Ingenious Adaptations: The Development of the Professionally-Made Architectural Model in Britain, 1883-2020

by

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Abstract

This thesis presents an historical account of the development of the professionally-made architectural model in Britain that aims to understand how the model came to be as it is today. With existing studies of the architectural model having been predominantly focused on its use within the design process and its cultural meanings, this thesis, in examining the architectural model from within the field of modelmaking rather than architecture, highlights developments in the making of architectural models as opposed to the dominant 'post-production' perspective that overlooks the role of the modelmaker and the materials and processes employed.

Drawing from extensive interviews with practicing and retired architectural modelmakers alongside historic documents and photographs from previously undocumented private archives, this thesis responds to Anna Fariello's call for a 'front-end' consideration of objects that considers their making through its conceptualisation of the model's contemporary form as an assemblage that emerged from the complex interactions between the various people, processes, materials, and ideas that have contributed to its history.

What this thesis reveals is how the contemporary form of the professionally-made architectural model in Britain emerged as a result of developments that took place during four distinct periods in its history: the initial emergence of architectural modelmaking as a distinct profession during the late-nineteenth and early-twentieth centuries; the adoption of plastics as the principal modelmaking materials during the post-war boom of the 1950s and early-1960s; the turbulent realignment of the model's 'stylistic palette' during the 1970s and 1980s; and the introduction of advanced digital manufacturing technologies from the 1990s to the present day. This thesis further argues that the notion of adaptability – emerging from the combined agency of the modelmaker's imaginative and ingenious intentions and the intrinsic adaptability of the materials, tools, and processes employed – has been the most significant influence that has shaped the overall development of the professionally-made architectural model in Britain.

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1: Introduction

Figure 1.0: Architectural model made by Unit 22, 2013. Photograph by Gareth Gardner

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1.1. Introduction

The architectural model illustrated in Figure 1.0, made in 2013 by the architectural modelmaking company Unit 22, is a typical example of its kind. As physical objects widely used by both architects and property developers in the development and communication of architectural designs, architectural models such as that shown are made in order to 'encourage the model's users to dream about an architectural idea that they may not be able to envision on their own' (Mindrup, 2019, p.48). Created as predictors of potential future realities (Dunn, 2007, p.54; Downton, 2007, p.45), architectural models, while outwardly appearing to be scale representations of buildings, are more correctly described as being representations of designs. As models of ideas, architectural models occupy a powerful position in the physical expression of architectural concepts before the intended design is fully realised.

While the functions of architectural models are relatively well-understood, their making has received far less consideration. Within both professional and academic circles there exists a common understanding of how models are best made, from which materials, and using which particular visual and material styles. What is less understood, however, is why they are made in these ways. How and when did the processes, materials, and styles of contemporary architectural modelmaking emerge? How and when did the profession of architectural modelmaking itself first originate? Having trained as an architectural modelmaker and progressed into an academic career as a Senior Lecturer in Modelmaking at the Arts University Bournemouth, this thesis has been borne from my own longstanding curiosity as to why architectural models such as that shown in Figure 1.0 are the way they are.

This thesis examines the development of the professionally-made architectural model in Britain in order to understand how the model's contemporary form emerged from a complex assemblage of the various people, processes, materials, and ideas that contributed to its history. In identifying a paucity of scholarly activity in relation to architectural models made by professional modelmakers, this thesis makes an original contribution to knowledge through its presentation of an historical study situated within the field of modelmaking rather than architecture, highlighting developments in the making of architectural models as opposed to the dominant 'post-production' perspective that overlooks the role of the modelmaker and the materials and processes employed.

As the literature view in Chapter Two outlines, despite the model's high standing as an ambassador of architectural design (Moon, 2005, p.129), the total volume of literature relating to the architectural model remains notably limited, and with almost all the research undertaken so far having been conducted by architects rather than modelmakers, the focus of existing studies has largely been centred on the use of models in architectural practice and education as opposed to their making (see Porter and Neale, 2000; Morris, 2006; Dunn, 2007; Mindrup, 2019). As a result, professionally-made architectural models and their makers have been consistently overlooked; as Oliver Elser and Peter Schmal have admitted, 'we know too little about modelmakers themselves' (Elser and Schmal, 2012, p.8), this despite architectural historian Karen Moon's observation that 'the most significant developments in [architectural] modelmaking during the 20th Century have come from the professional modelmaker' (Moon, 2005, p.185). How and when the architectural model came to obtain its present form has therefore only been fragmentally addressed. In particular, the professionally-made architectural model has not previously been the subject of an in-depth investigation, and neither has a history of architectural modelmaking in Britain been compiled.

For more than a century in Britain, however, the principal translator of architectural designs into their initial physical form has been the professional architectural modelmaker. Feted for their creativity, skill, and ability to empathise with architects' creative intentions, the term 'modelmaker' gives little indication of the complexity of their role, nor the 'breadth and expertise of knowledge that is possessed by a practitioner' (Lansdown, 2019, p.2). In

1939, the American architect Robert Hoyt, describing the skills involved in making the architectural models for that year's New York World's Fair, wrote that:

> Modelmaking, it appears, is essentially the adaptation of numerous tools and materials to purposes for which they were not originally intended. Thus, the success of a modelmaker often depends upon his imaginative use and ingenious adaptation of available tools and materials to meet his own particular requirements. It is this quest for new methods, tools and materials that makes modelmaking [an] interesting occupation (Hoyt, 1939, p.420).

Hoyt's description of architectural modelmaking continues to resonate today, with the twenty-first century architectural model displaying not only the benefits of the enduring application of the professional modelmaker's imaginative and adaptable nature, but also the intrinsic adaptability of the materials and tools used in contemporary architectural modelmaking. In Britain, where the modern profession first originated, the professionally-made architectural model remains notable for its high levels of quality, technical sophistication, and creativity, with dedicated professional architectural modelmakers constantly adopting new methods, tools, and materials, just as Hoyt observed some eighty years prior.

In approaching the professionally-made architectural model in Britain as an object with its own intrinsic characteristics and history rather than as a repository of architectural history, this thesis, in providing historical contextualisation to contemporary modelmaking practice, is more closely aligned to the disciplines of design history and material culture studies than it is to the field of architecture. Drawing from historic documents and photographs from public and private archives alongside extensive interviews with practicing and retired architectural modelmakers, this thesis applies the benefits of conceptualising the model as an assemblage (see Chapter Three) in order to reveal a detailed understanding of how the complex interactions between the various people, processes, materials, and ideas have contributed to its history.

What this thesis reveals is how the contemporary form of the professionally-made architectural model in Britain emerged as a result of developments that took place during four distinct periods in its history: the initial emergence of architectural modelmaking as a distinct profession during the late-nineteenth and early-twentieth centuries; the adoption of plastics as the principal modelmaking materials during the post-war boom of the 1950s and early-1960s; the turbulent realignment of the model's 'stylistic palette' during the 1970s and 1980s; and the introduction of advanced digital manufacturing technologies from the 1990s to the present day.

Through its analysis of the interactions that took place during these periods, this thesis further argues that the notion of 'ingenious adaptation' that Robert Hoyt first described in 1939 – reinterpreted as emerging from the combined agency of the modelmaker's imaginative and ingenious intentions and the intrinsic adaptability of the materials, tools, and processes employed – has been the most significant influence that has shaped the overall development of the professionally-made architectural model in Britain.

This opening chapter begins by outlining the thesis' aims, research questions and objectives, and its contribution to knowledge and broader significance. The chapter then presents an overview of the contemporary professionally-made architectural model in Britain and provides definitions for many of the key terms encountered in the thesis. The chapter then concludes with a brief overview of the proceeding chapters.

1.2. Aim, Research Questions, and Objectives

The overall aim of this thesis is to understand the historical development of the professionally-made architectural model in Britain. The two principal research questions it seeks to answer are:

- Question 1: How and when did the professionally-made architectural model in Britain come to gain its present form?

- Question 2: What have been the most significant influences that have shaped its development?

As Chapter Three outlines, this thesis applies the relational and 'new materialist' insights of Assemblage Theory to its conceptualisation of the architectural model in order to overcome the prevalent 'post-production' approach that overlooks the making of objects, and to reveal the complex socio-material relationships that have shaped the model's development. Viewing the present form of the architectural model as having emerged from the interactions between the various people, processes, materials, and ideas that have contributed to its history, in order to answer the above questions, the following objectives must also be met:

- Firstly, this thesis must outline the professionally-made architectural model in Britain today;
- Secondly, it must trace the emergence and development of the model throughout its history;
- Thirdly, the thesis must examine the complex interactions between the people, processes, materials, and ideas from which it emerged.

1.3. Original Contribution to Knowledge and Significance of the Study

This thesis makes an original contribution to knowledge through its presentation of a detailed historical study of the development of the professionally-made architectural model in Britain. Situated within the field of modelmaking rather than architecture, the thesis draws from extensive archival research and nearly forty interviews with practicing and retired architectural modelmakers to highlight developments in the making of architectural models as opposed to the dominant 'post-production' perspective that overlooks the role of the modelmaker and the materials and processes employed (Fariello, 2005, p.4). As the literature review in Chapter Two makes clear, existing studies of the architectural model have predominantly focused on the use of models in the design process, and on their symbolic and cultural meanings. Through its conceptualisation of the model as an assemblage, this thesis is able to reveal the contributions of materials and processes in a manner that a purely anthropocentric history would not. In tracing the significant roles of individual modelmakers such as John Thorp, Ernest Twining, David Armstrong, George Rome Innes, and Richard Armiger, the anonymity of the professional modelmaker within the existing literature is challenged. By charting the consequences of the adoption of plastics and the introduction of digital manufacturing processes on the development of the model, material and technological influences within the model's history are revealed. Furthermore, the specificity of this study in attending to the history of the architectural model in Britain goes some way to unravel the distorted global histories of the model that have resulted from the uncritical combining of British, European, and North American histories into a singular chronology (see Chapter Two).

The lack of any prior study of the professionally-made architectural model from within the discipline of modelmaking itself is largely due to its nascent academic status and the paucity of institutions around the world that teach modelmaking at degree-level or higher. Within Britain, there are two established degree courses in modelmaking at Arts University Bournemouth and the University of Hertfordshire; one new course at Salford University that began admitting students in 2018; and several degree courses that specialise purely in film and television prop-making such as at the University of Bolton and Greater Brighton Metropolitan College. Beyond the United Kingdom there is only the single degree course in Ireland at Dun Laoghaire University and two associate degree courses in the United States that are known to exist. Very little higher-level research relating to modelmaking has been carried out by any of these institutions, and the study of modelmaking itself is a therefore a rather neglected field. As such, this thesis, in contextualising contemporary modelmaking practice, also contributes to the establishment of modelmaking studies and modelmaking history as developing areas of discipline-specific knowledge and expertise.

The principal significance of this thesis, however, is the strength of its evidence-based historical account of the development of the professionally-made architectural model in Britain. An expanded discussion of the thesis' significance and broader impact in light of its findings can be found in Chapter Eight.

1.4. Subject Overview and Definition of Terms

While as unique and variable objects there can be no single archetypal architectural model, as a class of objects, however, the professionally-made architectural model in the twenty-first century can be described in general terms. Within the existing body of literature (as outlined in Chapter Two), architectural models have predominantly been described through the development of typologies based on their function and purpose, with Nick Dunn's identification of descriptive, predictive, evaluative, and explorative types of models standing as the most in-depth example (Dunn, 2007; 2014). In focusing on the work of professional architectural modelmakers, this thesis instead approaches architectural models in terms of their physical making, describing them in terms of the identity of their makers, the materials they are made from, their appearance, and the tools and processes used in their construction. Firstly, they are made by dedicated professional architectural modelmakers; secondly, they are most commonly made using plastics; thirdly, they draw from a diverse range of visual styles that extends from the highly realistic to the creative and abstract; and fourthly they are made using advanced digital manufacturing technologies such as laser cutting and 3D printing.

This section of the thesis presents an overview of the contemporary professionally-made architectural model in Britain that draws from research and analysis conducted during fifteen visits to architectural modelmaking companies (see Appendix 2 for details), interviews with twenty three practicing architectural modelmakers (see Appendix 1), and the author's personal experience as both a practicing modelmaker and as a Senior Lecturer on the BA (Hons) Modelmaking degree at AUB. This section also provides definitions for many of the key terms encountered in the thesis such as 'architectural model' and 'professional modelmaker'.

1.4.1. The Architectural Model

The use of architectural models has been recorded in Britain for over four hundred years, having gained favour during the sixteenth and seventeenth centuries due to the adoption of Italian architectural practices that had been developed during the Renaissance (Wilton-Ely, 1969, p.6). Although the writings of Roman architects such as Vitruvius indicate that architectural models were in common use during the ancient world in much the same way they are today (Stavric, Sidanin and Tepavcevic, 2013, p.25), their modern use in European architectural practice does not re-emerge until the fourteenth century. Strong evidence of their application exists during the planning and construction of Florence Cathedral in 1360 (Valeriami, 2012, p.29), with Brunelleschi later making extensive use of models when overseeing the building of the cathedral's famous dome during the 1420s. It was during this period that the use of models became central to the architectural design process, being used to explore and test construction ideas, and to communicate them to both the patrons who were financing them and the masons who would build them. Italian architect Leon Battista Alberti wrote enthusiastically about their use in his 1452 treatise *On the Art of Building in Ten Books* (modern English translation 1988).

> I will always commend the time-honoured custom, practiced by the best builders, of preparing not only drawings and sketches but also models of wood or any other material…these will enable us to weigh up repeatedly and examine, with the advice of experts, the work as a whole and the individual dimensions of the parts (Alberti, et al, 1988, pp.33-34).

The relationship between the model and the architect during the Renaissance has been relatively widely discussed (see Starkey, 2004; 2006; Valeriami, 2012; Mindrup, 2019), and it has been proposed that the use of architectural models was a crucial element in enabling the division of labour between those who designed buildings and those who constructed them (Starkey, 2006, p.324). Before the development of orthographic drawing in the mid-eighteenth century, design information was more commonly communicated through models, imbuing them with a highly significant role as 'in-between objects' that mediate between different social groups, either based on knowledge and skill or social hierarchy – between patrons and architects, and between architects and craftsmen (Valeriami, 2012, p.40). This role of the model as a means of communication between groups is still fundamental to its continued use today (Ganshirt, 2007, p.149), with architectural models providing an important means of visualising and representing architectural designs, despite the availability of alternative virtual media alongside more traditional drawings and illustrations.

In an increasingly digital world, the physicality of the architectural model stands as its most celebrated quality, being as close to the actual reality of a proposed building as can currently be experienced (Dunn, 2007, p.34; Ganshirt, 2007, p.149; Mindrup, 2019, p.2); the model being universally recognised as an ideal medium to express architectural ideas (Morris, 2004, p.28; Ratzlaff, 2016, p.15). Architectural models allow architects, clients, and the general public to understand the three-dimensional experience of a design without needing to rely solely on their imagination (Dunn, 2014, p.8), and are considered to be much more easily understood than technical drawings, thus expanding their appeal to a wider audience (see Trudeau, 1995, p.9; Moon, 2005, p.11; Mindrup, 2019, p.2). The architectural model's physical three-dimensional nature therefore makes it an effective and versatile tool to explore and validate architectural ideas within architectural practice, and to contextualise, explain, and convince others of their merit (Figure 1.1).

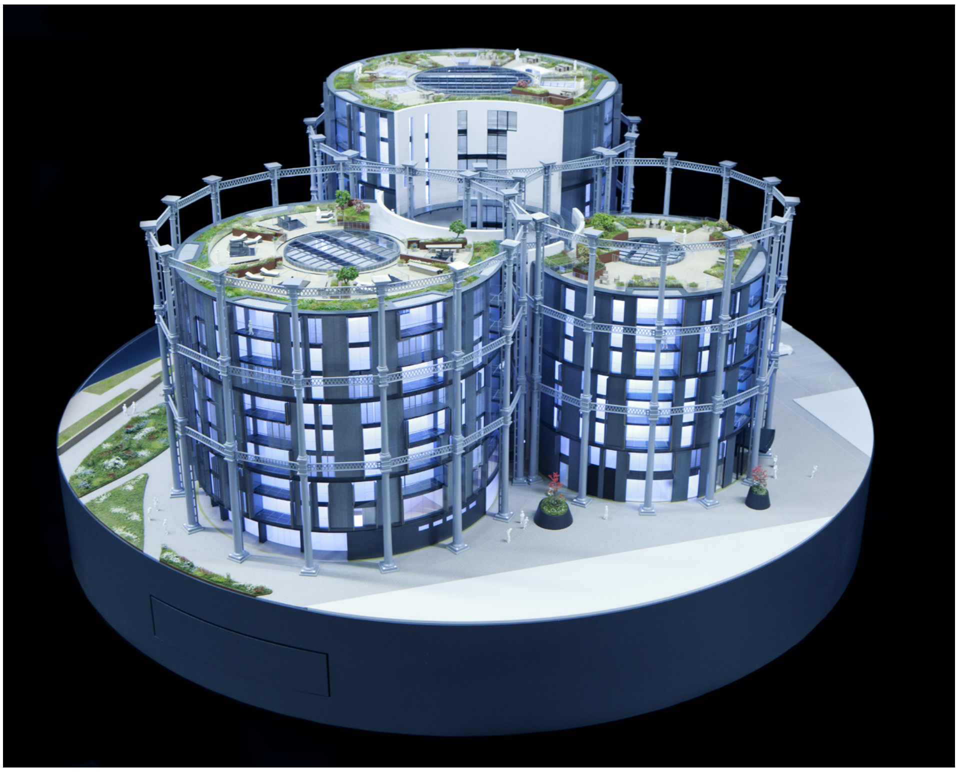

Figure 1.1: Architectural Model made by Pipers, 2015

The architectural model's function in this manner creates a clear distinction between other physical models of buildings such as souvenirs, heritage and museum models, doll's houses, and film and television miniatures, this despite all of these sharing a common property of reduced scale. Scale, while not a requisite feature of all architectural models, is however widely acknowledged as being crucial to their success (see Jetsonen, 2000; Smith, 2004; Moon, 2005; Morris, 2006; Oswald, 2008; Schilling, 2018), with most architectural models built at varying scales between 1:50 and 1:1000. The process of miniaturisation, while also being accompanied by strong associations with memories of childhood play (Moon, 2005, p.70), has often been employed as a device through which 'complex ideologies could be reduced, simplified and directed on a scale with which humans can relate' (Davy and Dixon, 2019, p.3). Claude Levi-Strauss has suggested that scale models allow for a perception of the whole first, before focusing downwards to the detailed parts – this being the opposite experience of our perception of real buildings, where we expand our perceptions from the detail around us to the wider whole (Levi-Strauss, 2004, pp.23-25). The advantage of a scale architectural model is that it allows for an appreciation of an overall concept at a glance.

Architectural models generally fall into one of two categories defined by their function – that of design development and of communication. Modelmaker Thomas Hendrick described these two functions in 1957 as experiment and explanation: 'In each case the function of the model is to help both creator and recipient to visualise a project more clearly in terms of three-dimensions' (Hendrick, 1957, p.13). While the role of architectural models in explaining designs has been utilised for over five hundred years, the use of models as an active part of the design process became increasingly central to architectural practice during the twentieth century (Morris, 2004), with architects – and, most notably, architecture students – today constructing models to explore spatial and architectural concepts in three-dimensions. These 'working', 'sketch', or 'study' models operate in much the same manner that pencil sketches and illustrations do in exploring design ideas. Through their exploratory nature, design development models serve to express elements of a project that are still emerging and are not yet completely defined (Morris, 2004, p.76). These models also play a dual explanatory role in architectural education by communicating the students' design ideas for assessment purposes (see Dunn, 2007). Explanatory models are then made when the design of a building has reached a point of certainty whereby an element of it is ready to be communicated to someone other than the architect, such as a client or the general public. This can occur at any stage of the design process, from simply presenting different massing options at an internal team review or an early design concept to a client or panel. Once a design has been finalised, more detailed models can be produced, and are often termed 'presentation models'. These are used to present a final design to a client or are used as sales and marketing tools by property developers. Peter Downton describes a spectrum of models based on these two categories of use, ranging from their design role at one end to their communication role at the other, noting that a model's position on the spectrum shapes it character. The later in the design process a model is made, the less of a role it plays in influencing the design, and becomes more focused on communicating decisions that have been made to other people; the dialogue turning more outward as the design progresses. At this end of the spectrum, the model becomes more confident, using higher quality materials and better finishes to achieve greater accuracy (Downton, 2007, pp.42-46).

The model's highly successful role as an explanatory device has long been acknowledged, being one of the principal instruments architects use to communicate their designs to others (Ratzlaff, 2016, p.15). The benefits of its physical nature and usually reduced scale, as discussed above, positions the model as the most accessible form of architectural communication (Morris, 2004, p.28). Albert Smith has noted that 'if pictures are worth a thousand words, a model is worth a thousand pictures' (Smith, 2004, p.xviii). Architectural models are highly versatile objects that are able to convey both factual and conceptual information about a design (Moon, 2005, p.11), especially to those not trained to read technical plans and drawings. Although sales and marketing models are ostensibly built for promotion and play no active role in the design process, the communication of architectural designs often plays a vital role in developing a project. Both Nick Dunn (2007, p.66) and Peter Downton (2007, p.45) have suggested that presentation models are not involved in decision making during the design process, however many architects and modelmakers have noted the crucial role models play in generating discussions during client presentations that lead to further evolutions of the design (Blythe, 2018; McWilliam, 2018; Miles, 2018).

1.4.2. Professional Architectural Modelmaking

The self-denoted use of the term 'professional' by modelmakers for whom the practice is their permanent occupation generally refers to the broadest sense of the word. Although entry into the profession is increasingly through a degree-level education route, there are no regulatory bodies or admission examinations in the sense of becoming a barrister, medical doctor, or civil engineer, for example. Indeed, as Chapter Four outlines, the origins of the profession of architectural modelmaking itself stems from the making of models being removed from the legally-recognised and monopolistic pre-industrial craft trades associated with building construction. 'Professional' in the sense that modelmakers employ the term today is used to denote the occupation's difference from hobbyist modelmaking (also sometimes referred to as 'modelling'), and specifically within architectural modelmaking between the work of individuals for whom modelmaking is their permanent occupation, and the making of explorative design development models carried out by architects as part of the design process. In focusing on the work of professional modelmakers, this thesis therefore excludes such models, and those made by architecture students as part of their education (a subject previously covered by Mark Morris in 2004 and Nick Dunn in 2007).

The distinction between individuals whose primary role is architectural modelmaking and those who make models as an aside to their main work in another area is much less clear when discussing the origins of the profession, however, as architectural models were previously made by craftsmen in other trades who made models as adjuncts to their principal businesses – often full-scale architectural work such as carpentry or ornamental sculpting. As Chapter Four outlines, this thesis establishes a clear start to the profession of architectural modelmaking in Britain with the work of John Thorp in the late nineteenth century, and it is from this point onwards that the study begins its focus. By excluding the work of pre-professional architectural modelmakers in the modern sense of the term, this thesis in no way intends to invalidate their work as examples of modelmaking, but rather to focus on understanding the development of the models that are produced by professional architectural modelmakers as the profession is recognised today.

With design development exploratory architectural models largely being made by architects themselves, it is the higher levels of quality and precision required by explanatory models that demands the skills of a professional architectural modelmaker. This is not to say that all such models are made by professional modelmakers as the expense of either employing a modelmaker directly, or hiring their commercial services, means smaller architectural practices, where models form part of their presentation methods, often rely on the architects themselves to produce whatever models are required. For larger practices, however, the professional modelmaker is usually called upon whenever a high quality model is sought after.

Modelmaking as a professional practice is based on the principle that all models are a form of communication. Modelmaking in its industrial and commercial application can therefore be described as the communication of messages through the creation of material culture. Though all models, whether professional or hobbyist in nature, are forms of material culture, the significance of communication to the professional practice of modelmaking is distinct from the broader range of activities found in amateur, hobbyist, or childhood engagement with models (see King, 1996). Whether a film prop, a museum replica, an animation set, a marketing or display model, or an architectural model, professionally-made models are designed and made to communicate a specific idea, message, concept, or likeness to a specific audience. This communication largely takes place, as noted above, across the boundaries of different social groups, and between experts and non-experts. An explanatory model in a museum communicates knowledge from a scientist to the general public, while a film prop communicates a fantasy world devised by the filmmakers to an audience with no prior knowledge of that world. An architectural model communicates an architect's design to a client or other non-architect.

Today, architectural modelmaking is a small but thriving industry in Britain, with over one hundred firms actively involved in architectural model construction at the time of writing. Two thirds of these firms are dedicated commercial modelmaking companies, while the rest are architectural practices that employ professional modelmakers in in-house modelmaking workshops. In-house modelmakers will often work on a much broader range of models than commercial modelmakers, including design development models for lighting or wind-tunnel testing. Practices such as Jestico+Whiles and Farrells employ single modelmakers, largely producing models for competition submissions or early design models for in-house discussions. Larger practices such as Fielden Clegg Bradley Studios, Rogers Stirk Harbour and Partners, and Make Architects employ small teams of modelmakers each producing several hundred models per year. The largest architectural practice in Britain, Foster + Partners, employs over fifty professional modelmakers in two locations, producing over five hundred models a year, as well as supporting the making of design development models by architects themselves by training and supervising their use of more advanced materials and machinery.

Beyond these in-house modelmakers, dedicated commercial architectural modelmaking firms make up the bulk of the profession, with over sixty companies active in 2020. Ranging from individual modelmakers working alone, producing as few as twenty models each year, to the largest firms such as Pipers who employ forty-five modelmakers and produce several hundred models annually, there are also a number of general modelmaking companies such as Amalgam who produce architectural models alongside advertising, heritage, and product models. While in-house modelmakers may make a wide range of models including those destined for internal use within the architectural practice, commercial modelmakers are normally only engaged to produce high-quality models designed for external communication – competition models, planning models, client presentation models, and sales and marketing models. These models are more time-consuming and expensive to produce, and even architectural practices that themselves employ in-house modelmakers will often make use of commercial modelmaking firms for models that are too complex or too large for them to produce in-house, or simply in order to free up their in-house modelmakers to concentrate on models of designs still early in the development process (Vandersteen, 2018). A significant difference between the in-house and commercial modelmaker is that the commercial modelmaker's clients are not necessarily architects. The need for sales and marketing models, which for many firms are the mainstay of their businesses, means a significant proportion of architectural models are commissioned by property developers rather than architects.

1.4.3. Materials

Although the making of architectural models embraces a diverse range of materials that includes timbers and metals, one material group in particular dominates their construction – plastics. Figure 1.2 shows a selection of models made by the students of the BA (Hons) Modelmaking degree at AUB during 2016, and of the eighty-five models included, only eight contain no plastics at all. Seventy-seven contain plastics, and of those, sixty-one use it as their principle material. Although a sample of student models, this proportion broadly reflects industry practice. Perspex (polymethyl methacrylate), in both sheet and block form, is the most commonly-used material within the profession, with polystyrene sheet (HIPS), model board (a high-density polyurethane block), and the various plastics-based 3D printing filaments and resins also being mainstays of the modelmaker's material stock. Expanded polystyrene (colloquially referred to as 'Styrofoam', although this is actually a trade name of an extruded polystyrene), is also heavily used in design development models, although

Figure 1.2: Modelmaking student models, AUB, 2016

this material is less regularly found in higher quality presentation models. Even models that ostensibly appear to be made from timber often contain large amounts of Perspex, either used to represent glass, or as a structural core that has been hidden under layers of timber veneer. Since the widespread introduction of Perspex to architectural modelmaking after the Second World War (see Chapter Five), plastics have become the default materials used in model construction; their versatility, stability, and in the case of Perspex, their transparency endearing them to the needs of the professional modelmaker.

While plastics, particularly Perspex, are by far the most common materials used in professionally-made architectural models in Britain today, it is also important to acknowledge that the diversity of visual styles required across the range of different model types dictates that the professional modelmaker complements their use with a variety of additional materials based on the needs of the specific model. Polymer-based resins, casting materials such as jesmonite, plaster of Paris, and even concrete are employed in more abstract or conceptual models, while timber remains the second most widely-used material after sheet plastics, having been employed in the construction of architectural models for over five hundred years. Today, unpainted timber plays an important role in providing a degree of abstraction in models that stands in opposition to the high levels of realism achievable with painted plastics (Figure 1.3), with a wide variety of timbers in use, ranging from balsa wood in design development models through to higher quality timbers such as cedar, jelutong,

Figure 1.3: Timber and metal model made by Base Models, circa 2010

pear, walnut, and oak, in either block or veneer form. The most common timber materials, however, are the composite boards plywood and medium-density fibreboard (MDF), which are largely used for the construction of model baseboards.

1.4.4. The Model's Stylistic 'Palette'

Designed and made to fulfil a number of different roles, the contemporary professionally-made architectural model in Britain employs a range of styles that extends from the highly abstract at one end to the photographically-realistic at the other. The creative application of different materials and processes to achieve such stylistic diversity is today an important aspect of the model's continued success, and is often referred to within the profession as the model's 'palette' (e.g. Armiger, 2018a; Fooks, 2018; Hamnell, 2018; McWilliam, 2018; Innes, 2019; Putler, 2019; Spencer-Davies, 2019). The breadth of this palette enables the professionally-made architectural model to serve the differing needs of both the architect and the property developer, with varying degrees of realism and abstraction called for depending on the function a particular model has been designed to fulfil.

At the most abstract end of the model's palette are early design development or 'sketch' models that are often fairly approximate and may not even conform to a specific scale (Figure 1.4); and concept models that express generalised architectural notions of space and form, and which do not always represent something that is intended to be built (Figure 1.5). In both of these model types, abstraction is enforced due to there being insufficient detail to be represented, while in models made for submission to juries in architectural competitions, abstraction is present not only due to the model being made at a very early stage in the design process where only basic concepts have been established, but also to impress a jury on the basis of creativity and showmanship (Figure 1.6). As such, competition models tend to be among the most visually expressive and innovative architectural models, while planning, structural, and interior models tend towards more accurate but stylistically-neutral approaches (Figure 1.7); the level of realism increasing the further along the design process a model is made (Downton, 2007, pp.42-46).

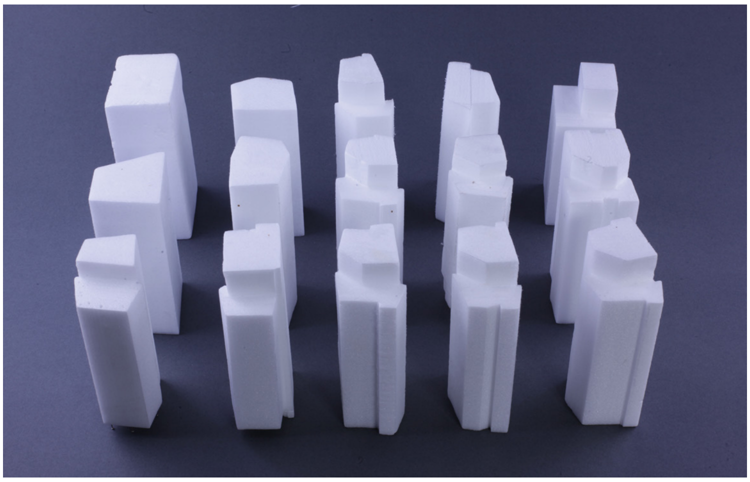

Figure 1.4: Sketch models made by Jestico+Whiles, 2017

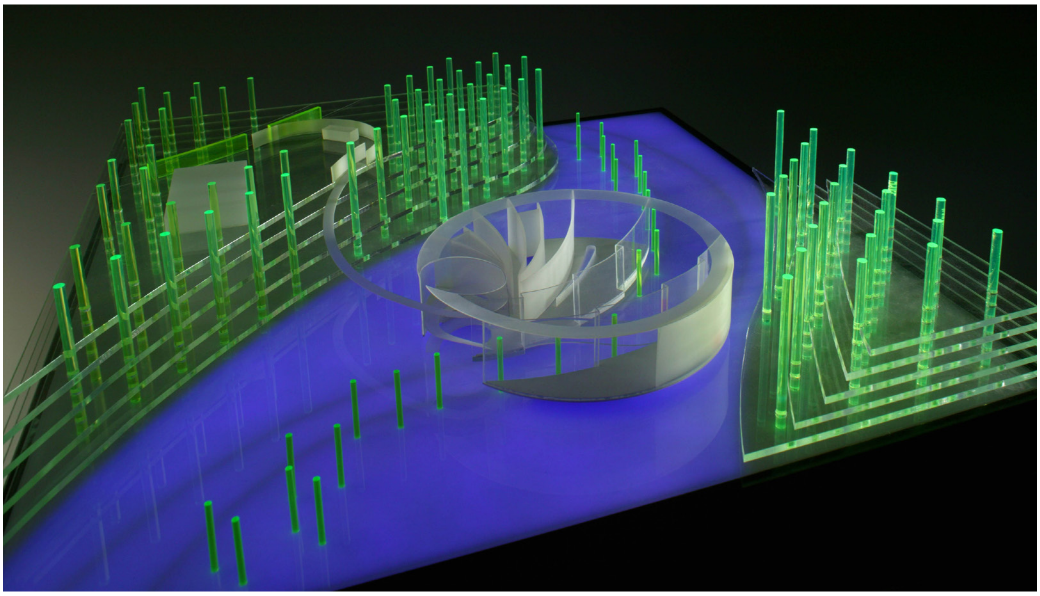

Figure 1.5: Concept model made by Unit 22, circa 2004

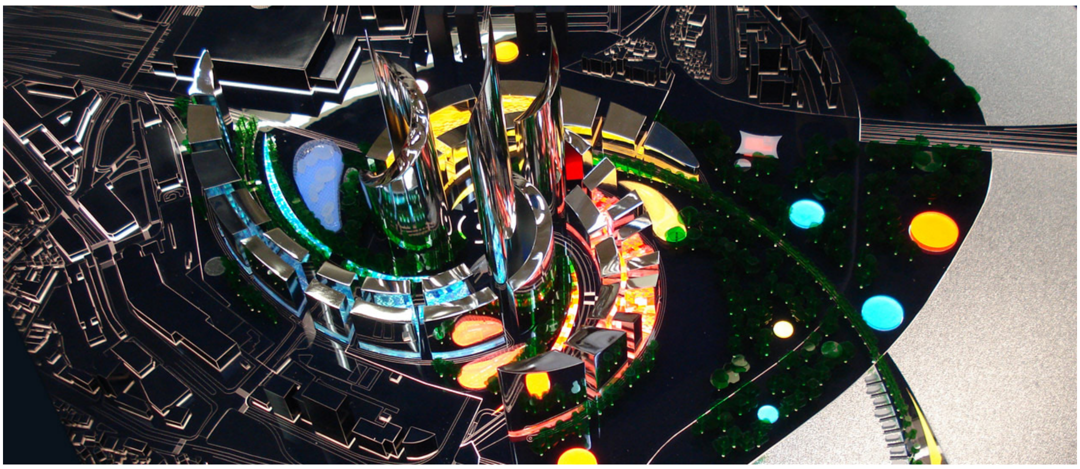

Figure 1.6: Competition model made by Amalgam, circa 2010

The term ‘presentation model’ is often applied to a range of models that are made towards the very end of the design process, and even during and after the building’s actual construction, in order to communicate a finalised design proposal to either clients or the general public. These models are often the most highly-finished and realistic type of architectural model, especially when used for sales and marketing purposes, with developers going to great lengths to specify ultra-realistic details to aid prospective buyers in visualising themselves occupying a particular property (Figure 1.8). Increasingly, such models have also come to include elements of interactivity, with the use of technology such as programmable lighting, touchscreen interfaces, and even digital animation being used to augment their often highly realistic nature. At the same time, presentation models used by architects tend to employ more creative and abstract approaches that strike a more muted balance between the realism of a developer’s marketing model and an architect’s competition model (Figure 1.9).

Figure 1.7: Planning model made by Farrells, 2016. Photograph by Andrew Putler

Figure 1.8: Marketing model made by MC Modelmaking, 2017

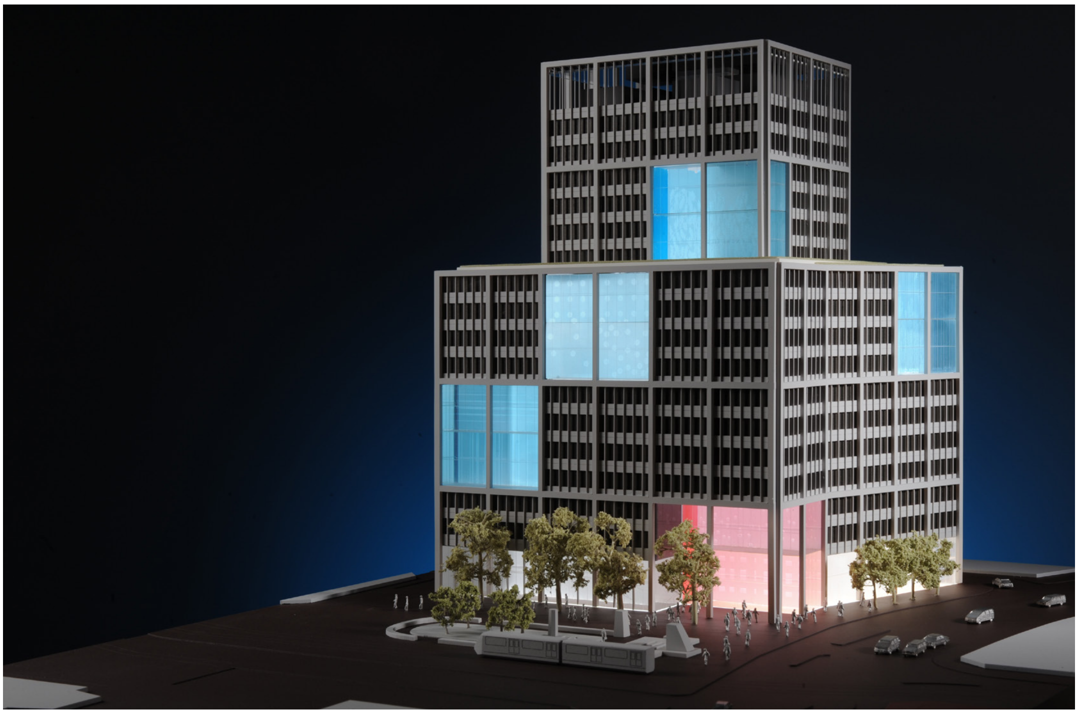

Figure 1.9: Presentation model made by Millennium Models, circa 2008

1.4.5. Digital Manufacturing Tools

While the use of more traditional machine tools and basic hand skills still remain important in the making of architectural models, digital manufacturing techniques such as laser cutting and 3D printing have largely replaced more time-consuming manual methods (Figure 1.10). As such, today's professionally-made architectural model in Britain utilises a range of advanced computer-driven processes in its making, with programmable lighting and other interactive features increasingly being designed into the most complex marketing and exhibition models (Figure 1.11). The use of the laser cutter in particular has had a dramatic impact on the precision and accuracy of the architectural model, working directly from CAD files to a tolerance of a fraction of a millimetre (Figure 1.12). Allowing for much greater levels of detail even at smaller scales, laser cutting has also greatly improved the efficiency of model construction, while 3D printing has enabled more organic and complex shapes to be produced much more accurately.

Laser cutters are now considered a standard tool of the professional architectural modelmaker, and few workshops are without at least one 3D printer. Modelmakers may spend as much as half of their time making a particular model working on computers to draw or otherwise prepare cutting or 3D printing files, before relying on more traditional hand processes such as sanding, masking, and painting during the assembly phase of a model.

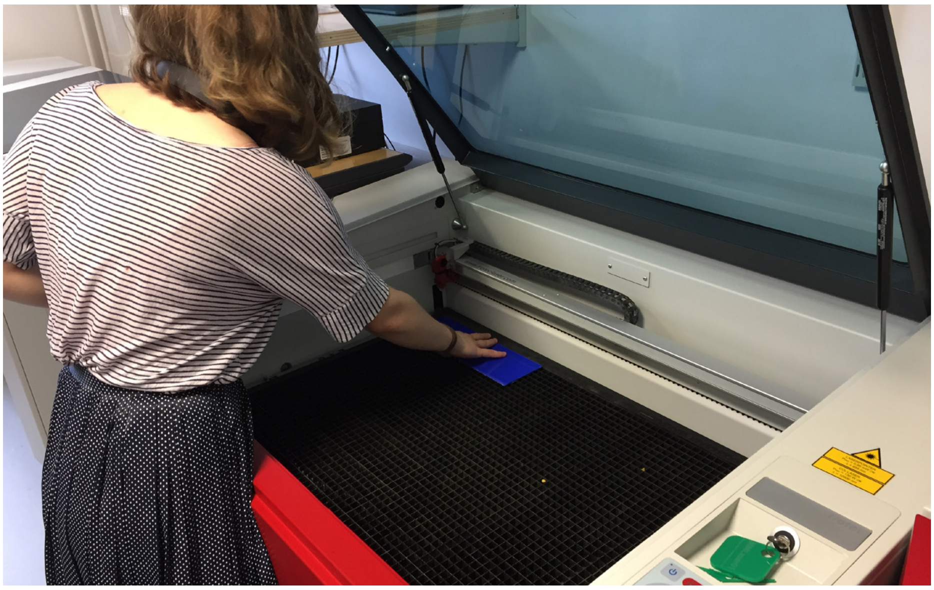

Figure 1.10: Modelmaker using a laser cutter

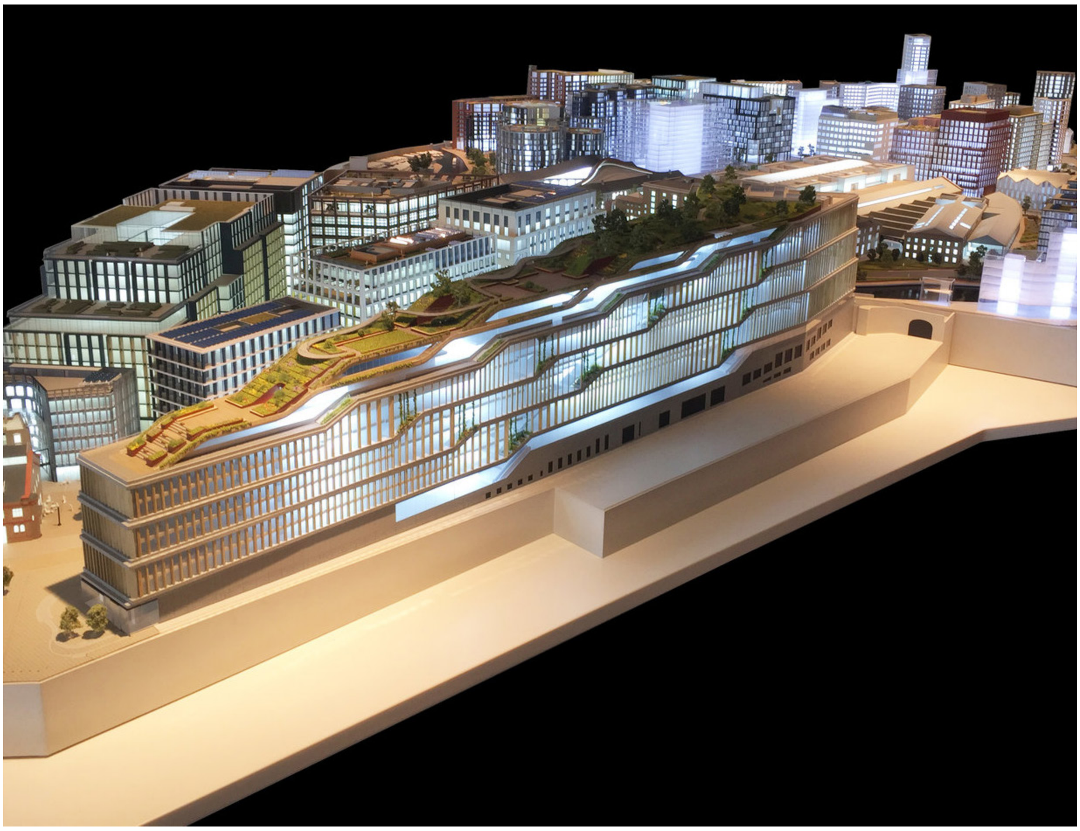

Figure 1.11: Model of Google HQ, London, made by Pipers, 2017

Figure 1.13: Interior model by Millennium Models, circa 2016

1.5. Summary of Chapters

With this chapter having established the thesis' aims, research questions, and objectives, and provided an overview of the professionally-made architectural model in Britain today, Chapters Two and Three continue to provide additional context to the discussion of the findings presented in Chapters Four to Seven.

Chapter Two reviews the existing literature relating to the architectural model upon which this thesis builds. Highlighting an emphasis in the literature on the use of architectural models in the design process, this chapter discusses the reasons behind an increased critical interest in the architectural model since the millennium, and in noting the dominance of a 'post-production' perspective that has resulted in a lack of research into the making of models, their materials, and professional modelmakers themselves, identifies the clear research gap in which this thesis is situated.

Chapter Three presents the methodological basis upon which the study was conducted, and outlines the necessity for adopting a conceptual framework that provides an alternative to the prevailing 'post-production' analysis of objects (Fariello, 2005, p.4) within the disciplines dedicated to the study of objects and their histories. The chapter then discusses this thesis' drawing from the relational perspective of Assemblage Theory to enable an understanding of the socio-material history of the model, and outlines the specific methods used.

Chapters Four to Seven then present the main discussion of the findings of the study, charting the development of the professionally-made architectural model in Britain during four distinct periods in its history and tracing the relationships and interactions that shaped the model within each period.

Chapter Four traces the origins of the profession of architectural modelmaking in Britain, establishing that the making of architectural models had previously been undertaken within the craft trades associated with building construction. Locating the emergence of the modern profession to within a period defined by the working career of John Thorp from 1883 to 1939, the chapter charts the developments that led up to the making of architectural models shifting from being an activity carried out within various individual craft trades and into the dedicated 'interesting occupation' that Robert Hoyt referred to (Hoyt, 1939, p.420), and examines the consequences of the imaginative and adaptable approach to modelmaking that the first generation of architectural modelmakers such as John Thorp established. In revealing their dramatic successes during the inter-war years, this chapter highlights how the initial professionalisation of architectural modelmaking transformed the realism and quality of architectural models, and established a template for the profession that has continued to shape the model throughout its subsequent history, embedding the notion of 'ingenious adaptation' that has been fundamental to the development of the model ever since.

Chapter Five traces the widespread introduction of plastics to architectural modelmaking during the plastics revolution that resulted from the post-war modelmaking boom in Britain of the 1950s and early-1960s, examining the convergence of the use of Perspex, an increased demand for models during post-war rebuilding efforts, the need for new modelmaking materials to represent modernist architectural styles, and the influx of significant numbers of military-trained modelmakers into the profession shortly after the Second World War.

