998; Forte and Siliotti, 1999).

Rather than focusing on creating a digital reconstruction in its entirety, forensic analysis is used to pinpoint specific lines of enquiry. Therefore, the resulting digital model could be anything from a two-dimensional line drawing to a virtual reality walkthrough. The key is to use the most appropriate technique to answer a question posed when researching the evidence available; hence the term ‘digital forensics’ due to similarities with the methodology used in crime forensics.

**CASE STUDIES ILLUSTRATING POTENTIAL LINES OF ENQUIRY**

In order generate lines of enquiry to test the process of augmenting critique using digitally mediated techniques, documentary evidence needs to be sourced relating to the unbuilt or lost designs which form case studies. This is achieved by reviewing primary archival sources such as letters, newspaper and magazine articles, meeting records, drawings, models and photographs as well as secondary sources such as monographs and biographies. Once all of the documentary evidence is collected, decisions can be made into which techniques are most appropriate to answer specific questions. Three specific case studies are reported here.

**Stirling’s 1950 community centre thesis project**

Sir James Stirling (1926-1992) graduated from the Liverpool School of Architecture in 1950 and his work formed part of a book and exhibition investigating the history and influence of the school (Dunne and Richmond, 2008). In Stirling’s final year thesis project he designed a community centre in Newton Aycliffe. A physical model was built but has since been lost; all that remained locally was a set of fragmented drawings and images. The model was reconstructed physically and digitally in order to enhance understanding of the architect in his formative years.

Lines of enquiry were generated by looking at specific elements of the design. For instance, collecting the archive information indicated that one of the external elevations and several courtyard elevations were missing; therefore a question posed was how to interpolate to fill in the missing elements in order to gain a clearer indication of the architect’s original intentions. This resulted in an investigation into circumstances surrounding the community centre design in order to gather sufficient information to fill in the missing elements, such as the precedent studies Stirling researched, the views of his tutors and the work of fellow students.

The missing external elevation proved a challenge to resolve as the design is based on a structural grid that is expressed externally on the façade. Somewhere along the missing elevation the grid changes from being two storeys in height to three; which was revealed by looking at the original sections. Copies of the original drawings were traced digitally as a precursor to creating the three-dimensional model; this enabled the drawings to be lined up and ascertain exactly where the change in storey height occurred. This process revealed to a relative degree of certainty that the level change happened
in the library area of the design (figure 2). Although this issue may have been resolved without the use of digital techniques, it is unlikely that someone inspecting the original drawings would have realised that a change of level occurred along the missing elevation without such a line of enquiry to follow. In this sense the research can be seen as digital augmentation techniques; a process that aims to enhance current knowledge of a design rather than creating something totally new. The issue of where the change in floor level occurred had to be resolved in order to successfully create a three dimensional digital representation of the scheme; hence the use of digital forensic investigation.

Perret's ideal museum
Auguste Perret (1874-1954) is known for his pioneering work designing rationalist concrete structures that are highly influenced by French Classicism. Two of Perret's unbuilt museum projects were chosen as case studies as they share a common typology allowing investigation to be carried out into the similarities between the two designs; a fact that is of particular significance as one of the schemes was a theoretical design describing his ideal museum; the Musée Moderne. Perret describes his ideal museum design primarily using text with the addition of two sketch isometrics and a diagrammatic floor plan. This was published in 1929 and two years later he put forward proposals for a museum to hold the works of the late Antoine Bourdelle; his friend and collaborator. This was Perret's first opportunity to put his theoretical ideal into practice; therefore digital representations have been created to directly compare the two designs. This line of enquiry is significantly augmented using digital techniques as it offered an opportunity to visualise Perret's theoretical ideal museum that has not been investigated beyond the text description and basic sketches. From this, further lines of enquiry could be generated as Perret

Figure 2
The interpolated short section was constructed by studying the original plan (above) to ascertain where the library was situated and hence discover where the change in grid pattern occurred.
sets out very specific requirements for his museum designs, for instance they should be planned across one floor as much as possible to allow natural lighting from above (Perret, 1929).

The models were constructed in reverse chronological order as there was more archival information available for the Musée Bourdelle than the Musée Moderne, therefore the information gathered to construct the Musée Bourdelle could subsequently be used for extrapolation purposes in unknowns of the Musée Moderne model. This is particularly appropriate for the work of Perret, who had very precise design ideals, such as expressing the structural grid and concrete materiality both externally and internally.

A direct comparative between the digital constructions made explicit how vast in scale the Musée Bourdelle design was in comparison to the Musée Bourdelle. This was further demonstrated using rapid prototypes of the two designs to accompany the findings during presentations (figure 3).

The digital constructions also showed that although the Musée Bourdelle occupies two storeys due to the reduced site area, Perret ensures that all of the gallery spaces occupy the first floor level to ensure access to natural light as proposed in his ideal museum. The digital construction of the Musée Bourdelle demonstrates that the layout reads as one single space rather than two separate storeys (figure 4). Other results were found during the process of construction that occurred serendipitously; an aspect of the research that will be discussed in the next section.