Identifying the post-war era as a period of unprecedented advances for the professionally-made architectural model, this chapter outlines the lasting consequences of this period in establishing plastics as the dominant materials of architectural modelmaking, and highlights the successful matching of the adaptable nature of the professional architectural modelmaker with the adaptable properties of Perspex.

Chapter Six examines the circumstances of the creative expansion that took place during the 1970s and 1980s that realigned the professionally-made architectural model in Britain to better match the pluralistic approach of architecture that had emerged after the collapse of the modernist consensus, and which allowed for the dual roles of the model as both a commercial sales tool and a visionary expression of architectural ideas to be jointly accommodated within a much broader palette of styles. Tracing the influence of the Arup modelshop in the context of an increasingly negative view of realism in architectural models, this chapter charts the convergence of factors that resulted in the diverse range of stylistic approaches that the model employs today, and reveals how the model adapted to meet the conflicting demands of both the architect and the developer during a period that saw a notable increase in the use of abstraction, more creative uses of materials, and a resurgence of the use of timber as a modelmaking material alongside plastics.

Chapter Seven is centred on tracing the introduction of digital manufacturing technologies such as CNC (computer-numerically controlled) machining, laser cutting, and 3D printing. Covering a period from the 1990s to the present day, this chapter examines their adoption in response to an urgent need to improve the efficiency of many of the basic process of architectural modelmaking, and considers their consequences for the making, creativity, and functionality of the architectural model, outlining the substantial gains in efficiency that the automation of repetitive processes brought about. In taking digital tools that had initially been seen as potential threats to their profession and adapting them to their own requirements, the chapter demonstrates how the adaptable approach of the professional modelmaker enabled the professionally-made architectural model in Britain to navigate the multiple threats of the emerging digital age and to thrive, adapting and adopting new tools and processes that resulted in the wholesale shift from analogue to digital ways of working that characterises the making of professionally-made architectural models today.

Finally, Chapter Eight brings the thesis to a conclusion by outlining how it has answered its research questions and met its overall aim and objectives. In summarising its principal findings of how the model's contemporary form emerged from a complex assemblage of the various people, processes, materials, and ideas that contributed to its history, this chapter also highlights the thesis' central argument that the notion of 'ingenious adaptation' – reinterpreted as emerging from the combined agency of the modelmaker's imaginative and ingenious intentions and the intrinsic adaptability of the materials, tools, and processes employed – stands as the most significant influence that has shaped the development of the professionally-made architectural model in Britain through its history. The chapter then considers the thesis' original contribution to knowledge in the context of existing research, and expands upon its broader significance before closing with some suggestions for further research.

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2: Literature Review

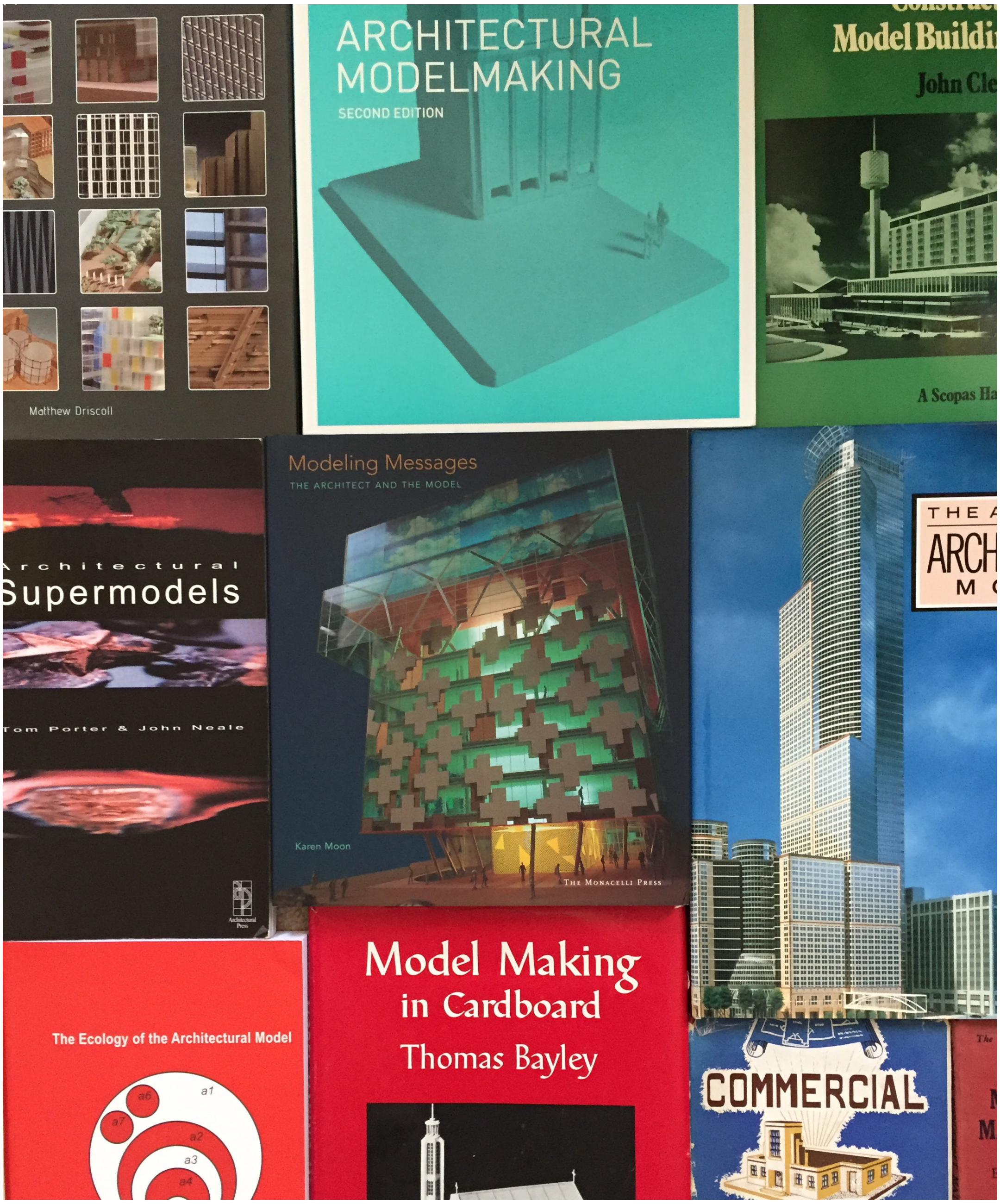

Figure 2.0: Examples of architectural modelmaking publications

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2.1. Introduction

A common theme in much of the published research relating to the architectural model is a recurring admission that the subject is not one that has been particularly well-researched. Where studies have been conducted, however, they have almost exclusively been carried out from within the field of architecture. While outwardly this may not seem particularly surprising given that this is the discipline within which the architectural model operates, the absence of a modelmaking perspective is an important point to consider, as the existing research has been predominantly tailored towards the interests of architects rather than modelmakers. As such, it is the use of the architectural model within the design process, and its broader cultural and symbolic meaning that has been emphasised, rather than the making of models and the role of the professional modelmaker. In this manner, the existing literature largely conforms to what Anna Fariello has described as a 'post-production' form of analysis (2005, p.4) in which a focus on how objects are used has led to less attention being paid to how objects are made (as discussed further in Chapter Three).

This chapter situates the thesis within the existing literature relating to the architectural model in order to highlight both the work that this study builds upon and the specific research gap in which it resides. Beginning with a general overview of the body of literature, the chapter outlines the legacy of *Idea as Model* (Frampton and Kolbowski, 1981) and *Great Models* (Buttolph, 1978a) in influencing a post-millennial research boom that has continued to emphasise the use of models by architects in design and education. The chapter then discusses the problems that have arisen in existing histories of the architectural model that have taken a global rather than regional or national perspective, and identifies the consistent overlooking of both the professional modelmaker and the materials and processes of architectural modelmaking. The chapter concludes by emphasising how this thesis makes a valuable contribution to the existing literature through its presentation of a historical study of the development of the professionally-made architectural model in Britain that is situated within the field of modelmaking rather than architecture, highlighting developments in the making of architectural models as opposed to the dominant post-production perspective that overlooks the role of the modelmaker and the materials and processes employed.

2.2. General Overview

The overall body of literature relating to the architectural model is mostly comprised of practical instruction books that date as far back as the 1820s (see Boileau, 1827; Richardson, 1859; Hobbs, 1926; Hendrick, 1957; Janke, 1978; Driscoll, 2013; Dunn, 2014; et al). These provide a rich source of information for the study of the model's history over the past two centuries, of which this thesis has been able to make productive use (see Appendix 4); however in terms of what might be more readily classified as critical or theoretical literature, the pool of available texts is much more limited. It is only since the millennium that a sustained interest in studying the architectural model has begun to gather pace, initially as a consequence of the critical re-evaluation of architecture's representational and design tools that took place as a result of the shift from analogue to digital processes during the late-1990s (McLening and Lund, 2018; see also Chapter Seven).

The first major theoretical considerations of the architectural model took place in the United States in the late-1970s: *Great Models* (Buttolph, 1978a), which published a number of short essays on the history, use, and nature of the model; and the 1976 exhibition *Idea as Model,* the catalogue for which was finally published after a five year delay (Frampton and Kolbowski, 1981). While *Idea as Model* and *Great Models* have been repeatedly heralded as marking a shift towards architectural models being considered worthy of in-depth study (see Morris, 2004; Moon, 2005; Hubert, 2011; Elser, 2012; Ratzlaf, 2016), there is little evidence that these publications had any great impact at the time. *Great Models* was a special issue of the student publication of the School of Design at North Carolina State University, and so its circulation is unlikely to have brought it much prominence, especially in Britain. It is not until both Mark Morris (2004) and Karen Moon (2005) separately rediscover the publications during their own research projects over twenty five years later that they receive any documented attention.

The New York exhibition *Idea as Model* was developed by the architect Peter Eisenman, who held a 'long-standing intuition that [...] a model of a building could be something other than a narrative record of a project or building.' (Eisenman, 1981, p.1). The aim of the exhibition was to show not finished presentation models, but conceptual and design development models, in order to encourage greater use of such models in architectural practice in the United States. The exhibition took place during a period where architects on both sides of the Atlantic were critically re-examining the purpose of architectural models, and the essays in the exhibition catalogue were the first to articulate the then novel position that architectural models were not merely representations of proposed buildings, but representations of architectural ideas (Eisenman, 1981, p.3; Morris, 2004, p.18). This shift in perspective can be seen as an attempt to re-instate the model as a conceptual medium during a period of intensive critical introspection for the architectural profession in the wake of the collapse of the modernist post-war consensus (see Chapter Six). The model was still seen as being a symbolic object, however, but no longer always standing in for a full-size building (Lauriat, 2011, p.299). In the publication *Great Model*s (Buttolph, 1978a), the architect Michael Graves echoed the concept that architectural models were models of ideas rather than buildings (Graves, 1978, p.43), while editor Suzanne Buttolph suggested that architectural models were of designs that could, or should, be built, rather than necessarily those that were planned to be built (Buttolph, 1978b, p.6). Alongside Eisenman's argument, Christian Hubert's essay in *Ideas as Model*, *The Ruins of Representation* (1981, pp.17-27), asked important questions about the duality of the architectural model as both a representation and as an object in its own right. Hubert discusses the model as being in some way similar to a picture frame – marking the boundary between representation and reality (Hubert, 1981, p.17); the tension between representation and objecthood expressed here having become a fundamental theme in much of the literature that has followed (see Ayres, 2012; Brejzek and Wallen, 2018).

The twin conjectures raised in *Idea as Model* and *Great Models* – that architectural models represent ideas rather than buildings, and that they are also both symbols and material objects with their own independent existence – first articulated the dual nature of the model that has been central to architecture's consideration of the model ever since. In terms of their wider influence on the literature that followed, both *Idea as Model* and *Great Models* largely focus on the use of models within the design process to generate ideas rather than those models made by professional modelmakers to communicate ideas to others outside of the architectural profession, and while they stand as the isolated precursors of a much more recent period of theoretical interest in the architectural model, their influence on later thinking cannot be overstated. Mark Morris credits *Idea as Model* as his principal inspiration for his PhD thesis and subsequent book (Morris, 2004, p.17), and it is perhaps inevitable that researchers at the start of the twenty-first century, in reviewing the extremely limited literature then available, would be influenced by the themes and ideas raised in the only two previous publications they could find.

Tom Porter and John Neale's *Architectural Supermodels* (2000) was written very much in the same spirit, presenting an overview of the model and its use within the design process at a time of potentially massive change due to the arrival of high-quality digital visualisations. Their aim was to celebrate the architectural model while simultaneously making a case for the importance of design development models. Porter and Neale put forward the idea that the most important models to be considered, 'supermodels' in their vernacular, are design and sketch models, just as *Idea as Model* proposed. They argue 'not for those immaculately crafted, prohibitively expensive and professionally-built miniaturisations [...] but for those built unashamedly as tools for engaging disputed aspects of the design' (Porter and Neale, 2000, p.vi). This decision to focus on sketch models by necessity should have ruled out much discussion of professional architectural modelmakers, however the book is curiously notable for being principally illustrated with photographs of presentation models as opposed to the design development models the authors were championing, and for containing several interviews with professional modelmakers (discussed further below).

Mark Morris, in directly acknowledging *Idea as Model* as the inspiration for his 2004 PhD thesis *A Model Education: Architecture and the Miniature* and the subsequent book-version *Models: Architecture and the Miniature* (2006), also focuses on design development models, particularly within architectural education. Outlining a history of the model in architectural education and its uses in contemporary practice, he discusses the symbolic nature of the model throughout history, and dedicates several chapters to the issues of scale, size, and miniaturisation. Morris' exploration of the model also takes into account other forms of miniature buildings such as model villages, souvenirs, toys and even cakes, following a similar path to Susan Stewart's broader examination of the miniature, *On Longing* (1984). Suggesting that models are small not only for practical and financial reasons, Morris puts forward the idea that we associate preliminary things as being smaller and less real than the end result, citing an association with human babies and childhood (Morris, 2006, p.9).

With both Morris and Porter and Neale having continued the emphasis on the use of architectural models in both the design process and architectural education that *Idea as Model* and *Great Models* established, much of the research that has followed has adopted the same approach. Nick Dunn carried out a detailed examination of the model within architectural education with his own PhD thesis and later book *The Ecology of the Architectural Model* (2007), exploring the contemporary use of models in architectural schools in Britain using an ecological approach to observing and classifying the types of models used. Christian Ganshirt (2007) and Peter Bertram (2012) both focused their research on models made by architects as design tools, while Peter Downton's *Homo Faber* research project produced three short volumes of essays from a variety of architects discussing the use of models in architectural practices in Australia, again specifically focused on their role in the design process (Downton et al, 2007; 2008; 2010).

Beyond the use of architectural models within architectural practice, a further area of focus within the existing literature is the small but influential body of more philosophical research that examines the model's cultural and symbolic meaning. Albert Smith's *Architectural Model as Machine* (2004) puts forward a specific view of the architectural model as a thinking machine, linking the model to a historical quest to measure the immeasurable, culminating in a discussion of the model's connections to the divine as a religious icon, suggesting that models help define a culture's reality. With this, Smith makes similar conclusions to James King in *Remaking the World* (1994), a rare example of a study of modelmaking as a hobby that includes the collecting and operating of model railways, boats, and aircraft. Patrick Healy's *The Model and its Architecture* (2008a) further explores the conceptual act of modelling in its widest sense, describing the creative process as a construction in itself – not just the resultant object, but the very act of translating it from an idea into reality (2008b). As with Smith, Healy relates the architectural model to iconographic religious art, suggesting that the embodiment of the divine in statues is a manifestation of the same conceptual process of modelling that dates back to antiquity (Healy, 2008b). Ultimately, Healy's argument is that models are in some way attempts to capture in physical form something that only exists conceptually – how can you give shape to something that has no shape? (Healy, 2008b). This is, incidentally, the same argument put forward by Peter Eisenman in *Idea as Model* (1981, p.3) and by Michael Graves in *Great Models* (1978, p.43), in that as ideas and mental concepts cannot substantively exist in the real world, any model made to represent them involves some degree of translation.

In examining the model's idealistic and utopian nature, James King suggests that all forms of modelmaking and miniature collecting reflect a desire to remake the world in some way better than it is, in response to a 'certain discontent with the world around us' (King, 1996, p.227), while Brejzek and Wallen in *The Model as Performance* define architectural models as 'world-building tools' (Brejzek and Wallen, 2018, p.1). Models are also described as offering an alternative, cleaner version of reality, if not a strictly utopian one (Holtrop et al, 2011, p.20), shifting the representational function of the model even further from that of standing in for a prospective building, and towards a representation of what 'architecture promises, yet can never attain itself.' (Gerrewey, 2011, p.36). Ansgar Oswald more directly links the architectural model to modernist utopias depicted in films such as the modelscapes in *Metropolis* (Oswald, 2008, p.22), Karen Moon discusses how models, which do not actually function as buildings, 'lend themselves particularly to the representation of the imaginary or ideal' (Moon, 2005, p.10), while Akiko Busch refers to the model's pristine existence as architecture removed from its context in an idealised state (Busch, 1991, p.27).

2.3. Histories of the Architectural Model

With the total body of research relating to the architectural model being comparatively small, there have consequently only been a limited number of historical studies undertaken. The early history of the architectural model, from the Renaissance to the nineteenth century, has been the subject of a number of articles (Briggs, 1929a, 1929b; Wilton-Ely, 1965, 1967, 1968; Wells, 2017), with an additional body of work having been undertaken and published in Germany. Matthew Wells completed his PhD thesis *Architectural Models and the Professional Practice of the Architect, 1834-1916* in 2019, which will provide a new understanding of the role of architectural models in Victorian Britain, however the thesis is embargoed until 2022 pending publication and its contributions currently remain unknown. In comparison, the architectural model in its modern guise, from the twentieth century onwards, has received surprisingly little attention (Moon, 2005, p.6). Mark Morris has suggested that architects and academics 'tend not to consider models', noting that they instead 'relegate them to footnotes' (Morris, 2006, p.7). The introduction to the catalogue for the Deutsches Architekturmuseum's 2012 exhibition *The Architectural Model: Tool, Fetish, Small Utopia* makes the admission that 'now [...] we have been alerted to the subject of the contemporary architectural model, we cannot help wonder why no one thought of it before' (Kalnein, 2012, p.7).

Where histories of the architectural model have been presented, however, their drawing from combinations of British, North American, and European sources into singular narratives have led to potentially distorted views of the model's history, especially when the role of professional modelmakers is concerned. Matthew Mindrup's extensive global history of the architectural model makes the claim that 'By the 1950s, for the first time in history individuals could specialize completely in architectural model making without having to supplement their income in some other way' (Mindrup, 2019, p.147). Using Jane Jacobs' much-cited article on the post-war modelmaking boom in the United States (Jacobs, 1958) as evidence, Mindrup entirely overlooks the pre-existence by over seventy years of the profession in Britain. Karen Moon similarly confuses North American and British developments in *Modelling Messages* (2005), with later authors citing her work rather than re-examining primary sources continuing to perpetuate misreadings of the model's history. Both Mindrup (2019, p.167) and Deriu (2012a, p.166) date the introduction of cardboard to architectural modelmaking to the 1920s, citing Moon as evidence, however Moon was drawing purely from American sources (Moon, 2005, p.43; p.161). While Moon does indeed make this clear, she does so in a chapter that purports to offer a global history of the model, giving prominence to the increased use of cardboard in North American practice in the 1920s without mentioning its common use in architectural models in Britain during the 19th century, and its earliest adoption during the 1630s (see Chapter Four). Moon further states that architectural modelmaking was mechanised after the Second World War, again extending the timeline of American modelmaking globally (Moon, 2005, p.147), while as Chapter Four of this thesis shows, machine tools had been in use in architectural modelmaking in Britain as early as the 1920s. In a similar manner, Mindrup suggests architectural models were in common use in Britain during the seventeenth century based on the architect Henry Wotton's contemporary writings (Mindrup, 2019, p.132), however Wotton was an English diplomat rather than an architect, and his 1624 book *Elements of Architecture* was a translation of Vitruvius' *Ten Books on Architecture* written during his time in Venice, which he had updated to reflect contemporary Italian architectural practice (Briggs, 1929b, p.245), and so Wotton therefore provides evidence of the use of models in Italy during that period rather than in Britain.

What is notable is that the same emphasis within the broader pool of literature on the use of architectural models is also prevalent in studies of their history. Matthew Mindrup's recent historical account *The Architectural Model: Histories of the Miniature and the Prototype, the Exemplar and the Muse* (Mindrup, 2019), is focused firmly on the model's use, observing that 'despite the long-standing presence of models in architectural practice...a historical survey of different uses for architectural models has rarely been undertaken (Mindrup, 2019, p.3). Similarly, Wells (2017; 2019), Wilton-Ely (1965; 1967; 1968), and Briggs also have focused on the use of models with architectural practice, while Mark Morris' reuse of a chronology of the use of architectural models in education from his PhD thesis within his 2006 book *Models: Architecture and the Miniature* is presented as a history of the architectural model as a whole.

As these examples highlight, the lack of either national or regional histories of the architectural model, and the continued focus on the use of models, has led to unintended distortions of the model's history, particularly in Britain, where global histories attempt to merge conflicting timelines in terms of the development of the profession, processes, and materials of architectural modelmaking. As it stands, there has yet to be an overall history of the architectural model in Britain, nor one specifically focused on professionally-made architectural models, either in Britain or elsewhere.

2.4 Modelmakers and Modelmaking

As was noted in the introduction to this chapter, the emphasis on the use of architectural models over their making described above is an example of what Anna Fariello describes as a 'post-production' perspective (2005, p.4), having observed that the influence that materials and technical processes have on finished objects have been consistently overlooked in the study of objects, and questioning whether 'certain materials [are] inherently humble, or certain makers incapable of expressive voice?' (2005, p.3). In criticising the over-use of this approach within the wider study of objects, Fariello suggests that a 'front-end consideration' of objects be made (2005, p.4), and champions the value of adopting the view of the maker. Due to the continued focus on the use of models as design tools and their broader symbolic meaning, however, discussions of the professional modelmaker and the processes and materials of modelmaking have been largely relegated to providing content for practical instruction books and photographic collections, and it is rare within the latter that the modelmaker is credited, listing instead the architect and the photographer only. A 'front-end' consideration of the architectural model is therefore noticeably absent from much of the published literature.

Thomas Fisher, while editor of *Progressive Architecture*, compared the work of the modelmaker to that of a translator of literature, noting that 'they, like their literary colleagues, have not always been treated with the greatest respect or given the proper credit', adding that 'we need to see them and their work anew' (Fisher, 1990, p.23). Neither of Mark Morris' publications (2004; 2006) contains any significant mention of modelmakers, the act of making, or the materials and processes used in the model's construction. Similarly, a paper on the post-war modelmaking boom in the United States manages to avoid any mention of either the modelmaker or the physical act of making (Lange, 2006), while a recent book on the history and use of both architectural and scenographic models also omits any discussion of the materials they are made from and the people who make them (Brejzek and Wallen, 2018). As recently as 2018, a research project organised by the V&A, *Architectural Models in Context*, which aimed to bring together all those interested in the history and current practice of architectural modelmaking, neglected to fully engage with modelmakers to the extent of hosting an event specifically discussing architectural modelmaking in contemporary architectural practice and not involving any modelmakers from the practices invited. Instead, architects talked about their practice's models and their making, despite all employing dedicated in-house professional modelmakers. Matthew Mindrup, in his study of the various uses of the architectural model throughout history, goes so far as to suggest that 'the challenge of finding new materials and methods for representing architectural ideas' in models was met by architects rather than professional modelmakers (Mindrup, 2019, p.173).

Several photographic volumes have attempted to redress this problem, however, and Akiko Busch's *The Art of the Architectural Model* (1991) contains a short essay positioning the book as a celebration of the presentation model in its own right. Covering American models only, Busch's essay is notable in that it not only credits specific modelmakers (rather than just crediting the architects behind the designs of the buildings), but also acknowledges a dramatic improvement in the quality of models during the 1980s in the United States due mostly to the introduction of better plastics and CAD/CAM processes. An equally photographic volume, *Architectural Models* (Oswald, 2008) takes the unusual step of focusing on the outputs of around twenty modelmaking workshops across Germany, Switzerland, and Austria, with an essay covering the current use and history of architectural modelmaking in Europe. The consequences of the CAD/CAM revolution are again explored, as is the model's deeply-rooted attachment to ideas of modernism and utopia. Ansgar Oswald further remarked on the co-dependent relationship that exists between the modelmaker and the architect (Oswald, 2008, p.34), noting that 'architects who wish to present their designs to the public usually order from a craftsman' (Oswald, 2008, p.9).

The extensive catalogue to the German exhibition *The Architectural Model: Tool, Fetish, Small Utopia* (Elser and Schmal, 2012) makes a deliberate effort to include the making of architectural models. As its editors rightly proclaimed, the exhibition was a 'major mark in the study of the architectural model' (Elser and Schmal, 2012, jacket), featuring over one hundred models drawn from both the Deutsches Architekturmuseum's extensive collection, and from architectural practices and museums around the world. Significantly, the written descriptions accompanying each model in the catalogue are focused on the models themselves rather than the architecture they represent – how they were constructed, the materials used, even such details as how the modelmakers solved problems such as transportation and packaging (Elser and Schmal, 2012, p.75). The stories of the modelmakers behind the models are included, and it was while working as a researcher for the exhibition that Teresa Fankhanel discovered the archive of the American modelmaker Theodore Conrad. His influential role in the post-war modelmaking boom in the United States became the basis for her PhD thesis *The Miniature Boom*: *A History of American Architectural Models in the Twentieth Century* (Fankhanel, 2016), which while currently embargoed pending its publication in book form in 2021, will be the first dedicated study of a professional modelmaker, and the author suggests it will also include the influence of new plastics on the growth of the profession in post-war United States. As far as British architectural modelmakers are concerned, only the early twentieth century career of Ernest Twining has been partially documented in a biography focused on his extensive work building live-steam miniature railway locomotives (Buck, 2004).

In *Architectural Supermodels* Porter and Neale acknowledge that modelmakers 'often remain hidden behind the reputation of the architectural practices who commission them' (Porter and Neale, 2000, p.vi), and in response the authors interviewed five British modelmakers, presenting them as case studies in a chapter that highlights the importance of the modelmaker in the design process. Of note, Porter and Neale remark on the lack of acknowledgement afforded modelmakers for their work, and on the relationship of trust that needs to exist between architect and modelmaker, however while the chapter sets out to increase the modelmaker's standing, it draws no comparisons or conclusions, nor does it offer any in-depth analysis of the nature or history of the profession.

By far the most comprehensive discussion of professional modelmakers can be found within Karen Moon's *Modelling Messages* (2005), a wide-ranging study of the contemporary architectural model. While the research undertaken for the book during the period 2000-2001 now positions her description of the 'contemporary' model to be nearly twenty years old, *Modelling Messages* particularly benefits from the extensive interviews Moon held with practicing architectural modelmakers. By including the involvement of modelmakers in her research rather than just architects, Moon – an architectural historian who briefly worked as a prop maker for the BBC – presents a study that is more centred on the model as an object made by modelmakers than just as a design tool used by architects. Describing the model as a construct – the result of a series of choices regarding what to show and what to omit (Moon, 2005, p.12), the duality of the model is celebrated, with the book covering both the use of models in the design process, and, more comprehensively, their function as communication tools. In covering the model from its construction right through to its use, Moon also includes an entire chapter dedicated to professional modelmakers. This is a more thorough treatment of the professional modelmaker than Porter and Neale allowed for in *Architectural Supermodels* (2000), and touches briefly on a global history of the profession, before discussing (as had Porter and Neale) the relationship of trust that needs to exist between an architect and their chosen modelmaker. Marketing and presentation models are featured heavily throughout the book, and a specific chapter on the materials used in modelmaking discusses timber, cardboard, and plastics.

Written during the peak of the CAD/CAM revolution in modelmaking, Moon additionally considers the future of the model in a digital age, suggesting that the model's physicality becomes all the more important when there are digital alternatives available. The model's identity, she argues, gains clarity in such a situation. Moon's examination of the history of both modelmakers themselves and the materials they use also serves as evidence to support her final optimism that the model will continue to thrive in the digital age, noting that the model has always been evolving (Moon, 2005, p.212). Moon's is a noticeably more emphatic statement of confidence in the future of the model than is evident in *Architectural Supermodels* (Porter and Neale, 2000), and significantly embraces a much broader continued role for the model than just the design development one favoured by Porter and

Neale, Morris, and others. It is important to note, however, that Moon's broad inclusion of presentation models and the roles of professional modelmakers in the construction of architectural models generated some considerable negativity upon publication. Architectural critic Thomas Muirhead, in reviewing Moon's book, commented that while 'architects will certainly enjoy looking at some of the photographs', it was 'hard to see what other purpose this book might serve' (Muirhead, 2005). According to Muirhead, the coverage of professionally-made models alongside architect-made ones was confusing as 'the only thing they have in common is they're both models, but that's not much of a discourse' (Muirhead, 2005), indicating a reluctance to acknowledge the role of professional modelmakers.

The general lack of focus on professional modelmakers within the existing literature is also as much due to modelmaking's lack of an established research agenda as it is the dominance of architecture's interest in the use of models rather than their making. With the profession centred on praxis rather than theory, the main focus of modelmaking as an academic discipline is on practical skills-based teaching, and as noted in Chapter One, there has been very little theoretical research published by academic staff working within the discipline. A notable recent exception, however, is Will Strange's 2019 Master's thesis that examined the skills set of the contemporary modelmaker, which is discussed further in Chapter Eight.

With modelmakers consistently absent from existing studies of the architectural model, the focus on their use and meaning has equally diminished the attention placed on their processes of making and the materials used in their construction. Although the impact of technology was very much on the mind of authors writing during the early post-millennial research boom (Porter and Neale, 2000; Moon, 2005; Morris, 2006), the actual influences CAD/CAM processes such as laser cutting and 3D printing have had on the architectural model have yet to be fully acknowledged. Similarly, the role of materials in shaping the development of the model has only fleetingly been addressed, and, as noted above, given the differing timelines of the adoption of materials such as cardboard in Britain and the United States, the picture presented has been somewhat confused.

Outside of practical books on architectural modelmaking, discussions of materials and making processes remain a very limited part of the overall body of literature. Jane Jacobs' article on the post-war modelmaking boom in the United States (Jacobs, 1958) has been much-cited for its focus on the impact the introduction of plastics was having on American modelmaking at that time, and the consequences of this development has been noted in passing by several authors (Busch, 1991, p.14; Oswald, 2008, p.21). Karen Moon devotes an entire chapter to the materials of architectural modelmaking and tentatively acknowledges the impact of plastics in driving an expansion of architectural modelmaking on both sides of the Atlantic during the post-war era (Moon, 2005, p.162). Continuing with a description of the basic properties of Perspex, Moon focuses on its transparent properties and its ability to represent glass, noting of Perspex that 'none of the basic materials in contemporary modelmaking has been quite so widely and effectively used' (Moon, 2005, p.163). Moon also briefly discusses the other principal materials of architectural modelmaking – timber and card – although little mention is made of how the introduction of these materials influenced the methods of construction and appearance of the model, leaving the scope of these materials' contributions to its history tantalisingly unexplored.

2.5. Conclusion

With the overwhelming bulk of theoretical research into the architectural model having taken place within the past twenty years, the body of literature is still in its very early days of establishment. Consequently, there is potentially more about the model that has not been studied than has. It is clear that for the reasons outlined above, the emphasis of research so far undertaken has been on the model's role as a tool within the architectural design process, and its conceptual or symbolic aspects, as opposed to its making, employing a 'post-production' perspective (2005, p.4) that dominates the study of all forms of material culture (as discussed in Chapter Three). This observation is not intended as a criticism of architecture's interest in the model, however. On the contrary, it is highly understandable that as the model becomes a complex object requiring the dedicated skills of professional modelmakers in its construction, it moves out of the normal arena of architectural research. The paucity of research into the professionally-made model is also as much a symptom of modelmaking's lack of an established academic position as it is of architecture's relative interest in the subject.

It is also apparent that the main instigator for the increase in attention paid to the architectural model around the millennium was a response to the existential threat of digital forms of architectural visualisation. Reacting to the possibility of the model's communicative function being made redundant, a critical movement to reposition the architectural model more firmly within its design development role can be seen as an attempt to protect the model from these threats. The increasingly conceptual view of the architectural model expressed by *Idea as Model* and *Great Models* in the late-1970s became lauded as a manifesto to support this drive, and their influence on the literature continues to this day. A consequence of this is that the professionally-made architectural model, largely constructed to communicate design ideas to non-architects, has been consistently overlooked in the research that followed. Despite the post-millennial research boom being a largely UK-centred activity, it is also notable that the history of the architectural model in Britain has yet to be specifically studied in detail, and that the drawing of global histories of the model from conflicting timelines of localised development has unintentionally resulted in a confused and somewhat misleading understanding of the model's history in this country. Equally, it is clear that the actual making of architectural models, the role and history of the professional modelmaker, and the materials and processes that have been involved throughout the model's history have yet to be examined in any sufficient detail. While Karen Moon (2005) provides the most detailed discussion of the professional modelmaker and the materials used in constructing models, these are limited to single chapters.

Moon's study, however, stands as the most comprehensive survey of the contemporary architectural model to date, and it is largely upon Moon's work that this thesis seeks to build. In presenting a historical study of the development of the professionally-made architectural model in Britain that is situated within the field of modelmaking rather than architecture, this thesis highlights developments in the making of architectural models in opposition to the dominant 'post-production' perspective that overlooks the role of the modelmaker and the materials and processes employed. The methodological basis upon which this thesis employs an alternative perspective drawn from the relational implications of Assemblage Theory to enable a 'front-end' consideration of the model's history centred on its making is presented in the following chapter.

3: Methodology

Figure 3.0: Concept model by Base Models, circa 2015

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3.1. Introduction

In outlining the methodological basis for this thesis, this chapter begins by describing the need for this study to adopt an alternative approach to the prevailing 'post-production' perspective that largely overlooks the making of objects and the materials they are made from. This leads into a discussion of how the growing use of 'relational', 'new materialist' approaches can be employed to help realise Anna Fariello's call for a 'front-end' consideration of objects (Fariello, 2005, p.4), before introducing the concept of assemblages and their application in the study of objects within design history, material culture studies, archaeology, and history. The methodological implications of establishing Assemblage Theory as a guiding conceptual framework for this thesis are then presented, before concluding with an overview of the research design and the specific methods employed by the investigation.

3.2. Moving beyond the 'Post-Production' Analysis of Objects

As was established in the previous chapter, the majority of existing research relating to the architectural model has focused on its use in the design process, with its making consistently overlooked. This emphasis is also present in much of the wider literature relating to the study of material culture, employing what Anna Fariello has described as a 'post-production' form of analysis (Fariello, 2005, p.4). A focus on how objects are used and circulated within social and cultural frameworks has led to less attention being given to how objects are made and the materials they are made from. With the conception and execution of an idea being deemed separate acts, conception has traditionally been considered more important (Dormer, 1994, p.7); art having increasingly been appraised for its intellectual merit rather than its skill of execution, and 'craft seen as a ghetto of technique and art an arena of ideas' (Adamson, 2007, p.71). In discussing architecture, Jules Prown has observed that 'the mental activity of design has been considered an appropriate pursuit for a gentleman, while the actual physical labour of building has been carried out by labourers of lower classes' (Prown, 1982, p.2). The same view also extends to the physical labour of making architectural models. Bradley Starkey has commented that architects have consistently emphasised the intellectual nature of their work, with models overlooked due to their associations with materiality and manual labour (Starkey, 2006, pp.323-4). It is perhaps understandable then that within the literature available on the architectural model, its social and symbolic aspects have been emphasised, with its making and physical properties placed in an 'appropriate secondary place' (Biggs, 1996, p.2).

In approaching the architectural model from within the field of modelmaking in order to establish a modelmaking history rather than a design history or an architectural history, this thesis therefore places modelmakers, materials, and processes of making central to its historical narrative, aligning with Anna Fariello's call for objects to receive what she terms a 'front-end consideration' from the point of view of their making, proposing that if 'materials and processes were considered as primary components of object analysis', the conclusions that could be drawn might be quite different to those using the post-production perspective that is centred on their use (2005, p.4). Historical studies of material culture, despite observations that 'it is through the human-object relationship that history is written' (Gerritsen and Reillo, 2015, p.7), generally approach objects as evidence of the human past rather than seeing them as subjects of interest in themselves, with a continued emphasis on 'the culture over the material' (Hannan and Longair, 2017, p.9). As Judy Attfield admitted, pointing out the contradiction that pervades much of material culture studies, 'it is not really about things in themselves, but how people make sense of the world through physical objects' (Attfield, 2000, p.1). This has led to criticisms such as Fariello's that rather than actually considering objects, the disciplines dedicated to their study have instead continued an anthropocentric emphasis on the use of objects by people (see Alberti et al, 2013, p.24; Hodder, 2012, p.40; Knappett, 2008, p.146; Olsen, 2010, p.40; Shove et al, 2007, p.18). Objects are largely seen as being a means to reach something else – society or meaning – that lays behind them, reducing a physical object to being a 'secondary expression of society' (Olsen, 2010, p.45).

By embracing Fariello's call for a 'front-end' consideration of the model that supports a balanced examination of the materials, processes, people, and ideas that have shaped the model's history in opposition to the dominant post-production perspective that emphasises its use and cultural circulation, this thesis also draws parallels from a growing movement within design history, material culture studies, history, and further afield in sociology, anthropology, and particularly within archaeology, to apply the benefits of 'relational' and 'new materialist' thinking to the study of objects and their histories (Fowler and Harris, 2015, p.127). In highlighting the active role materials play in the social world (Alberti et al, 2013, p.23), new materialist approaches such as Assemblage Theory offer highly effective conceptual lenses that look beyond purely representational notions of symbolic meaning within material culture.

In response to the realisation that objects are often seen 'purely as illustrations of ideas [and] not considered worthy of study in their own right' (Fariello, 2005, p.4), across a wide range of disciplines including design history (Boradkar, 2009; Fallan, 2008, 2010; Meroz, 2017), sociology (Dant, 1999, 2005), and most significantly, within archaeology (Der and Fernandini, 2016; Domanska, 2006a, 2006b; Fowler, 2013a; Fowler and Harris, 2015; Hodder, 2012, 2016; Knappett, 2005, 2008, 2011; Olsen, 2010; Watts, 2013), an increasing number of historical studies of objects have been adopting 'new materialist' or ' relational' insights based on the ideas put forward by Bruno Latour, Gilles Deleuze and Felix Guattari, Graham Harman, and Manuel DeLanda, in order to move beyond the post-production perspective and to consider the making and physicality of material culture alongside its use and cultural circulation.

3.3. Assemblages and the Emergent Past

Through their rejection of an anthropocentric privileging of the social over the material (Coole and Frost, 2010, p.20), 'new materialist' or 'relational' approaches such as Actor Network Theory and Assemblage Theory offer a well-founded theoretical framework to support this thesis' adoption of Fariello's 'front-end' consideration of the architectural model, conceptualising all entities – whether social, material, or otherwise – as bundles of inter-connecting relations between human, material, and conceptual components, removing any hierarchical distinction between the social and material worlds. Objects are therefore considered in relational terms and viewed as 'manifestations of process, movement, emergence and becoming' (Harvey and Knox, 2014, p.15). With Jules Prown having stated that 'Artefacts, like other historical events, do not just happen, they are the result of causes' (Prown, 2002, p.221), and Hazel Conway having argued that 'the forms that [objects] take, and the ways in which they were produced and used are the material result of complex changes and choices' (Conway, 1992, p.6), adopting a relational perspective in studying the history of objects encourages an understanding of the contributions of materials, processes, and technologies alongside those of people and ideas. By 'disassembling phenomena… to examine how they are made up' (Muler, 2015, p.32), relational approaches have been recognised as offering the potential to move beyond a purely anthropocentric understanding of objects (Meroz, 2017), enabling Fariello's 'front-end' approach focused on their making than the dominant 'post-production' form of analysis centred on their use.

Actor-Network Theory, conceived by Bruno Latour, John Law, and Michael Callon (Law, 1999; Law, 2007; Latour, 2007), has increasingly been used in the study of objects within a number of disciplines and is now considered mainstream within both design history and general history discourse (Clarke, 2018, p.xvii; Fallan, 2010, p.56; Hannan and Longair, 2017, p.59). Through its understanding of the concept of agency – the ability to act or be the cause of change – to be an emergent property that arises from the interaction of human and non-human entities within any given network (Malafouris, 2008, p.12), Actor Network Theory's decentralisation of agency as not being inherent to people or things but rather being distributed across networks of both combined (Jervis, 2013, p.221), enables a detailed understanding of the relationships between people and objects, based on the premise that all components of a network are as able to hold influence as each other, regardless of whether they are human or not (Knappett and Malafouris, 2008, p.xi). Objects themselves become viewed as effects of 'an array of relations' (Binder et al, 2011, p.14), a structure that can be mapped and understood (Boradkar, 2009, p.1; Knappett, 2005, p.32). In terms of applying such an approach to the study of models, Albena Yaneva has successfully employed Actor Network Theory to examine the contribution of architectural models in the design process at Rem Koolhaas' practice OMA (Yaneva, 2009), while Jane Insley has used Actor Network Theory as the basis of her study of the educational use of models in museums (Insley, 2019).

Similarly, Assemblage Theory, a fuller articulation of Gilles Deleuze and Felix Guattari's concept of assemblage (Deleuze and Guattari, 2013) put forward by Manuel DeLanda (2016), has gained even more widespread use within the study of objects by theorists such as Jane Bennett (2010), Chris Fowler (2013a; 2013); Oliver Harris (2013), Penny Harvey et al (2014), Ian Hodder (2012; 2016), Carl Knappett (2005; 2008; 2011), Lambros Malafouris (2008; 2013), Bjornar Olsen (2010), Chris Watts (2013), and many others (see Alberti et al, 2013), with Douglas Mitcham notably advocating the use of Assemblage Theory in the study of miniatures (Mitcham, 2019). As with Actor Network Theory, Assemblage Theory proposes that each phenomenon in the world, whatever its scale, emerges from the relationships that comprise it. Objects, landscapes, places, and ideas are all considered assemblages – arrangements or compositions arising from the fluctuating interactions of entities, materials, and forces (Fowler, 2013a, p.2). The properties of an assemblage are understood to be emergent phenomena arising from the combined interaction of all of its parts, and while Actor Network Theory has been criticised for not fully accounting for temporality in the creation of the network (Der and Fernandini, 2016, p.15), Assemblage Theory additionally proposes that the current state of an assemblage at any given moment can be understood to be the result of its evolution (Chien, 2015, p.32).

With the study of history being centred on understanding the 'complex interactions in the actions and situations that determine the past' (Burns, 2000, p.489), Assemblage Theory is therefore well-suited for investigating the histories of objects as assemblages that have developed over time. Their present form becomes seen as an emergent outcome that must be unravelled to 'trace, discover and recreate past actions, however diverse, that combined to produce the present' (Bonner, 2013, p.112), with objects seen not just as 'socially entangled or socially constructed, but as crystallisations of histories' (Harvey and Knox, 2014, p.10).

Archaeologist Chris Fowler refers to his extensive use of Assemblage Theory in the study of historical artefacts and landscapes in this manner as illuminating 'the emergent past' (Fowler, 2013a; 2013b), examining the historical socio-material relationships that have contributed to an object's history. In enabling an appreciation of the contributions of materials and processes alongside social and ideological components, this approach overcomes the anthropocentric bias of the 'post-production' form of analysis prevalent in existing studies of the architectural model, and in the wider study of material culture, and enables a realisation of Fariello's call for a 'front-end' consideration of objects that embraces their making as opposed to their use and cultural significance. While criticisms have been made that relational approaches such as Assemblage Theory do not offer any defined methodological tools (Muller, 2015, p.31), and often fail to lead to anything other than traditional methods and conventional analysis (Frieman, 2015; Aspock, 2015; Huppatz, 2018, p.11), there is strong evidence for their effectiveness – particularly within archaeological studies (see Fowler, 2013a, 2013b; Hodder, 2010, 2012; Knappett, 2005, 2008, 2011; Mitcham, 2019), and increasingly within design history and material culture studies – as conceptual frameworks that can be applied during the interpretation and analysis of information gathered relating to a particular subject (Chien, 2015, p.112).

3.4. Research Design, Methods, and Sources

The adoption of Assemblage Theory as a conceptual framework that supports Fariello's call for a 'front-end' consideration of objects enables a broad rethinking of the nature of the architectural model's present form as 'emerging from the performance of a complex grouping of relations' (Binder et al, 2011, p.14). Conceptualising the professionally-made architectural model in Britain as an assemblage refocuses attention onto the processes by which things come together and develop. As a result, this thesis' construction of an historical narrative relies on a consideration of material and technological developments as much as it does on social factors, and – crucially – how their interactions with one another brought about change. Its research design and methods must therefore align with this intention by gathering data on materials and processes as much as it does people.

Due to its wide-ranging implications, Assemblage Theory offers no specific methods and practices as it does not conform easily to a 'one-size-fits-all template' (Baker and McGuirk, 2016, p.29). A further challenge in drawing from Assemblage Theory in an historical study is that the discipline of history itself has been noticeably reticent in discussing its methodological concerns beyond acknowledging its role as an interpretative act – history as a concept being distinct from the actual past. As a subject of debate, 'research methods have all but disappeared' within the discipline (Gunn and Faire, 2012, p.1), while Richard Evans has remarked that 'how we know about the past, what historical causation is...[and] whether there is such a thing as a historical truth or objectivity – these are questions that most historians have happily left to one side as unnecessary distractions from their essential work in the archives' (Evans, 2000, p. 10).

Chris Fowler's use of Assemblage Theory in his studies of the 'emergent past' of objects and landscapes has emphasised the need to investigate the effect of past relationships between people and materials in the development of an assemblage (2013a, p.2). Ian Elsmore further suggests using relational approaches (in his case, Actor Network Theory) to locate specific points in the development of the relationships between material, social, and ideological components, making it possible to identify key periods where new components enter the overall network and generate relational changes that determine the future of the assemblage and its emergent properties (Elsmore, 2008, p.221). Such an approach allows for an appreciation of not just the processes and interactions by which objects come into being (Cheetham, 2012, p.6), but also the performance of the relations in the assemblage through which they are actively maintained (Baker and McGuirk, 2016, p.11; Chien, 2015, p.35).

Applying the implications of such an approach to this thesis' aim of understanding the historical development of the professionally-made architectural model in Britain, a number of parameters arise. Firstly, the research design must be focused on gathering information about the material and technological development of the model in addition to considering its 'human' history. Secondly, changes in the model's development must be viewed as the result of interactions between the various people, processes, materials, and ideas that have contributed to its history. These establish a number of objectives that must be met, and which guide the overall research design:

- Firstly, this thesis must outline the professionally-made architectural model in Britain today;
- Secondly, it must trace the emergence and development of the model throughout its history;
- Thirdly, the thesis must examine the complex interactions between the people, processes, materials, and ideas from which it emerged.

In order to meet these objectives, the research design was divided into two main phases. Phase 1 set out to determine an overall view of the professionally-made architectural model in Britain today, while the aim of Phase 2 was to conduct a historical investigation of the model's development. In both phases, understanding the contributions of materials and processes were deemed of equal potential value to the human and social elements, as was understanding how their relationships with one another brought about change.

As has been noted above, the adoption of a relational approach such as Assemblage Theory does not suggest any specific data-gathering methods, instead providing a framework to guide the interpretation and analysis of information once it has been collected. In considering the specific methods used in this thesis, both the study's aims and Assemblage Theory's focus on understanding the complexity of phenomena necessitated the use of qualitative research methods due to their ability to identify and highlight patterns, trends, and relationships between the variables being studied (Grix, 2010, p.121). It therefore followed to make use of traditional data-gathering methods that have been well-proven in previous historical studies within the established disciplines of history, design history, and material culture studies, including interview and oral testimony, and documentary and visual archival analysis.

The design of Phase 1 was centred on a number of visits to architectural modelmaking workshops, both in-house within architectural practices, and at dedicated commercial firms, to both observe current making practices and to conduct a number of interviews with practicing modelmakers. With the profession largely centred on London and the South East of England, contact was also made with modelmakers from other parts of the country in order to provide a balanced view of the profession today. In total, fifteen visits were carried out over a period of eighteen months, while twenty three interviews were conducted, either in person or via Skype (for full details, see Appendices 1 and 2). Observations of current practice were included in addition to interviews in order to more directly access the material and processual elements of the assemblage.

The use of interviews as a method of data collection was selected due to interviews and oral histories being proven, reliable methods widely used by both historians and design historians (Sandino, 2006, p.276; 2007, p.3), with interviews also having been highlighted as a particularly effective method of identifying relations within an assemblage (Alldred and Fox, 2015, p.407), although these will generally include a certain anthropocentric bias. Linda Sandino notes that interviews have been proven effective for design historians in gathering information from people about objects, while oral histories reveal information about the people themselves (Sandino, 2006, p.275), which suggested interviews as the more appropriate method for this thesis as it is the object – the architectural model – rather than the modelmaker, that is the subject of this study. It followed that architectural modelmakers, as the human elements within the assemblage, would be the primary target subjects for any such interviews. Because individual modelmakers themselves may not be entirely aware of the influences shaping the models they make, some elements of the assemblage would likely remain hidden to them. This suggested that the wider the pool of interviewees, the more hidden influences were likely to come into view. Care was taken to ensure a broad cross-section of the different types of architectural modelmaking companies – from large in-house teams, through the small single modelmaker in-house teams, and to both large and small dedicated commercial architectural modelmaking firms. Open-structured interviews were used as these allowed the participants to offer their own understanding of the composition of the assemblage, rather than being restricted by the researcher's assumption-led questioning.

The data gathered during Phase 1 allowed for the first objective to be met and the overview of the model today presented in Chapter 1.4 to be put forward on the basis of strong and reliable evidence. This phase also identified potential avenues to explore within Phase 2, having highlighted a number of developments in the model's history that had clearly shaped its overall development. What was apparent during Phase 1, however, was that few practicing modelmakers today, even those with decades of experience, were in possession of a clear timeline of events, with the history of the model and the profession remaining hidden to them. This prompted a change in emphasis within the research design of Phase 2, in that in conducting a historical investigation of the model's development, archival evidence was going to be crucial in connecting the fragments of historical insight being provided by interviews with contemporary modelmakers.

Phase 2, in focusing on the second and third objectives, therefore involved a combination of archival research and more targeted interviews with modelmakers who had been working during periods in which major developments in the model's history occurred. This meant interviewees were identified in response to findings revealed through archival research, and a further sixteen interviews were conducted, bringing the total to thirty nine. In total, over forty-seven hours of transcripts were compiled based on interviews conducted over the course of a three year period, providing an extensive resource of both historical and contemporary reflections on professional architectural modelmaking.

Given the paucity of any prior scholarly work on the history of architectural modelmaking in Britain, much of this thesis' investigation of the early development of the model is based on new analyses of documentary and visual sources such as historic publications on how to make architectural models, articles on modelmaking published in British architectural journals, and through the previously undocumented private archives of several long-standing architectural modelmaking firms including Thorp, Pipers, and Architectural Models International. The Thorp archive in particular, covering a period from 1883 to the mid-1990s, proved to be an exceptionally rich source of information, containing over twenty-five thousand items. As the archive has yet to be catalogued, only a fraction of it could realistically be examined, however given that the profession in its modern sense began with John Thorp (see Chapter Four), having access to archival material dating back to its very origins proved to be especially revealing. Further public archives such as the LCC/GLC Models Division archive held by the London Metropolitan Archives, the Imperial War Museum archive, the Medmenham Collection at RAF Wyton, the Brighton Toy Museum, and records of models made for the Festival of Britain held by the National Archives, were also consulted. In addition, access was granted to several important privately-held archives, principally photographic in content, belonging to a number of architectural modelmaking companies including Pipers, Architectural Models International, Millennium Models, and Unit 22. In total, over four thousand photographs of architectural models were examined.

Photographic analysis proved to be the principal means of gathering data on the historic development of the materials and processes used in architectural modelmaking, largely unbiased from the subjective interpretation present in oral testimony and interviews. Where conflicts arose between sources, evidence drawn from the visual analysis of photographs of architectural models was given primacy. As this thesis is concerned with the making of architectural models, the strongest evidence of their making could be determined from analysing the construction methods used (where discernible) in datable images. Histories of materials and processes, and their influences, were accessed directly from these images, providing strong dating evidence of major developments.

Additional primary sources consulted included newspaper and journal archives, historic business directories, and historic publications outlining the making of architectural models. Secondary sources were drawn from the literature relating to architectural models discussed in the previous chapter, as well as publications on the history of architecture, and general social and economic histories of Britain. Once compiled, oral and archival sources were cross-compared to test validity and to build a reliable historical record. Full lists of primary sources, interviews and archival documents used are provided in Appendices 1-4.

As the third objective established above implies, Phase 2 also required more than a simple chronology to be compiled, seeking to understand the interactions between the people, processes, materials, and ideas that contributed to the model's development, guided by Assemblage Theory's focus on how relationships generate change. This removed the temptation to put forward 'monocausal explanations' of historical events (Evans, 2000, p.158), in that within an assemblage, change is itself an emergent effect. This is particularly important when discussing this thesis' second research question, as having identified Robert Hoyt's notion of 'ingenious adaptation' as the most significant overall influence that has shaped the development of the model throughout its history, Assemblage Theory's understanding of agency as a distributed phenomenon (Jervis, 2013, p.221) generates a more complex interpretation of Hoyt's statement than merely celebrating the adaptability of the professional modelmaker. Adaptability – the ability to change to meet the requirements of circumstance – is therefore a form of agency, which Assemblage Theory views as the result of performance and effect rather than intention (Bennett, 2010, p.viii). When viewed from a relational perspective, adaptability requires not just the intention of the modelmaker to adapt materials and tools, but also the intrinsic properties and functions of those materials and tools that makes them suitable for adaptation. In this regard, Assemblage Theory frames the types of conclusions that this thesis can draw, and as Chapter Eight discusses, enables a much richer understanding of the development of the professionally-made architectural model in Britain, and applies an expanded meaning to Hoyt's perceptive observation that goes beyond its obvious anthropocentric interpretation.

The findings of the investigation that are discussed in the proceeding chapters therefore demonstrate how the approach adopted by this thesis helps realise Fariello's call for a 'front-end' consideration of objects in that if 'materials and processes were considered as primary components of object analysis', the types of conclusions that could be drawn would be quite different to those using a post-production perspective (Fariello, 2005, p.4). In drawing from a qualitative critical analysis of its oral, documentary, and visual sources, and guided by its conceptualisation of the model's contemporary form as having emerged from the complex relationships between the people, processes, materials, and ideas that have contributed to its history, this thesis presents an historical study of the professionally-made architectural model in Britain that highlights developments in the making of architectural models and reveals new insights into how the model came to be as it is today.

4: ‘An Interesting Occupation’: John Thorp and the Emergence of the Professional Architectural Modelmaker in Britain, 1883-1939

Figure 4.0: Modelmakers at work, John Thorp’s workshop, circa 1935

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4.1. Introduction

In the summer of 1906, architects across London began to receive by post a 'handy little booklet on models' (The Builder's Reporter, 1906) issued by John Thorp of the London Drawing and Tracing Office at 98 Gray's Inn Road. Updated and re-issued again in 1913 (Figure 4.1), Thorp's booklet was illustrated with photographs of some of the many architectural models he had made for clients over the past decade, the accompanying text extolling the benefits of commissioning them. Suggesting that when an architect needed a model, they 'communicate with one, who from long experience and knowledge, could undertake to turn the work out in an efficient way' (Thorp, 1913, pp.3-4), Thorp's innovative marketing efforts were well-received by the architectural press, noting that 'as the use of models is now becoming so common we have no doubt readers will be glad to know where

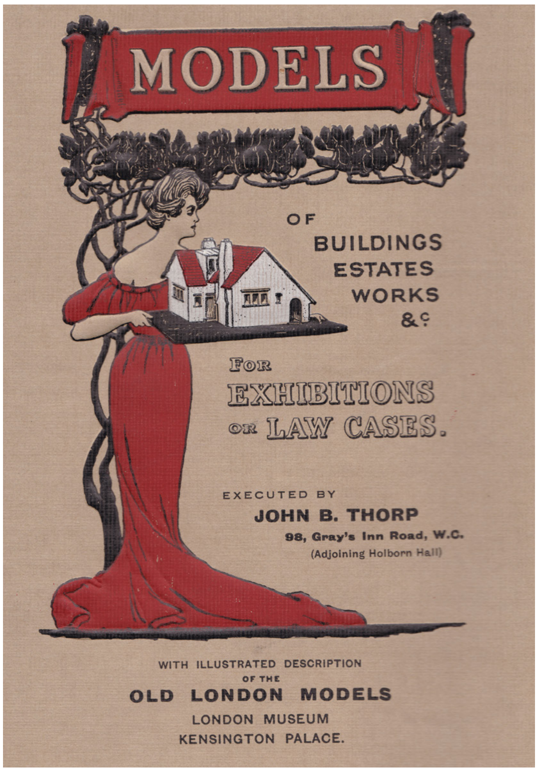


Figure 4.1: John Thorp's 1913 booklet cover

they can get them prepared' (The Builder's Journal, 1906). With a strong reputation for high quality work, and a shrewd eye for marketing and publicity, John Thorp had quickly established himself as a well-known architectural modelmaker in the capital.

Thorp's business and his approach to marketing his services as an architectural modelmaker would be deeply familiar to any architect or modelmaker practicing today; however at the start of the twentieth century this was an entirely novel situation. As was noted in Chapter One, the architectural model as an object is far older than modelmaking is as a profession. While architectural models had been in common use in Britain for several hundred years by Thorp's time, and had become increasingly central to architectural practice during the nineteenth century, the existence of a company solely dedicated to their making, widely-known and heavily advertised was a radical departure from how architectural models had previously been made. Before the twentieth century few individuals had worked purely as architectural modelmakers in Britain (Moon, 2005, p.145), most models having been made by craftsmen from building trades such as carpentry or ornamental plastering as adjuncts to their normal employment. It was not until John Thorp saw an opportunity to rededicate his drawing office's work to that of architectural modelmaking during the 1880s that the dedicated profession began.

In order to understand the historical development of the professionally-made architectural model in Britain, the emergence of the profession itself is a crucial development that needs to be considered in some depth; for there to be a professionally-made architectural model, there first had to be a profession (see Chapter 1.4.2 for a definition of this thesis' use of the term 'professional'). Applying the thesis' conceptualisation of the architectural model as an assemblage, this chapter aims to understand the interactions between the people, processes, materials, and ideas from which the modern profession arose, paying particular attention to the material influence of paper and card during the nineteenth century. Drawing from a detailed analysis of the previously undocumented archive of Thorp Modelmakers, and new examinations of publically-available documentary sources such as Victorian and early-twentieth century newspaper and journal articles, as well as photographs and documents held by public archives including the Imperial War Museum, The National Trust, the RIBA

Library, and the Brighton Toy Museum (see Appendices 3 and 4), this chapter traces the origins and early development of the profession of architectural modelmaking in Britain, primarily centred on the working career of John Thorp between 1883 and 1939.

Beginning with a brief outline of the history of the architectural model in Britain up to the end of the eighteenth century, this chapter first examines the nature of architectural modelmaking prior to the formation of a dedicated profession, establishing that the making of architectural models largely took place within strictly differentiated craft trades associated to building construction that were restricted to the use of single materials or processes. The chapter then charts the development of architectural modelmaking during the nineteenth century when new materials such as card and paper enabled a change to who was making models, moving them away from the workshops of stonemasons and carpenters and into the drawing offices of architects themselves. The increased removal of model construction from within the siloed building trades dramatically altered the circumstances in which a modelmaker could operate by bringing together previously separate processes and materials into a singular activity, creating the opportunity for a specialist trade dedicated to their making to emerge.

The chapter then progresses into a detailed examination of the career of John Thorp, who in seizing this opportunity became the first professional architectural modelmaker in Britain in the modern sense. Thorp, and other early professional modelmakers who began working in the decades that followed, adopted a much more open and adaptable relationship towards materials and processes than had been possible by the craftsmen who had made architectural models in the centuries that preceded them. In abandoning the specific-material-based approaches of earlier modelmakers working within the siloed building trades, these new professionals broke away from using any single material, utilising any and all that were suited to the demands of a particular model, adopting and adapting materials and processes from other trades for the benefit of their own.

In charting the model's increased advancement in the hands of a growing number of professional modelmakers during the inter-war years, this chapter then explores the initial consequences of the professionalisation of architectural modelmaking by examining how this new relationship with materials led to a significant improvement in the quality and realism of models which contributed to a substantial increase in their use. It then outlines the increase in both the weight and cost of models that followed, arguing that the boom that resulted from the professionalisation of architectural modelmaking ultimately drove the model to the limits of affordability during the 1930s as its size and complexity increased. The chapter then highlights how a growing perception that models had become too expensive led to an early interest in the new, potentially lighter and cheaper synthetic materials that first brought plastics to the modelmaker's attention shortly before the outbreak of the Second World War.

Finally, the chapter concludes by detailing how the changed relationship with materials that accompanied the initial professionalisation of architectural modelmaking became the template for the profession thereafter, leading to Robert Hoyt's 1939 observations of the 'ingenious adaptation' so central to architectural modelmaking and the 'quest for new methods, tool and materials that makes modelmaking [an] interesting occupation' (Hoyt, 1939, p.420). As such, this chapter provides an understanding of how the dedicated profession of architectural modelmaking in Britain first emerged through the career of John Thorp, and highlights the role of materials in shifting the making of architectural models from being an activity carried out within various individual craft trades and into the dedicated 'interesting occupation' Hoyt described.

4.2. Early British Architectural Models

On December 10th 1567, a note was made in the accounts of Longleat House in Wiltshire that Adrian Gaunt, a French joiner who had been previously employed in the making of wooden screens, was paid an initial instalment of £4 15s for a model of the then under-construction house (Girouard, 1966, p.57). This record of Gaunt's payment is the earliest reference to an architectural model in Britain that can be confidently identified. Given his background, it can be assumed that Gaunt's model was likely to have been made from timber, but beyond this, the model's size and appearance remains unknown (Wilton-Ely, 1968, pp.250-251). Confirming the existence of such early architectural models is problematic, and not only because so few have survived to this day. Documentary sources such as the Longleat accounts are not always entirely reliable given that both the words ‘model’ and ‘modeller’ have shifted their meaning over time. During the sixteenth and seventeenth centuries, any mention of a model of a building could also be referring to a drawing; the word model being used in the sense of a plan or ideal version to be copied (Griesemer, 2004, p.437). Additionally, until the mid-nineteenth century, the term modeller generally referred to architectural sculptors who were also sometimes known to produce miniatures alongside their full-scale work. Gaunt’s model of Longleat House could therefore have actually been a drawing rather than a physical object; it is only his background as a joiner that suggests otherwise.

That Gaunt was a joiner and not a modelmaker is typical of early British architectural models; for more than three centuries prior to the birth of the profession, architectural models in Britain were made by craftsmen from other trades – initially carpenters or joiners, but later also stonemasons and architectural sculptors – who were applying their skills to a secondary purpose. Being associated with building construction meant that these trades were the likely choices for architects seeking skilled craftsmen to produce models of their proposed buildings. Until the middle of the nineteenth century, most of the architectural models made in Britain were therefore constructed out of a single material using processes that belonged to their makers’ established trades. For a specific profession dedicated to architectural modelmaking to exist, the rigid division of materials and processes that were the legacy of the medieval craft guilds posed a considerable barrier that even the changes to labour structures wrought by the industrial revolution failed to break down.

The making of architectural models was already an established activity by Gaunt’s time, models having been widely used in Europe since the fourteenth century, but it was not yet one that was carried out by a specific trade or profession. The re-emergence of the architectural model in Europe as a significant tool for the communication of architectural designs is generally traced to the rebuilding of Florence Cathedral; the administration of which was carried out by the city authority using public funds rather than the church’s, leading to a greater importance being placed on keeping the public and their representatives informed – models providing the ideal means of doing so (Mindrup, 2019, p.82). In Britain, the architectural model initially came into its own in the seventeenth century, particularly under architects such as Christopher Wren and Nicholas Hawksmoor (Wilton-Ely, 1968, p.250; 1969, p.6), during a period when wealthy landowners began to rebuild their homes to better match new, more elaborate architectural styles that were then becoming fashionable (Wilton-Ely, 1968, p.251). These new styles required greater explanation, and thus the need for detailed architectural models increased. Due to their construction by carpenters such as Gaunt, timbers such as pine or oak were the principal materials used in the making of architectural models during this period. When stained or painted, models could either be realistically finished, as the surviving model of Melton Constable Hall demonstrates (Figure 4.2), or more simply treated as with the model of Sudbury Hall shown in Figure 4.3. Both models were constructed in the 1660s, and along with the surviving 1690 model of Nicholas Hawksmoor's design for a house at Easton Neston (Figure 4.4), illustrate how the different finishes and levels of detail that could be applied to a timber model changed its character. Christopher Wren commissioned at least one mahogany model during the construction of Pembroke College in 1663 (Briggs, 1929b, p.246), and over seventy timber models during the design and construction of St. Paul's Cathedral (Valeriami, 2012, p.32). This large number of models included William Cleere's 1675 Great Model – an oak, pear, and plaster of Paris model that contained over nine hundred separate detailing items (Wilton-Ely, 1968, p.253), and which was painted to represent stone and lead. Both this model and carpenter John Smallwell's 1699 model of Wren's design for the Royal Naval Hospital in Greenwich still survive (Figure 4.5), and although the total known collection of British models from this

Figure 4.2: Melton Constable Hall model, 1660. Modelmaker unkown

Figure 4.3: Sudbury Hall architectural model, circa 1660. Modelmaker unknown

Figure 4.4: Easton Neston architectural model, 1690. Modelmaker unknown

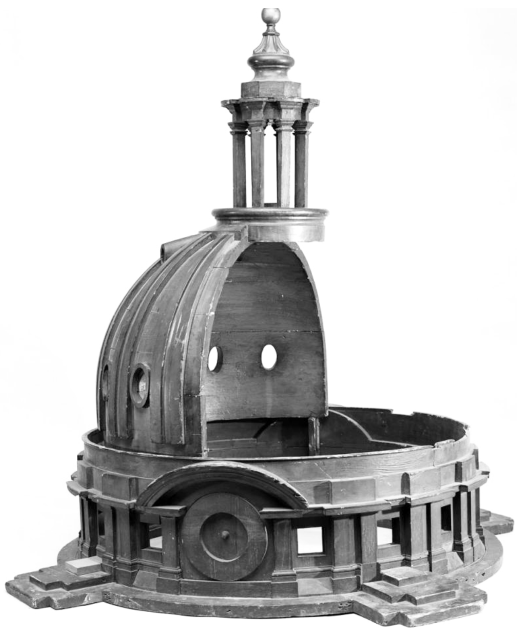


Figure 4.5: Sectional model of Royal Naval Hospital Greenwich made by John Smallwell, 1699

period is comparatively small, the commonalities between them suggest these models were typical of the era.

The limited information that has been preserved relating to the makers of these models gives little insight to the balance of their activities between making models and full-scale architectural work, although it is possible that joiner William Cleere, given the scale of Wren's model of St. Paul's, may have been employed full time on model construction for at least a year. Nicholas Hawksmoor also commissioned several models from John Smallwell in 1717, some eighteen years after Wren's 1699 commission, implying that Smallwell – or possibly his son, as John Wilton-Ely has suggested (1968, p.256) – continued to make architectural models for at least several decades. Despite the eighteenth century also seeing an expansion of the use of models in many other disciplines such as in science and engineering, and through the establishment of early museums (Baker, 2004, p.19), there remains little evidence of dedicated professional modelmakers working during this period. Most models seem to have been produced, as with those by Smallwell, by carpenters or joiners taking on occasional work alongside their principal specialist trades.

By the late-eighteenth century, however, an additional group had also become associated with the construction of architectural models as a result of an increased demand for plaster models. During the 1780s, the work of the Parisian father and son modelmakers Jean-Pierre and Francois Fouquet had started to gain fame in Britain, and it was evident that they were achieving a quality that far outstripped anything being produced in timber at the time. Working in plaster of Paris, the Fouquets initially made a range of model souvenirs depicting ancient classical architecture before extending their work to current architectural commissions (Figure 4.6). John Nash was so taken by their quality that he ordered a set of fifteen models of Roman and Greek buildings from them for £1000 (Leslie, 2004, p.163), while both the South Kensington Museum and John Soane added several to their respective collections (Leslie, 2004, p.169). With the classical revival sweeping change through European architecture, architects such as John Nash and John Soane began to favour plaster models over timber ones, as although the timber models being produced at this time were of admirable quality, timber – which remained the dominant material used in architectural

Figure 4.6: Plaster model by Jean-Pierre and Francois Fouquet, Paris, circa 1820

modelmaking in Britain throughout the eighteenth century – was a challenging material in which to reproduce the intricately detailed forms and the material likeness of stone that neoclassical architecture demanded. As a result, plaster models increasingly began to appear alongside timber models in Britain during the nineteenth century, adding stonemasons and sculptors to the list of trades involved in architectural modelmaking. As with carpenters such as Smallwell and Gaunt, such modelmaking was rarely more than an adjunct to their main businesses, however. R.N. Hanwell, an architectural sculptor, was noted as having produced several plaster models in 1860 (The Builder, 1860, p.262), while in 1866, the sculpting firm of Farmer and Brindley produced the model for the proposed Albert Memorial in London (Leslie, 2004, p.198). C.H. Mabey, who produced architectural details for the Houses of Parliament, also made several scale models (Physick and Darby, 1973, p.15), as did the architectural sculptor William Grinsell Nichol (Wells, 2017, p.8). The same trend of occasional modelmaking as part of a larger business dedicated to full-scale architectural work also continued for timber models; the models for John Soane's design for the Westminster Law Courts (Figures 4.7 and 4.8), for example, were produced by the Greenwich timber merchants and carpenters Thomas and George Martyr in 1827 (The London Gazette, 1827, p.848; Baker, 2004, p.198).

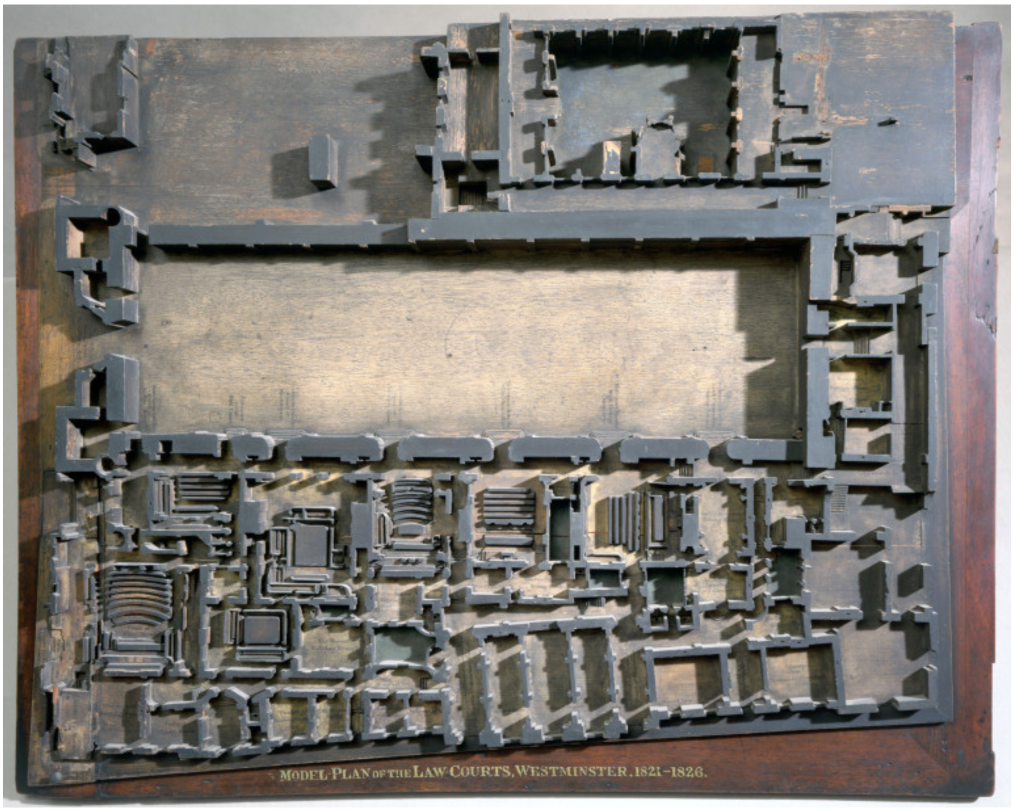


Figure 4.7: Model of the Westminster Law Courts made by Thomas and George Martyr, 1827

Figure 4.8: Detail model of the Westminster Law Courts made by Thomas and George Martyr, 1826

What is notable about these early makers of British architectural models is that they rarely, if ever, strayed across the boundaries of their principal trades. Carpenters made models from timber while masons used plaster. This rigid adherence to single materials or processes was an over-lasting legacy of the medieval guilds system. The guilds had an effective monopoly on craft production, paying taxes in exchange for the exclusive rights to conduct particular trades in different regions in the form of a royal charter (Raizman, 2003, p.20). Their intended purpose was to maintain standards of craft skill, and to protect craftsmen from both exploitation and competition (Lucie-Smith, 1981, p.126), and this was achieved by regulating a strict division of the crafts, confining practitioners to a single trade, and preventing one craftsman's market from being encroached upon by another (Lucie-Smith, 1981, p.14). In Europe, both stonemasons and carpenters were already adept at making scale models of their work; in Germany for example, local ordinance required them to produce 'master pieces' in model form to demonstrate their skills before the title of master was conveyed (Mindrup, 2019, p.37). The strict differentiation of trades that the guild system established also prohibited members of one guild from carrying out the work of another, to the extent that a joiner (using adhesives to join timber) and a carpenter (using mechanical joints and nails for the same purpose) could not use each other's techniques. This undoubtedly restricted the choice available to architects commissioning models. If a joiner was already engaged on a building site, his services would likely be used and the model made from timber. If a mason were called upon, however, the model would be cast in gypsum plaster. As such, early British architectural models were made using a distinctly materials-focused approach. Rather than considering the model's purpose first and then determining the most suitable materials and processes to deliver it, as a modelmaker would undertake today, pre-professional modelmaking largely involved starting with a set material and process and applying that trade's skills at a reduced scale.

Even by the time Gaunt made his model of Longleat house, however, the influence of the guilds had already peaked, and during the second half of the eighteenth century the labour structures of craft production underwent a period of radical change as a result of the industrial revolution. The hold of the guilds had been weakened in part due to the increasing complexity of handmade items such as furniture, where a growing need had arisen for coordination across multiple trades. A fine cabinet, for example, might require the services of an upholsterer, a goldsmith, and an inlayer in addition to a joiner and cabinet maker. This led to the role of the master in any given trade increasingly becoming that of a merchant-craftsman, liaising between the different trades while also acting as a bridge between the craftsmen and the customer (Raizman, 2003, pp.21-22). Rather than craftsmen and artisans banding together for mutual protection while selling directly from an individual trader to an individual customer, industry began to be organised around the concept of multiple employees working for capitalist employers, who then sold their combined outputs. This contributed to a substantial change in social structures as workers began to increasingly choose the protection and security offered by employers rather than the guilds (Lucie-Smith, 1981, p.128-9). The main consequence of this change was an erosion of the vertical divisions that separated the different trades from one another, replacing them with a common horizontal division between worker and employer (Cope, 1939, p.142). While in principle this meant that workers could then utilise materials and processes from across multiple trades, workers' roles instead became increasingly specialised as the demand for standardised products for mass consumption required complex manufacturing processes that necessitated a division of labour that would ensure high standards across a virtually identical batch of goods (Forty, 1995, p.34). Individual craftsmen were then no longer responsible for the complete manufacturing process of a single item, and the design of the item itself was further removed from their control and developed into a separate role.

What is significant to note, however, is that the changes to labour structures that took place during the industrial revolution entirely bypassed the construction of architectural models, principally due to there being no specific trade for them to affect. Architectural models were being made by individuals who were primarily involved in the construction of full-size buildings, and the division of labour within building construction had already been established during the Renaissance with the separation of the role of the architect from that of the mason. This meant that the carpenters, masons, and plasterers making models right through to the nineteenth century were being doubly affected by the vertical division of trades inherited from the guild system, and by the horizontal division of labour that separated the design of a building from its construction. Building construction largely resisted the consequences of industrialisation in part due to the bespoke nature of buildings, and the continued need for specialist trades such as masonry and carpentry that effectively extended guild-based trade distinctions into the nineteenth century. The possibilities afforded by the erosion of the vertical divisions between trades were therefore to be lost on the architectural model for as long as its production remained within the material silos of the traditional building trades.

Throughout much of the pre-professional era, the complexity and advancement of architectural model construction was hampered by the material and processual restrictions of the trades that produced them. For the making of architectural models to become unified as a defined activity under a single professional identity, as would happen with the work of John Thorp, the construction of architectural models needed to be removed from the rigid divisions of materials and processes that had guided their early history. Just as the modern profession of the architect had emerged from the various construction trades during the mid-sixteenth century, so too would the profession of the architectural modelmaker follow suit some two hundred and fifty years later, a move that the model itself had already made during the nineteenth century due to the adoption of materials that radically altered who was able to make them, and where.

4.3. From the Workshop to the Drawing Office in 19th Century Britain

During the nineteenth century the making of architectural models in Britain underwent a significant change with the adoption of cardboard instigating a shift towards models being made within architectural drawing offices rather than in workshops, moving their construction away from the siloed building trades and their material-based boundaries. Effectively freed from any particular trade, architectural models benefited from the use of multiple materials in their construction, becoming more realistic and easier to make. Having increasingly become a central part of architectural practice, by the end of the century the circumstances in which a specific profession dedicated to architectural modelmaking could exist had been established, and through the embryonic careers of modelmakers such as Richard Day and C.N. Thwaite (as discussed later in this section), architectural modelmaking began to distinguish itself as a pursuit in its own right, rather than as an extension of existing craft practices.

A widely held notion in existing histories of the architectural model is that the use of models fell dramatically during the nineteenth century until their return to popularity under the influence of the Bauhaus in the 1920s (see Wilton-Ely, 1965, p.2; Buttolph, 1978, p.12; Morris, 2004, p.86; Moon, 2005, p.41; Mindrup, 2019, p.136). While the influence of the French Beaux-Arts Academy teaching template during this period undoubtedly elevated drawing as the preferred communication medium in architectural education, the use of models in architectural practice appears to have actually experienced a significant increase. The demand for models for public display, their use in architectural competitions, general everyday use by architects, and a wider public interest in viewing and even making architectural models all show clear intensification. Seventy models alone were submitted for the 1839 competition for the design of Nelson's Column in Trafalgar Square (Physick and Darby, 1973, p.13), while a year later a £400 (approximately £28,000 today) timber model was displayed for the competition to design the Royal Exchange Building in London (Wells, 2017, p.7). In 1851, an entire temporary structure had to be built to show the models for the proposed Smithfield Market (Physick and Darby, 1973, p.13), and by 1876, the South Kensington Museum had over one hundred and fifty architectural models on display, many of which had been presentation models for competition committees (Leslie, 2004, p.170). An exhibition held by the Society for the Illustration and Encouragement of Practical Sciences (1836) displayed over three hundred models of all types, including engineering and patent models, with around a third being architectural models; while the 1851 Great Exhibition included a model of Liverpool Docks that occupied ninety-six square feet and cost £750 (£90,000 today) to construct (The Builder, 1850). A notice in *The Builder* in 1870 called for submissions for a major exhibition to be held the following year dedicated to architectural models of schools and colleges (The Builder, 1870), and it appears that for over thirty years, the same architectural journal operated an informal campaign for the establishment of an entire museum dedicated to architectural models in London (Benson, 1848; The Builder, 1877, p.1146).

Despite the sheer number of architectural models being produced by the middle of the nineteenth century, there was still no dedicated trade or profession devoted to their making. Although the demand was evidently there, it appears likely that there was still more work – or perhaps more profitable work – available in the building trades their makers were primarily working in. The making of architectural models was often advertised as a service alongside full-scale architectural work by architectural sculptors, carpenters, and plasterers such as Farmer and Brindley, Jackson and Sons, the Maybey brothers, and Thomas and George Martyr. These firms were evidently producing high-quality timber and plaster models, however their modelmaking work continued the tradition of the past three hundred years in not drawing on either materials or processes from beyond their established trades, nor dedicating themselves solely to the making of architectural models. The brief craze for collecting cork models of the classical architecture of Italy during the late-eighteenth and early-nineteenth century provided short term work for several British artists such as Richard Du Bourg, and Joseph Parkins, who made several such models for Sir John Soane, however these were souvenirs of existing buildings rather than architectural models of proposed designs (Gillespie, 2017, p.126).

It was during the nineteenth century, however, that a handful of individuals began to pursue careers as full-time architectural modelmakers, with Richard Day appearing to have dedicated almost his entire working life to making plaster architectural models, although with intermittent success. While the 1851 census lists him as a 'modeller', which implies he was a full-scale architectural sculptor, Day appears to have almost exclusively worked as a modelmaker from a very young age. The son of a mason (Wells, 2017, p.13), Day was born in Camberwell in 1816 and by the age of twelve had already completed a period of employment as a stonemason for John Nash. It was at this point that Day built a highly-regarded plaster model of the proposed Royal Academy in London (Mechanics Magazine, 1828, p.191). His talent was already sufficient at this age to have been immediately engaged by King George IV to make a model of his plans for the renovation of Windsor Castle (Mechanics Magazine, 1828, p.191). By the mid-1830s, Day appears to have established himself as a prolific maker of architectural models, including one of the then under construction National Gallery in Trafalgar Square. The catalogue for the 1836 exhibition held by the Society for the

Illustration and Encouragement of Practical Science lists fourteen of his models on display, with major competition models following in the 1840s (Wells, 2017, p.13). Although Day is still recorded as a modeller in an 1860 London Post Office directory, he appears to have fallen on desperately hard times in the late 1840s. A notice in *The Builder* on October 7th 1848 reports that while ‘there are few architects who are not acquainted with the admirable models made by Mr Day’, he had for several years been struggling to make a living as a modelmaker, and ‘must either seek some other occupation or starve’ (The Builder, 1848b). By this point Day was only thirty-two years old, and given his later 1860 listing, seems to have enjoyed a later resurgence in his fortunes, appearing in the 1891 census as a ‘retired modeller living by his own means’ in Maidstone. Although Day was making models for most of his adult career, he was effectively still working as an architectural sculptor, albeit producing items at a reduced scale. Working purely in the single material he had honed his skills on during his earlier career as a mason, Day’s example nevertheless highlights that the increased demand for architectural models had allowed for at least one individual to fully dedicate a career to their making by this time.

Throughout much of the nineteenth century, the continued dominance of craftsmen from the building trades as the makers of architectural models meant that whoever an architect commissioned a model from had a profound influence on the appearance of the model produced. The properties of the materials used led to radically different visual styles, and so choosing between craftsmen who worked in a specific material effectively determined the type of model the architect was ordering. Plaster of Paris continued to be used alongside timber in model construction throughout the whole of the nineteenth century, but while able to capture intricate detail (Figure 4.9), plaster was really too fragile for handling (Liddell, 1843, p.198), as well as being extremely heavy when used in large-scale models. As a consequence timbers such as oak, pine, mahogany, and lime remained the principal modelmaking materials. Other than the use of small plaster details on timber models such as William Cleere’s seventeenth century model of St. Paul’s, the two materials were largely not found together. This reflects the continued practice of craftsmen such as Richard Day working solely in the materials of their primary trade. Although the influence of the guild system was no longer in effect, to be a successful stonemason or carpenter still required specialisation.

Figure 4.9: Model of the New State Paper Office, 1830. Modelmaker unknown

By the middle of the century, however, the making of architectural models had begun to move beyond the purview of the building trades as the increasingly organised architectural profession (the RIBA having been founded in 1834) embraced the importance of models in their practice. An 1843 article in *The Builder* noted that:

> ...of late the models of houses and other structures and their grounds have been used by our intelligent architects and civil engineers to convey to themselves and others the appearance of the real or proposed originals (The Builder, 1843b, p.317).

By the 1870s, the benefits of models over drawings were also being clearly articulated: 'Few clients can understand plans and sections, and perspective drawings are made so deceptive as to mislead the client so that they become dissatisfied' (The Builder, 1877, p.1145). The same article further observed that it was cheaper to make mistakes in a model than in the real building, and that 'a well-executed model, instead of being an additional cost, proves in the end to be a considerable saving' (The Builder, 1877, p.1145). Even by the start of the century, the architect Sir John Soane had already become widely known for his extensive use of models during presentations to clients and building committees, and for using them in his lectures as educational aids (Wilton-Ely, 1965, p.7; Baker, 2004, p.26). As a result, architectural models were increasingly being made within architectural drawing offices rather than in the workshops of carpenters and plasterers, beginning to establish a more unified activity of dedicated architectural modelmaking as young architectural assistants were regularly assigned the task. T. Richardson's 1859 book on architectural modelmaking specifically addresses his words to 'a large and increasing body, the architectural assistants, [to whom] it is hoped that this little hand-book will prove to be acceptable' (1859, p.16). By 1877, it appears that the practice of architects – or their assistants – making 'sketch' models in their offices had become routine (The Builder, 1877, p.1145). At the same time, architectural modelmaking was also becoming a popular hobby for the growing middle classes. As early as 1827 a publication describing the construction of architectural models noted that it was aimed at both architects and amateurs (Boileau, 1827), while an 1843 article suggested architectural modelmaking was an ideal pursuit for women, who 'may now, at no extra cost, and without soiling a finger, construct [models] for themselves' (The Builder, 1843a). The same journal also published letters from amateurs seeking advice on the hobby (Liddell, 1843; Benson, 1849), suggesting a much wider public awareness of architectural models evolving by the 1840s. Rather than offices and private studies being filled with woodworking tools and bags of gypsum plaster, however, this expansion of modelmaking was being driven by the adoption of the much cleaner and more readily-accessible materials of card and paper.

The use of card and paper in architectural models dates back until at least 1521 in France when a papier-mâché model of a church in Rouen was made, with a further record of cardboard models, most likely using pasteboard, dating to 1601 (Mindrup, 2019, p.33; p.130). In Britain, a pasteboard model of University College Oxford was made in the 1630s (Mindrup, 2019, p.133), while in 1806 a large card model of James Wyatt's design for Fonthill Abbey was constructed (Wilton-Ely, 1980, p.50). Pasteboard, an early type of cardboard made from laminations of paper and glue, was promoted as a common and suitable material for the construction of architectural models as early as 1827 (Boileau, 1827, pp.93-106). The use of card and paper marked a noticeable change in the fundamental properties of the materials used in the construction of models, as being sheet materials, they required a significantly different approach to not only making a model, but also in planning its assembly. Solid materials such as timber and plaster need to be approached three-dimensionally from the start; timber can be cut and shaped to the required size of the overall mass of the required model, and then either be further cut into, or built up with additional pieces. Using sheet materials changes this completely, forcing a conceptual shift to consider a model as a series of elevations. This may suggest why card was increasingly used by architects themselves during the nineteenth century. Not only did the relatively clean construction methods of working with card allow the making of models to move out of the workshop and into the drawing office, but their reliance on flat elevations was also much more familiar to architects used to drawings. Card models, using either pasteboard or Bristol board to construct the basic walls, could be painted or tinted to create much more realistic representations of brick, tile or stone. Warm sepia was suggested for stone, with Indian red ink for brick (Benson, 1849, p.141). Cork or softwoods could also be used to create more three-dimensional details such as columns (C.L.O, 1838).

Significantly, in 1859, the architect T. Richardson published *The Art of Architectural Modelling in Paper*, which the author describes as 'the first ever published practical dissertation upon the Art of Architectural Modelling' (Richardson, 1859, p.iii). Noting that students and others in the architectural profession had been demanding such a book for some time, Richardson's book takes the reader through the construction of models in remarkable detail. Observing that paper and card could be easily procured, Richardson suggested that the beauty of the model is no longer in 'the material employed, but in the skill displayed in the working' (Richardson, 1858, p.19). This marks an important shift away from the materials-focused approach of modelmakers working in timber and plaster. Because of its ready availability, and the lack of specialist knowledge necessary to work with card and paper, the use of paper products stands almost as a democratising influence on the architectural model. Anyone can obtain card and anyone can use it. It does not require specialist equipment or a workshop, and so paper and card moved the making of models out of the effective control of masons and carpenters.

For architectural modelmaking, Richardson recommended the use of Whatman's double-elephant drawing paper, which was sold under the name of Crayon paper (Richardson, 1858, p.20). Its suitability was highlighted due to its natural colour being reminiscent of Bath stone, its relative flexibility, and the fact that it did not absorb the paste that was used to stick sheets together. He suggests the use of this layered paper over that of Bristol board, and includes a recipe for making a suitable adhesive paste using sugar, flour, corrosive sublimate, and lavender oil or peppermint to reduce odour; the mixture to be boiled and stirred into a paste (Richardson, 1858, pp.21-22). A modelling press (Figure 4.10) is then used to make cardboard to the correct thicknesses required by pressing layers of paper and paste together. Ivory obtained from comb manufacturers is suggested as an ideal material to carve into to create moulds for pressing textures into the surface of the card, while windows are carefully cut out and clear sheets of mica placed behind to represent glazing – either left clear to see internal spaces, or backed with a piece of blue paper (Richardson, 1858, p.76). Tinted velvet could be used for grass, and burnt cork to represent the soil of flowerbeds (Richardson, 1858, pp.93-95). The skill of making a model, he suggests, lies in the 'symmetry and correctness of parts, all the angles being clear, well-defined, and sharp' (Richardson, 1858, p.13).

As well as reducing the mess associated with the making of models, bringing their construction into offices and homes, card and paper also provided a range of alternative materials that allowed for more choice in the appearance of architectural models. By the 1870s, card was becoming recognised as the more superior material – timber being heavy, cork being unsuitable for accurate detail, and plaster not offering realistic representations of anything other than stone. Cardboard models, on the other hand, could be coloured to imitate different materials with an 'excellent level of detail obtained' (The Builder, 1877, p.1145).

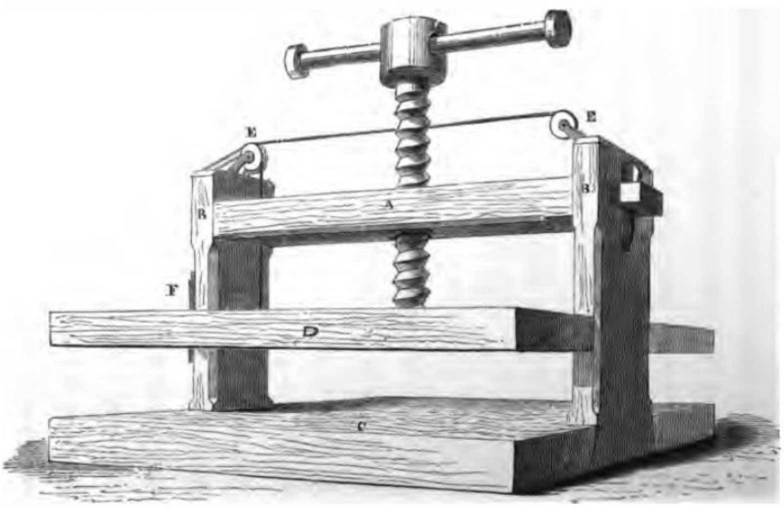


Figure 4.10: Drawing of a cardboard modelling press, 1859.

Stephen Salter is recorded as having made many card architectural models during the 1860s and 1870s, and alongside Thomas Dighton, was credited as having 'first brought cardboard modelling to very high perfection' (The Builder, 1877, p.1146). While almost nothing is known about Salter's work, Dighton's 1844 model of Scotney Castle in Kent survives to this day (Figures 4.11 and 4.12). An artist by training, Dighton's model demonstrates the combination of the fineness of detail and realistic colouring that card offered over both timber and plaster, and stands in stark contrast to the simpler timber models illustrated earlier in this chapter. Dighton's work was evidently very highly regarded, it being noted in a description of one particular model in 1848 that his models were 'well known to the profession, and have given him a reputation which will be further increased by the work to which we are

Figure 4.11: Card model of Scotney Castle by Thomas Dighton, 1844

Figure 4.12: Card model of Scotney Castle by Thomas Dighton, 1844 (rear view)

alluding' (The Builder, 1848a, p.225). The same article also makes it clear that such models were extremely expensive due to the time and skill required to make them, and that at £100 each (£10,000 today), few people would be willing to pay for them (The Builder, 1848a, p.225). How much of Dighton's time was dedicated to making models is unknown, though it appears that like almost all of his contemporaries, his model work was effectively a side business. This appears to reflect the great expense that modelmaking entailed. An editorial in 1877 questioned why models were not more widely used given their obvious benefits, and noting a lack of modelmakers, concluded that 'those who have given to it a lifelong study have been so inadequately rewarded that they have thrown it up in disgust' (The Builder, 1877, p.1145). The author continued with a more hopeful note that 'there is no reason why architectural modelling should not assume its place among the art-industries of the country. Few pursuits afford a finer scope for the exercise of the inventive faculties' (The Builder, 1877, p.1145).