**Lutyens’ Liverpool Metropolitan Cathedral**

Sir Edwin Lutyens’ (1869-1944) design for the Metropolitan Cathedral at Liverpool will form a future case study; however, lines of enquiry have already been generated and are reported here. The cathedral design was vast in scale, second only to St Peter’s Basilica in Rome (figure 5). Construction began in 1933 but was abandoned in 1941 as wartime restrictions

![Figure 3](image-url)  
Rapid prototyping was used to produce physical scale models highlighting the vast difference in size between Perret’s theoretical Musée Moderne (centre) and the Musée Bourdelle (bottom right); his first opportunity to put this theories into practice.
resulted in a lack of labour and materials. After both the architect and Archbishop who commissioned the build died, the decision was taken to complete the crypt only and in 1959 an architectural competition was announced to provide a new design incorporating the crypt; this forms the current built design by Sir Frederick Gibberd. A wealth of archival information relating to Lutyens’ design remains including drawings, a physical model, perspective images, newspaper articles, correspondence between various parties as well as several biographies. These sources offer lines of enquiry for digital augmentation of research into the cathedral design.

The first of these will be to investigate the parallel relationship described between the cathedral design and the Thiepval Memorial to the Missing of the Somme both of which were designed by Lutyens in the late 1920s. Critics have commented on their similarities in geometry, materiality and form (Hussey, 1950). Digital techniques such as two dimensional overlays of the digitised original drawings and ‘x-ray’ views of overlaid 3d reconstructions offer enhanced critique into this line of enquiry.

Another opportunity for forensic investigation lies in correspondence between the architect and cathedral authorities; Lutyens wanted the entire building to be lit by candles whereas the authorities preferred electric lighting (Hussey, 1950). Ray tracing of a three dimensional interior model will be used to test both scenarios and ascertain whether Lutyens’ proposal would have produced the ‘glorious and mysterious’ effects he desired. The effects of natural lighting in the interior will also be analysed.
The same model will also be used to model the acoustics within the cathedral; Lutyens designed the organ to be located in the crypt with the sound rising up into the main space. This could be investigated using sound ray tracing which works in the same way as light ray tracing except the effect of sound rather than light is modelled.

**SERENDIPITY**

In the case of an analysis of the work of Connel, Ward and Lucas, Brown (2001) showed that the creation of digital artefacts can sometimes serendipitously reveal unexpected information and understanding. One of the results found relating to the Perret case study occurred serendipitously; it was not established as a result of generating lines of enquiry rather it was found during the process of constructing the Musée Bourdelle model itself. The unexpected finding brought into question preconceptions held by some architectural historians who state that Perret’s construction technique involved expressing the structural column and beams which left non load bearing elements that needed to be filled in order to protect the building from the elements. Perret designed a system of precast blocks which were unique to each scheme he worked on and seemingly fit perfectly into the infill areas required (Collins, 2004). In this sense he was working in the opposite way to masonry construction today, where it is seen as good practice to design using standard brick dimensions. Instead Perret worked out the appropriate size of the structural frame regardless of standard block dimensions and then made his own custom concrete blocks cast on site to fit the frame. However, the process of constructing the digital model revealed this technique is not as effective.
as previously suggested as it does not take into account that the column dimensions change depending on the load they are supporting. For example, in the Musée Bourdelle a dimension of 5070mm for the infill area between two 650mm wide columns forms the basis of the infill blocks, however, when constructing the model it highlighted different scenarios such as a 450mm column next to a 650mm column, leaving an infill area 100mm wider than the standard dimension. To deal with this issue in the digital reconstruction an investigation into Perret’s other works, in particular the Church of Saint Joseph at Le Havre, was carried out. This revealed that Perret resolved the matter by increasing the mortar joint between the infill blocks to compensate for the extra width (figure 6).

Without the process of constructing a three dimensional digital model, it would have been highly unlikely that anyone would have spotted this; the original drawings are two dimensional therefore such elements are easily overlooked, whereas producing a three dimensional digital model ensures that all aspects of the design have to be thoroughly understood to produce satisfactory results.

**SUMMARY**

The research reported here demonstrates how digital techniques can be used to enhance our understanding of lost or unbuilt architecture; it offers an opportunity to augment knowledge about particular aspects of a design that are commonplace in contemporary architecture but would have been unfeasible historically. For example Lutyens would not have been able to accurately predict the effects of lighting a cathedral entirely by candlelight in the 1930s whereas today digital technologies make this increasingly possible. The process also enables us to challenge previous research into an architect and their work, for instance Perret’s approach to constructing non load bearing blocks is easily overlooked when inspecting the original drawings alone.

Elements of the research could be achieved without the use of digital techniques; however, their use makes lines of enquiry straightforward in answering questions objectively. This can be compared to Muybridge’s experiment to prove that a horse raises all four hooves off the floor when galloping; one could argue this could be proved simply by observing a horse galloping with the naked eye, however, photographic evidence made Muybridge’s research irrefutable.

The forensic investigation process reveals how systematic enquiry into a specific architect and buildings they designed enhances discourse into historic architecture, whether built and destroyed or not built at all.
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