The use of card as a modelmaking material continued to expand during the 1860s and 1870s, with an increasing number of individuals working almost exclusively on model construction, both on a commercial basis, and within architects' offices. Alongside Stephen Salter and Thomas Dighton, C.N. Thwaite appears to have sustained a career dedicated to making card architectural models for over twenty years. Thwaite's work was first reported in 1862 where he was producing models for architects in Manchester (The Building News, 1862a; The Building News, 1862b), before moving to Peckham in London sometime before 1867 (The Builder, 1867). Thwaite's models were noted as being 'executed in cardboard in a painstaking and careful manner' (The Building News, 1869), and in 1872 made a model of the proposed chapel at Tyntsfield house (Figure 4.13), continuing to work until the 1880s (Physick and Darby, 1972, p.15). During the same period, the architect George Devey employed an assistant as a full-time in-house modelmaker to make cardboard architectural models to be presented to clients in custom briefcases (Figure 4.14). While the identity of Devey's modelmaker remains unknown, contemporary accounts report that he was in constant work (Allibone, 1991, p.118).

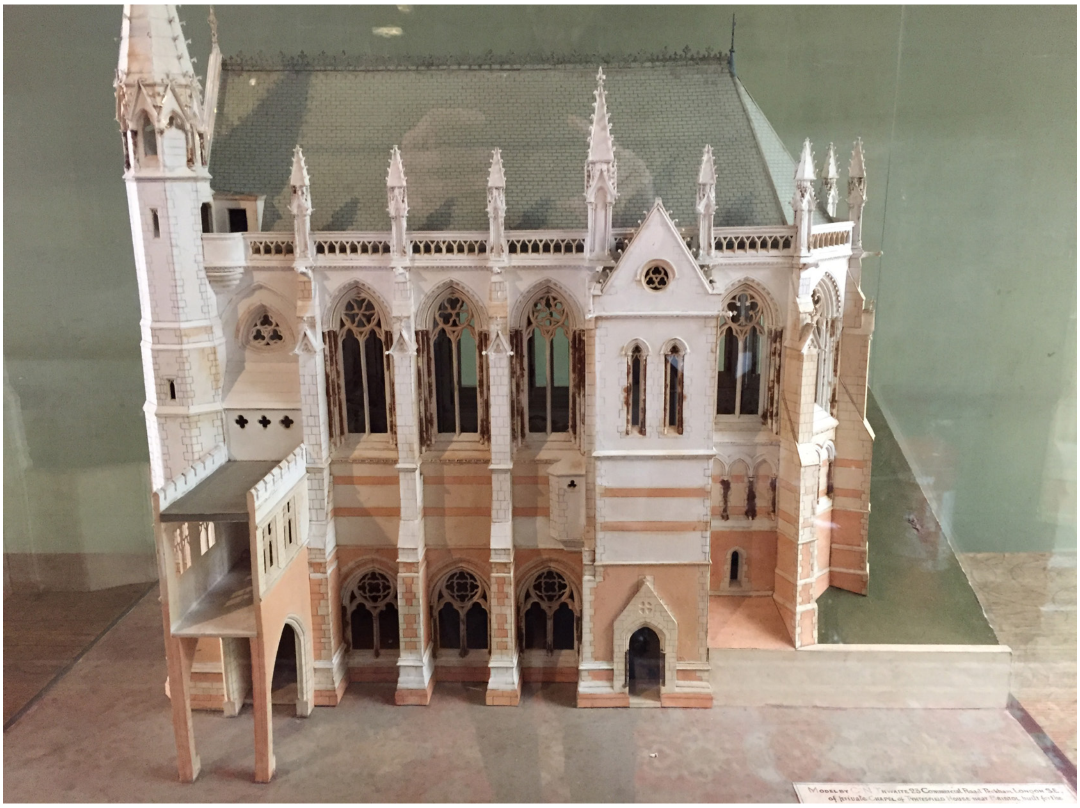


Figure 4.13: Model of Tyntsfield House Chapel, made by C.N. Thwaite, 1872

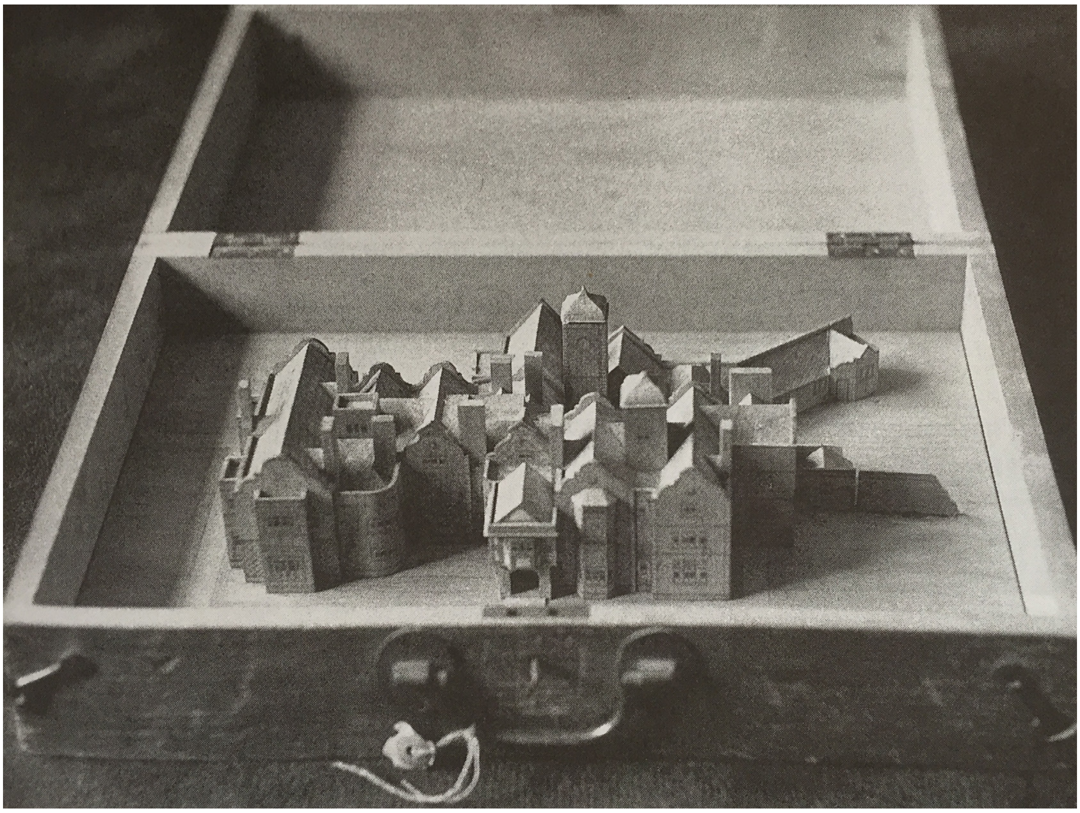


Figure 4.14: Model of The Ledgers, made by George Devey's unknown modelmaker, 1882

Towards the end of the century, the making of architectural models within architectural practices had become the norm, with increasing numbers of architectural assistants working almost exclusively as modelmakers as part of their training. Card had by this time become the material of choice, used either on its own or to clad simple timber shapes, the card being coloured with ink to provide the illusion of surface detail without any depth. An 1885 model of the design for the Admiralty in London (Figure 4.15) initially appears to be highly complex, but a closer inspection reveals it is actually made with flat painted card attached to timber blocks.

Demonstrating how significantly the construction of architectural models had shifted during the nineteenth century is an earlier, more complex cut-through model of a proposed building in Whitehall made in 1869 by the assistants to the architect Lieutenant-General Sir Andrew Clarke (Figure 4.16). Using a combination of timber, card, and glass for the building itself, and with plaster used for the ground, the model made use of almost all the materials then suited to architectural modelmaking. Such a mixed-media approach stands in dramatic contrast to the separate timber or plaster models that had by this point been the typical approach to modelmaking in Britain for some three hundred years. The construction methods and choice of materials have clearly been selected for their suitability for meeting the demands of the model, rather than being dictated by its maker's familiarity or expertise. While this model was not yet one constructed by a dedicated professional, the specific activity of architectural modelmaking within some architectural practices had clearly by this point become an identifiable task that was able to take an overall view of the needs of the model and which was no longer restricted to individual materials.

Fundamentally, this approach to making architectural models could not have existed until materials such as card and paper allowed individuals from outside the building trades to construct them. By moving the making of models out of the rigid, materials-based silos of the mason, sculptor, and carpenter, not only could different materials be brought together, but the less specialised and less intensive making processes involved allowed for the knowledge required to make them to be transmitted through books and articles rather than through the direct experience of an apprenticeship. Whereas architectural models had previously

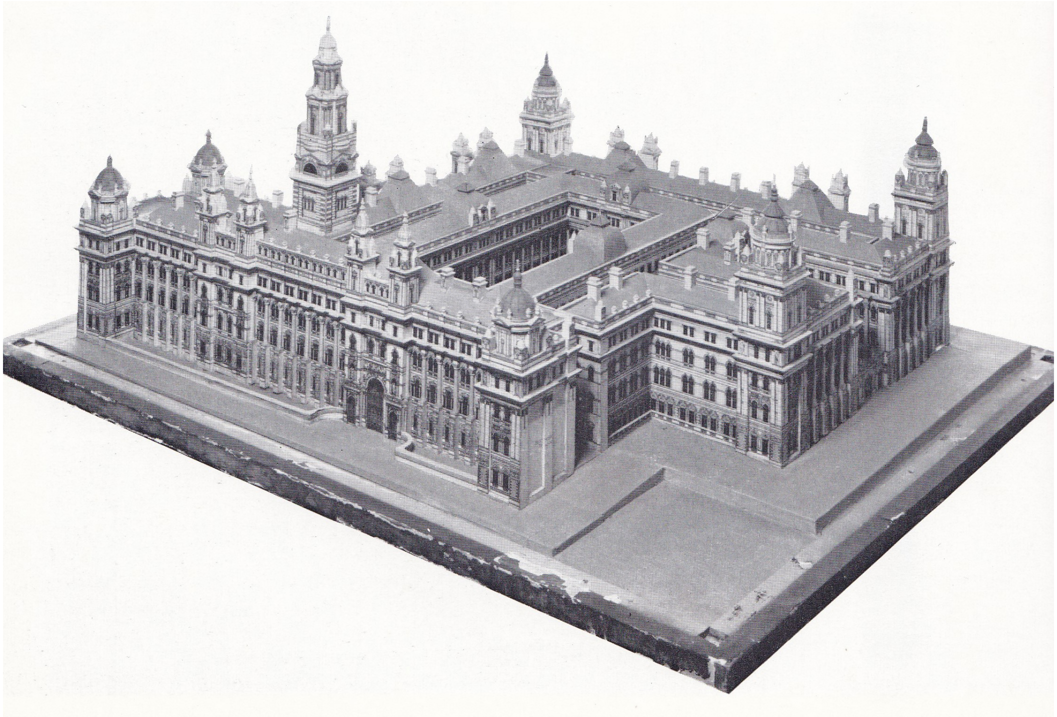


Figure 4.15: Model of the Admiralty and War Office buildings, 1885. Modelmaker Unknown

Figure 4.16: Mixed media model of the proposed rebuilding of Whitehall made by the office of

Lieutenant-General Sir Andrew Clarke, 1869 been made by individual craft disciplines each utilising different materials in pursuit of the same outcome, by the end of the nineteenth century the making of architectural models had become a much more consolidated activity, and the circumstances in which a dedicated profession could exist were in place.

4.4. John Thorp and the Birth of Modern Architectural Modelmaking

Although the making of architectural models had expanded beyond the material silos of the building construction trades during the nineteenth century, by the 1880s, there was still no one working as a professional architectural modelmaker in the modern sense. Richard Day and C.N. Thwaite had made careers out of making models solely from plaster and card respectively, and within many architects' offices, architectural assistants were increasingly producing card and timber models on a regular basis. The majority of architectural models were still being made by craftsmen from within other trades, however, with companies such as Jacksons and Sons, and Farmer and Brindley producing plaster models alongside their full scale architectural work. The potential afforded by the mixing of materials and processes across the different craft trades associated with building construction could only be realised by individuals working outside of those trades, which as outlined above, is why the advances in modelmaking that took place during the late-nineteenth century largely took place in the hands of architects, not the building trade craftsmen historically referred to as modelmakers in the pre-professional era. In many respects, these trade-based modelmakers had reached a dead-end, their use of singular materials unable to produce the kinds of highly detailed, realistic, and comparably low-cost mixed-media models architects and their assistants were increasingly making for themselves. The architectural model had moved on without them, and a space had been created for a new role dedicated to their making. Fundamentally, the relationship between the makers of models and materials had radically changed. The model no longer had to be the product of a specific craft, but could instead be the product of a process of design. The desired solution could now come first; the choice of material then made based on its suitability to deliver that outcome.

The first person in Britain to take advantage of this new relationship with materials and to establish himself as the first professional architectural modelmaker in the modern sense was John Thorp. (Figure 4.17). As the founder of a modelmaking company that still trades today, one hundred and thirty seven years later, Thorp's impact on both the profession and the architectural model cannot be overstated; the broad and adaptable approach to architectural modelmaking he established having become the template for all that followed. Born in 1862, by the time he had completed his schooling at Christ's Hospital School in Horsham, John Thorp had already developed both a keenness for modelmaking and a commercial streak that would characterise his entire career. As a child, Thorp charged his school friends to see a stage set he had designed and presented in a cardboard theatre (Thorp Modelmakers, 1983, p.1). With a clear interest in theatrical design and display, Thorp went on to study at the Royal Academy and began working for the architect Frederick Kemp in Chancery Lane (Thorp Modelmakers, 1983, p.1). In 1883, at the age of just twenty one, Thorp established his own company at 98 Gray's Inn Road, The London Drawing and Tracing Office.

Figure 4.17: John Thorp with a model of Southwark Cathedral under construction, circa 1930

Thorp was quite literally of a different social class to the craft-based modelmakers who had preceded him in the nineteenth century. Privately educated, and having been tutored in art at the Royal Academy, Thorp's background could not have been more removed from that of Richard Day's – who was largely uneducated, having begun working as a mason around the age of eight or nine. Where Day had been a working-class tradesman, Thorp was a middle-class gentleman – of a typically Victorian entrepreneurial kind – who embraced business and marketing as well as his creative interests. Initially, Thorp set out to produce architectural drawings for London architects, however within just a few years of opening his business, Thorp had added the preparation of models to his list of services (The Builder, 1897). Thorp's offices were in close proximity to one of the four Inns of Court, and he began to receive commissions for architectural models to be used in legal cases, particularly lawsuits relating to party wall disputes and 'light and air cases' (The Builder's Journal, 1906). These models, as Thorp himself described, were 'indispensable for enabling Counsel to grasp fundamental facts of a case, and are of primary service to him when describing to the court the principal points in question' (Thorp, 1913). Until the outbreak of the First World War, a substantial part of Thorp's business was given over to making these legal models, but by 1900, commissions for models for architects had begun to appear in much greater numbers. Sometime between 1906 and 1910, as evidenced by Thorp's stationery items and newspaper advertisements, although still registered as the London Drawing and Tracing Office, Thorp began trading as John B. Thorp, and exclusively marketed his work as an architectural modelmaker.

Thorp's models were radically different from most of the architectural models that the building trade firms such as Jacksons and Farmer and Brindley were producing at the time. His architectural training, while having only lasted a few years, had evidently equipped Thorp with an understanding of the principles of architectural design as opposed to the knowledge of architectural construction that earlier makers such as Richard Day had accumulated through their primary trades. Combined with the precision and accuracy he was required to achieve for his legal models, Thorp's architectural models demonstrated a strong appreciation of the ability of models to communicate and the vital role of context. Visually, this translated into a greater sense of realism, with much greater attention being paid to fine detail, and the inclusion of a portion of the existing landscape in which the proposed building was intended to be located. Early work such as his two hospital models made for the 1900 World Exposition in Paris included roads, paths, grassland and trees, as well as boundary walls and other landscape features that were rarely included in earlier British architectural models (Figures 4.18 and 4.19). Both were each six feet square and made from timber and card, with billiard table felt used for grass, and stained sponges for trees (The Builder's Journal, 1900). Combined, the two models cost £400, approximately £50,000 today, and

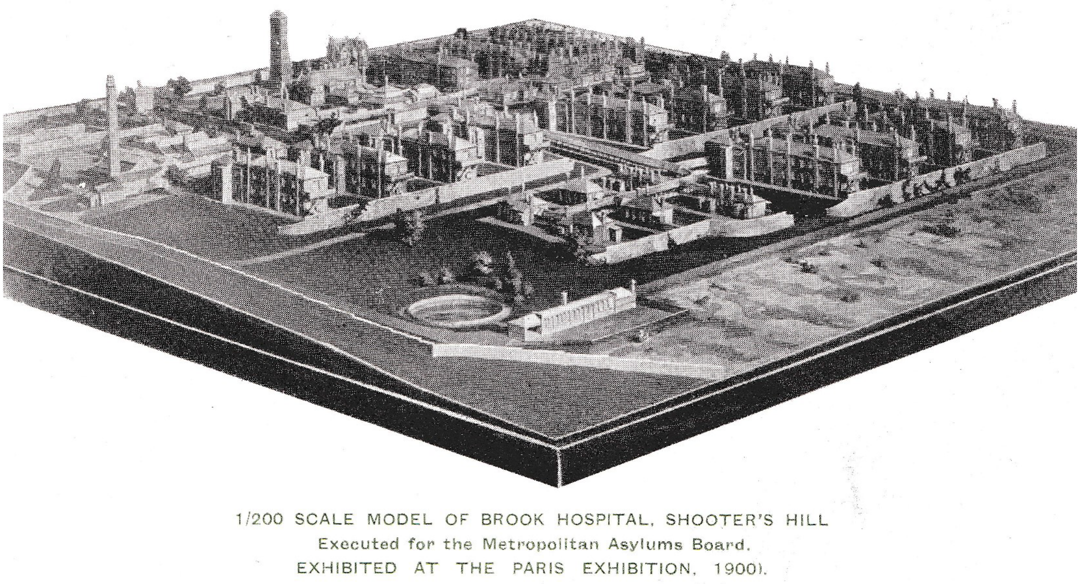


Figure 4.18: Model of Brook Hospital made by John Thorp, 1900

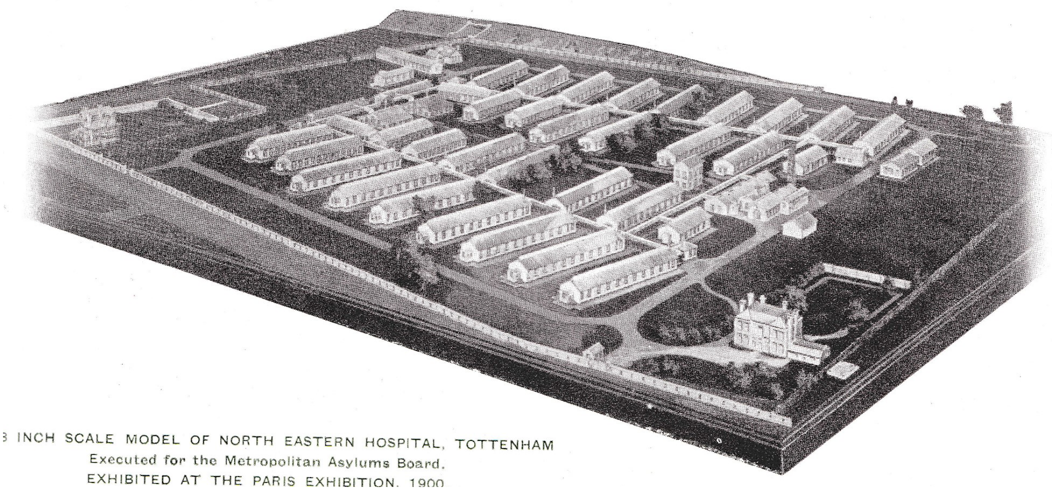


Figure 4.19: Model of North Eastern Hospital made by John Thorp, 1900

took nine months to complete (Soutar, 1910, p.616). Thorp's model of an improvement scheme for Derby (Figure 4.20) showed the proposed building in an even larger context, with minute details such as telegraph poles and railings being carefully modelled, while a model of a proposed hotel included a fully-landscaped garden (Figure 4.21).

Effectively teaching himself the skills of architectural modelmaking while drawing from his art studies at the Royal Academy, Thorp was able to employ an imaginative and adaptable relationship with materials that allowed for working in whichever materials provided the best solution for the particular model in question. Where previously craftsmen working in

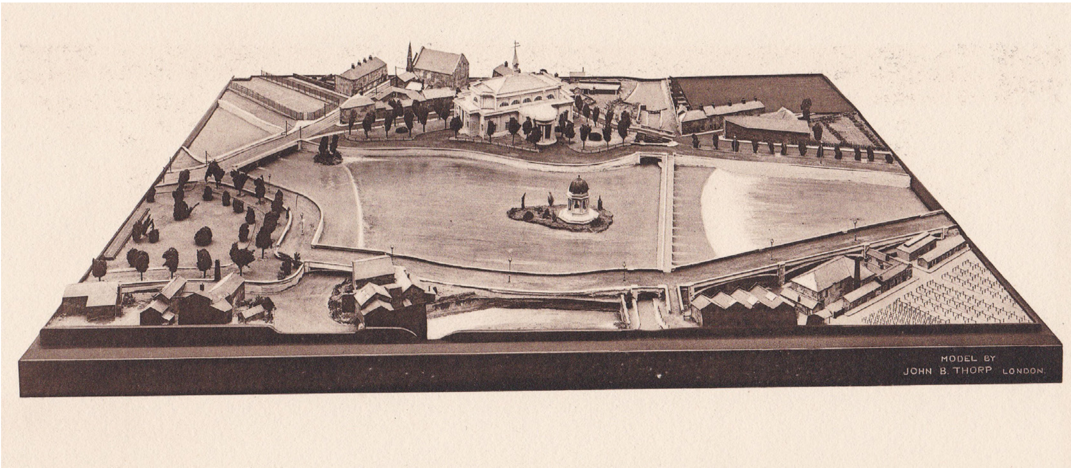


Figure 4.20: Model of Derby Improvement Scheme made by John Thorp, circa 1910

Figure 4.21: Model of a hotel, made by John Thorp, circa 1920

the material silos of their respective trades had found their materials and processes limiting the scope for the design of a model, Thorp was able to conceive the finished model first and then select from the variety of materials and processes that would best realise it. For Thorp, modelmaking was as much a process of exploration as it was a craft; he was able to make decisions about the style, function, and cost of a model before determining the materials he was going to use.

Thorp began his models with the construction of the baseboards, drawing a plan of the building in the centre. For legal models, compo-board – an early form of plasterboard – was used, while noting that for presentation models, ‘a more elaborate base, made from some choice timber, with moulded and polished edges, is required’ (Thorp, cited in Collins, 1915, p.262). For the buildings themselves, Thorp used a variety of approaches and materials depending on what the model required. In 1906 Thorp received a commission for a large and highly complex model of a proposed brewery in Wandsworth (Figures 4.22 and 4.23). The model needed to separate into layers so that each floor could be removed and individually viewed, with every room modelled with full interiors (Thorp, 1913, pp.17-21). With strength

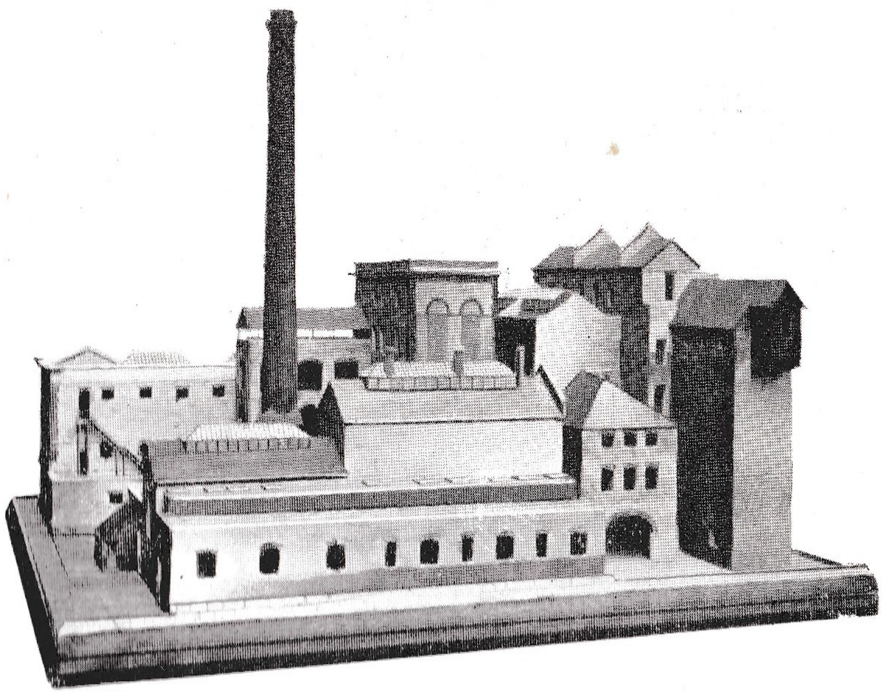


Figure 4.22: Brewery model made by John Thorp, 1907

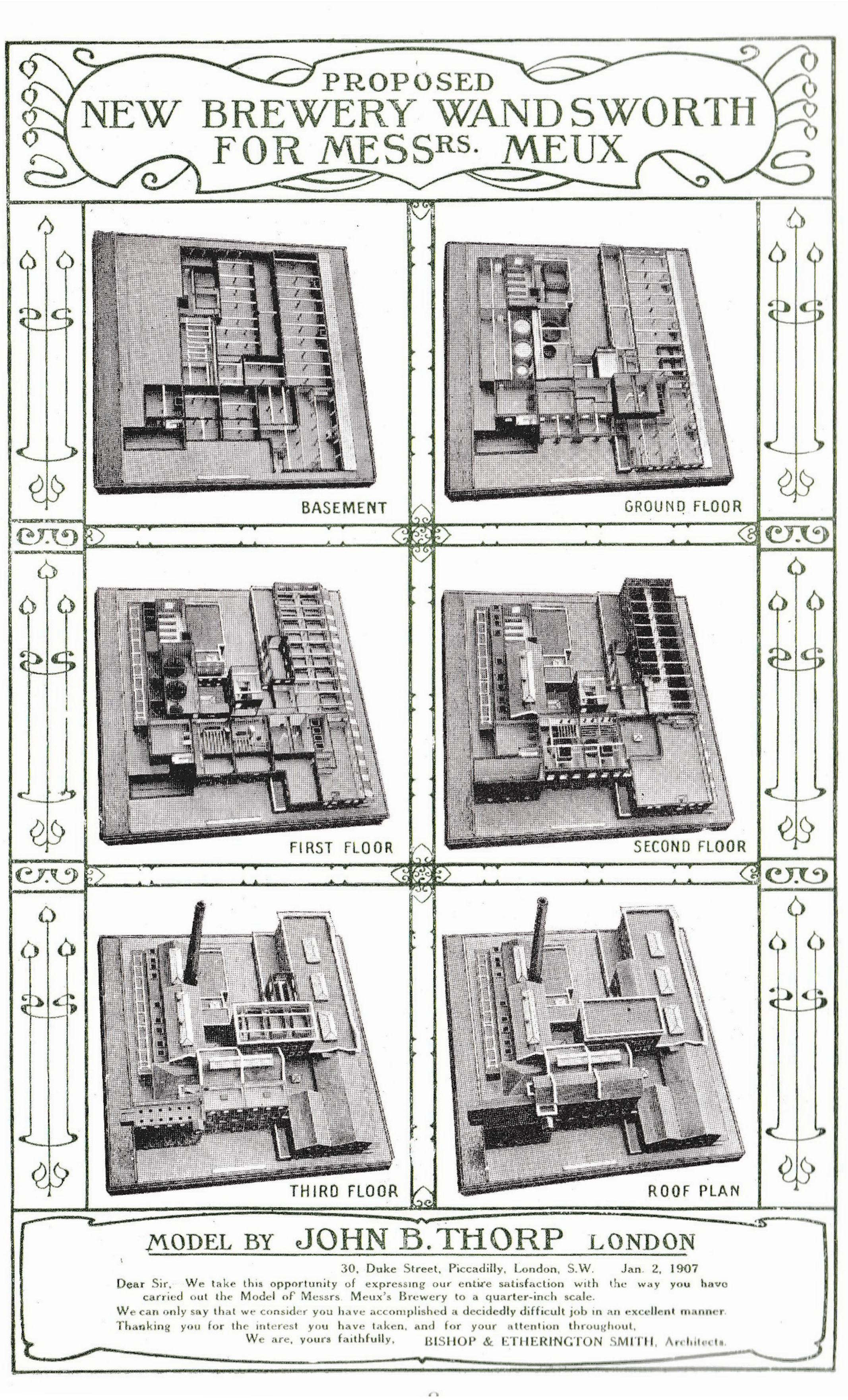


Figure 4.23: Advert showing a model of a proposed brewery made by John Thorp, 1907

and repeated use being important considerations for the design of the model, Thorp used an all-timber construction; had card facades been applied they would have been easily damaged through regular handling. For a 1905 riding school model (Figure 4.24) Thorp used both timber and Bristol board (Anon, 1905), this particular combination of materials necessary to achieve the hollow dome; had the model not been a cut-through, a solid block of timber might have instead been turned on a lathe.

For most models, however, Thorp's general approach was to cut thin sheets of timber and clad them with cartridge paper upon which the facade details were drawn and coloured (Figure 4.25), the same method that had been favoured within architectural practices described in the previous section. Where window apertures were included, Thorp made use

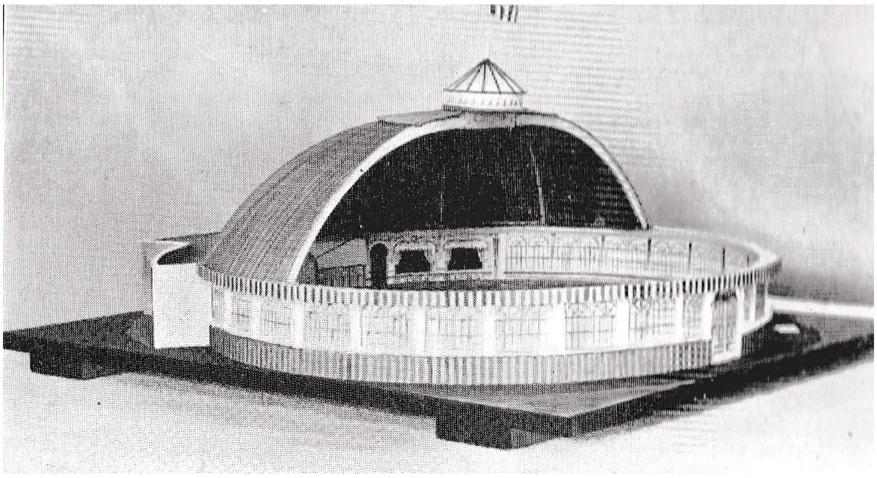


Figure 4.24: Model of riding school for Baron Rothschild made by John Thorp, 1905

Figure 4.25: Model of Covent Garden Market, made by John Thorp, circa 1904

of either celluloid or sheet gelatine for the glazing, and if the model was to be internally lit, less-flammable mica was employed (Collins, 1915, p.263). For smaller scale buildings, solid timber blocks were shaped and then clad. This combination of timber cores and card facades provided a reliable mix of strength and stability with a fineness of surface detail and realistic colouring. The use of card also allowed Thorp to produce models at a lower cost than wholly timber ones (Moon, 2005, p.146), and without as many specialist tools during the early days of his career. In 1901, Thorp wrote of cardboard models that 'the elevations should be drawn and then inked in [and] the whole then carefully cut up, care taken to bevel the corners so not to show a square joint' (Thorp, 1901). The drawing of two-dimensional elevations in card modelmaking was a natural fit for Thorp given his initial work as a draughtsman, though it is also clear that from a very early stage he was making extensive use of timber and plaster where these materials were appropriate for a particular model. A 1902 price list from a timber merchant found in Thorp's archive suggests the use of ash, birch, lime, mahogany, oak, pine, walnut, and cedar (James Latham Ltd, 1902).

Perhaps just as significant as his approach to the materials of modelmaking was Thorp's approach to the business of it. Having experienced an increasing demand for architectural models for architects rather than for legal purposes, he aggressively promoted his services and centred his marketing efforts on extolling the benefits of commissioning such models. A focus on efficiency and cost is clear in all his marketing, outlining at first the problem that architects faced – convincing potential clients who had difficulty reading architectural drawings of the merit of particular designs – and then how he, as a modelmaker, could solve it. 'How frequently has an architect experienced a difficulty in getting a client to understand his working drawings, and had to prepare a perspective, sometimes more or less "faked", to bring out a certain feature' (Thorp, 1913, pp.13-16). Noting that with a perspective, only one view can be obtained, Thorp highlights that the cost of a model, 'which compares favourably with say two perspectives', gave the client unlimited views for the price of two drawings (Thorp, 1913, p.16). Thorp clearly took pride in his work and put a great deal of effort into both presenting his business and recording the publicity his efforts achieved. Investing in free gifts that he sent to potential clients, placing expensive adverts, and encouraging favourable editorials in the major architectural journals, Thorp employed modern business techniques to establish himself and generate future business. In 1900, he sent a wall calendar promoting his work to every architect in London (The Builder, 1900), while in both 1906 and 1913, he produced the two editions of the booklet described at the start of this chapter (The Builder's Journal, 1906; The Builders' Reporter, 1906; Thorp, 1913). Adverts, publications, and letterheads designed by Thorp were of a very high quality and re-enforced a message to potential clients that he was effectively one of them – an architecturally-literate businessman and not a common labourer or tradesman.

Seeing an opportunity to put his long-standing interests in theatre and performance to profitable use, in 1908 Thorp produced a series of large-scale historical models of the City of London as it was before the Great Fire of 1666, under the collective title 'Old London' (Soutar, 1910, p.613). Displayed at the Franco-British Exhibition at Shepherds Bush that year, the entrance fee of sixpence to view the models generated £7000 over the five months they were on display. A statement from the exhibition shows Thorp received a quarter of this money, bringing him just under £2000 – around £250,000 today (Thorp Modelmakers, 1908). Over the next decade, Thorp continued to offer the models for hire, before eventually becoming part of the collection of the Museum of London, where several can still be seen today. Thorp evidently benefited from both the financial boost and the significant publicity the Old London models brought him. By 1910, his workshop at Gray's Inn Road was described as having 'hundreds of models stored there' (Soutar, 1910, p.614), and in 1912 a section of the Ideal Home Exhibition in London was dedicated to models of houses he had made especially for the event (Figure 4.26).

By the outbreak of the First World War, Thorp's business had grown to the extent that it was employing ten additional modelmakers; extra workshop space having been constructed behind the frontage of the offices on Gray's Inn Road (Thorp Modelmakers, 1983, p.4). Having himself become the first professional architectural modelmaker during the 1880s, Thorp had managed to not only sustain and develop his business for over thirty years, but was now training other modelmakers who were working for him. In just a few decades, Thorp's success had completed the transformation of architectural modelmaking from being a side-pursuit belonging to craftsmen within the building trades into a dedicated profession

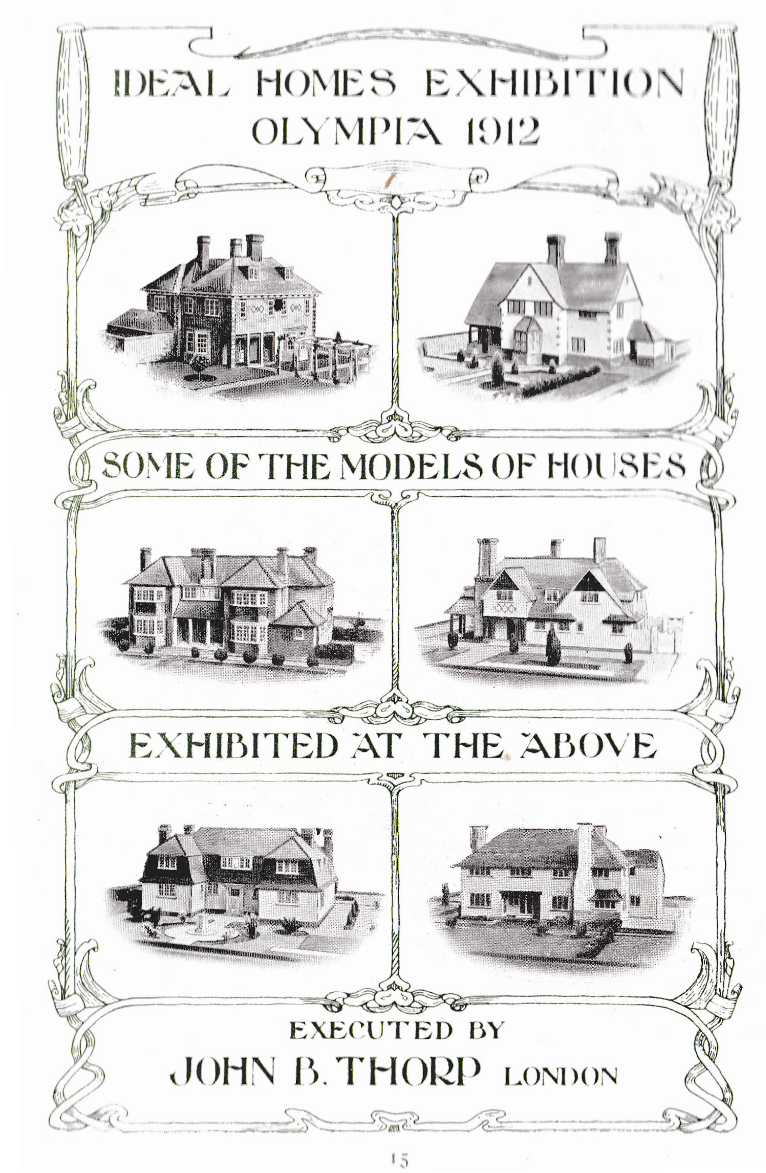


Figure 4.26: Advert showing models for the Ideal Homes Exhibition made by Thorp, 1912.

in its own right. Architectural modelmaking was now not just a possible career, as Richard Day and C.N Thwaite had proved it could be, but a viable business, involving a company with multiple employees, marketing strategies, and a recognition that efficiency was an essential part of making it a success. Models, as Thorp saw them, were beautiful objects but also practical ones. They had a job to fulfil and had to be completed on time and within a budget that was acceptable to the client, and with an appropriate profit margin to keep the business sustainable. Mixing materials was a large part of achieving this efficiency, as were attempts to move towards hollow model construction, making them lighter and cheaper to build. Thorp had identified a market, and developed the architectural model into a product that could be successfully sold to that market.

Fundamental to Thorp's early success was the utilisation of an imaginative and adaptable relationship with materials that had been impossible for the earlier makers of models to employ from within their strictly divided trades. Through the work of John Thorp, architectural modelmaking had become a specialist activity that employed a generalist approach – specialised on the creation of models, but open to any and all means of making them. Creativity and versatility had become more important than the mastering of any single craft skill or material, and it is with Thorp that architectural modelmaking first employs the 'ingenious adaptation of available tools and materials' that Richard Hoyt later so acutely observed (Hoyt, 1939, p.420). Having seized the opportunity presented by the gradual liberation of the architectural model from within the building trades afforded by the adoption of cardboard in the nineteenth century, John Thorp established the template for the profession that would follow, focused firmly on the model rather than the material. The immediate consequences of this were rapidly apparent; benefiting from the attention of professionals solely dedicated to its making, the inter-war years saw the architectural model undergo a period of intensive development that brought about dramatic increases in its quality, realism, and technical sophistication that cemented its position as a principal means of communicating architectural designs.

4.5. Expanding the New Profession

The new and highly successful approach to architectural modelmaking that John Thorp pioneered led to significant improvements in the quality and realism of models that did not go unnoticed by both the architectural profession and the public at large. This in turn contributed to a substantial increase in their demand during a period of extensive property building, and which instigated a rapid expansion of the profession as other dedicated architectural modelmakers began to set up business. This resulted in a boom in architectural modelmaking that secured the future of the fledgling industry as it expanded beyond being merely one man's successful business, and which enshrined the template John Thorp had established as the fundamental approach of the profession that remains to this day.

During the inter-war years, John Thorp saw a dramatic increase in his level of business. Major projects such as models of Industry House for ICI, the National Gallery, Cambridge University Library (Figure 4.27), the National Cash Register Company building (Figure 4.28), and the Royal Hospital School in Holbrook, all added to his growing success – the latter model alone bringing in over £1000 in revenue, approximately £50,000 today (Thorp Modelmakers, 1983, p.4). Thorp's reputation was also growing: 'Few people have realised how much we owe to Mr John B. Thorp, who more than twenty years ago started making these most instructive and invaluable models', one writer enthused (The Building News, 1924). The same article went on to describe a huge model under construction in Thorp's workshop of an entire town with 'town hall, church, shops and other buildings, and also a park with a bandstand and a river, a large factory [and] a flour mill' (The Building News, 1924). It continued:

> This is a marvellous piece of work, and everything is correct even to the smallest details. There is a railway line which runs into the factory grounds, and model trains on the line, with miniature lorries and wagons all complete, and it gives the whole scheme a realistic appearance of industrial activity. Even a system of lighting has been efficiently installed, and a great variety of beautiful effects are obtained. The various buildings and even the trains are lighted in sections, as well as the small street lamps; and the lighting of the clock face in the town hall gives a charming finish to the whole model (The Building News, 1924).

After the First World War, however, Thorp was no longer the only professional architectural modelmaker working in Britain. Having proved a company could thrive by tending to this niche industry, the inter-war years saw a number of other architectural modelmaking firms being established as demand increased. S. Lloyd Young was operating as a 'model maker

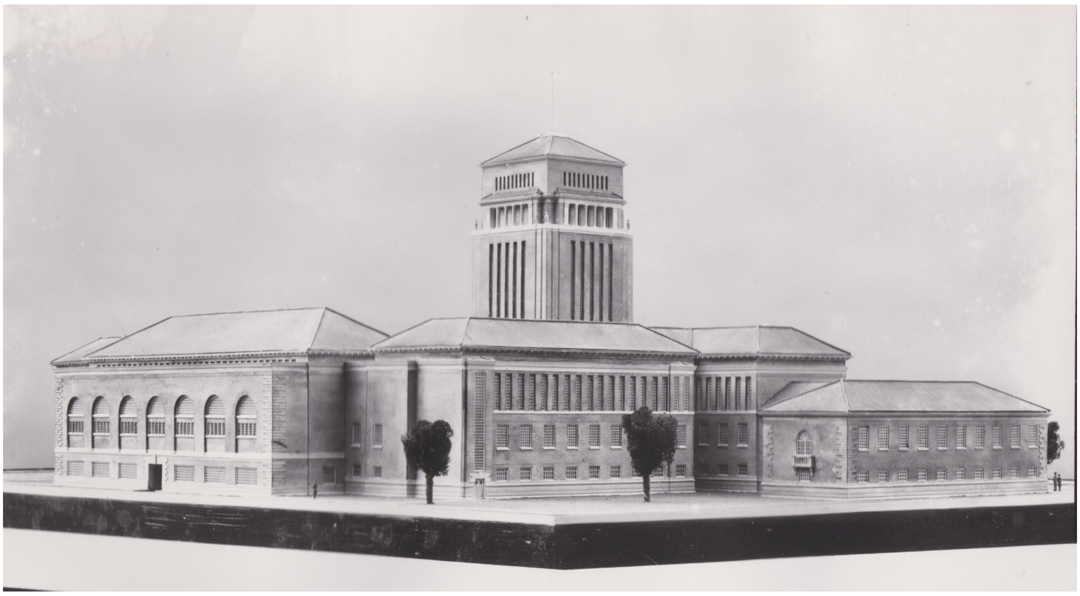


Figure 4.27: Model of Cambridge University Library, made by Thorp, 1931

Figure 4.28: Model of the National Cash Register Company building, made by Thorp, 1935

and experimental engineer' in the then brand new town of Welwyn Garden City in the 1920s, with his brochure almost exclusively featuring architectural models (Lloyd Young, 1925); while Cyril Mills set up business as an architectural modelmaker in Ruislip during the early 1930s (Mills, 1932). Alongside these, the inter-war years also saw the flourishing of several major competitors for Thorp – Twining Models, Partridge's Models, and McCutchon Studio. Ernest Twining had begun making models for Bassett-Lowke in 1912, while Partridge's Models and McCutchon Studio – for both of whom little information survives relating to their early histories – set up in London during the 1920s and 1930s respectively. Partridge's were advertising as early as 1922 and continued trading until the late-1960s, while McCutchon Studio started in 1935 and became one of the major architectural modelmakers during the post-war boom of the 1950s and 1960s (see Chapter Five). Partridge's Models in particular appears to have gained significant commissions during the 1930s, largely due to their success in building a substantial model of the proposed new Bank of England in 1925. Twenty five years later, the company was still promoting the model, with the company advertising as 'Model Makers to H.M. Government – The Bank of England, etc.' (Partridge, 1950). Work on models of the proposed Guildford Cathedral, the Royal Institute Library, and a new library for Leeds City Council soon followed (Figure 4.29). These new architectural modelmakers closely followed the template Thorp had established; Partridge's notably copying Thorp's success with models of historic London, as their 1922 advert shows (Figure 4.30). More broadly, however, the diverse and adaptable approach towards materials that Thorp had adopted was accepted as the underlying principle behind successful architectural modelmaking, it being noted in 1926 that 'there is no hard and fast rule for the use of a particular material, but the builder should utilise any which is appropriate for the purpose and will yield the desired result' (Hobbs, 1926, p.15).

In addition to the growing number of architectural modelmakers, the inter-war years also saw the establishment of many general modelmaking companies. While the development of these largely falls outside of the boundaries of this thesis, it was during this period that they began to include architectural models as part of their commercial offerings. Firms such as the Models Manufacturing Company, which specialised in aircraft models, also took on occasional architectural work during the 1920s (Models Manufacturing Company,

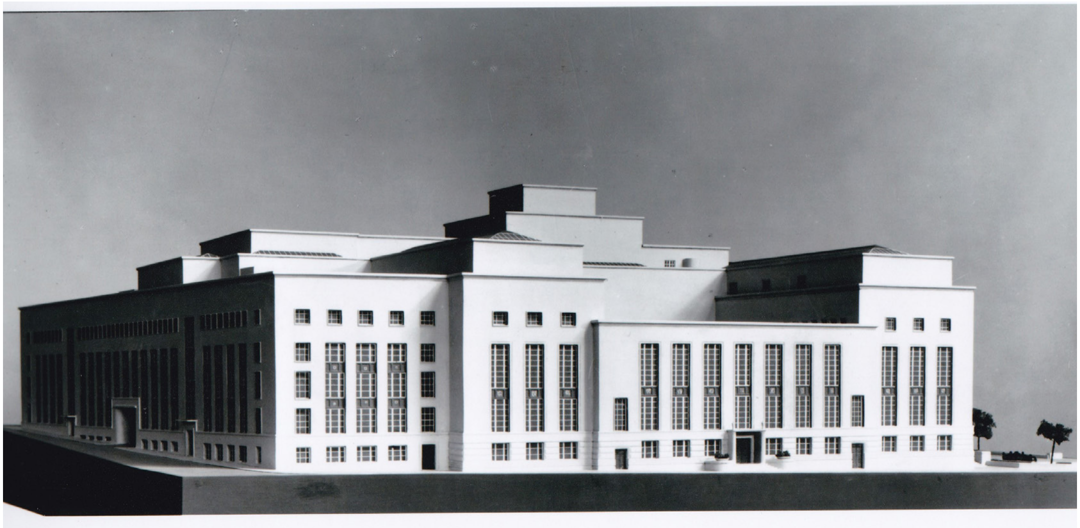


Figure 4.29: Model of the proposed Leeds Central Library, made by Partridge's Models, 1936.

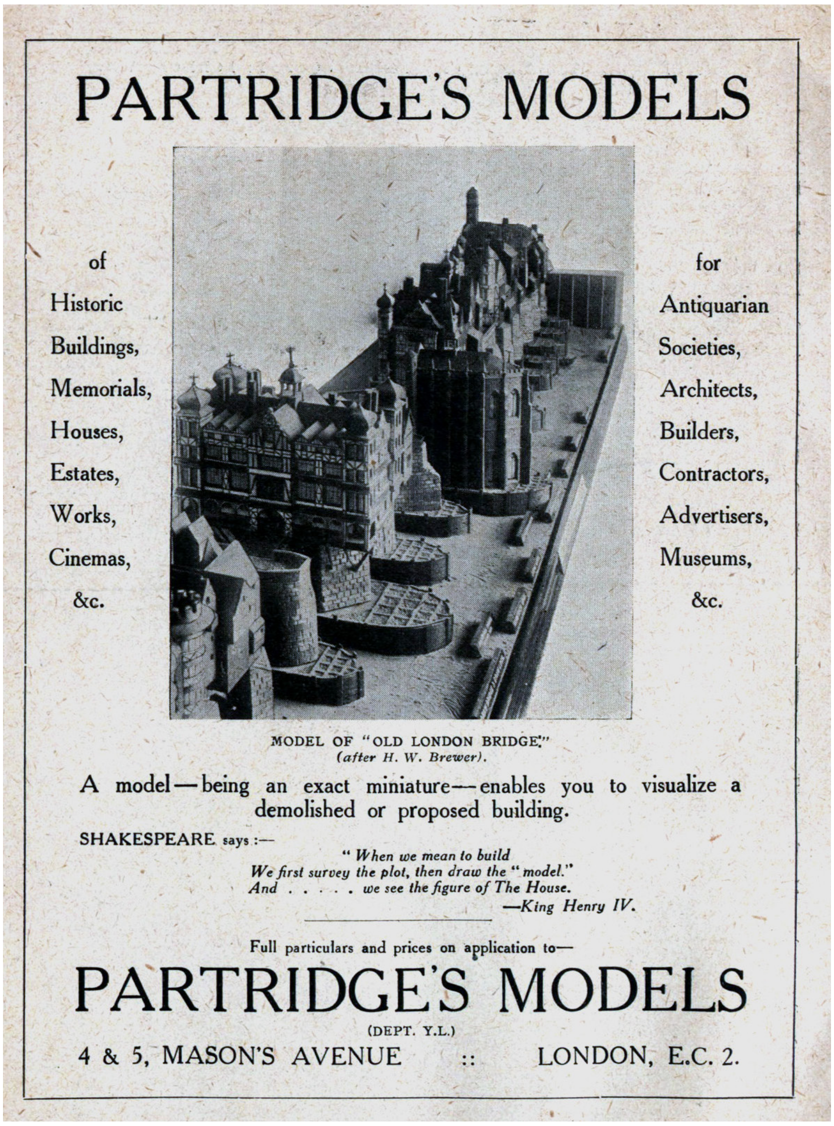


Figure 4.30: Advert for Partridge's Models, 1922

1928). By the 1930s, there were at least twenty general modelmaking companies trading, this particular type of modelmaker having developed from the role of the pattern maker during the nineteenth century, with several non-architectural modelmakers advertising in both London and Nottingham by the time Thorp began trading in 1883. As the need for public display of the outputs of industrialisation increased, pattern makers, whose skills and employment within manufacturing firms made them ideally suited to the task, began to produce scale models of engines, structures, locomotives, and eventually, aircraft and road vehicles. Pattern makers by the inter-war years were often advertising both functions (Brett, 1929); with many such as Braun and Company, Crawford and Sons, and Marshall, Stewart and Sons advertising as modelmakers first, pattern makers second. Having initially focused on purely mechanical engineering models, an increased demand for scenic models and dioramas for museum and exhibition display meant their skills began to overlap with those of the architectural modelmaker, however the architectural components of their businesses remained small, likely due to the success of specialist architectural modelmakers such as Thorp and Partridge's.

For both specialist architectural and general modelmaking firms, there was more than enough work to go around due to an increased demand for architectural models as a result of the housing boom that followed the First World War. During the 1920s and 1930s, four million new homes were constructed in Britain, with many slums being cleared in a large-scale transition from high density housing to suburban living that resulted in some twelve million people had been re-housed (Pugh, 2009, p.58; Gardiner, 2011, p.272; Scott, 2013, p.233). Much of the burden for house building fell to the local authorities, and an increased need to inform the public about these plans generated a rise in the use of the by now much more realistic and higher quality architectural models being offered by professional modelmakers. Exhibitions such as *New Homes for Old* toured the country during the 1930s; models being commissioned to demonstrate to the public the improvements to housing that were being proposed (Figure 4.31). From slum clearances in the major cities – Leeds seeing a quarter of its housing, some thirty thousand back-to-back terraces, being demolished – to the garden city experiments at Letchworth and Welwyn, models were frequently used to both educate and sell these new ways of living. Photographs of models were also in great demand to

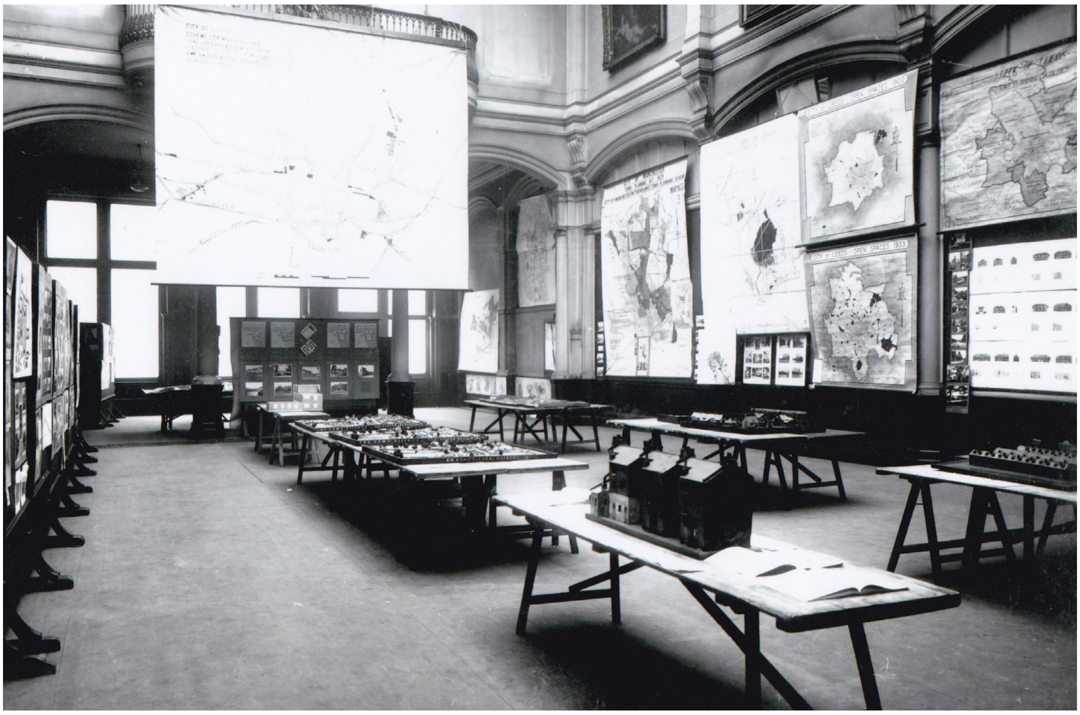
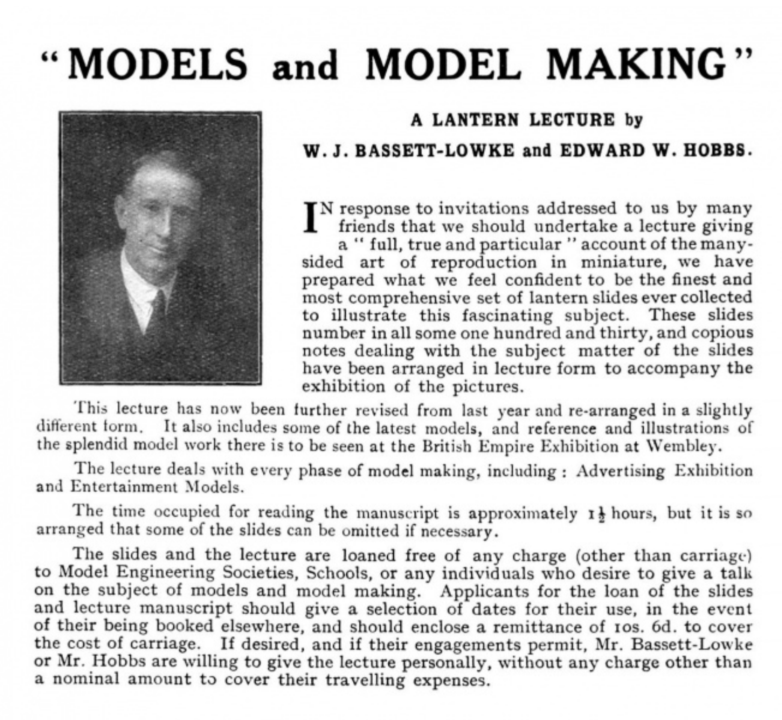


Figure 4.31: Architectural models on display as part of the travelling exhibition 'New Homes for Old' in Leeds, 1933

provide content for the boom in illustrated magazines during the same period. This was particularly the case for the *Architect's Journal*, which began to make heavy use of model photography to illustrate articles about the work of new modernist architects such as Le Corbusier and Lubetkin (Deriu, 2012a).

At the same time, the inter-war years also saw a further expansion in public interest in modelmaking, with a large number of books and periodicals dedicated to both architectural and general modelmaking being published. The making, collecting, and even playing with models became a popular adult pastime during this period, with boats, railways, and houses being the principal subjects of interest. Central to this movement was the publisher and champion of model engineering, Percival Marshall. Marshall established a publishing house that produced a wide range of books and periodicals that both responded to, and fuelled, a boom in hobbyist modelmaking. Other publishers soon followed, with titles such as *Pictorial House Modelling* (Hobbs, 1926), *Models of Buildings: How to Make and Use Them* (Harvey, 1927), *Model Maker's Workshop* (Hobbs, 1934) and *The Craft of Model Making* (Bayley, 1938) being just a selection of architecturally-focussed titles within an enormous range of modelmaking topics that were covered. Marshall was well-connected in the modelmaking and model engineering scenes, and appears to have been a friend of John Thorp, having delivered a paper in tribute of Thorp's achievements at the Institute of Junior Engineers in 1902 (Soutar, 1910, p.614). His connections proved especially useful when, in 1899, W. J. Bassett-Lowke approached him for his advice in setting up a mail order model engineering supplies company. Marshall provided Bassett-Lowke with a list of contacts, and the company went on to become the country's largest supplier of railway and ship models, based in Northampton (Brighton Toy Museum, 2018a; 2018b).

In 1908, Bassett-Lowke opened a showroom in Holborn in London, recruiting the marine architect Edward W. Hobbs as the manager. Through Percival Marshall's publishing firm, Hobbs authored a large number of books on modelmaking, varying from ship building and model engineering to timber turning and architectural modelmaking. In 1924, Hobbs and Bassett-Lowke held a public lecture on the subject covering advertising, exhibition, and entertainment models (Figure 4.32). With Bassett-Lowke's increased presence in London, the firm soon began to receive architectural commissions, even though these were quite removed from their usual hobby-orientated models of steam locomotives and battleships.



"MODELS and MODEL MAKING"

A LANTERN LECTURE by
W. J. BASSETT-LOWKE and EDWARD W. HOBBS.

IN response to invitations addressed to us by many friends that we should undertake a lecture giving a " full, true and particular " account of the many-sided art of reproduction in miniature, we have prepared what we feel confident to be the finest and most comprehensive set of lantern slides ever collected to illustrate this fascinating subject. These slides number in all some one hundred and thirty, and copious notes dealing with the subject matter of the slides have been arranged in lecture form to accompany the exhibition of the pictures.

This lecture has now been further revised from last year and re-arranged in a slightly different form. It also includes some of the latest models, and reference and illustrations of the splendid model work there is to be seen at the British Empire Exhibition at Wembley.

The lecture deals with every phase of model making, including : Advertising Exhibition and Entertainment Models.

The time occupied for reading the manuscript is approximately 1½ hours, but it is so arranged that some of the slides can be omitted if necessary.

The slides and the lecture are loaned free of any charge (other than carriage) to Model Engineering Societies, Schools, or any individuals who desire to give a talk on the subject of models and model making. Applicants for the loan of the slides and lecture manuscript should give a selection of dates for their use, in the event of their being booked elsewhere, and should enclose a remittance of 10s. 6d. to cover the cost of carriage. If desired, and if their engagements permit, Mr. Bassett-Lowke or Mr. Hobbs are willing to give the lecture personally, without any charge other than a nominal amount to cover their travelling expenses.

Figure 4.32: Modelmaking lecture press cutting, 1924

As many general modelmakers found during this period, the growing public interest in amateur modelmaking could be successfully married with supplying models for industry, and Bassett-Lowke rarely turned away any customer, whether the models were for home display or professional use.

In 1912, the firm began construction of its first architectural model, a large model of Blackpool seafront, however halfway through the project, Bassett-Lowke's newly hired architectural modelmaker, Berthold Audsley, announced he was emigrating to the United States. Audsley had previously worked as an interior decorator and furniture maker for his architect father, and began making cardboard models as a hobby (Asbury, 1920, p.54). After his brief employment as a professional modelmaker for just a few months with Bassett-Lowke, Audsley later became known as the 'foremost cardboard modeller in the world' – at least to American audiences – having pursued a successful career as an architectural modelmaker in New Jersey, including a long period working for General Electric (Asbury, 1920, p.54; Hobbs, 1926, p.xi). With Audsley's departure imminent, Bassett-Lowke invited Ernest Twining, a telephone cabling engineer and amateur model locomotive builder to complete the model (Buck, 2004, p.11). Twining was likely introduced to Bassett-Lowke through Percival Marshall, who had already published numerous articles by Twining in his model engineering titles. Accepting the commission, Twining moved to Northampton to continue to work on further architectural models that Bassett-Lowke had been approached to make, including a large model of Port Sunlight in 1913 (Figure 4.33) that contained fully-glazed buildings that were internally-lit from below (Audsley, 1914, p.216).

For the next twenty-seven years, Ernest Twining made every architectural model that left Bassett-Lowke's workshop, despite never actually working for the company. As with much of his business, Bassett Lowke acted as a commissioning agent, sub-contracting all the architectural work to Twining, who set up his own company and eventually moved from Bassett-Lowke's facility and established his own workshop nearby in Northampton (Buck, 2004, p.15). Bassett-Lowke encouraged Twining to take on his own commissions directly from other clients when workload permitted, though in practice his company appears to have operated as a direct subordinate to Bassett-Lowke. All architectural models that have

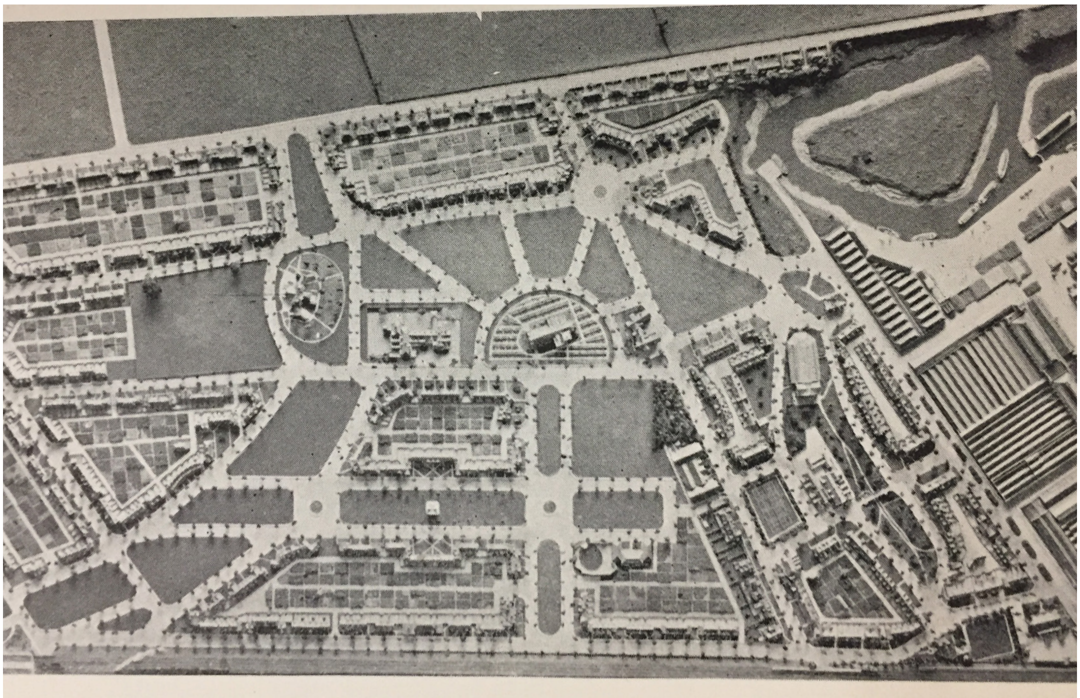


Figure 4.33: Model of Port Sunlight made by Ernest Twining for Bassett-Lowke, 1913.

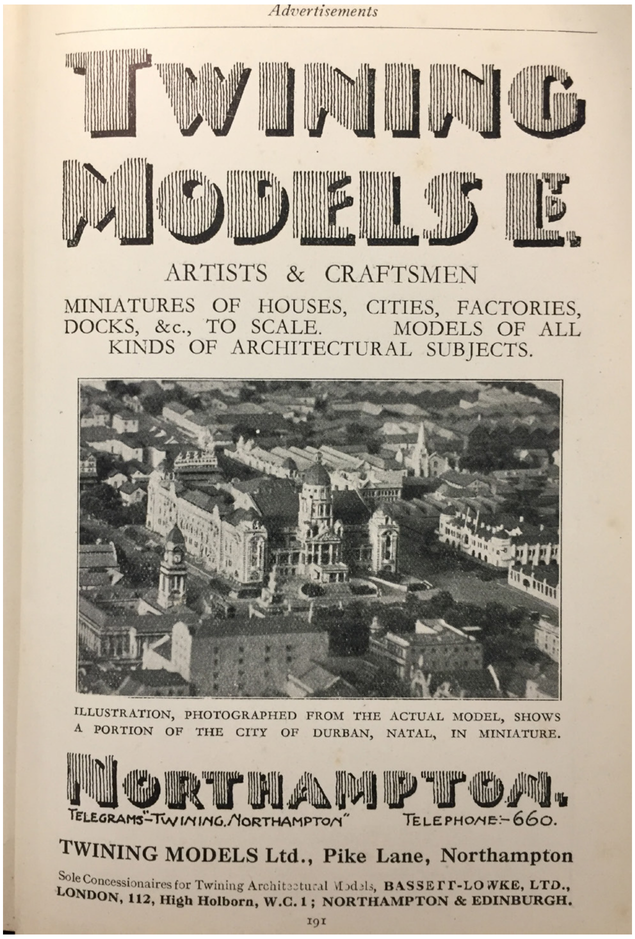


Figure 4.34: Advertisement for Twining Models, 1924.

been credited to Bassett-Lowke were in fact made by Twining, putting his architectural output at around two hundred models during his career (Buck, 2004, p.85). Business quickly boomed, and in 1914 Twining recruited Harry Clifton as a workshop foreman straight from school (Buck, 2004, p.14), the pair continuing to make models for Bassett-Lowke during the First World War, providing both ship recognition and landscape models (Buck, 2004, p.82). As with Thorp, Twining quickly found enough work to warrant employing additional modelmakers, reaching a peak of around eight staff by the late-1930s, and by the 1920s was advertising solely as an architectural modelmaker (Figure 4.34).

Twining's models were often quite large in size and highly detailed in an attempt to be as realistic as possible (Figures 4.35 and 4.36), even going to the extremes of ensuring that the trees on his models were of the correct species for the location (Buck, 2004, p.106). For most of the models, timber and cardboard were the principal materials used, with timber for the internal structure and card used for the facades – just as Thorp had been using them. Bristol board and other forms of card were still popular materials during the inter-war years, with various timbers and cork continuing to be used alongside newer materials such as timber veneers and plasticine (Hobbs, 1926, p.14; Harvey, 1927, p.86; Bayley, 1938, p.7). Shrubs and flock wallpapers could be purchased from the art suppliers Sanders & Sons in London,

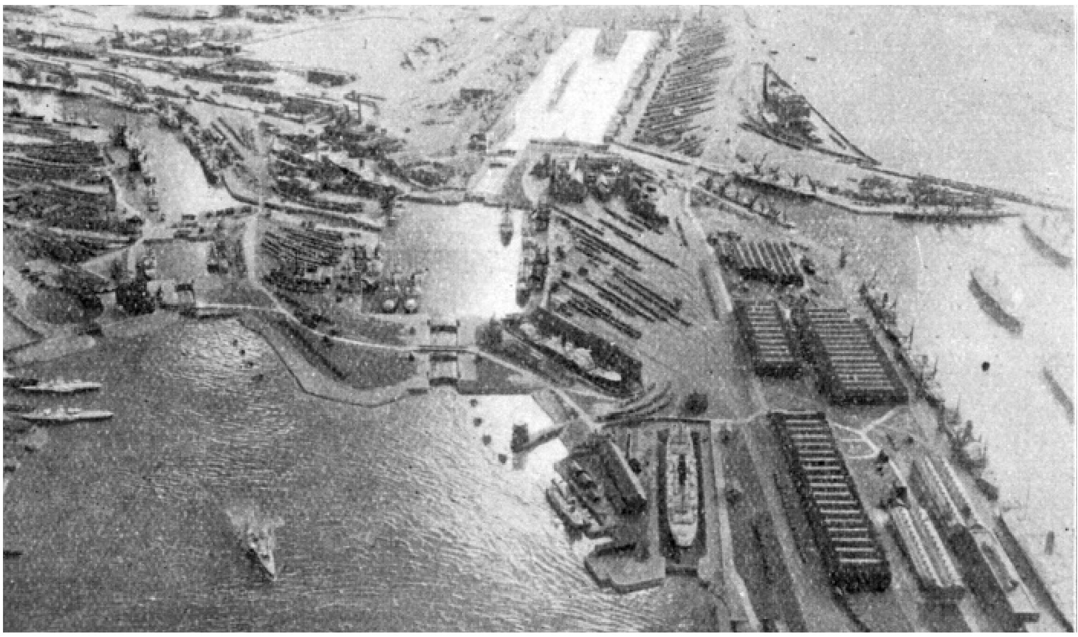


Figure 4.35: Model of Cardiff Docks made by Twining Models, circa 1920

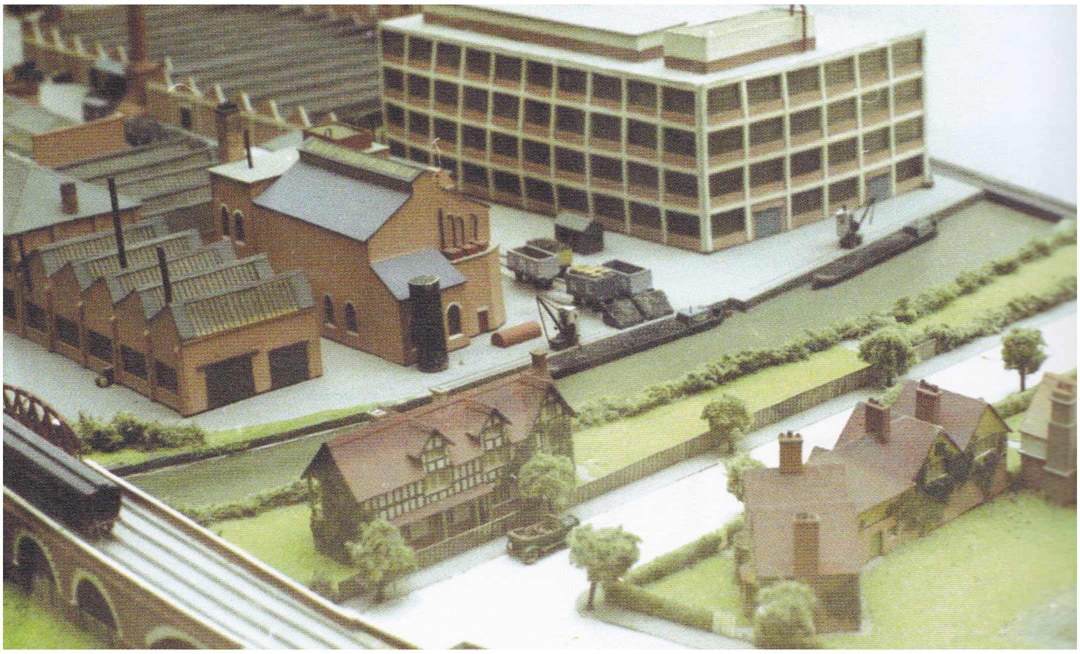


Figure 4.36: Hypothetical factory model made by Twining Models, 1923

who appear to have stocked basic modelmaking materials (Hobbs, 1926, p.118). While plaster of Paris was still being used, modelmaker Kenneth McCutchon noted in 1936 that plaster models themselves were losing favour due to their inability to successfully represent different materials other than stone, making clear his own preference for card and plywood in his own work (McCutchon, 1936, p.460).

While the application of materials and the construction approaches used in making architectural models continued to advance during this period, workshop facilities were also increasingly being modernised. Two photographs of John Thorp's workshop in 1924 capture not only the scale of the operation, with eleven modelmakers visible at work on at least six different models, but also the range of equipment being employed (Figures 4.37 and 4.38). Electric lighting is present, and there is a mixture of both electrically-powered and treadle-powered table saws, alongside a variety of hand tools. It was noted in the same year that 'Mr Thorp's workshops are equipped in the most excellent fashion with all the most modern machinery', and that it was all driven by electricity (The Building News, 1924). A later photograph from 1929 shows the belt drives powering a number of wood lathes from an electrically-powered transfer shaft above (Figure 4.39). Developments in the design of machine tools during the early twentieth century had greatly improved the range of equipment that was suitable for

Figure 4.37: Thorp workshop, 1924

Figure 4.38: Thorp workshop (reverse view), 1924

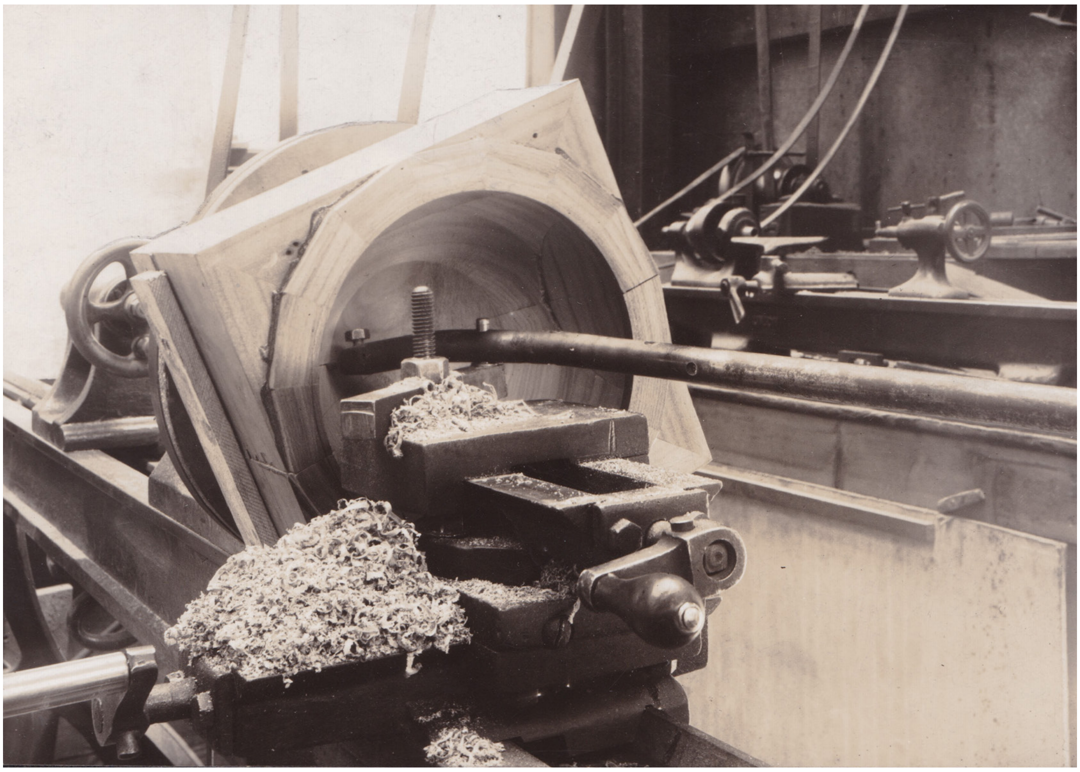


Figure 4.39: Turning a wooden model in the Thorp workshop, 1929

architectural modelmaking, with the modern band saw, self-contained milling machine, and higher precision lathes and pillar drills becoming available (Bradley, 1972). Gear boxes on lathes, mills and drills had been introduced around the turn of the century, smoothing the power from belt and pulley drives. Thorp's workshops, behind an office front in central London, were able to benefit from the use of light engineering machinery applied to the small-scale production of models, with the professional modelmaker's flexible approach to materials and processes meaning they were generally open to exploring new substances and tools where they offered a potential benefit to their work.

During the inter-war years, the benefits of architectural models in communicating designs to either clients, committees, or the general public, were firmly established. So too was the importance of the professional modelmaker recognised in making such models, with their increased quality acknowledged as a contributory factor behind their success. An American article on the subject highlighted the ability of the architectural model to create 'a desire on the part of the client, who sees a beautiful creation without the exercise of imagination. He wants it. His mind is on the thing itself, not the cost' (Grumbine, 1925, p.59). The author further states that:

> Such a model should be made by an artist and a craftsman. The purpose of a model is to illustrate the architect's conception. It has a story to tell, and the more plainly, directly, simply and truthfully it tells this story, the better it is as a model. The modelmaker should be familiar with the fundamental principles of architectural design...so that he can interpret the architect's ideas with the minimum of effort and supervision. He bears a relationship to the architect similar to that between pianist and composer. He must be sufficiently familiar with the effects of architectural details as to be able truthfully to portray them (Grumbine, 1925, pp.60-61).

In Britain, William Harvey wrote in 1927 that he was 'firmly convinced that model-making is a necessary part of architectural design' (Harvey, 1927, p.vii), and that 'professional model-makers can be trusted to make faithful representations to scale in minute detail' (Harvey, 1927, p.26). In the United States, it was deemed prudent by the end of the 1930s that while architects were frequently making their own sketch models, 'it pays in this as in other important matters to go to a specialist, a professional modelmaker' (Murray, 1939, p.429). That there were such specialists in Britain, advertising and promoting their services, no doubt meant that architects found it much easier to commission models, with enough business to sustain a growing number of architectural modelmaking companies during the inter-war years, turning the fledgling profession into a small but recognised industry. As their success both drove and responded to demand, however, the eagerness of the first generation of professional architectural modelmakers began to push the architectural model to new levels of sophistication that, while ultimately unsustainable, demonstrated the extent to which the model had been transformed by the emergence of the profession dedicated to their making.

4.6. The Limits of Affordability

The profession of architectural modelmaking had matured during the inter-war years, with new architectural modelmakers, new machines and processes, and new demands for models due to both extensive house building and a general recognition of the benefits of professionally-made architectural models. The convergence of numerous developments, however – a strong demand for models by both architects convinced of their utility, and by planners using them for public display; the improved quality of models in the hands of dedicated professionals; and their ready availability from a growing number of modelmaking companies – was having a dramatic effect on the models that were being produced. Quite simply, they were getting larger, heavier, and more expensive. Even singular models of proposed buildings were becoming ever more sophisticated and costly, being made at larger scales than had been previously the norm (Figures 4.40 and 4.41). While clearly highlighting the significant advances that had taken place as a result of the professionalisation of architectural modelmaking, such models also indicate the rapidly increasing costs associated with making them, ultimately pushing the professionally-made architectural model to the limits of what architects and planners could afford.

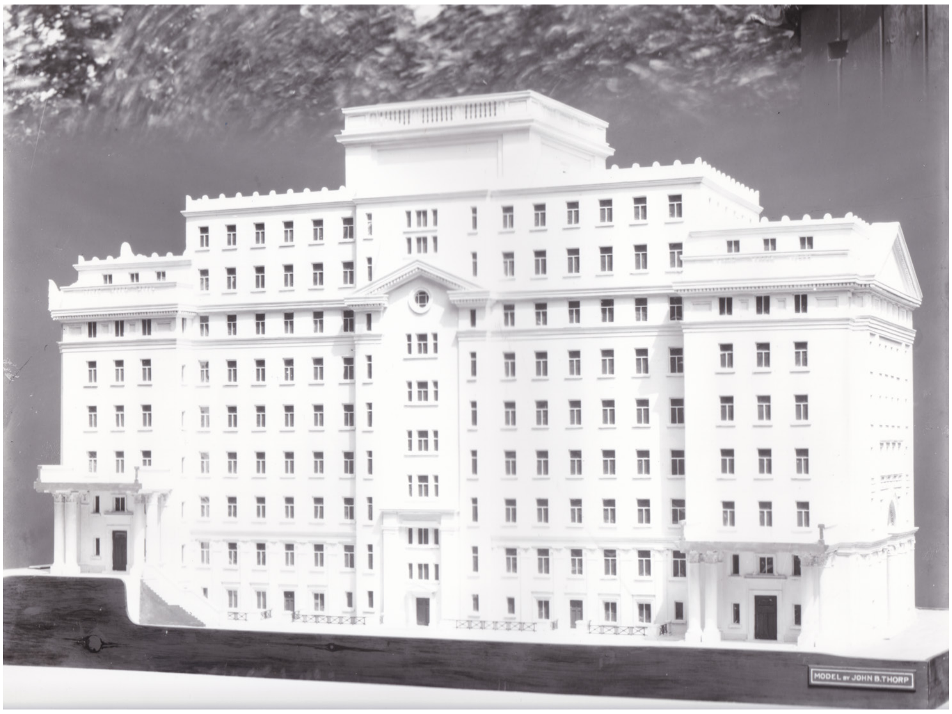


Figure 4.40: Bush House model made by Thorp, 1919.

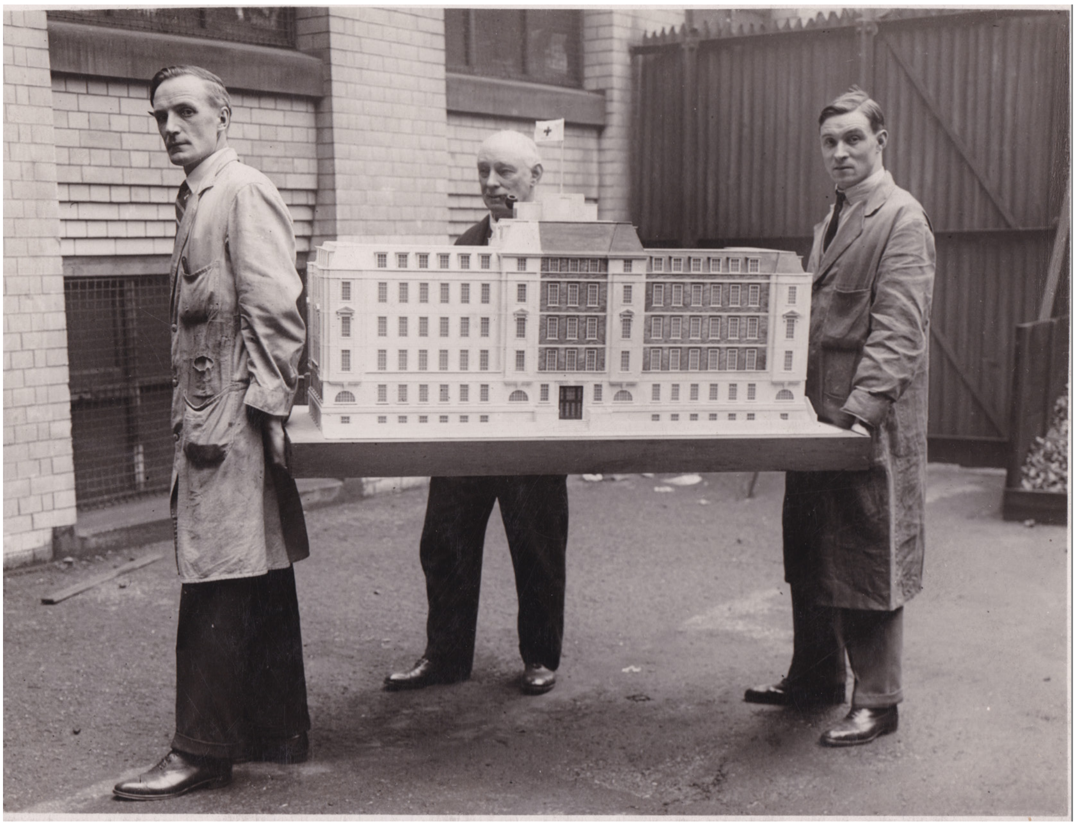


Figure 4.41: John Thorp (centre) with two modelmakers carrying a model for delivery, circa 1935

The popularity of highly-detailed planning models, often for public exhibition, further pushed both the size and complexity of architectural models towards new extremes; a trend that was inevitably accompanied by a commensurate increase in costs. In 1924, Thorp produced a model of Hull docks for display at the British Empire Exhibition in Wembley (Figure 4.42) that was over forty feet long and seven feet wide. The model included every dock, warehouse, crane, bridge, hedge, and tree (The Building News, 1924), and was only outdone at the exhibition by a similarly-sized model of Liverpool docks that included moving ships (Weaver, 1925, p.81). The same exhibition also contained many hundreds, if not thousands, of models of all types. Large and impressive models were the main attractions in many of the exhibits at Wembley, with the Port of London Authority's pavilion alone including an entire hall dedicated to models (Weaver, 1925, p.81). Several architectural and engineering models for the exhibition were built by Ernest Twining, with countless others being supplied by additional companies whose identities have since been lost, though no doubt providing significant work for the many general modelmakers who produced engineering models and scenic dioramas.

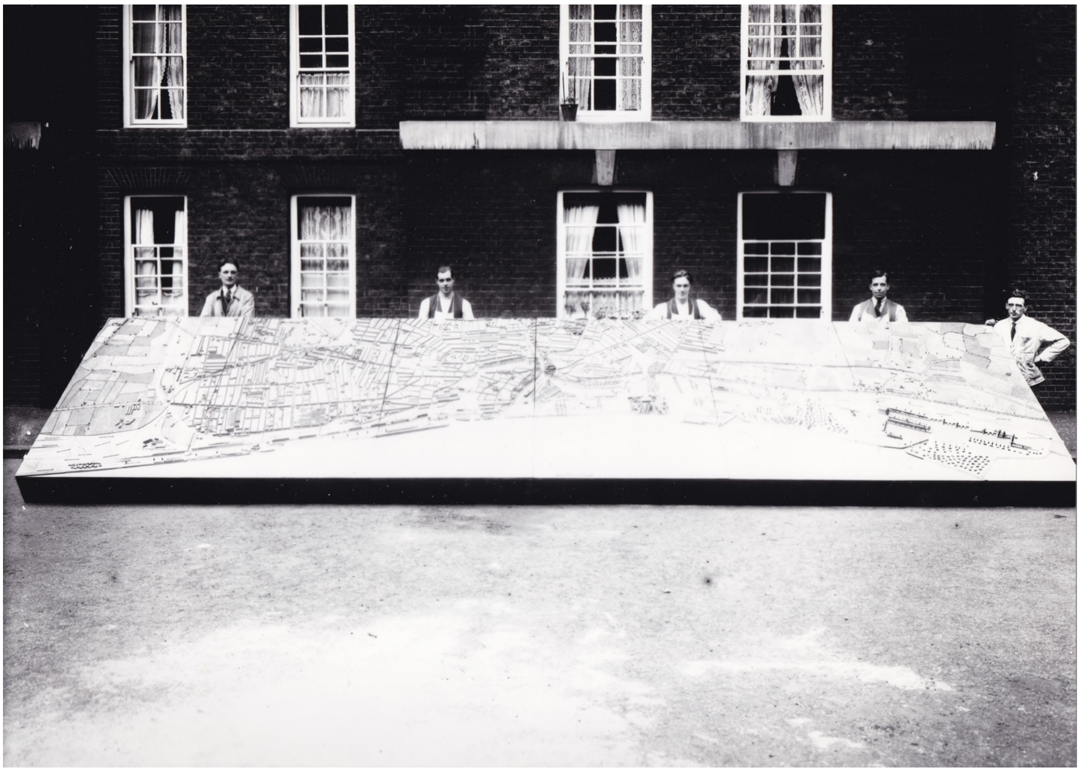


Figure 4.42: Model of Hull Docks made for the British Empire Exhibition by Thorp, 1924

In the same year as the Wembley exhibition, Ernest Twining's company also made a large and highly complex model for the National Cash Register Works of Dayton, Ohio, that was constructed almost entirely from sheet metal, with glass windows that gave visibility to the fully-electric internal lighting system that illuminated the model from below (Figure 4.43). The model was built with an open base that stood over ventilated troughs that contained low-wattage light bulbs (Buck, 2004, p.108). The use of lighting in this way was becoming common in larger models during the 1920s; Thorp having built a 1:24th scale model of the London Coliseum that included a five-stage lighting system that used two hundred and fifty twenty-watt lamps and fifty dimmers to operate a choreographed lighting sequence (Thorp Modelmakers, 1983, p.4).

As the size and complexity of such models increased, so too did their costs. A sectional model of a suburban house made by Thorp to demonstrate a hot water installation system cost the National Radiator Company £3,600 – over £200,000 today (Hobbs, 1926, p.109), while Thorp's most famous model, that of Edwin Lutyens' design for Liverpool Cathedral (Figure 4.44), occupied ten modelmakers for an entire year at the cost of £5,000

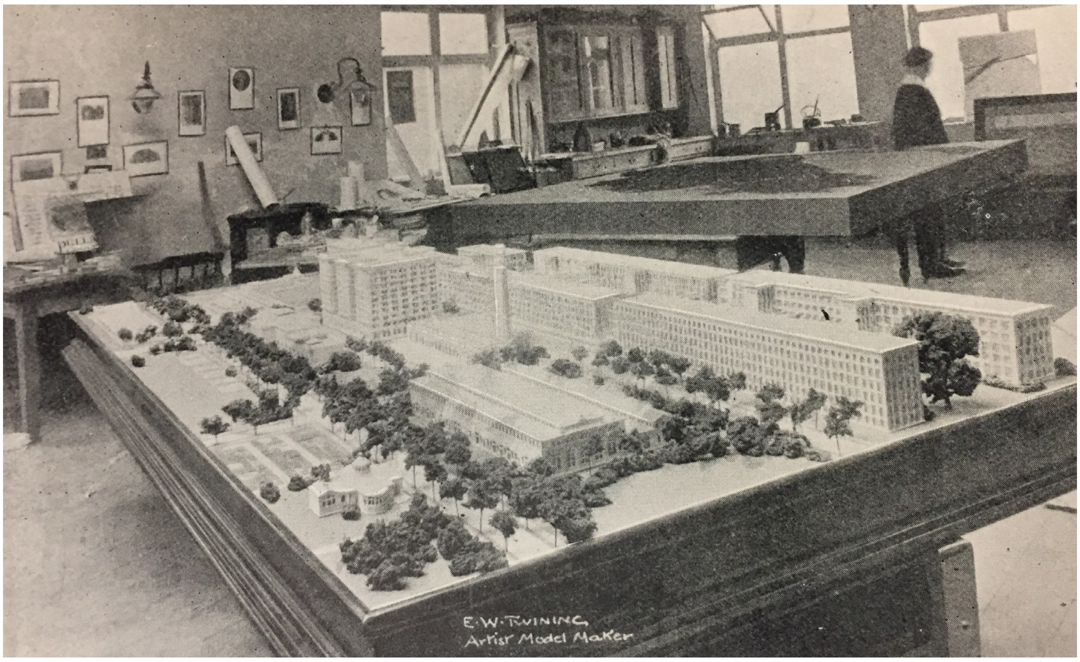


Figure 4.43: Model of the National Cash Register Works, made by Twining Models, circa 1924

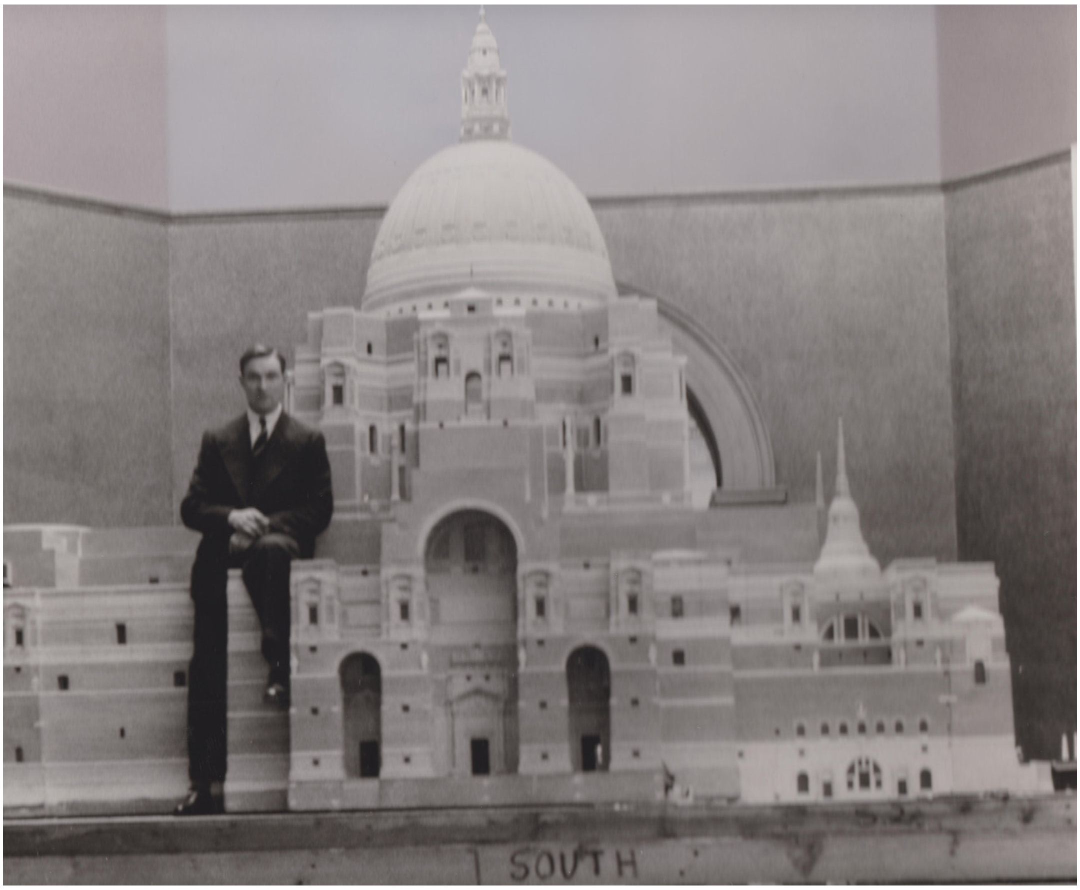


Figure 4.44: Leslie Thorp with the model of Liverpool Cathedral, 1933

– some £330,000 today (Thorp Modelmakers, 1983, p.5). Photographs of the model under construction (Figures 4.45 and 4.46) show the enormity of the project, and the change by 1933 to more advanced machinery with integral electric motors – the table saws possessing power cables rather than the belt drives still visible on the wood lathe. Models on the scale of the Liverpool Cathedral commission undoubtedly benefited from the increased availability of more advanced machine tools, and Thorp in particular appears to have invested heavily in new equipment as soon as it became available. Even by the 1930s, most machine tools were still being powered by belt drives from a common transfer shaft; the introduction of on-board electric motors at the turn of the century taking a considerable amount of time to be widely adopted. This was most likely due to the long lasting durability of existing machines, and the high cost of converting from belt drive to direct electrical power. A 1934 catalogue of machine tools lists two hundred and thirty eight machines for sale, of which only eleven contain electric motors; the vast majority still being belt driven (Lee & Hunt Ltd, 1934). That Thorp was using motor-driven equipment indicates he was able to invest in the very latest tools, with electric pistol-grip hand drills, radial arm table saws, and electric disk and belt sanders having been introduced in the 1920s. The use of electric motors also no doubt helped

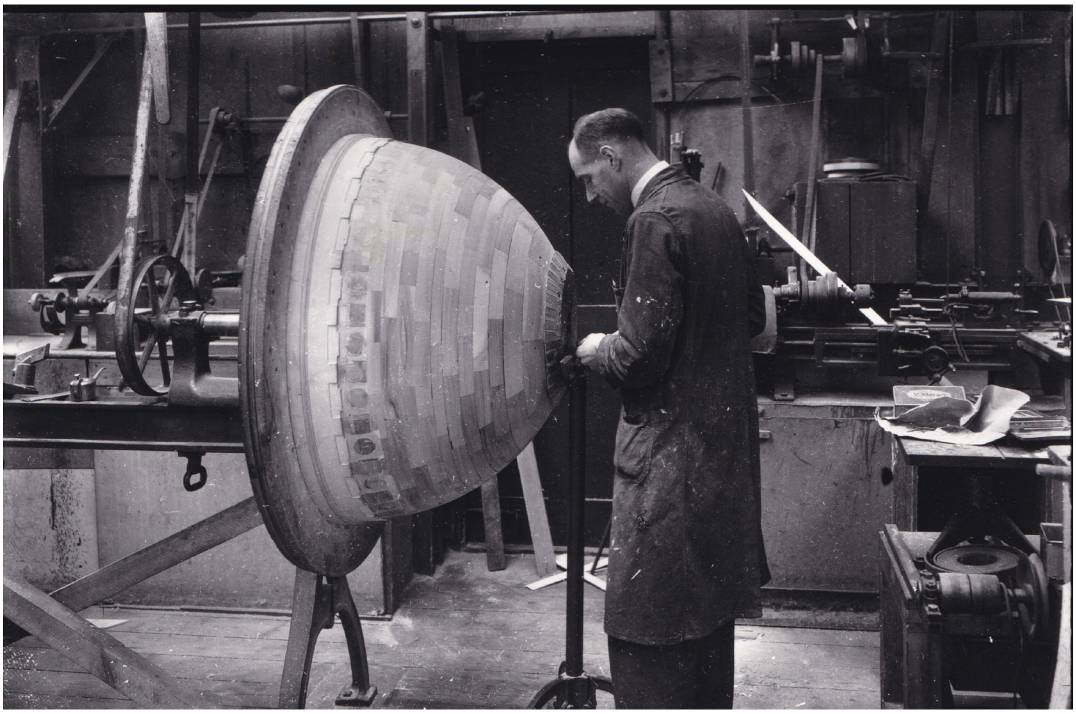


Figure 4.45: Construction of Lutyens' Liverpool Cathedral model by a modelmaker (possibly Leslie Thorp) at Thorp, 1933

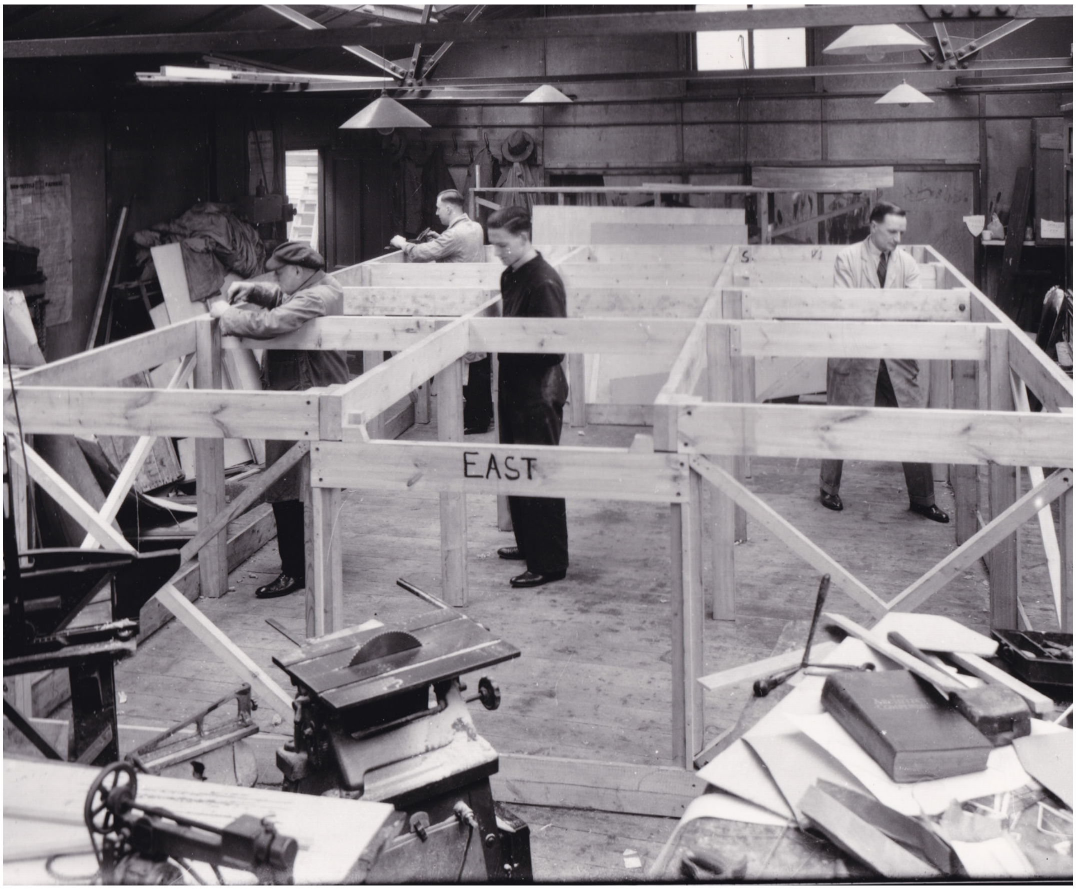


Figure 4.46: Liverpool Cathedral model base under construction, Thorp 1933

lower the cost of entry for other modelmakers such as Twining, Partridge, and McCutchon, who no longer had to equip their workshops with complex systems of power transfer shafts; the electric motor helping to disperse industrial machines away from large factories and into the small-scale workshops that suited the architectural modelmaker.

Two models in particular summarise the extreme size and complexity that architectural models had reached by the 1930s. Thorp's model of Lutyens' scheme for a new Charing Cross bridge and surrounding buildings, commissioned by the Ministry of Transport and the London County Council, is one of the most complex models John Thorp ever made. A 1929 photograph shows John and his son Leslie working on the model's construction (Figure 4.47), with Thorp's standard method for small scale models of using timber block shapes with card facades applied clearly visible, as is the detailed hand-drawn plan of every building they had to represent. The completed model contains hundreds of individual buildings, all painstakingly painted and detailed (Figure 4.48 and 4.49). The combined weight of this

Figure 4.47: John Thorp and son Leslie working on the construction of the Charing Cross Bridge model, 1929

Figure 4.48: Charing Cross Bridge model made by Thorp, 1930

Figure 4.49: Detail of the Charing Cross Bridge model made by Thorp, 1930

twelve feet square model must have been considerable given the amount of timber used, as no doubt would have been the cost.

Ernest Twining's largest and most dramatic model was a 1934 diorama of Bournemouth that was displayed in Waterloo station for several years (Figure 4.50). Encompassing the entire town, the model included over four thousand individual buildings, each with an average of ten windows that allowed interior lighting to shine through. Two thousand vehicles were added to the model, along with location-appropriate trees and shrubs. Twining cleverly designed the model to include an element of forced perspective – the scale shrinking from 1:550 at the front of the model to a much smaller scale at the rear, where it merged with a highly detailed painted backdrop. A timed lighting sequence lit the entire model with white for daylight, orange for mornings and evenings, and a blue hue for moonlight (Buck, 2004, pp.108-109).

Although the cost of the Bournemouth model is unknown, Twining's method of estimating his prices was based on a standard charge-out rate per hour that included all overheads, expenses, plus a small profit margin, for each man hour the model required. To this was

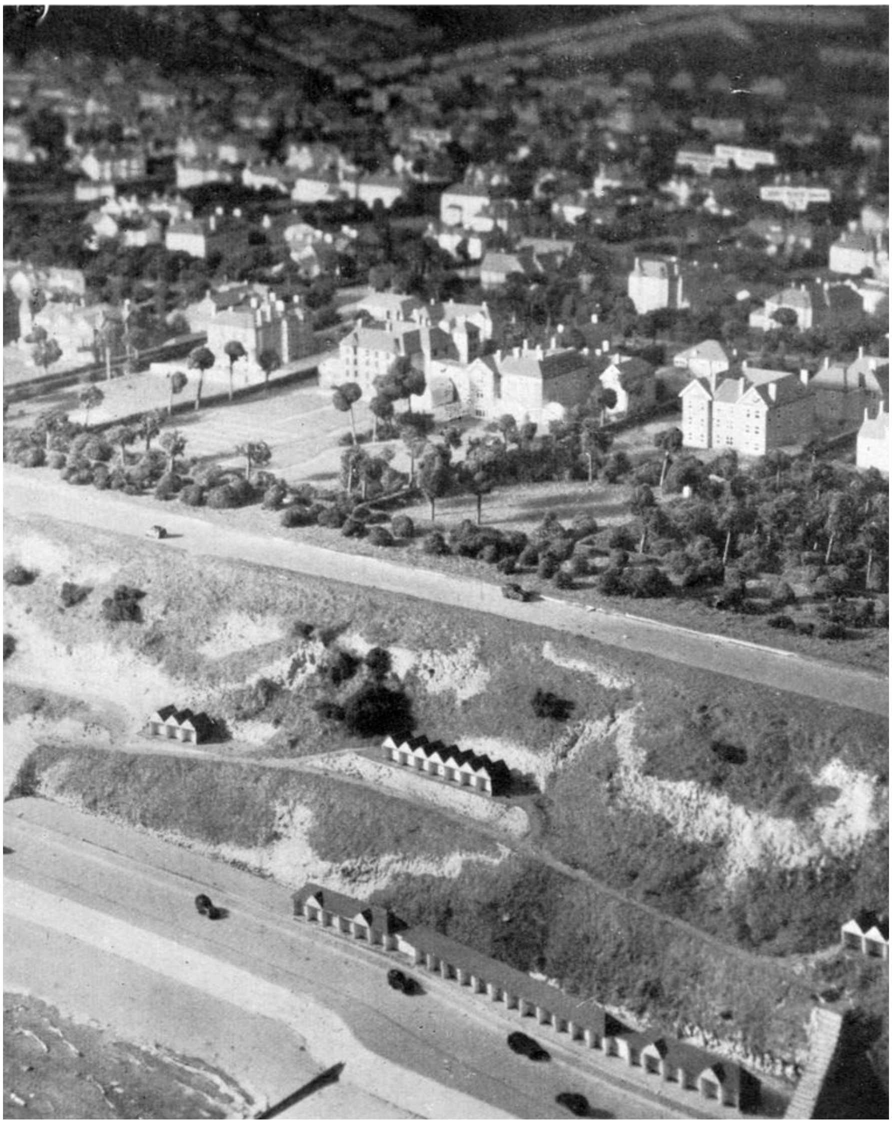


Figure 4.50: Model of Bournemouth made by Twining Models, 1934

added the actual cost of materials, and for models sold through Bassett-Lowke, an additional thirty three percent was charged for their own costs and profits – which no doubt did much to contribute towards price inflation (Buck, 2004, p.103). Clients were evidently accepting these costs however, and a strong desire for elements of showmanship and spectacle appears to have been behind the increased commissioning of larger and more complex models. Just as Thorp's Old London models had shown before the First World War, the public were deeply attracted to large, well-presented models, and displaying one to promote a proposed scheme was one sure way to gain attention.

Models such as these were, however, reaching the limits of affordability. Thorp's 1913 claim that a good model cost no more than two perspective drawings (Thorp, 1913, p.16) had been continually repeated (Grumbine, 1925, p.61; McCutchon, 1936, p.461), as was the idea that models ought to cost no more than one percent of the total cost of a building (The Building News, 1924). Nevertheless, a perception was developing that architectural models were both costly and difficult to make, with rising costs and high demand pushing up prices (Collins, 1915, p.261; Moon, 2005, p.43; p.146). In a 1936 article, modelmaker Kenneth McCutchon attempted to counter this opinion by stressing that 'models are not so costly as is generally supposed', noting that the price of a model was ultimately determined by the requirements of the client in terms of quality and finish, before outlining a range of ways in which models could be specified that would allow them to be made at a lower cost (McCutchon, 1936, p.460). As well as increasingly being viewed as expensive, the weight of models was also becoming a problem, and this was largely down to the use of timber – if not for the buildings themselves, but for the base, which had to be strong enough to support the model and survive transport, which could sometimes include travel abroad. A large timber model was therefore extremely heavy, time consuming, and expensive to build and deliver; while card, despite being cheaper, lighter, and quicker to work with, was much more susceptible to the effects of wear and humidity, and not sufficiently strong enough to be used without internal timber supports (Moon, 2005, p.161). Throughout the late-1920s and 1930s, there was a growing awareness that the standard materials of card and timber were potentially no longer the most suitable choices as models began to grow to such extremes of size and complexity.

With this problem in mind, throughout the inter-war years modelmakers continued to employ the curiosity and inquisitiveness towards materials that had quickly become the defining quality of the profession, and were keenly exploring potential alternatives. In 1926 Edward Hobbs described the 'considerable skill and manipulative dexterity coupled with originality of thought [that] is required in the construction of these elaborate models' (Hobbs, 1926, p.10), adding that 'many different materials are pressed into service and in some cases in a most unlikely manner, yet with pleasing and satisfactory results' (Hobbs, 1926, p.10). One American commentator wrote that 'The practitioners of the art of model making are almost invariably good resourceful craftsmen and the ingenuity which they show in finding and adapting accessory materials for various details is amazing' (Reid, 1939, p.407).

As a result, modelmakers were constantly open to exploring the potential of new substances, especially if they were either lighter or cheaper. This exploration of new materials is particularly evidenced by the publication of Edward Hobbs' 1932 book *Modern Handicraft Materials and Methods*, which acknowledged that 'one of the most interesting developments of chemical science during recent years has been the production of many new materials adapted to the requirements of the amateur worker, the craftsman and the creative artist' (Hobbs, 1932, p.1). The focus of the book was on 'synthetic materials' (Hobbs, 1932, p.1), with the aim of explaining the characteristics of these new materials and the best ways of working with them. These materials were, of course, the early plastics, and Hobbs described the properties and potential applications of, among others, Nacrolaque, an artificial timber inlay; Cristalux and Celastoid, translucent acetate sheets; and Bakelite (phenol formaldehyde), the first fully synthetic plastic. Lactoid (casein) had also become available in both sheet and rod form, making it suitable for carving into small details such as model furniture (Bayley, 1938, p.9), but none of these materials presented themselves as viable alternatives to card and timber for the bulk of architectural model construction. While these new materials failed to offer much promise to architectural modelmakers, Hobbs' book suggests there was a growing sense that the ongoing development of new plastics might potentially be of use to them, particularly as lightweight replacements for heavy glass, which was still often being used in models that featured internal lighting. As has already been noted, celluloid had been used as a glazing material by Thorp as early as 1905, however its rapid discolouration rendered it unsuitable for permanent use (Harvey, 1927, p.116). Its high flammability also ruled out its use where buildings were to be lit.

In 1938, however, just two years after its commercial introduction, Thomas Bayley commented in *The Craft of Model Making* on the suitability of a brand new transparent material, Perspex, for use in models as a lightweight glazing material (Bayley, 1938, p.9). Listing Perspex alongside both clay and plaster as 'plastics' – the broadest use of the term in reference to their general plasticity – Bayley hints that the 'new materials also known as plastics [might be] very useful to the model maker' (Bayley, 1938, p.7). Quite how revolutionary Perspex was going to be to the professional modelmaker would not be realised until after the Second World War (see Chapter Five), and while its benefits as a glazing material were immediately recognised, it is uncertain how widely acknowledged it was at the time that plastics might offer a potential solution to the growing problem of weight and cost that the success of the professional modelmaker had effectively created.

With the outbreak of war in 1939, the spectacular growth in both the size and cost of architectural models during the inter-war years was abruptly halted, potentially rescuing the model from its own success. By the end of the decade, however, the architectural model was clearly demonstrating the benefits of the dramatic transformation that the emergence of the profession had brought about, and the role of the professional architectural modelmaker, using the template of adaptability that John Thorp established, had become firmly assured.

In the same year, at the age of seventy seven and still making models, John Thorp died. He had just begun to oversee a major extension of his premises at 98 Gray's Inn Road, adding an additional ten thousand square feet of workshop space, which was finally completed after the Second World War (Thorp Modelmakers, 1983, p.6). John's son Leslie, who had been working alongside his father for many years, took over the business and the company continued. A few months later, Ernest Twining sold his interest in Twining Models to Harry Clifton, who carried on making architectural models until 1967. Partridge's Models and McCutchon Studio also continued, but with the loss of both John Thorp and Ernest Twining from the industry, the first generation of professional modelmakers had effectively handed control over to the next.

By the outbreak of the Second World War, the profession of architectural modelmaking was barely fifty years old, and yet its emergence had already substantially altered what an architectural model could be. Models were now vastly more sophisticated, realistic, and, as their greatly increased use suggests, more successful in communicating architectural designs to clients and the general public. Gone were the material silos of the previous centuries, and in their place was a specialist role that through adopting a much broader, open, and adaptable approach to the choice of materials was now tightly focused on the needs of the model without being restricted by the choice of materials available to any one specific pre-existing trade. By bringing together previously separate processes and materials into one defined activity, architectural modelmaking had become specialised in terms of its output, but generalised in its approach to making them. Architect Price Nunn remarked in 1942 that 'it is now possible to select for any kind of model the right material with the most appropriate finish', commenting on the benefits of the wide variety of materials then available for modelmaking (Nunn, 1942, p.554).

Written in the same month as John Thorp's death in 1939, Robert Hoyt's description of modelmaking as a process of 'ingenious adaptation', from which this thesis takes its title, astutely captured the fundamental approach that had become firmly engrained in the profession on both sides of the Atlantic (the emigration of British architectural modelmakers seemingly being instrumental in establishing the profession in the United States – see evidence in Audsley, 1914; Covell, 1914; Murray, 1939); with modelmaker Thomas Hendrick writing in 1952 that 'improvisation is one of the greatest achievements of the [modelmaker], and in the stores of model establishments may be found the most unexpected materials' (Hendrick, 1952, p.19). Echoing Hoyt's phrase, Hendrick further described how alongside improvisation, versatility and 'flexibility of imagination' were the key attributes of the professional modelmaker (Hendrick, 1952, p.26). 'We may therefore sum up...by stating that in a well-staffed model workshop each craftsman is a jack-of-all-trades but master of at least one' (Hendrick, 1952, pp.26-27). As later chapters will reveal, the notion of 'ingenious adaptation' that Hoyt described can today be understood as emerging from the combined agency of the modelmaker's imaginative and ingenious intentions and the intrinsic adaptability of the materials, tools, and processes employed. In 1939, however, Hoyt was discussing adaptability as an integral approach that any successful modelmaker needed to adopt, and it was through the career of John Thorp and the other professional modelmakers who followed him that the adaptable intention of the modelmaker was established. As Hoyt further wrote, it was the 'quest for new methods, tools and materials that makes modelmaking [an] interesting occupation' (Hoyt, 1939, p.420), and the 'interesting occupation' Hoyt observed stood in utter contrast to the working approaches of earlier modelmakers such as Richard Day, Thomas Dighton, and especially Adrian Gaunt, who made the first known architectural model in Britain in 1567. Despite having reached the limits of affordability by the late-1930s, through the efforts of John Thorp, the professionally-made architectural model in Britain, and the profession itself, had well and truly emerged.

4.7. Conclusion

This chapter set out to understand the origins and early development of the profession of architectural modelmaking in Britain. In drawing from a detailed analysis of archival documents and photographs, it has traced the interactions between the people, processes, materials, and ideas from which the modern profession emerged, revealing how the making of architectural models developed from being an activity carried out within various individual craft trades and into the dedicated profession that exists today. In doing so, this chapter has located the formation of the profession to a period defined by the working career of John Thorp from 1883 to 1939, traced the historical influence of materials that contributed to the circumstances of the profession's emergence, and examined the initial consequences of the professionalisation of architectural modelmaking on the quality and complexity of the architectural model during the first decades of the twentieth century.

Chapter 4.2 outlined how prior to the establishment of a dedicated profession, the construction of architectural models in Britain had largely taken place within strictly differentiated craft trades associated to building construction that were restricted to the use of single materials or processes. For a specific profession dedicated to architectural modelmaking to exist, the rigid division of materials and processes within these trades that were the legacy of the medieval craft guilds posed a considerable barrier that even the changes to labour structures wrought by the industrial revolution failed to break down due to the continued specialisation that those trades required. As described in Chapter 4.3, however, it was the material influence of card during the nineteenth century that ultimately enabled a change to who was making architectural models, with architectural modelmaking expanding away from the workshops of stonemasons and carpenters and into the drawing offices of architects themselves. Effectively freed from any particular trade, architectural models greatly benefited from the use of multiple materials in their construction, becoming more realistic and, to a certain extent, easier to make (see page 83). With models having increasingly become a central part of architectural practice by the end of the nineteenth century, the circumstances in which a specific profession dedicated to architectural model construction could exist had been established, and through the embryonic careers of modelmakers such as Richard Day and C.N. Thwaite (pages 77 and 84), architectural modelmaking began to distinguish itself as a pursuit in its own right.

With the adoption of card as a modelmaking material having broken the hold of the building trades over the making of architectural models, the circumstances were established for the new mixed-media approach to architectural modelmaking to be consolidated into a dedicated occupation, and seizing this opportunity, John Thorp then became the first professional architectural modelmaker in Britain in the modern sense during the 1880s (see pages 89-99). As Chapter 4.4 revealed, Thorp adopted a much more open and adaptable relationship towards materials and processes than had been possible by the craftsmen who had made architectural models in the centuries that preceded them. In abandoning the specific-material-based approaches of earlier modelmakers working within the building trades, Thorp was free to employ any and all materials that were suited to the demands of a particular model (see page 92). Introducing standardised methods of model construction, primarily using a combination of timber and card, Thorp employed an appreciation of architectural design rather than of building construction, and established a constant striving for improved realism and spectacle (see page 97). At the same time embracing a strong business ethic and a striving for efficiency and innovation, Thorp developed architectural modelmaking into specialised activity that employed a generalised approach, demonstrating an inquisitiveness towards new materials and equipment that might aid the making of specific models.

Recognising Thorp's success, other professional modelmakers such as Ernest Twining and John Partridge who began working in the decades that followed adopted the same approach (Chapter 4.5), and during the inter-war years the profession grew steadily in confidence and size. The immediate consequences of this were rapidly apparent, as benefiting from the attention of professionals solely dedicated to its making, the architectural model underwent a period of intensive development that brought about dramatic increases in its quality, realism, and technical sophistication that cemented its position as a principal means of communicating architectural designs; securing the future of the fledgling industry, and enshrining the template John Thorp had established as the fundamental approach of the profession. As Chapter 4.6 described, the success of this first generation of professional architectural modelmakers during the inter-war years began to push the architectural model to new levels of sophistication, demonstrating the dramatic extents to which the model had been transformed by the emergence of the profession dedicated to their making. At the same time, however, the model's increased advancement ultimately drove the model to the limits of affordability as its size and complexity increased. A growing perception that models had become too expensive then led to an early interest in new potentially lighter and cheaper synthetic materials, bringing plastics to the modelmaker's attention shortly before the outbreak of the Second World War.

As the pioneers of both their rapidly expanding industry and the new open relationship with materials that John Thorp had established, the first generation of professional modelmakers had effectively been exploring new territory, and through their inquisitive and adaptable nature, were testing their own limits as much as those of the model's potential. The combined use of various materials had shown them how realistic their models could become. Electricity and lighting had allowed them to introduce elements of motion and spectacle into architectural models, while new power tools and improved workshop machinery had enabled ever higher precision and accuracy in their work. The model's full potential had been unlocked; as had the remarkable ability of the professional modelmaker to put to good use a wide range of materials and processes in achieving a dramatic increase in the quality and realism of architectural models. By 1939, Robert Hoyt's observation of the 'ingenious adaptation' so central to architectural modelmaking (Hoyt, 1939, p.420) described the fundamental approach of a newly-emerged and confident profession.

Through its examination of the origins of professional architectural modelmaking in Britain, this chapter has revealed not only how the dedicated profession first emerged through the career of John Thorp, but has also highlighted the role of materials in the making of architectural models shifting from being an activity carried out within various individual craft trades and into the dedicated 'interesting occupation' Hoyt described. Without the liberating consequences of card shifting the making of architectural models away from the siloed building trades, the circumstances for Thorp to establish himself were unlikely to have occurred. In providing the space for mixed-media models to be adopted, and for the making of models to move into the offices of architects themselves, card enabled the making of architectural models to become a specialism in its own right, rather than as an extension of existing craft practices.

With the tentative exploration of plastics shortly before the outbreak of the Second World War, the influence of materials, and the far-reaching consequences of the professionalisation of architectural modelmaking that had already manifested themselves by the end of the 1930s continued to unfold during the post-war era, where the convergence of an expanding profession; an unprecedented demand for models to communicate re-building and modernisation projects in the new modernist style of architecture; and the widespread adoption of Perspex as a modelmaking material propelled the model to new levels of quality, complexity, and realism. As the following chapter reveals, the post-war boom in architectural modelmaking era brought about a plastics revolution, and it is during this period that the ingenious and adaptable intensions of the modelmaker were matched with the intrinsic adaptability of plastics.

5: The Post-War Boom and the Plastics Revolution: Establishing the Materials of the 'Modern Architectural Model', 1945-1963

Figure 5.0: Model of Magnet House, made by Nick Quine/AMI, 1963

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5.1. Introduction

In 1957, modelmaker Thomas Hendrick's comprehensive practical guide to architectural modelmaking, *The Modern Architectural Model*, was published by the Architectural Press in London. The title Hendrick chose for his book neatly encapsulated the scale of the radical changes in architectural modelmaking that were taking place at the time; not only referring to modern approaches to making architectural models, but also the fact that they were models of modern architecture. Compared to the heavy timber and card models of the inter-war years featured in the previous chapter, the post-war 'modern' architectural model that Hendrick described was above all notable for one significant difference: the use of plastics. The widespread adoption of these synthetic materials by architectural modelmakers during the post-war era had enabled new lightweight construction methods, higher levels of technical precision, and perhaps most importantly, an increased sense of realism through finer detail, better paint finishes, and properly transparent windows. In discussing the impact of plastics on architectural modelmaking, Hendrick wrote that 'the use of these materials has done more to facilitate the methods of construction and to improve the finish of architectural models than any other substance or method' (Hendrick, 1957, p.34). Just a few years later, the work of Nick Quine, who in 1959 embarked on what was to be a fifty-four year career as an architectural modelmaker in London, demonstrated just how accurate Hendrick's statement had been. Quine's 1963 model of the proposed Centre Point development (Figure 5.1), made almost exclusively from either Perspex sheet or injection-moulded plastic parts from his own metal tooling (MacKay, 2018), illustrates how significantly the introduction of plastics had altered the professionally-made architectural model in Britain during the post-war era.

With Chapter Four having traced the emergence and initial development of the profession of architectural modelmaking in Britain up until the outbreak of the Second World War, this chapter examines the circumstances of the professionally-made architectural model's

Figure 5.1: Model of Centre Point, made by Nick Quine/AMI, 1963

post-war development and traces the origins of the plastics revolution that followed the widespread adoption of Perspex during the 1950s. In further embracing Anna Fariello's call for a 'front-end' consideration of objects (Fariello, 2005, p.4) and considering the material influences on the development of the model throughout its history, this chapter traces the convergence of a number of material, ideological, and human elements that resulted in a period of rapid change for the professionally-made architectural model in Britain, with the introduction of new materials, an influx of highly trained ex-RAF modelmakers into the profession shortly after the Second World War, an intensive demand for models during the post-war rebuilding efforts, and the challenge of representing new modernist architectural styles generating an unprecedented architectural modelmaking boom.

Defining the post-war boom in Britain as a period that extends from the end of the Second World War until Quine's era-defining all-plastics construction of the Centre Point model in 1963, this chapter draws from new analyses of publically-available archival documents and photographs from contemporary architectural journals, practical publications on the making of architectural models, and the archival collections of the Imperial War Museum, the Medmenham Association, the London County Council, the Festival of Britain records held by the National Archives, and the previously undocumented archives of Thorp Modelmakers and Architectural Modelmakers International (AMI). Interviews with Thorp modelmaker Alec Saunders, AMI owner David MacKay, and former Second World War V-Section modelmaker Alan East additionally provided important insights into the complex unfolding of events that characterise the post-war boom as a crucial era in which the level of realism that could be reached in an architectural model took a dramatic leap forward – a development that would later have significant ramifications for the broadening of the model's visual palette during the 1980s, as Chapter Six addresses.

In tracing the origins of the post-war boom and the plastics revolution that followed there is by necessity some discussion of earlier events leading up to this period, notably the first uses of Perspex by architectural modelmakers shortly before the outbreak of the Second World War, where its potentially revolutionary consequences for model construction were almost immediately identified upon its commercial introduction in 1936. Consequently, there is some initial historical overlap with the period covered by the previous chapter. The chapter then charts the influx of a significant number of highly-skilled ex-RAF modelmakers into the profession after the end of the war who had been trained to make exceptionally accurate and highly realistic landscape models at the top secret V-Section modelmaking section at RAF Medmenham, before examining the enormous demand for planning models during the rebuilding and modernisation of Britain in the late-1940s and early-1950s. These models provided ideal work for the ex-military modelmakers, where they brought about significant improvements to their levels of realism.

The chapter then discusses how the high standards of realism that developed during the initial post-war period began to pose a challenge due to the adoption of modernist architecture, with the development of entirely new forms of building such as high-rise tower blocks that made extensive use of glass, steel, and concrete driving the need for new approaches to architectural modelmaking that Perspex fulfilled. The revolutionary consequences of the widespread adoption of Perspex in architectural modelmaking are then outlined, with entirely new construction approaches bringing about radical shifts in precision, detail, and realism.

Finally, building upon Chapter Four's discussion of Robert Hoyt's description of 'ingenious adaptation' as central to successful architectural modelmaking, this chapter concludes by outlining how the introduction of plastics to modelmaking as a result of the post-war boom enabled an expansion of the notion of adaptability in architectural modelmaking to encompass more than just the modelmaker's ingenious and adaptable intentions, with the intrinsically adaptable properties of Perspex itself playing a major role in shaping the development of the professionally-made architectural model in Britain during this period.

5.2: The Potential of Perspex

Although the widespread adoption of Perspex (polymethyl methacrylate) as the principal material used in architectural modelmaking occurred during the post-war modelmaking boom, its first uses by architectural modelmakers can be traced to the late-1930s, where it was immediately apparent that Perspex offered a revolutionary new way of approaching the construction of architectural models. As the previous chapter has outlined, plastics in general had already come to the architectural modelmaker's attention as early as 1905 with John Thorp's use of celluloid (cellulose nitrate) sheet as a glazing material. Extremely flammable, the use of celluloid remained limited, and few of the other 'synthetic materials' described by Edward Hobbs in his 1932 book *Modern Handicraft Materials and Methods* proved to be of much use to architectural modelmakers at the time (see Chapter Four). Upon its commercial introduction in 1936, however, the adaptable nature and transparency of Perspex seemed ideally suited to the modelmaker's needs, and while the diversion of all Perspex production to military purposes during wartime meant its full potential within architectural modelmaking would not be realised until the late-1940s, the early pre-war explorations of its use hinted at its transformative role during the post-war boom and beyond.

In 1938, the same year that Thomas Bayley first wrote about the potential of Perspex as a glazing material for architectural models (see Chapter Four), twenty-eight year old Kenneth McCutchon, early in what was to be a remarkably successful career as an architectural modelmaker, made a pair of models that were completely different from anything else being made at the time: they were constructed almost entirely from Perspex. The January 13th edition of the *Architects' Journal* ran an article on a *News Chronicle* competition for new designs of schools, with the two winning entries, one for an urban location designed by Denis Clarke Hall, and one for a rural location designed by the firm of Durell, Penn and Walter, illustrated by McCutchon's models. The roofless model of Hall's design (Figure 5.2) in particular shows that all the walls were constructed from thin sheets of Perspex with paint applied directly to their surfaces, areas masked off to leave the windows clear; an effect that is especially apparent in the photograph of the long facade of the rural school model (Figure 5.3).

McCutchon's use of Perspex in this manner was nothing short of revolutionary, and was a method of model construction would not become commonplace for at least another fifteen years. While McCutchon was exploring the potential of all-Perspex models, Thorp, Twining, and Partridge's continued to employ the by then well-established approach of using timber and card as the main modelmaking materials. Whether McCutchon chose what was then an

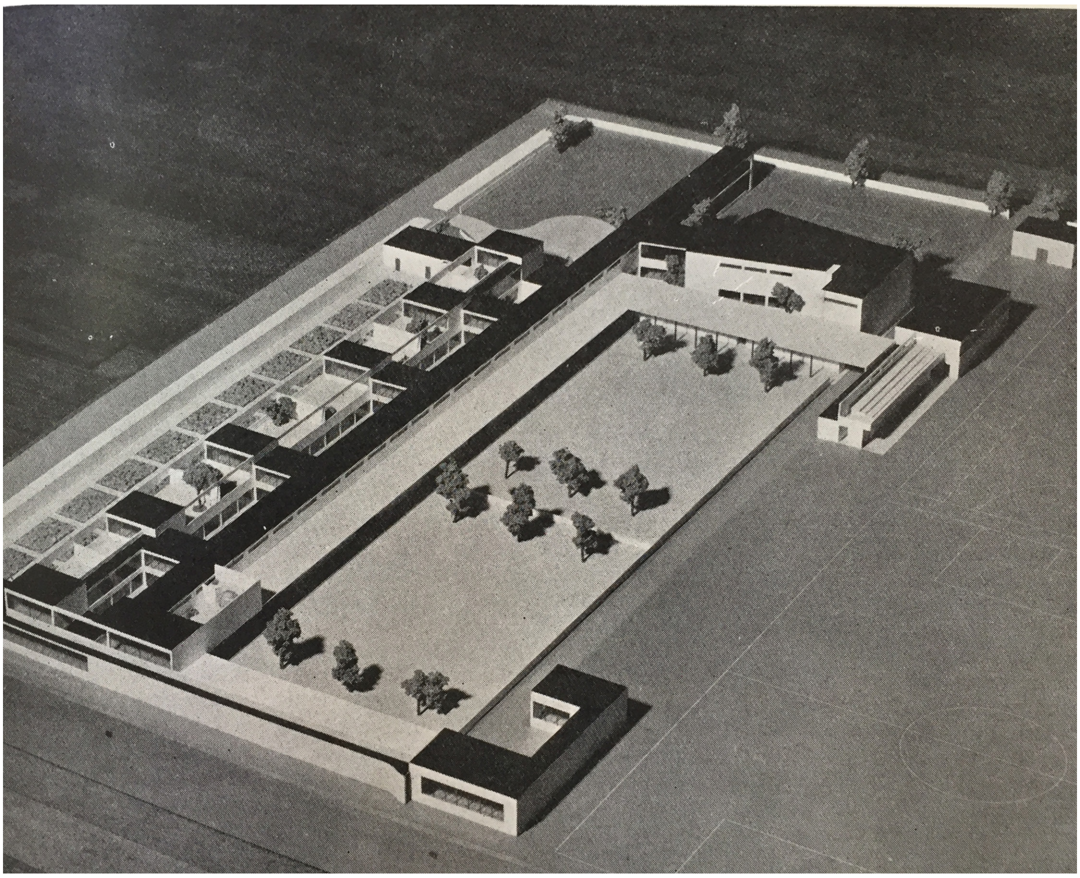

Figure 5.2: Roofless Perspex model of a proposed school, made by Kenneth McCutchon, 1938

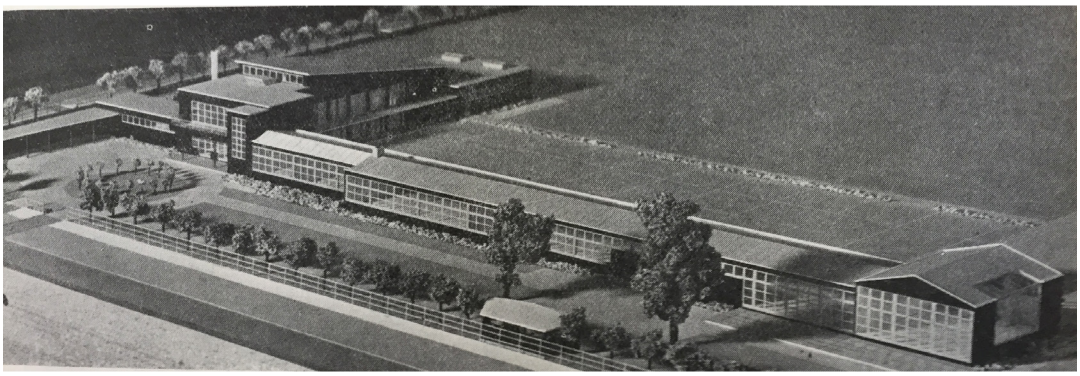

Figure 5.3: Perspex model of a proposed school, made by Kenneth McCutchon, 1938

entirely novel material in order meet the requirements of the model, or whether the properties of the material dictated the model's design remains unknown, however McCutchon had evidently realised that Perspex's transparency and its ease of working would allow for a very different approach to making architectural models. The extensive amount of glazing in both the schools would have been particularly difficult to achieve on such a small scale using existing materials, especially given the necessity to model the interior of Denis Clarke Hall's design. With the lack of a suitable alternative to glass, most architectural models at the time were either solid constructions or hollow facades with opaque representations of windows. Where glazing was included on a model, this was usually to allow internal lighting to shine through rather than to give visibility to their interiors; internal floors and wall divisions normally being omitted unless specifically called-for in a sectional or cut-through model. The crispness of the construction of McCutchon's roofless model would have been almost impossible to achieve using the standard methods and materials of the day. Using sheets of card or thin strips of timber for the walls, window apertures would have had to have been cut out, with squares of either mica or celluloid inserted into the corresponding gaps. Given the small scale of the model, and the lack of anywhere to hide any joints between overlapping surfaces when viewed from above, this would have been an extremely challenging exercise. McCutchon's apparent realisation was that he could make the entire model from the same material – sheets of transparent Perspex – and then paint on the wall surfaces where appropriate, leaving the windows clear; a much cleaner and more effective way of representing such a large expanse of glazing. This approach was a considerable shift from how models had previously been constructed, enabled by the physical properties of this new synthetic material, and McCutchon's models were a tantalising hint of what was to come – both in terms of model construction and the style of architecture that models would have to represent in the post-war era.

Although the previous chapter briefly described the tentative explorations of new synthetic materials during the inter-war years as potential solutions to the growing problems of the weight and cost of architectural models, the precise circumstances by which Perspex came to the attention of architectural modelmakers may never be specifically identified. Who first used it, and how they had become aware of its existence currently remains unknown, however two years before McCutchon’s models and Bayley’s mention of the material in his 1938 book on modelmaking, a model made for the architect Alan Marlow of the proposed Gatwick Airport terminal building (Figure 5.4) made use of Perspex for both the curved glazing of the building and for the propeller disks of the aircraft to give the impression of motion, demonstrating just how rapidly Perspex was applied to architectural modelmaking within months of its commercial introduction in 1936 (ICI, 1984, p.12).

Initially developed as the result of a demand for a laminated interlayer for safety glass that could replace the badly-yellowing cellulose nitrate, polymethyl methacrylate was first developed by the British chemicals company ICI in 1931 (ICI, 1984, p.6). Having trademarked the material as ‘Perspex’, it was almost simultaneously developed quite independently by Rohm and Hass in Germany, who named their material ‘Plexiglass’, while later in the same decade the American firm DuPont followed with their own formulation of the polymer that they named ‘Lucite’. Perspex (as with all the other trademarked polymethyl methacrylates) is a rigid and transparent plastic that is more optically clear than glass (Brydson, 1995, p.391),

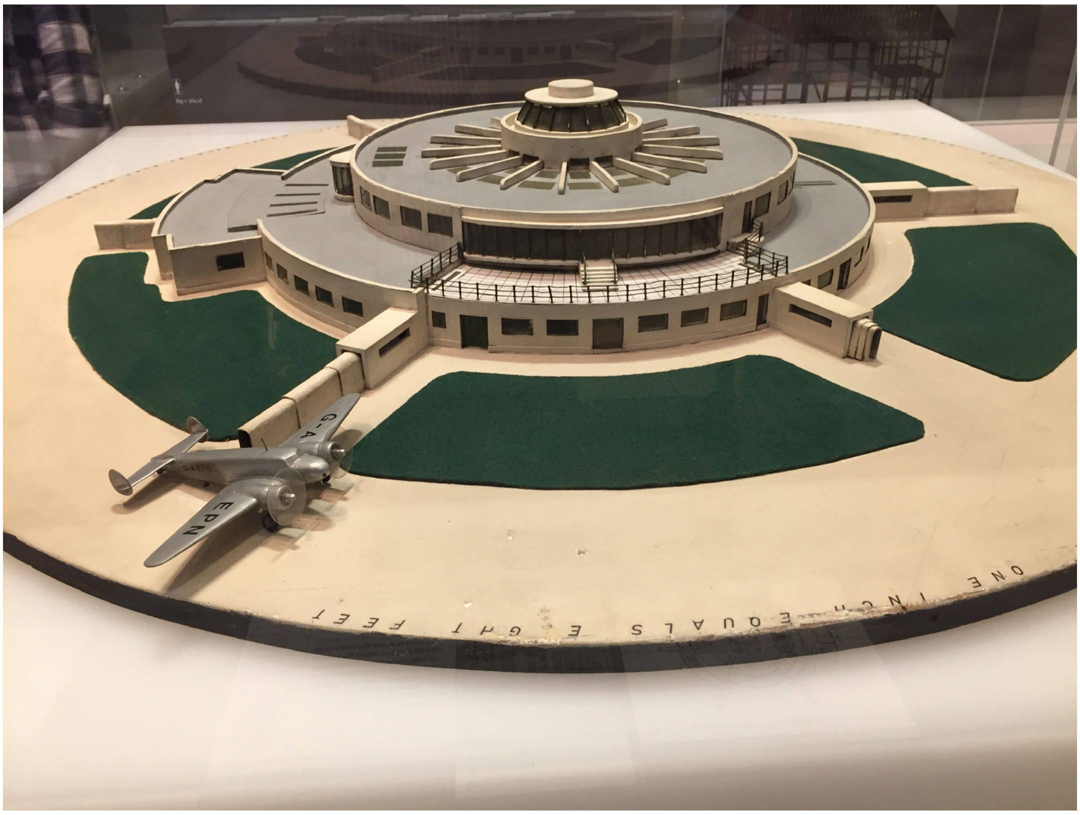

Figure 5.4: Model of Gatwick Airport Terminal, modelmaker unknown, 1936

and being more flexible than glass, it is less likely to shatter, with its fragments less likely to cause harm if it does so. With a low moisture-absorption rate and strong dimensional stability, its suitability as a form of safety glass is clearly evident. Commercial production of Perspex began at ICI in 1936 by pouring what was effectively a thick syrup between two sheets of glass before being heated and fixed into shape. As a thermoplastic, Perspex could be cast, extruded, or injection moulded into a variety of forms, and was initially made commercially available in sheets of varying thicknesses. Almost immediately after its development, Perspex's potential use within the aircraft industry was identified, as being less than half the weight of the comparable amount of glass, and being shatterproof, it was ideally suited for use in cockpit canopies. By 1937, ICI had opened a dedicated casting plant in Birmingham, with much of its output going to the production of aircraft (ICI, 1984, pp.12-14).

By the late 1930s, the existence of Perspex had evidently come to the attention of architectural modelmakers; likely through their eager interest in exploring the potential of new materials noted in Chapter Four. As Edward Hobbs' 1932 book *Modern Handicraft Materials and Methods* indicates, the development of new plastics were of great interest to modelmakers, and it was virtually impossible to not be aware of the potentially revolutionary offerings being created by the plastics industry as a combination of aggressive marketing and extensive press coverage greeted each new material with excitement. During the inter-war years, plastics were seen as wonder materials and a miracle of the modern age (Wahlberg, 1999, p.5), and quickly became associated with utopian visions of a transformed society where the conditions of everyday human life would be dramatically improved (Meikle, 1997, p.67; Shove et al, 2007, p.95). Dreams of a future emerged where nations could become independent of their unequally-distributed natural resources, and where 'man, like a magician, makes what he wants for almost every need, out of what is beneath and around him, coal, water and air' (Yarsley and Couzens, 1941, p.152). This was all to create a 'new, brighter, cleaner and more beautiful world...the perfect expression of the new spirit of planned scientific control, the Plastics Age' (Yarsley and Couzens, 1941, p.152). This optimistic view of the promise of plastics was especially strong in the United States, where plastics began to absorb the moral overtones of the modern movement (Sparke, 1990b, p.8;

Meikle, 1997, p.41). Plastics seemed set to help realise a new prosperous future that was a welcome contrast to the economic depression that had followed the 1929 financial crash (Meikle, 1997, p.143; Clarke, 1999, p.24) (Figure 5.5).

The expectant reverence in which plastics were held during the 1930s meant that architectural modelmakers such as Kenneth McCutchon were likely acutely aware of their development, although as Hobbs' 1932 book makes clear, their interest in plastics was much more mundane than bringing about a plastics age utopia. For modelmakers, the physical properties of plastics were immediately attractive as lightweight alternatives to glass, but as McCutchon's school models show, their use as a material in architectural models could be applied to far more than just glazing. What plastics offered architectural modelmakers was a single material group that could convincingly imitate almost any other. With plastics, the adaptable approach of the modelmaker became perfectly matched with an equally adaptable material.

Figure 5.5: Modernist utopian imagery in a 1933 Plastics advert

The ability of plastics to adopt ‘a variety of infinite forms’ had captured the imagination of many commentators during the inter-war years (Fisher, 2015, p.122), with much excitement expressed regarding the potential of synthetic materials replacing more familiar materials such as timber, glass, china, and even fabrics (Yarsley and Couzens, 1941, p.11). Plastics were seen as a form of modern alchemy, enabling an industrial transformation from natural materials to synthetic ones where chemists could specify the properties of the materials they wanted to create (Meikle, 1997, p.1). Plastics offered the potential of improving on the perceived imperfections of nature (Meikle, 1997, p.68), being ‘a material that lends itself so readily to transformation’ (Manzini, 1986, p.33), and it is this chameleon-like ability of plastics to imitate other materials that made them highly attractive to architectural modelmakers.

Architectural models have always been made with the intention of using one material to represent another – timber, plaster, or card in a model actually standing in for brick, stone, slate, or even glass, with pigments and paints being used where possible to render the deception less obvious and the overall effect more realistic. The development of Perspex provided architectural modelmakers with a material that was lighter than glass and most timbers, stronger than mica and card, and with a smoother surface than both timber and card it could be marked and painted much more effectively, making Perspex an ideal replacement for not just one but all of these materials. Perhaps most important of all, however, was its transparency. As is highlighted throughout this chapter, the increasingly popular modernist architecture of buildings such as the two schools McCutchon made in model form embraced much larger areas of glass in their designs than had previously been the norm, and so the ability of modelmakers to replicate this, and to bring light both into and from within models became crucially important as modernism became the dominant architectural style of post-war Britain.

The experimental use of Perspex in architectural models during the late-1930s was short lived, as less than eighteen months after McCutchon so convincingly demonstrated its use, Perspex was no longer available as the outbreak of war saw the diversion of all Perspex production to military applications. Having tantalisingly begun to explore Perspex’s potential, architectural modelmakers would have to wait until the early 1950s before it could be fully employed. For the profession, however, this was of little immediate consequence, as the demand for architectural models ceased almost entirely between 1939 and 1943, and for the few firms that continued trading, work switched instead to military commissions. At Thorp, Leslie had inherited the business after his father's death in 1939, and throughout the war, made a number of planning and training models for both the RAF and the Army. At the same time, he turned over much of his workshop space to the production of oil burner jets, which he made on a small watchmaker's lathe. Eventually, the bombing of London during the blitz became too disruptive, and he moved the business to his own home in Tulse Hill, setting up a small workshop under the stairs (Thorp Modelmakers, 1983); staffing numbers dropping from twenty-two in 1937 to just five in 1942. In Northampton, Harry Clifton, having taken over Twining Models after Ernest's retirement, switched to the production of aircraft and ship recognition models for the armed forces, while also making several architectural models to demonstrate potential camouflage designs to protect factories from bombing (Buck, 2004, p.102). As material shortages began to take hold, the remaining architectural modelmakers worked primarily in timber, with even card becoming difficult to obtain. Thoughts of Perspex and its revolutionary potential quickly receded into the background.

By the time Perspex returned to full commercial availability in the late-1940s, however, the demand for planning models during the rebuilding and modernisation of war-damaged Britain, the arrival of a new generation of military-trained architectural modelmakers entering the profession, and the adoption of new forms of architecture had generated the conditions for an unprecedented boom in architectural modelmaking. With the convergence of these elements, the ideal suitability of Perspex that had been initially explored before the war was finally realised during the plastics revolution that followed.

5.3. The Pursuit of Realism in the Post-War Boom

Despite architectural modelmaking largely ceasing as an activity in Britain during the Second World War, by the late-1940s the architectural model had rather unexpectedly benefited from significant wartime advancements. The occupational and technical requirements of the war equipped many members of the armed forces with new skills that they were encouraged to put to civilian use once peacetime returned, and the Royal Air Force's training of over one hundred men and women at its top-secret V-Section modelmaking unit at RAF Medmenham to make highly accurate and realistic landscape models had a direct influence on the standards of post-war architectural modelmaking. Many of V-Section's modelmakers sought work in the profession upon their return to civilian life, bringing their impressive abilities to the industry just as an enormous demand for architectural models during the post-war rebuilding and modernisation efforts generated a modelmaking boom. The rising standards of realism and accuracy in architectural models that followed soon created a problem, however, as the new forms of modernist architecture being built in Britain proved to be particularly challenging to represent to the same high levels of realism using established methods and materials.

During the Second World War, models of all kinds were in great demand, from aircraft recognition models used in pilot training lectures to full-sized dummy tanks; many commercial modelmakers being awarded contracts to supplement the capacity of the hastily-established forces workshops (Hendrick, 1952, p.7). As the use of models across the war effort increased, the RAF in particular began to realise that architectural and landscape models were much easier to understand than maps and drawings, and so in 1940 the architectural modelmaker L.J. Starkey was approached to set up an experimental modelmaking unit as part of the Directorate of Camouflage at the Royal Aircraft Establishment at Farnborough (ACIU, 1942). No information regarding Starkey's pre-war work as a modelmaker appears to have survived, however his knowledge of the profession suggests he had been established for some years in order for his reputation to have brought him to the attention of the military at this point. Noting that professional modelmakers were few and far between even in peacetime, Starkey suggested that recruits be found from within the ranks who had been artists before the war. Where this proved challenging, artists, sculptors, and illustrators in civilian life were directly approached to volunteer to join the unit, and with the briefest of training, were given a service rank and commissioned into the RAF (Abrams, 1991, p.15; Downing, 2011, p.15). The last surviving V-Section modelmaker, Alan East, recalled in an interview how he worked alongside artists, composers, and window dressers among the various professionals who had been drawn from the arts (East, 2019).

Starkey brought with him his two employees – both architectural modelmakers – Donald Lindfield and William Sunter, and a core unit of nine men began to experiment making briefing and battle planning models based on aerial photographs of German targets (ACIU, 1942). Making highly accurate and detailed models, their early work was mostly focused on supporting Commando operations, and having proved immediately successful, an increase in demand rapidly followed. As the team quickly expanded, so too did the complexity of their models, which ranged from ports and coastlines to entire cities (Figures 5.6 and 5.7). In 1941, Geoffrey Deeley – seconded from the Regent Street Polytechnic School of Art – took command of the unit during its transfer to RAF Medmenham in Buckinghamshire. Renamed V-Section, it became part of the highly secretive Central Interpretation Unit (Abrams, 1991, p.22), and at this point, the skill of the modelmakers was more properly recognised with the creation of a new rank – initially 'Pattern-Makers, Architectural', and by 1944 as simply 'Modelmaker' (Pearson, 2002, p.228; East, 2019).

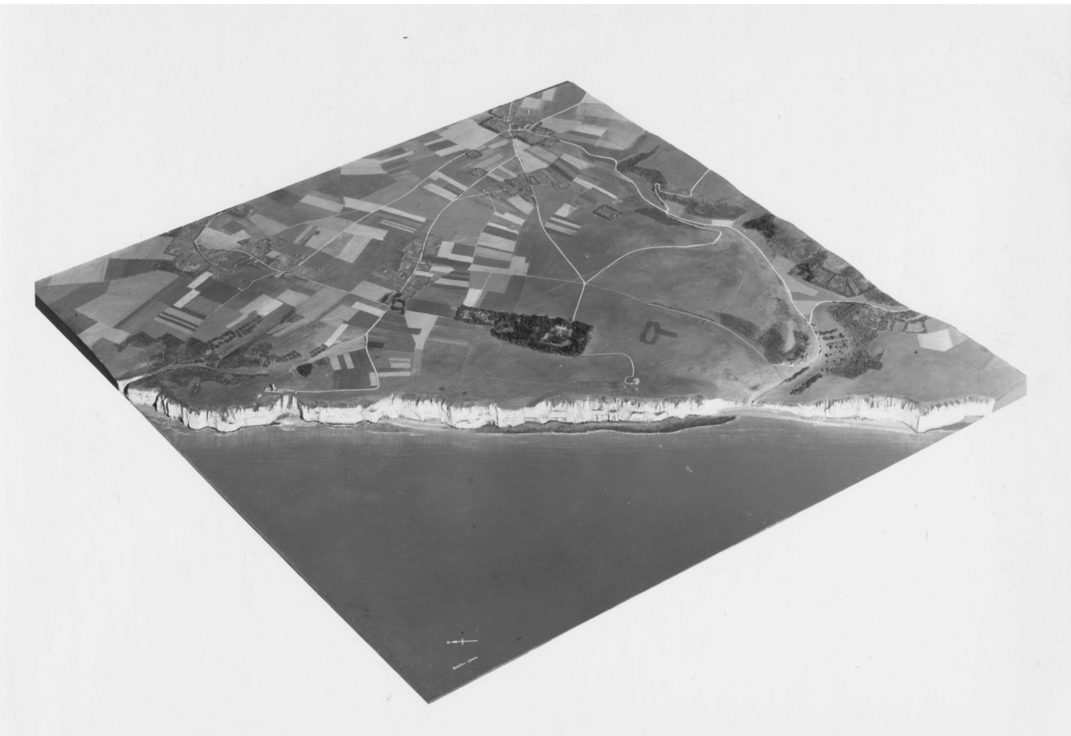

Figure 5.6: Coastal model made by V-Section modelmakers, RAF Medmenham, circa 1943

Figure 5.7: Model of Kiel, Germany, made by V-Section, RAF Medmenham, circa 1942

The Central Interpretation Unit had been set up to combine the RAF's top secret photographic interpretation unit with the modelmaking unit from Farnborough in order to make full use of briefing and planning models based on aerial reconnaissance photography (East, 2019). Within a year, V-Section had expanded with the arrival of the US Army Engineer Model Making Detachment, and by 1943 there were over one hundred modelmakers working at Medmenham, and a further fifty working in modelshops in North Africa, India, and the Middle East. The construction methods adopted for these models were evidently heavily influenced by Starkey, Lindfield, and Sunter's background, and would have been familiar to any architectural modelmaker of the time. Various approaches were used depending on the model's scale, however the principal method was to construct a well-braced baseboard, then to study the aerial photographs using a stereoscope (twin images were always taken, allowing for an analysis of depth and thus height to be made), which, when combined with cartographic information where available, allowed for hardboard contours to be cut out, stacked up, and smoothed with an electrically-powered chisel before being coated with a mixture of plaster of Paris and wood pulp. The black and white aerial photographs were then soaked in water and stretched over the contoured base where extra detail was needed, before the whole model was painted in colour by hand. Trees, roads and buildings were then added

(Figure 5.8), with linoleum used for buildings, and moss and lichen for vegetation (Pearson, 2002, p.230).

The resulting effect was both highly accurate and extremely realistic, as the models produced for the planning of the Dambusters bombing mission show (Figure 5.9). Such accuracy was vital in V-Section's work; pilots conducting bombing runs on German battleships in the Norwegian Fjords found it impossible to recognise their location using maps, and so in their cockpits carried lightweight cardboard and canvas models produced by V-Section to help them identify landmarks (Abrams, 1991, p.40). V-Section modelmaker Alan East recalled a friend who served on these missions telling him he was convinced that the models had saved the lives of many bombing crews (East, 2019). The pressure for achieving such realism and accuracy was tragically demonstrated on a large model of Dieppe that had shown the sea wall as being high enough to provide cover for the Allied tanks that were due to land on the beach, but in reality it was found to be too low. While the modelmakers were explicitly told that this was the only error found on the model after the operation was over, and that overall it had saved many lives, many of the modelmakers became distressed at the thought that their error might have contributed to some of the three thousand casualties sustained during the battle (Abrams, 1991, p.24).

The size and format of the models V-Section produced varied widely, from portable campaign planning models at 1:40,000 scale, to terrain models up to twenty feet square of entire towns and cities for briefing bombing crews at 1:1,000 scale. In total, the V-Section modelmakers made over one thousand four hundred models, including four hundred just for the Normandy landings in 1944 (Downing, 2011, p.14). By then enormously experienced, the intense pressures of wartime had further embedded the importance of adaptability to modelmaking; the V-Section modelmakers making use of what limited materials were available to create extremely accurate and realistic models upon which lives literally depended.

At the end of the war in 1945, the Central Interpretation Unit was disbanded, however V-Section, returning to its original title of the RAF Models Section, continued with a much reduced core of eighteen modelmakers before moving to RAF Wyton in 1951, where it

Figure 5.8: V-Section modelmaker detailing a landscape model, RAF Medmenham, 1945

Figure 5.9: Sorpe Dam briefing Model made by V-Section, RAF Medmenham, 1943

remained until 1993. In the immediate aftermath of the Second World War, the remaining RAF modelmakers found themselves working on civilian projects; Alan East remembers building a large model of the proposed runway layout for Heathrow Airport in 1946 (East, 2019). With significant numbers of servicemen and women returning to civilian life at the end of the Second World War, V-Section had effectively trained a sizable population of extremely talented modelmakers who were looking for peacetime applications of their new-found skills. The levels of realism and accuracy to which they had been expected to work were far more advanced than architectural modelmakers such as Thorp and Twining had reached in the inter-war years, and having been initially trained by architectural modelmakers, it was perhaps not-unexpected that a significant number of the V-section modelmakers decided to apply their skills to architectural modelmaking after the war, bringing with them an intensively honed ability to achieve almost photographic realism in their models.

The core of the Central Interpretation Unit had begun as the pre-war aerial photography company Aerofilms, and on the closure of the unit in 1945, although photographic interpretation and aerial reconnaissance continued within the RAF, the company itself was returned to private ownership as part of Hunting Aerosurveys, which continued to employ a small team of the V-Section modelmakers (Foreman, 1949), including Margaret Watson, one of V-Section's senior WAAFs. Hunting branded their work as Hunting Aeromodels, and a 1949 brochure for the company promoted their work making detailed planning models from aerial photographs, just as had been the case within the RAF (Figure 5.10).

On leaving the RAF, V-Section's principal modelmaking instructor Edmund Thring set up as an independent architectural modelmaker and illustrator in London, working until at least the mid-1960s. Kim Allen, a silversmith who had run the V-Section modelshop in North Africa before being appointed as the commanding officer at Medmenham in 1946, established Preview Modelmakers in 1948, specialising in 'topographic, architectural, planning and exhibition models' (Allen, 1955). Allen employed as many of the RAF modelmakers as he could, including Frank Willis, who in 1955 was put back in touch with Allen by the Imperial War Museum, having asked them for help in finding modelmaking work when he left the RAF (Willis, 1955). Leslie Yeo, Dick Martin, and Nancy Hayes were recruited straight from

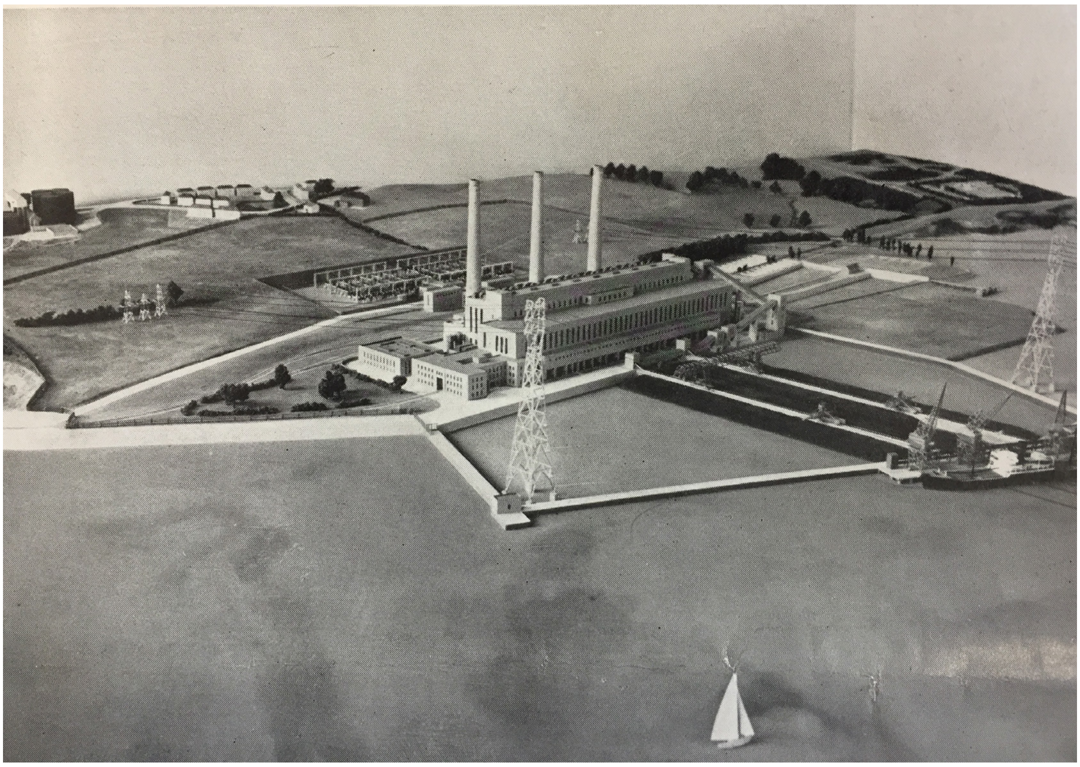

Figure 5.10: Model of Cliff Quay power station, Ipswich, made by Hunting Aeromodels, circa 1948

the RAF Models Section to set up the modelmaking section of the London County Council (LCC) Architects' Department (Karslake, 1981), while just a few years later, newly-recruited LCC modelmaker Mike Karslake found himself being posted to Medmenham to run a team of thirty five modelmakers working on models for the Korean War effort during his national service in 1951, briefly returning to the LCC before going on to a successful career as an architectural modelmaker in Southend (Karslake, 1981). Other branches of the military had also been employing dedicated modelmakers, and Alfred Greenside, who had been an Army modelmaker in the Royal Corps of Signals training unit, switched from making models of landing craft and Commando assault ships to making planning models for architects, having established his own company in Harrogate after he was demobbed (Greenside, 1954). With a huge demand for planning models in the immediate aftermath of the war, these former military modelmakers found that the small-scale models that were required for planning purposes were extremely similar to the models they had been making for the RAF, and their experience in making such precise and ultra-realistic landscape models brought about a significant improvement in the levels of realism in the architectural models they worked on once they entered the profession (Figure 5.11).

Figure 5.11: Model of a proposed new town at Chipping Ongar, 1944. Modelmaker unknown.

The pre-existing architectural modelmaking profession appears to have welcomed the influx of military modelmakers with great enthusiasm as there was a general sense that while Britain embraced the possibilities of peacetime again the demand for architectural models was about to increase, and that more architectural modelmakers were going to be needed. P.R. Wickham, in his 1945 book *Commercial Model Making*, noted that:

> [This] book is mainly written for the benefit of those who may be considering the possibilities of model making as a post-war career. No-one can say what post-war conditions may be, but in an age of increased building...the model maker's work cannot but be needed (Wickham, 1945, p.6).

The popular magazine *Model Maker* noted again in 1952 that any hobbyist modelmakers who wanted to take on commercial architectural work would find many opportunities in just their local area (Sutton, 1952, p.490). In the same year, Thomas Hendrick's first book *Model Making as a Career* (1952) was explicitly targeted at amateur modelmakers who wanted to become professionals, particularly within architectural modelmaking, 'the branch of the art which is probably in the greatest demand' (Hendrick, 1952, p.8). Certainly the established firms were already actively recruiting to build their numbers back up as business returned to normal. Leslie Thorp opened up 98 Gray's Inn Road once more and completed the ten thousand square foot extension his father had begun before his death, finding the immediate demand for models so great that within four years he had hired wartime film special effects artist Ray Pfaendler to serve as manager to oversee the company's rapidly expanding operations (Thorp Modelmakers, 1983, pp.6-7). Twining Models under Harry Clifton also continued to grow, employing eight additional modelmakers by the mid-fifties (Buck, 2004, p.103). Partridge's Models, of whom little information exists relating to their wartime work, quickly began marketing themselves again, sending out a brochure of their pre-war work in 1949, while Kenneth McCutchon also began to take on extra staff, renaming his company McCutchon Studio.

Due to the flow of V-Section modelmakers into civilian life, by the late-1940s the profession of architectural modelmaking in Britain was substantially larger than it had been before the war. With expansions underway at the existing firms, new companies being set up by ex-military personnel, and a move by local governments such as the London County Council to establish dedicated modelmaking departments meant there were over four times the number of architectural modelmakers working compared to the late 1930s. The skills of the workforce had been significantly advanced during the war with a much greater emphasis on achieving near-photographic levels of realism, and the profession was ready to put them to good use as the enormous demand for architectural models during the post-war era gave rise to a modelmaking boom.

During the late-1940s, however, the materials needed to make architectural models remained in short supply. Harry Clifton at Twining Models had noted the extreme difficulties he faced in obtaining any modelmaking materials at all during the war itself (Buck, 2004, p.102), and the situation appears to have continued through to the end of the decade. In 1945, modelmaker P.R. Wickham wrote that:

> Under the present circumstances, considerable difficulty is likely to be experienced in obtaining any type of tools; and many materials, especially wood of any type, are now in short supply. Generally speaking, however, cardboard is still obtainable in the small quantities needed by the model-maker at the time of writing (Wickham, 1945, p.8).

Perspex, despite the enormous capacity of the now no longer needed wartime manufacturing plants, initially remained difficult for modelmakers to obtain in sufficient quantities; modelmaker David Armstrong having recalled the challenge of getting hold of Perspex even in the early-1950s. Making use of the material in small sculptures before he embarked on his modelmaking career, Armstrong found the most accessible source of Perspex to be the broken canopy remains of the seemingly large number of crashed experimental jet aircraft to be found in the fields close to his home near Farnborough. ‘In those days planes would crash quite a lot and you could just find the bits of Perspex which was quite a new substance in those days...if there was a crash, I would go and collect the Perspex remains' (Armstrong, 1999). Despite the challenges in obtaining Perspex, its use as a glazing material in architectural models rapidly became the standard as the decade progressed (see Forman, 1946, p.46; Wickham, 1948, p.41). Fortunately, given the materials shortages, a general demand for larger models of individual buildings remained some years in the future as planners needed to first design the overall redevelopment masterplans before architects could turn their attention to the design of specific buildings.

While there was much wartime damage to repair, the post-war rebuilding program also embraced wider aims, additionally seeking to address the incomplete attempts to improve the quality of British housing stock that had begun during the inter-war years and which had contributed to that period's own modelmaking boom (see Chapter Four). Combined with the widespread damage and destruction of homes during the Second World War, housing in post-war Britain was in a dismal state. Twenty million people were living in homes that had no bath or hot water, with a fifth of homes in London officially classified as slums (Turner, 2011, p.8). As early as 1941, discussions were being held within government about how to address these problems, and the following year the Ministry of Town and Country Planning was established in anticipation of an imminent end to the war after the entry of the United States into the conflict (Powers, 2007, p.75). With a renewed sense of optimism, pre-war modernist ideas of garden cities and new towns were enthusiastically explored through large planning models such as one made by Leslie Thorp in 1943 of a hypothetical new town to demonstrate the principles laid down by the Ministry's chief advisor, the town planner Patrick Abercrombie (Figure 5.12).

Models were considered the ideal way to communicate the post-war rebuilding plans to the general public and were put to effective use in exhibitions such as *Rebuilding Britain* in 1943, and the *Modern Homes Exhibition* of 1946. Public information posters such as one produced by the Ministry of Information in 1943 (Figure 5.13) highlighted the clean and orderly vision of the future that models were able to portray in stark contrast to the awful ruins of the many bomb-damaged towns and cities across the country (an optimistic and

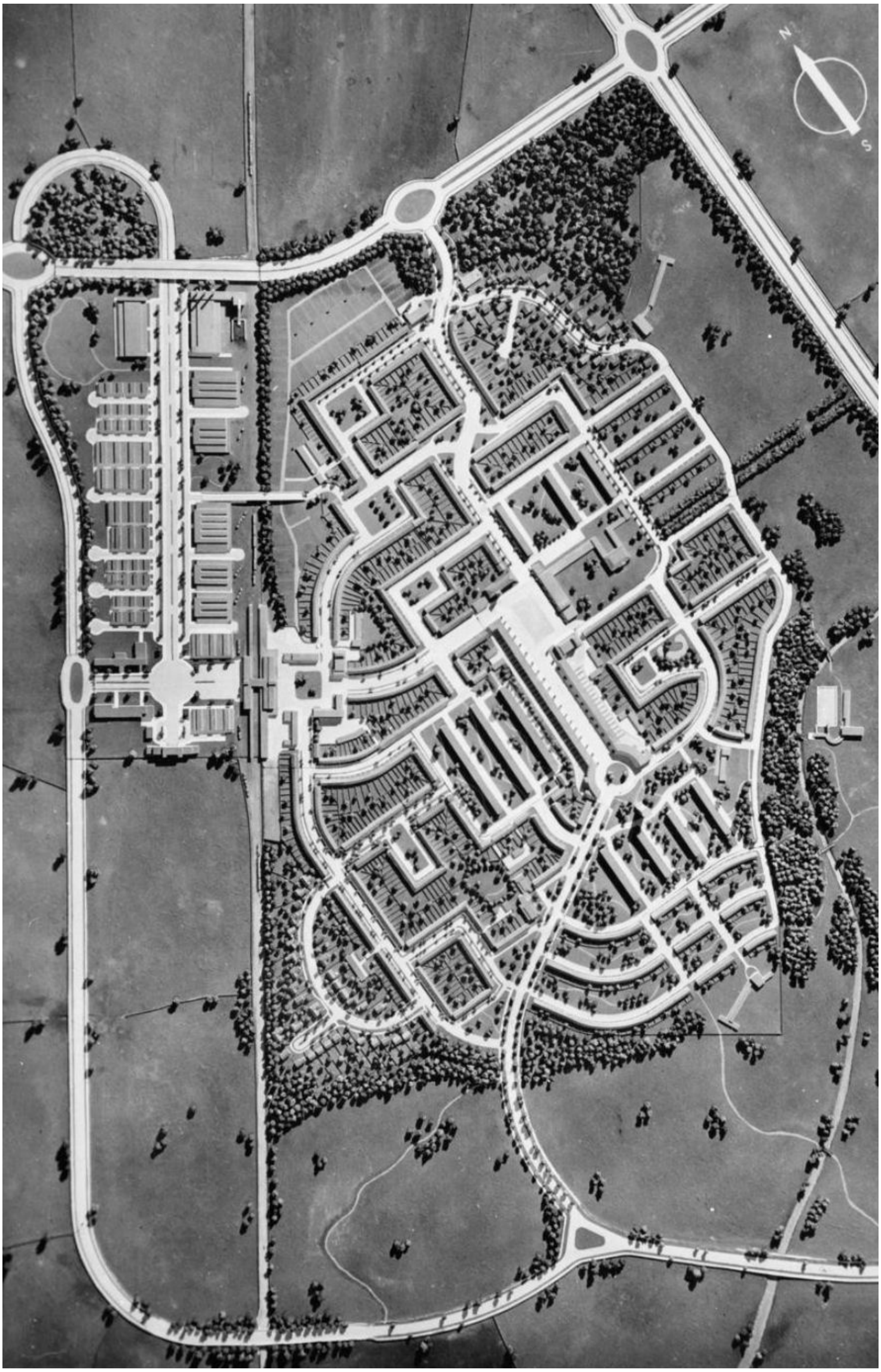

Figure 5.12: Model of a hypothetical new town made by Thorp, 1943

Figure 5.13: Ministry of Information poster, 1943

utopian association that is further explored in Chapter Six). A large model of the proposed rebuilding of Coventry, even before the bombings that destroyed much of the city centre, was displayed at an exhibition in 1941 (Grindrod, 2013, p.105), while Harry Clifton at Twining Models was commissioned to make a highly detailed model of a revised proposal for a new city centre in 1943 (Figure 5.14). During a two-week public exhibition in 1945, fifty seven thousand visitors inspected his model of ‘Coventry of the Future’ (Buck, 2004, p.102; Kynaston, 2008, p.166). In 1948, Thorp began working on a large fifteen square feet planning model of Cambridge that took two years to complete, and which remained in service, regularly updated as late as the mid-1960s (Pfaendler, 1966, p.1), while Thorp also made a large model of proposals for the redevelopment of Aberdeen in 1953 (Figure 5.15).

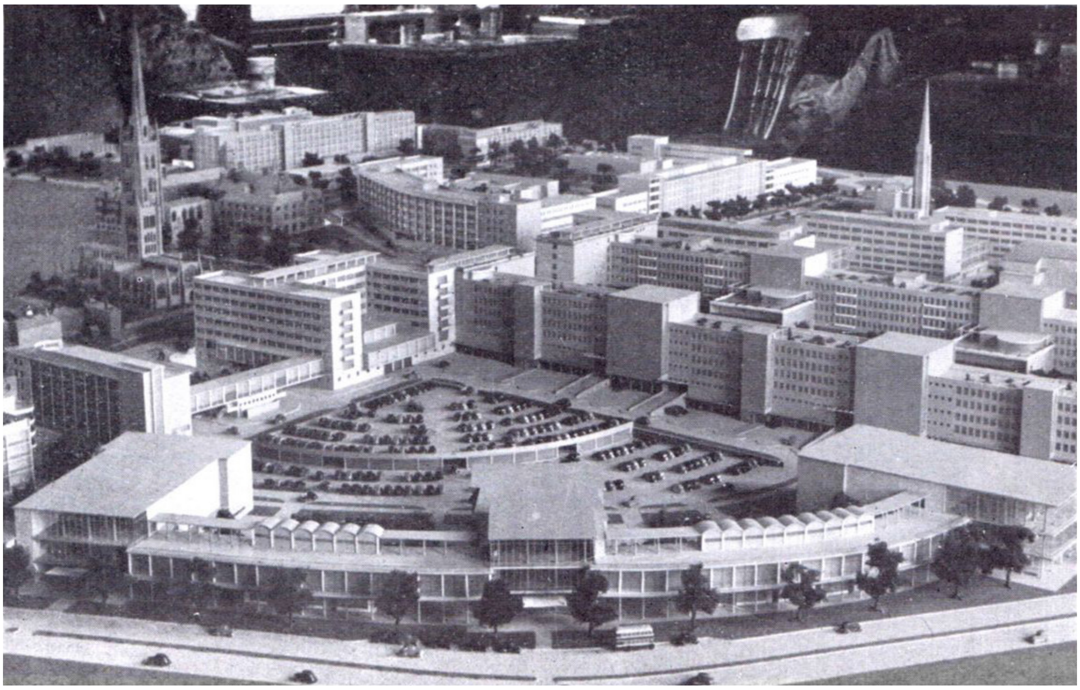

Figure 5.14: Model of the proposed designs for the redevelopment of Coventry under construction at Twining Models, 1943

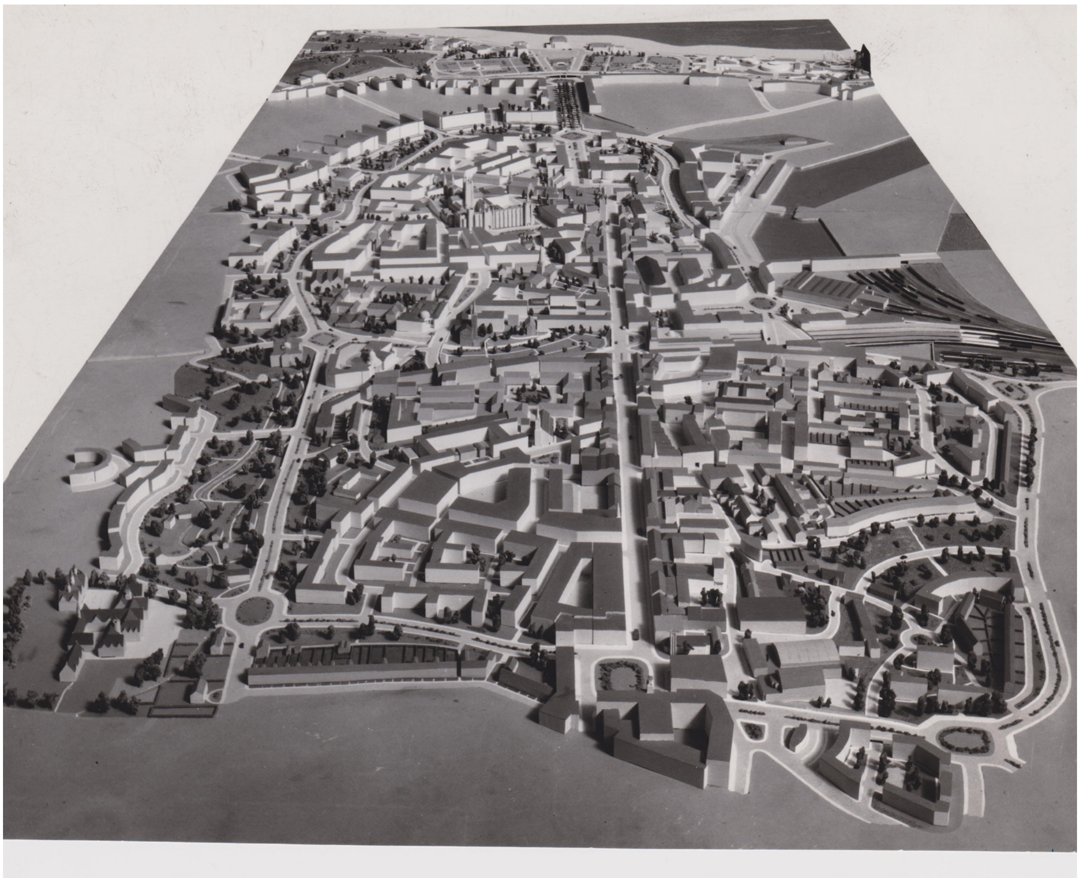

Figure 5.15: Model of the proposed redevelopment of Aberdeen, made by Thorp, 1953

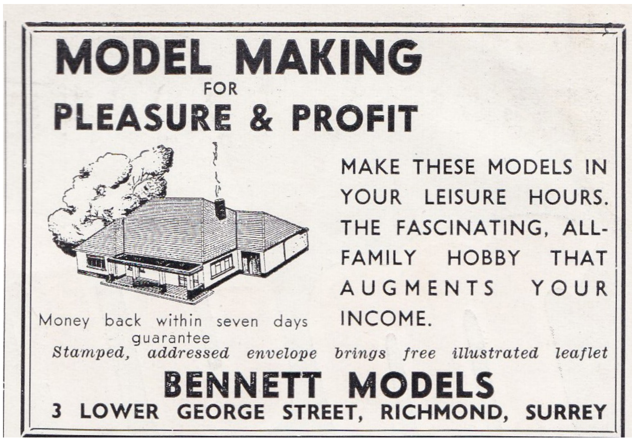

Figure 5.16: Advert for Bennett Models, 1952

At the same time, the creation of the National Health Service meant the building of countless new hospitals, planning models of which were duly commissioned. Between 1945 and 1955, two and a half thousand new schools were also built, including the new secondary moderns, again adding to the demand for models. As far as housing was concerned, in just six years after the end of the war, some one million new homes were built in Britain (Kynaston, 2008, p.597), with demand so high for models of these new developments that an inventive company called Bennett Models came up with a postal modelmaking scheme whereby hobbyist modelmakers were paid to make models of bungalows at home, an indication that the demand for such models was outstripping supply (Figure 5.16).

A further impetus to the post-war modelmaking boom was the large number of models required for the planning and promotion of the first wave of new towns – Stevenage, Crawley, Hemel Hempstead, Harlow, Hatfield, Welwyn Garden City, Basildon, Bracknell, Corby, Newton Aycliffe, Peterlee, East Kilbride, Glenthroes, and Cwmbran. The development corporations set up for each new town commissioned large numbers of models of all types and sizes, from early planning models to show the proposed layouts of the towns, to detailed larger-scale models of the town centres and the different types of housing being built. As the development of these towns generated further models during the early-1950s, and the availability of modelmaking materials returned to some semblance of normality, the changes to the modelmaking profession that had taken place as a result of the arrival of the ex-RAF modelmakers became especially apparent. The models made for the planning of Harlow in particular demonstrate all the hallmarks of the striving for precision and realism that their wartime experiences had instilled. The 1950 masterplan model made by the exhibition and modelmaking firm Cockade was constructed using precisely the same techniques as the wartime topographic models made by the V-Section modelmakers at RAF Medmenham, the model consisting of aerial photographs stretched over a contoured baseboard that gave a highly realistic appearance (Figure 5.17). The seventeen square feet model contained several thousand model trees made by dipping panel pins into a mixture of glue, sawdust, and plaster before being painted. Fishing wire was used for hedges and walls, with flock for fields, and strips of beech timber shaped and cut to size for the buildings (Gibberd, 1962, p.161). The model cost over £700 to make (approximately £28,000 today) and was an unusually expensive outlay in what was ostensibly a period of austerity, signifying how valuable an investment models were deemed to be in successfully communicating such plans to the public. At least two larger-scale models were made of Harlow's proposed Civic Centre, including a 1950 model made by Partridge's Models (Figure 5.18), while McCutchon Studio made a highly detailed model of the designs for the town centre (Figure 5.19), and were filmed by British Pathé in 1955 at work on a model of Harlow's The Lawn, Britain's first post-war high rise tower block (Figure 5.20).

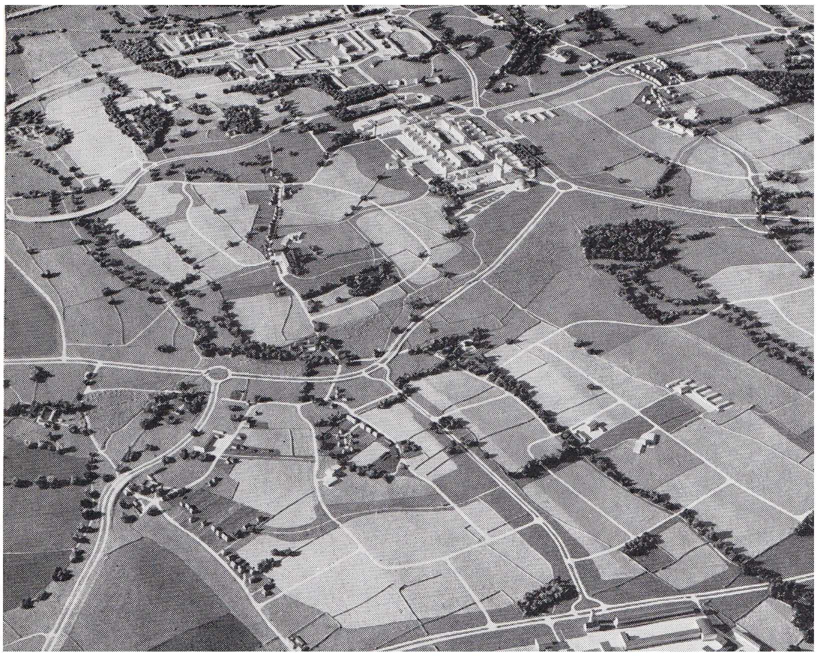

Figure 5.17: 1:2500 scale model of the proposed road layout and initial masterplan of Harlow, made by Cockade, 1950

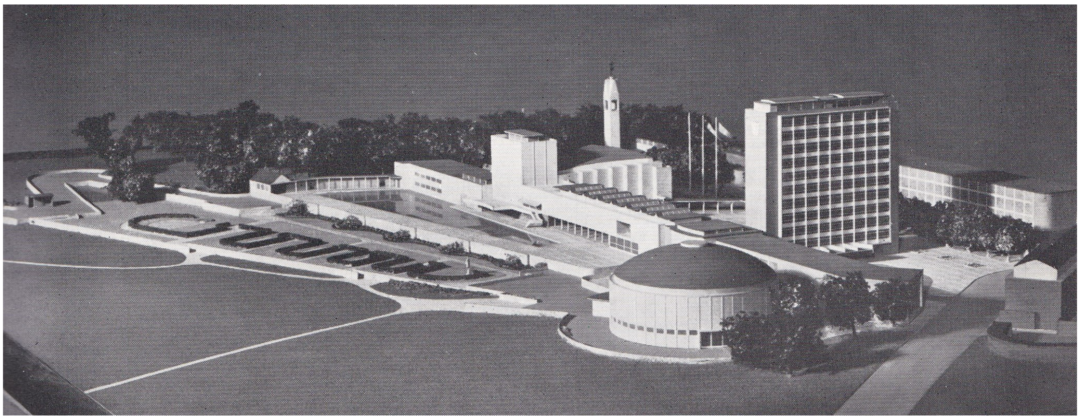

Figure 5.18: Model of Harlow Civic Centre, made by Partridge's Models, 1950

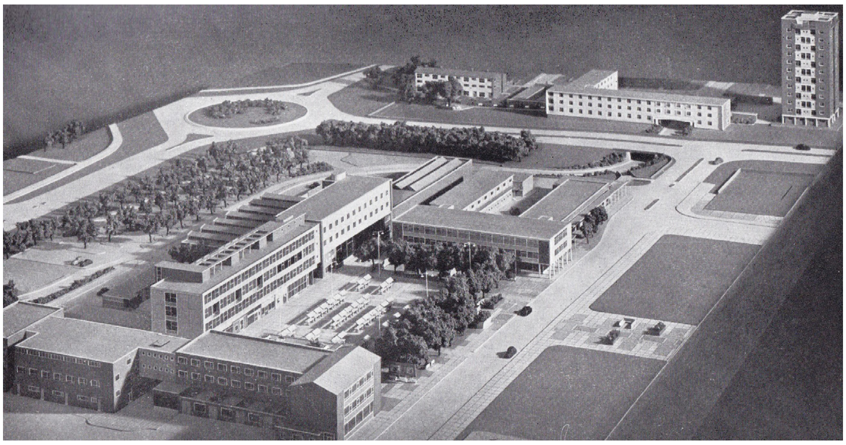

Figure 5.19: Model of Harlow town centre, made by McCutchon Studio, circa 1957

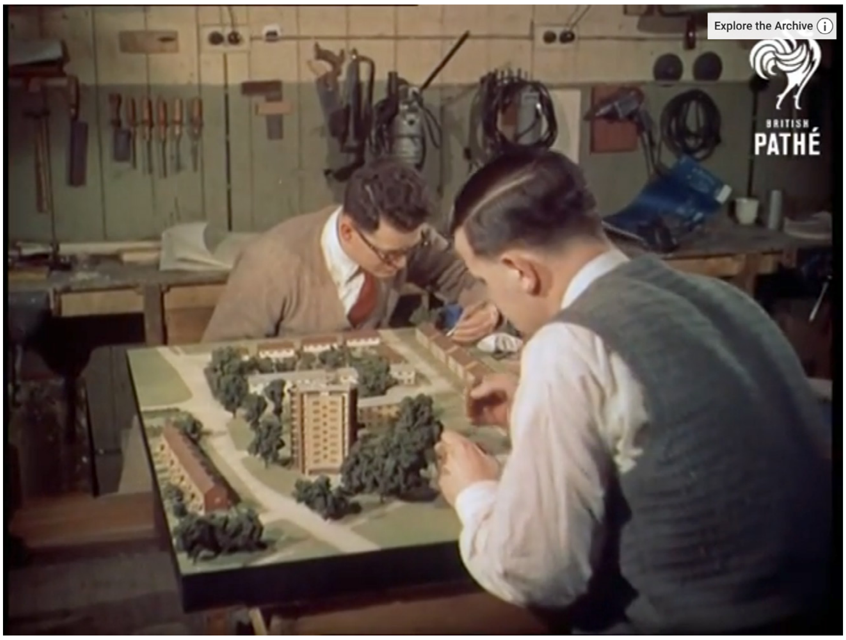

Figure 5.20: Modelmakers at McCutchon Studio working on a model of Harlow new town, 1955

While Harlow in particular provided much work for many of the major post-war architectural modelmaking firms, several of the new town development corporations created their own modelmaking departments due to the number of models required. After completing his national service running the modelmaking section at RAF Medmenham, Mike Karslake spent two years as the in-house modelmaker for the Basildon development corporation in the 1950s (Karslake, 1981). At the same time, the architects' departments of many of the larger towns and cities had also begun to create dedicated modelmaking teams to produce the detailed planning models required for public display, with the commercial architectural modelmakers such as Thorp continuing to work to capacity (Thorp Modelmakers, 1983, p.7).

The most significant of the new local government modelmaking teams was the one created by the London County Council (LCC). As has been previously noted, this was established by three ex-Medmenham modelmakers, and rapidly expanded to become one of the largest architectural modelmaking outfits in the country, pre-empting a trend for many of the larger private architectural practices during the 1980s such as Foster + Partners to operate an in-house modelmaking workshop. With Leslie Yeo, Dick Martin, and Nancy Hayes all being ex-RAF modelmakers, the models the LCC (and later GLC) Models Section produced were of a very high standard, their V-Section training having instilled a rigorous striving for realism and accuracy, as their 1950 model of the Portsmouth Road housing scheme in the Roehampton estate demonstrates (Figure 5.21). Describing one of the many planning models made of the Roehampton estate, LCC architect John Partridge noted that the model 'not only had all the contours but every tree to scale with its correct position and spread. Never subsequently have I experienced such a design tool at hand...in the 1950s these expensive accurate models were remarkable' (Partridge, 2008, p.117). It is difficult to discern from the photograph of the Portsmouth Road model precisely which materials were used in its construction, however the transparency of the windows on the tower block, and contemporary records of other models made by the LCC at the time (LCC Models Section, 1960), suggest a combination of Perspex and card, which was rapidly becoming the standard approach during this period (as is outlined later in this chapter).

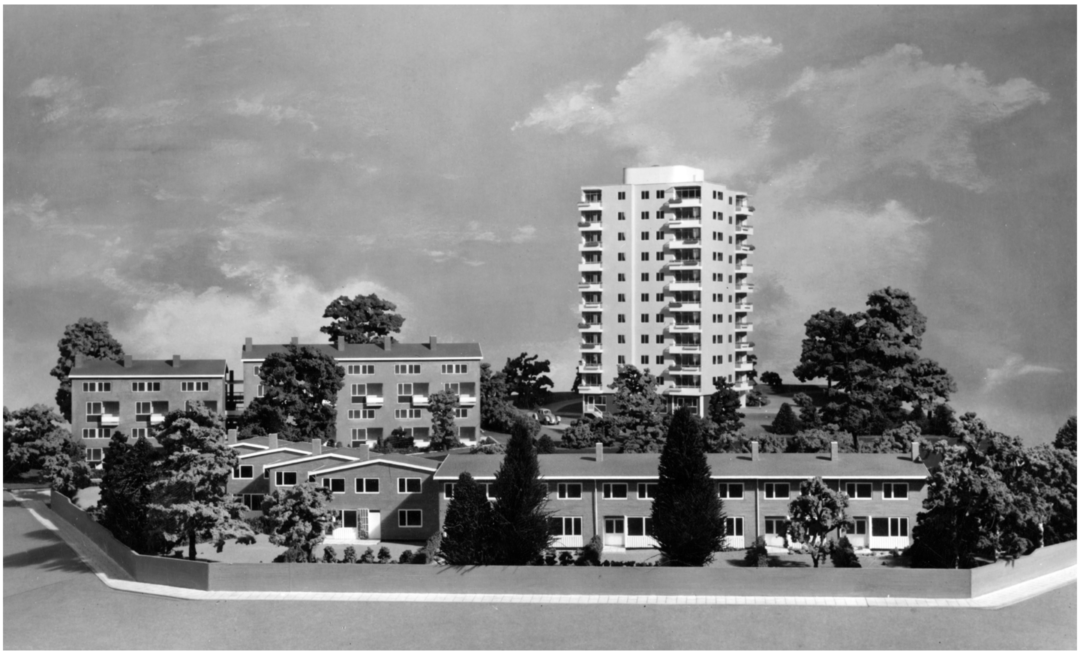

Figure 5.21: Model of the Portsmouth Road housing scheme, Roehampton Estate, made by the LCC Models Section, circa 1950

As the new town and estate models show, by the 1950s the post-war boom was well and truly underway, with commercial modelmakers struggling to keep up with demand. Thomas Bayley wrote in 1959 that many of his former pupils at the Ealing School of Art had gone on to become ‘professional model makers of considerable repute and are producing work of the highest quality’ (Bayley, 1959, p.5), and both Thomas Hendrick’s 1957 and Norman Taylor’s 1959 books on architectural modelmaking made explicit calls for more individuals to take up the career, so strong was the demand for work (Taylor, 1959, p.xii). By the end of the decade, the ‘ever increasing importance of the professional model maker in industry’ (Taylor, 1959, p.1) was confidently assured:

> Many of Britain’s largest industrial undertakings rely on these model manufacturers to supply their model requirements with every confidence, in the knowledge that by doing so they are drawing on countless years of experience in this highly specialized trade (Taylor, 1959, p.xii).

The expansion of the profession during the post-war boom was not without its problems, however, as the ubiquity of models to communicate rebuilding and modernisation plans (Figure 5.22), and the high standards of realism that the arrival of the ex-RAF modelmakers had brought about posed a considerable challenge when the demand for relatively small-scale planning models began to be replaced by commissions for much larger, more traditional models of specific buildings. The complication was that having established such high expectations of the degree of realism that could be achieved in architectural models, the new styles of architecture being employed in the rebuilding and modernisation of Britain were using radically different principles, materials, building types, and construction techniques, and as the post-war boom progressed, an urgent need arose for the materials and construction methods of architectural modelmaking to evolve as well. Realistically portraying modernist architecture required a wholescale rethinking of how models were made, however as Kenneth McCutchon's 1938 school models – discussed at the start of this chapter – demonstrate, the solution had actually already been identified shortly before the Second World War.

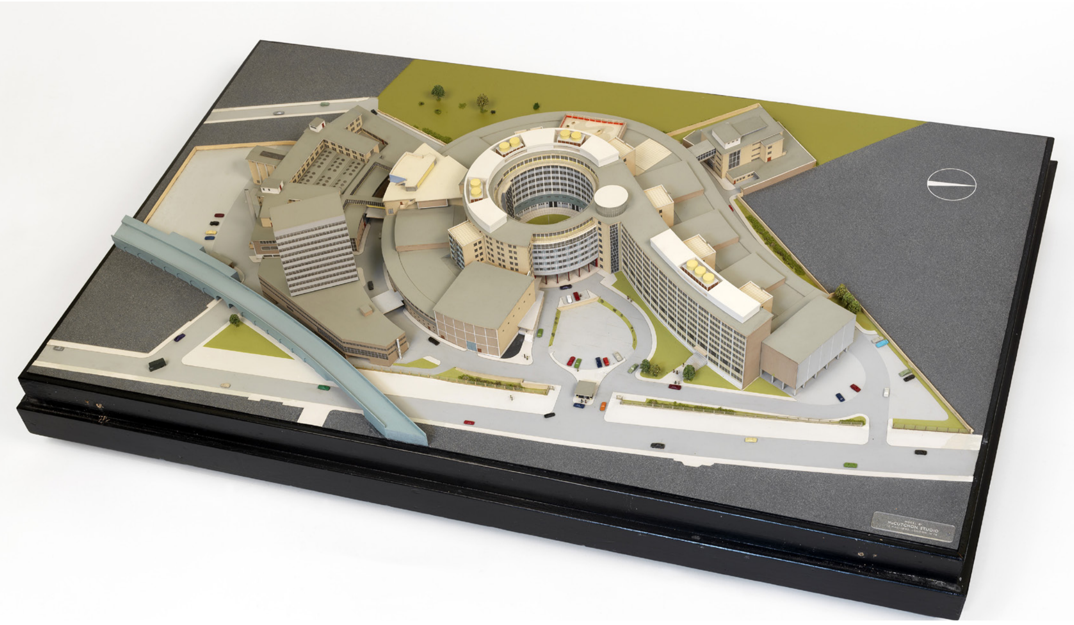

Figure 5.22: Model of BBC Television Centre, made by McCutchon Studio, circa 1955

5.4. Meeting the Challenges of Modernism

As the 1950s progressed and the planning of the new towns and the rebuilding of bomb-damaged city centres moved into actual construction, larger more traditional architectural models were increasingly required to explain to both the planning authorities and the public at large what the new buildings that were going to occupy these masterplans were actually going to look like. The use of highly-realistic architectural models to communicate the ambitious ideas of a new generation of modernist architects and planners keen to put into action their visions for a better world (Hall, 2002, p.237) was exemplified by the 1951 Festival of Britain, which made a clear statement to the public that new buildings constructed in the post-war era were going to be quite different to what had gone before; the architects and planners behind the post-war rebuilding of Britain having fully embraced the principles of modernist architecture. Being a relatively new style of architecture in Britain, models were in great demand to present its merits to an often sceptical public. For modelmakers this created the challenge of effectively representing this new architectural language, as modernist architecture conformed to very different rules.

The 1951 Festival of Britain was intended to play an important role in the rebuilding of Britain in the post-war era as it allowed the public to not only celebrate Britain's historic achievements, but also to experience first-hand the brave new world that was being promised by the reconstruction of Britain's cities and the creation of the spacious new towns. A decision to place three-dimensional exhibits – artefacts, models, and dioramas – as central to the main London exhibition (Atkinson, 2012, p.46) generated a huge amount of work for modelmakers of all specialisms. Thomas Hendrick, in describing the impact of the Festival on the profession, noted that 'with regard to cultural assembly, what greater stimulus can ever have been given to model makers than the 1951 Festival of Britain?' (Hendrick, 1952, p.4). Hendrick was the production manager of Cockade, an exhibition and display company that had been formed by Sir Stephen Tallents and Hugh Casson in 1946 with the aim of creating a consortium of designers and makers to improve the artistic quality of models and displays for the public (Hendrick, 1976, p.163). Cockade took on a large proportion of the model and display work for the Festival – no doubt through the close involvement of Tallents and Casson in both endeavours – as well as becoming a major provider of architectural models during the 1950 and 1960s. The Festival itself contained thousands of models of all types and scales, and virtually all the architectural modelmaking firms contributed work, sometimes applying their skills to non-architectural subjects. Thomas Bayley made several models of townscapes, McCutchon Studio and Partridge's Models both submitted a large number of architectural and engineering models, while Shawcraft built a model of London Airport (Office of the Festival of Britain, 1951). Hunting Aeromodels made seven architectural models, while Preview and freelance architectural modelmaker Richard Hamilton each provided several large models of the new towns (Office of the Festival of Britain, 1951). Cockade itself produced countless models, including an architectural model of the proposed BBC Television Centre (Hendrick, 1976, p.163), while in Harlow, the top floor of The Lawn, the first completed tower block, was given over to a public exhibition as part of the Festival that allowed visitors to compare a large model of the proposed new town with the view of the actual work in progress below (Atkinson, 2012, p.186). Thorp, while apparently not displaying any models in the Festival itself, found substantial work making models of the Festival buildings during the lead up to its opening. Many planning models of the Festival site on London's South Bank were commissioned during the design process, with further models made specifically for public display in the Festival's office in central London (Figures 5.23 and 5.24).

With over eight million visitors attending the South Bank exhibition, the models on display were seen by a significant proportion of the British population, and as had been the case with the planning models of the rebuilding of war-damaged cities such as Coventry, and of the new towns such as Harlow, acted as miniature physical embodiments of post-war optimism. As projected improvements to the country's infrastructure were unveiled during the early 1950s, further publicly-displayed models explained the plans for motorways, civic buildings, and the modernisation program for Britain's railways, all firmly predicting a brighter more prosperous tomorrow – an association that would later cause problems for the architectural model when the gleam of modernism began to fade in the late-1960s (see Chapter Six). More immediately, however, was the challenge of accurately and realistically representing modernist architectural styles to the same high standards that had been established since

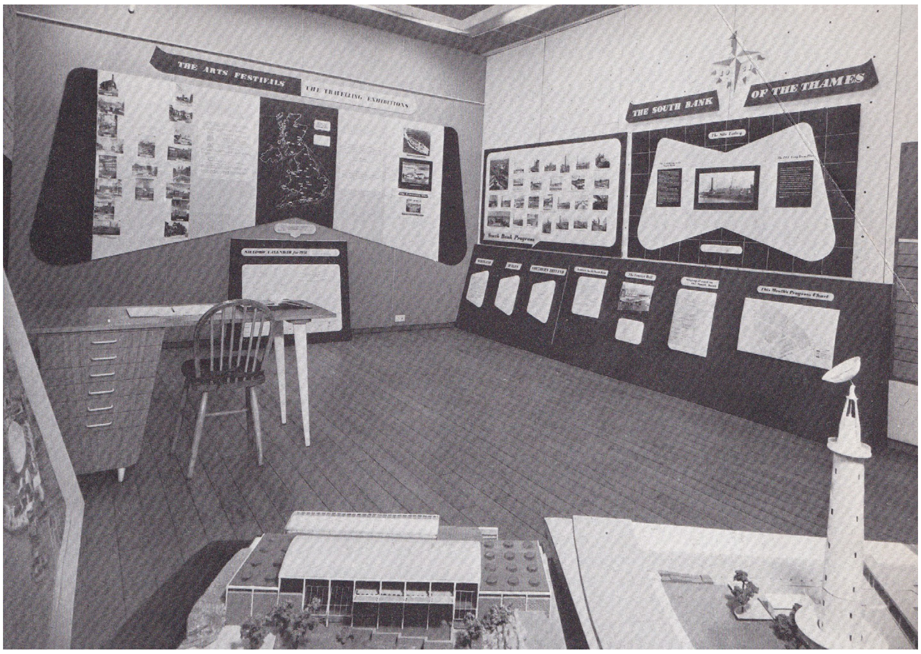

Figure 5.23: Models on display in the Festival of Britain Information Office, 1949

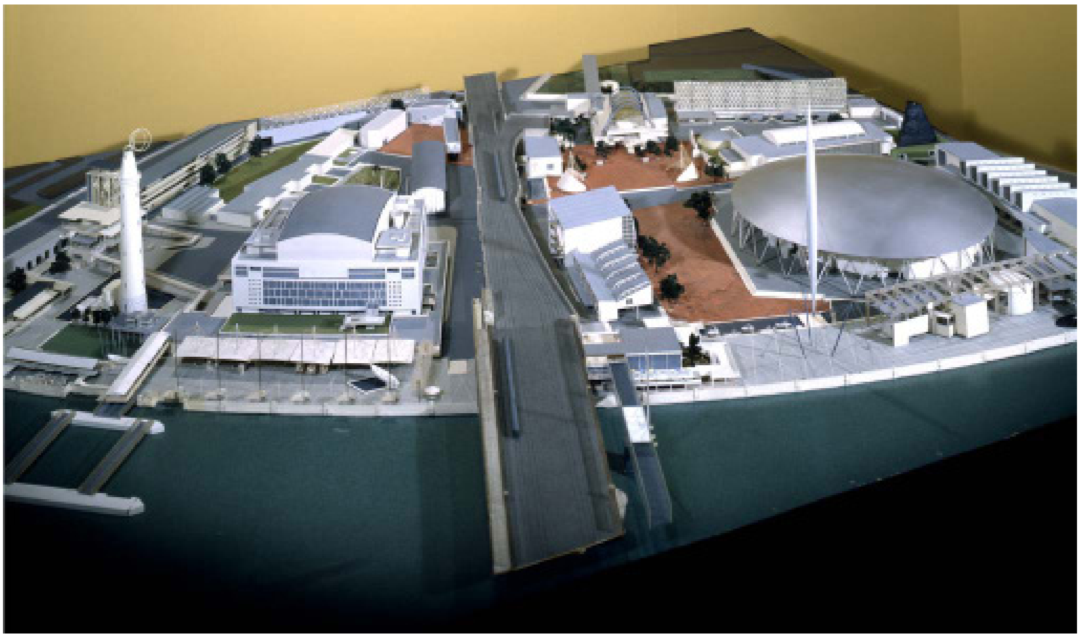

Figure 5.24: Model of the Festival of Britain, made by Thorp, 1950

the Second World War, with the Festival of Britain marking a watershed moment for the architectural modelmaker. Having served as an important opportunity to present a new style of architecture and design to the public, and to show a vision of how the modernists thought Britain should look (Powers, 2005, p.231; Atkinson, 2012, p.24), it was clear that few modelmaking commissions in the foreseeable future were going to follow the more traditional styles of the inter-war years, and that the established methods of architectural modelmaking needed to change as a result.

Modernism had begun to spread through European architecture from the turn of the century, however Britain lagged behind for several decades; the first examples of modernist buildings being constructed in 1925, with the movement only properly becoming popular within architectural circles in Britain during the late-1930s (Powers, 2007, p.13). The work of Edwin Lutyens and Giles Gilbert Scott (both of whom were prolific commissioners of models from John Thorp), along with the garden city movement, had steered the architectural style of the country in a different direction, particularly in regards to housing. By the outbreak of the Second World War, only nine hundred modernist houses had been built out of a total of four million new homes (Gardiner, 2011, p.354). Throughout the 1930s, modernist architecture in Britain had largely been restricted to public buildings, as despite a growing interest in the movement, house buyers simply wanted to live in more traditionally-styled dwellings with gable roofs, half-timber facades, and lattice windows, as exemplified by the popularity of the mock-Tudor style in the inter-war years (Pugh, 2009, p.71).

While modernist architecture was perhaps slow to catch on with the general public in the 1930s, within British architectural schools it had virtually swept all other forms of architecture aside, largely inspired by the arrival of several prominent modernist architects from Europe as the political situation began to deteriorate, and through the spread of Bauhaus teaching approaches that embedded both modernism and the architectural model as central to architectural education. Erich Mendelsohn and Serge Chermayeff had arrived in Britain in 1928, while Berthold Lubetkin and Denys Lasdun formed the Tecton Group in 1932. Walter Gropius arrived in 1934 and formed a partnership with Maxwell Fry, while Marcel Breuer arrived the following year and went into business with F.R.S. Yorke. Le Corbusier was a frequent visitor to London in the 1930s, and by 1933 the Modern Architecture Research Group (MARS) had been established in London to promote the ideas of architectural modernism (Powers, 2007, p.40; Turner, 2011, p.34). Students at the major architectural schools during the 1930s, particularly at the Architectural Association (the AA) and the Liverpool School of Architecture openly embraced the modernist movement, and increasingly through the decade, the architectural journals' reporting of their graduation shows was accompanied by photographs of their final project models, all in the modernist style (see for example The Architect and Building News, 1936). A 1938 exhibition by the MARS Group was similarly filled with models demonstrating the clean lines of modernist architecture (Figure 5.25), and by 1942 it was regarded that modelmaking had become an essential part of the curriculum at most of the schools of architecture in Britain, 'a necessity in the process of present-day architecture' (Nunn, 1942, p.553).

Initially, there had been a polarising debate between two factions of the modernist movement in Britain – the 'new humanists' who drew from a softer Scandinavian form of modernism, and the harder modernists who were inspired by Le Corbusier (Partridge, 2008, p.116). This was particularly noticeable within the LCC's architects' department, where different groups who were split between admirers of Alvar Aalto and of Le Corbusier were given free rein to experiment, often within the same development (Carolin, 2008, p.106). The Roehampton

Figure 5.25: Models on display at the MARS Group exhibition 'New Architecture' at the New Burlington Galleries, London, 1938

estate, for example, incorporated a ‘softer’ low density mix of point blocks – narrow blocks of flats surrounded by grassed areas – and low-height maisonettes with traditional pitched roofs, alongside the ‘harder’ more slab-like complexes that were reminiscent of Le Corbusier’s *Unite* designs. By the early 1950s, modernism had come to dominate British architecture, and the urbanist high density views of Le Corbusier’s followers had largely won the argument. As David Kynaston has aptly described the consequences of this debate, ‘the future was to be modern, urban, vertical, and communal, and unambiguously so’ (Kynaston, 2010, p.280). A high rise housing boom had begun, with blocks as tall as seventeen floors under construction in East London as early as 1950, and various attempts to fully realise Le Corbusier’s concept of *La Ville Radieuse* passing through the planning system such as the 1958 proposal for ‘High Paddington’ above the station’s goods yard. The model of the proposed vertical township of over eight thousand people was constructed by Hunting Aeromodels (Figure 5.26), and became a lightning rod for protests against the development led by John Betjeman (Kynaston, 2010, p.284).

For architectural modelmakers, the adoption of modernist architectural styles in the rebuilding of post-war Britain meant they were facing a double demand. Not only were enormous numbers of models required to communicate the rebuilding and modernisation plans to the public, but the newness of the style of architecture being used led to a further demand to explain the architecture itself. Kenneth McCutchon had noted as early as 1936 that due to the ‘growth of new materials and new methods of construction [of buildings]

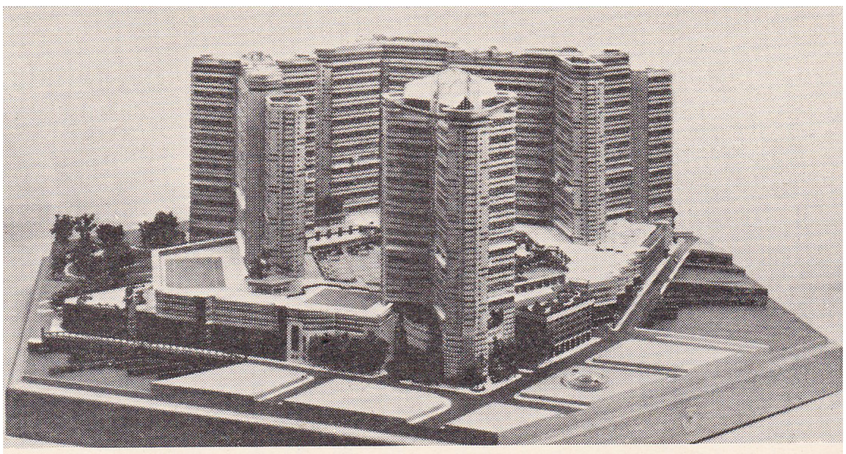

Figure 5.26: Model of Paddington development made by Hunting Aeromodels, 1958

giving rise to new values in the questions of space and scale, the use of models is increasing in popularity' (McCutchon, 1936, p.459). In 1942, the British architect Price Nunn wrote that 'the potentialities of the model for publicising the aims of architecture are high, especially in present times, when the popular interest in the future shape of our buildings is so intense' and that drawings were unable to 'convincingly convey to clients unaccustomed to the them the effects which modern architecture is designed to produce' (Nunn, 1942, pp.553-4). The complex combinations of asymmetrically arranged masses that were common features of modernist architecture were particularly difficult to understand in plan and elevation drawings, with models – and photographs of models – becoming 'almost a necessity for both architect and client' (Reid, 1939, p.407). This is demonstrated in the model of a proposal for Hayes Civic Centre built by McCutchon Studio in 1960 (Figure 5.27), where the interrelation of the component masses of the design is revealed in a way that a set of drawn elevations could not.

Realistically representing the elements that comprised modernist architecture in model form was not an easy task, and with the demand for realism having been bolstered by the impressive achievements of the ex-RAF modelmakers working on planning models, an urgent practical need arose for modelmakers to find new methods of construction that could more realistically portray the new materials, construction methods, and visual language of the buildings being designed. During the inter-war years, the materials used in buildings had begun a wholesale shift from brick and stone to glass, steel, and concrete. Steel-framed

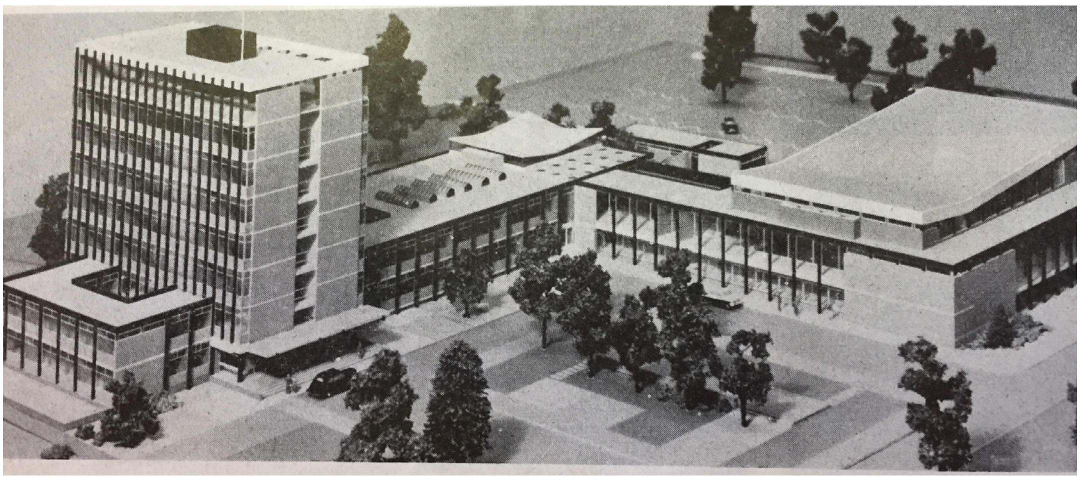

Figure 5.27: Model of Hayes Civic Centre, made by McCutchon Studio, 1960

construction methods allowed for much more open expanses of glass to be used, while entirely new forms of building such as high-rise block of flats posed a double challenge to architectural modelmakers. Large numbers of windows across multiple floors left little room to hide any internal bracing, and the solid construction approach favoured by Thorp and many other modelmakers before the war, where card facades were applied to solid timber blocks, simply couldn't be used to effectively represent these new building types. By the early-1950s, the crispness demanded by modernist architecture, with sharp corners and clean lines, had forced a radical rethinking of model construction and finishing techniques.

Crucially, modernist architecture had embraced concepts of light and air, with internal spaces intended to be flooded with light from the outside during the day, while at night buildings almost became glowing boxes, in complete opposition to the heavy masonry walls featured in more traditional architectural styles. Mies van der Rohe's 1922 proposal for a glass skyscraper in Berlin was widely publicised through photographs of a model made entirely from glass (Figure 5.28), an extremely time consuming and expensive approach to

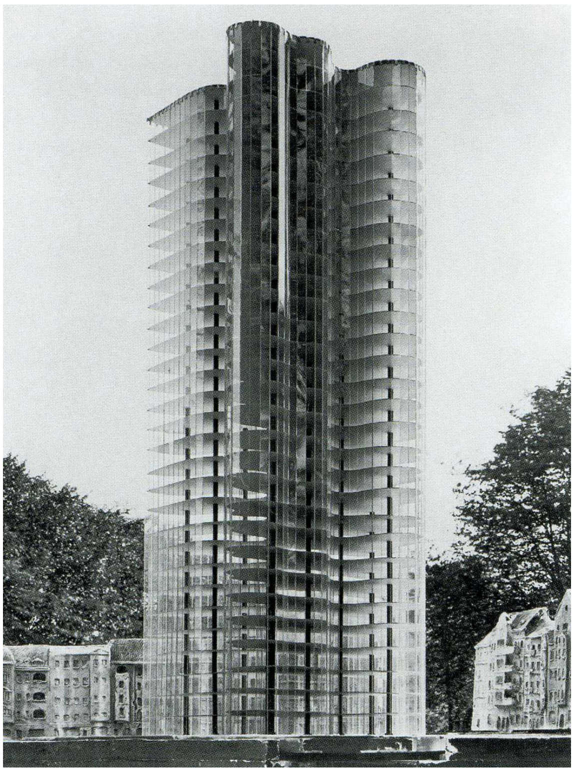

Figure 5.28: Glass model of Mies van der Rohe's Berlin Skyscraper proposal, 1922. Modelmaker unknown

modelmaking that, while capturing the essence of the design, was clearly not a workable solution for routinely representing large areas of glazing. As Nick Quine's 1962 model of a more mundane development in St. Martins Lane in London demonstrates (Figure 5.29), modernism demanded a completely different balance of solid wall to glass, and transparency consequently became a hugely important requirement in architectural models. As Kenneth McCutchon had realised before the Second World War, Perspex, produced as a rigid and optically-clear sheet, was ideally suited for representing the new modernist aesthetic, and by the early-1950s, it was once again commercially available in large enough quantities for modelmakers to utilise, just as the demand for architectural models intensified as the post-war boom moved from planning models to larger scale models of individual buildings in the new modernist style. With the profession now benefiting from the skills of the ex-RAF modelmakers and their high expectations of realism, the arrival of Perspex was to enable a significant leap forward in the quality, precision, and realism of the professionally-made architectural model in Britain.

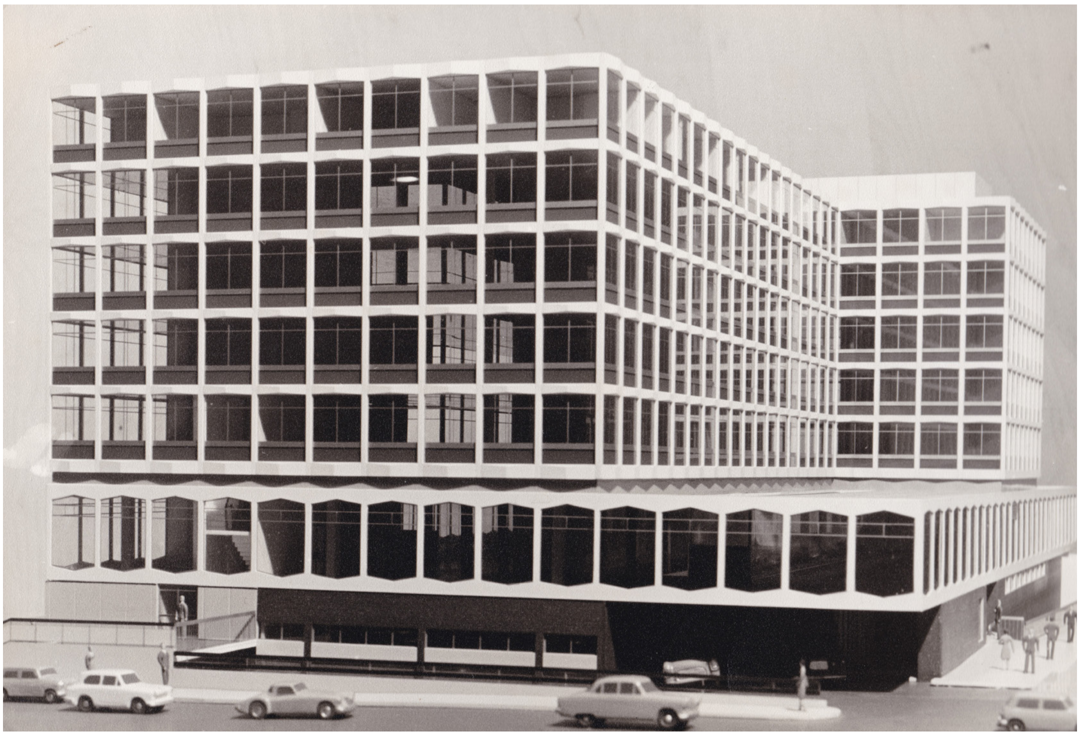

Figure 5.29: Model of St. Martins Lane. Made by Nick Quine/AMI, circa 1962

5.5. The Plastics Revolution

The increased availability of Perspex by 1950 finally allowed architectural modelmakers to unleash its revolutionary potential, having initially been identified as a solution to the problems posed by the changing requirements of representing modernist architecture. The use of Perspex in the making of architectural models rapidly increased during the early-1950s, with its innate transformability and transparency instigating a series of shifts in construction methods that ultimately resulted in the widespread adoption of the all-Perspex approach exemplified by Nick Quine's models of the early-1960s; the potential of which had been identified by McCutchon's school models in 1938. With the plastics revolution emerging from the post-war modelmaking boom, the use of Perspex was to outlast the modernist architecture that was a crucial driver behind its adoption, bringing about longstanding changes in the levels of realism that were possible to achieve in an architectural model. While the post-war boom can be viewed as a golden age for the professionally-made architectural model in Britain, it was also the start of the plastics age, one in which the architectural model arguably still resides.

By the end of the war, Perspex production had reached nearly two thousand tons a year, the war effort having fuelled the rapid development of both the casting process and refinements to the material's chemical composition, becoming even clearer, stronger, and less prone to shrinkage and deformation (Perry, 1943, p.254; ICI, 1984, p.16). Mechanised production had replaced the original hand-pouring approach, and by the late-1940s ICI had a large number of factories dedicated to the production of what was by then a dramatically more refined plastic, for which its main application, in aircraft canopies, had been substantially reduced. ICI was therefore keen to find new uses for its material, and so began an active period of promotion to various industries. In 1945, an exhibition was held by ICI in Birmingham to showcase the material to architects, industrial designers, and manufacturers (British Plastics, 1945), with the British Plastics Federation holding a similar exhibition in London in the following year (British Plastics, 1946); both shows encouraging potential peacetime applications of Perspex. The first major industry to make use of Perspex after the war was the lighting industry, with ICI producing pigmented and opal sheets especially for their use

(ICI, 1984, p.26). This success quickly spread the use of Perspex to signs and shop fascias. The creative industries had become aware of the potential uses of Perspex before the war, as McCutchon's use exemplifies, and as early as 1941, other innovative uses by craftsmen and designers were being demonstrated in various art colleges (Yarsley and Couzens, 1941, p.116), while its availability in large blocks had already attracted the attention of sculptors (ICI, 1984, p.28).

As Kenneth McCutchon's 1938 school models had so effectively demonstrated, Perspex was well suited for use in architectural models to represent glazing, and it was its transparency that first attracted modelmakers to its potential as the material solution to the problem of realistically portraying modernist architecture. The more modelmakers began to work with the material, however, it became apparent that Perspex's potential was far more extensive than just its transparency. By the late-1940s, Perspex's reputation as a vital material for architectural modelmaking had been firmly established, P.R. Wickham noting that:

> Of the transparent plastics, Perspex is the best known, and has many virtues, being quite clear; easily worked and fitted, and very light. The snags about Perspex are its high cost, and the fact that it is not, at present, available below 1/16th inch for thickness (Wickham, 1948, p.46).

By 1952, Perspex was considered to be an 'essential part of the modelmaker's stock', being able to be bent and formed into 'almost any shape imaginable' (Hendrick, 1952, p.19). Overall, Perspex's intrinsic adaptability proved to be an excellent match for the modelmaker's requirements. It could be cut on a circular or band saw with ease, sanded quickly, and could be polished clear after machining. As a thermoplastic, it could be bent to fit over a mould or former when heat was applied, after which it retained its new shape. The precision with which Perspex could be cut or shaped was considerably higher than with either card or timber, and its dimensional stability meant that two pieces cut to size by a machine tool would invariably join with no visible gap; a light sanding removing all trace of the edges of Perspex sheets where two met at a corner of a model building. Solvents such as chloroform and dichloromethane could be used to weld it together, and its ability to be machined with existing woodworking tools made it a highly attractive choice for its use in modelmaking (ICI, 1984, p.62). Taking paint well further added to Perspex's list of admirable qualities for the modelmaker, and by 1947 its use in the construction of both hobbyist model kits and professional models of cars and boats had become widely established (British Plastics, 1947). A rapidly expanding branch of modelmaking – that for aircraft models – was also making extensive use of Perspex in both design and display models (British Plastics, 1950), and it was clear by this point that Perspex offered far more to the modelmaker than simply being a glazing replacement as Thomas Bayley had first suggested, although its transparency remained a crucially beneficial property.

In terms of practical advances in the construction and quality of architectural models, Perspex went through several phases of use. Initially, Kenneth McCutchon's all-Perspex models from 1938 were an exceptional approach to the use of the material that most architectural modelmakers did not widely adopt until the mid-1950s. Particularly in the late-1940s, when materials were still difficult to come by, Perspex was generally only used as a direct replacement for glass and mica as a glazing material. Norman Taylor enthused in 1959 that 'there are a hundred and one uses for Perspex in model making, but the first one which comes to mind for the architectural modeller is the representation of glass in model windows' (Taylor, 1959, p.29). Actual transparent window representation was quite rare in architectural models both before and immediately after the Second World War. For small scale models, solid timber blocks with card facades were still the norm, although for larger scale models, a hollow plywood carcass with internal bracing to prevent warping was used (Hendrick, 1957, p.59). Windows on these types of model were often represented by applying strips of coloured card or paper to the plywood exterior before being covered with a suitable clear material, usually mica, celluloid, or – after 1945 – Sellotape. Card facings were then applied over the top of this, with window apertures carefully cut out. (Figure 5.30). Where the interior of a building needed to be seen, apertures were cut into the plywood with a fret-saw, and small strips of mica, glass, or celluloid placed behind the opening. Perspex was a natural replacement for these materials, but the approach left many unsatisfactory compromises, as Thomas Hendrick observed in 1957:

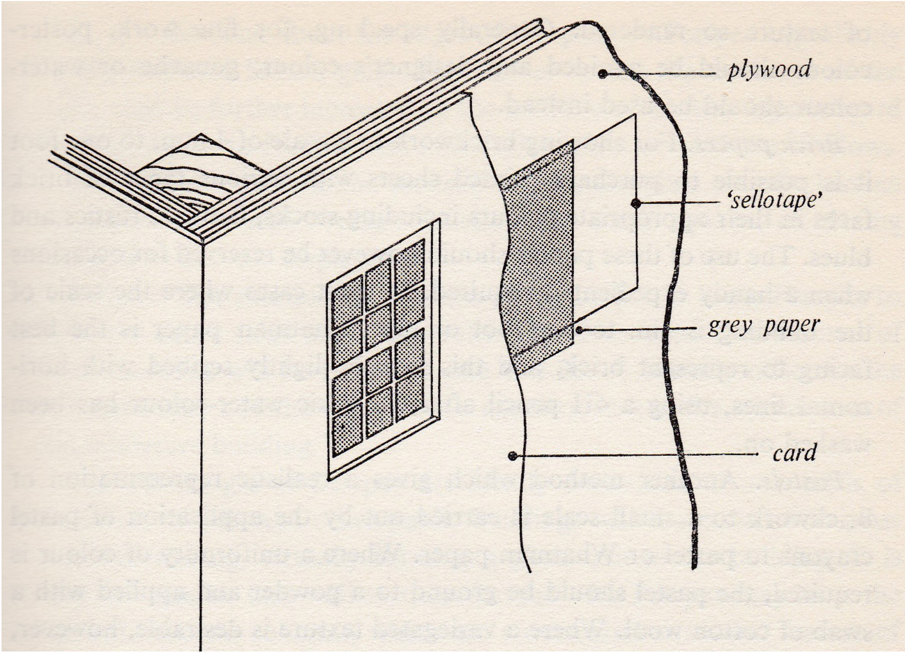

Figure 5.30: Diagram showing timber and card model construction, Thomas Hendrick, 1957

> In the first place, unless the scale of the model is so great that the thickness of the plywood forms a true representation of the width of the reveals, the proportions are badly out, particularly if the plywood has to receive an additional layer of card to provide a suitable surface for the exterior colour treatment. Looking at the walls from the inside, what is to be done about the edges of the glass or Perspex? (probably oozing beads of Scotch glue). The answer is that the thickness of the walls must be further increased by the addition of another layer of card on the interior to form a trim and flush surface around the window (Hendrick, 1957, pp.66-67).

This approach, while tidying up the visible interior of the model, was not only complicated to construct and unnecessarily time consuming, but further increased the thickness of the walls beyond what was true to scale. The solution, as Hendrick further noted, was to use Perspex for the entire structure (Hendrick, 1957, p.67), just as McCutchon had demonstrated in 1938. The Perspex walls could then be clad with either plywood or card facades with windows cut into them, leaving the Perspex underneath completely clear. Window bars could be scribed

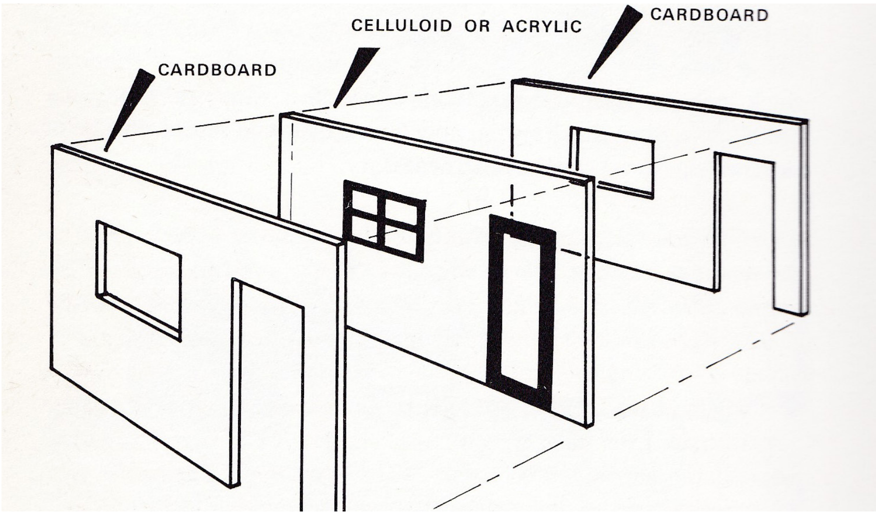

Figure 5.31: Diagram showing Perspex wall construction. Drawn by John Cleaver, 1973

into the Perspex and paint rubbed into the grooves to simulate the appearance of frames (Figure 5.31). The combination of a Perspex structure and card facings proved to be highly successful, and by the mid-1950s, pre-printed brick papers and rub-down transfers were adding extra realism in the representation of different materials such as concrete, brick, and tile. In 1952, Thorp made a large 1/8th of an inch to 1 foot model of a proposed office block for the Albert Embankment in London (Figure 5.32) using this approach, while McCutchon Studio, by the mid-1950s having become one of the largest architectural modelmakers in London – likely advantaged by McCutchon's early adoption of Perspex before the war – built an impressive model of the proposed new terminal for London Airport that used a combination of both approaches to wall and glazing construction; solid plywood walls with card facades used for the main buildings, and clear Perspex for the heavily glazed areas overlooking the apron (Figure 5.33). A later airport terminal model by McCutchon shows the degree to which the latter method could so enticingly represent modernist architectural designs; the openness and transparency of the model only being possible with the use of all-Perspex walls with card facades (Figure 5.34). Being able to see into buildings greatly improved the sense of realism in architectural models, while the effect of internal lighting such as in Nick Quine's 1963 all-Perspex model of Magnet House (Figure 5.35) encapsulated modernism's idea of architecture as forms assembled in the light. The technical precision with which pieces of Perspex could be cut, engraved, sanded, and attached to one another

Figure 5.32: Model of Albert Embankment offices, made by Thorp, circa 1952

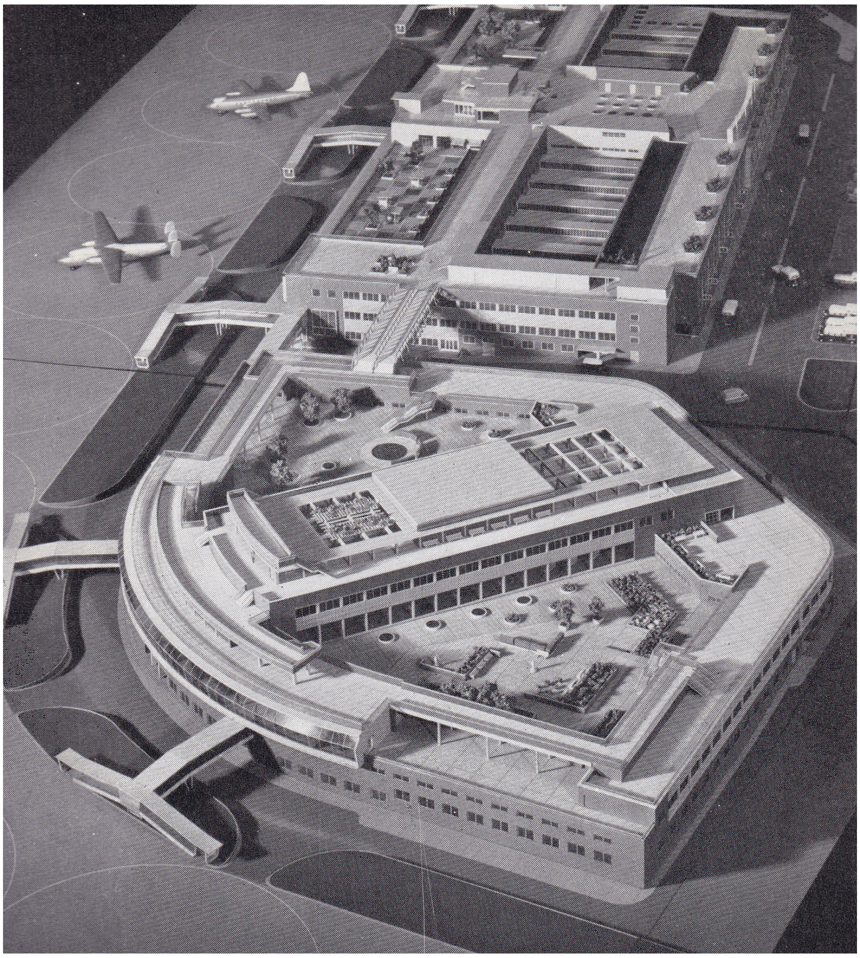

Figure 5.33: Model of London Airport, made by McCutchon Studio, circa 1954

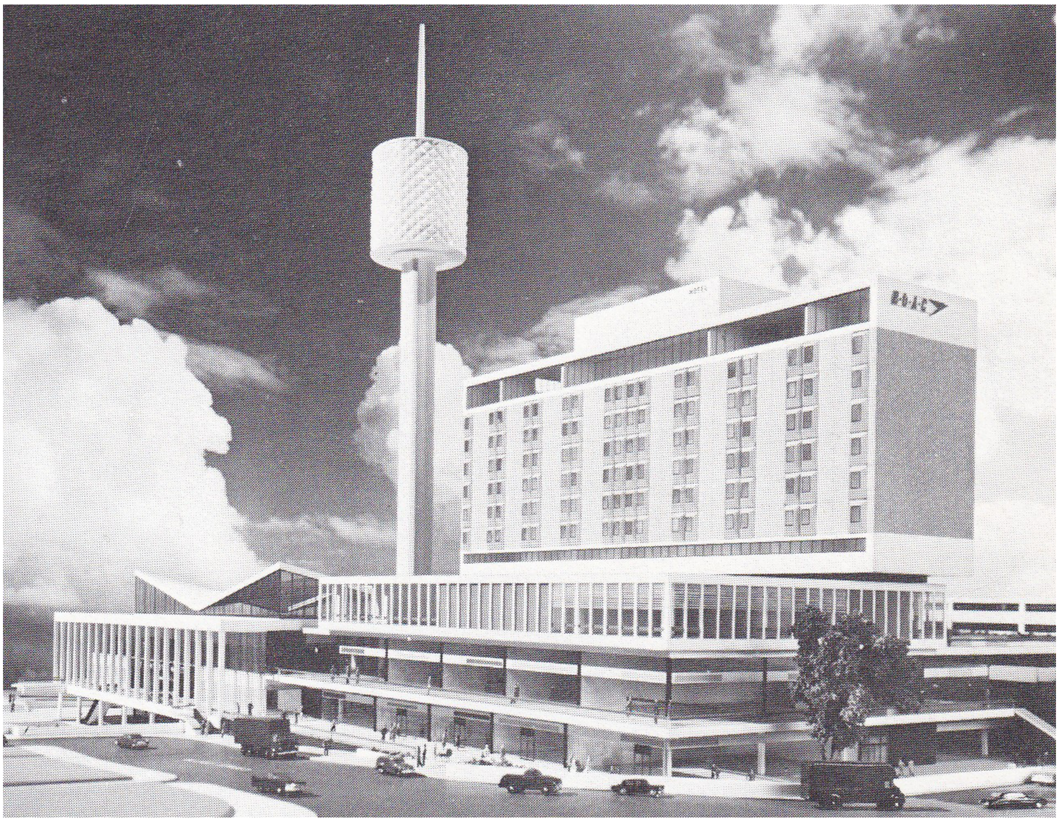

Figure 5.34: Model of an airport terminal, made by McCutchon Studio, circa 1960

Figure 5.35: Illuminated model of Magnet House, made by Nick Quine/AMI, 1963

also allowed for cleaner and often invisible joins between component parts, further adding to the realism of models.

The use of Perspex walls with card facings remained a widely-used approach to model construction until the late 1980s, particularly so within in-house modelshops such as those maintained by the LCC and other local councils. This was partly due to the cleanness of construction. The cutting and assembly of Perspex walls required only the most basic of workshop machinery – circular and band saws, a sanding disk, and pots of dichloromethane to weld the pieces together. Card, being either painted by hand with inks and watercolours, or furnished with brick papers and rub-downs, required no messy or potentially toxic paints, cellulose-based paint having become the norm in the commercial architectural modelmaking firms during the 1950s (Taylor, 1959, p.149). For commercial architectural modelmakers such as Thorp and McCutchon Studio, however, card was gradually replaced with high-impact polystyrene sheet (HIPS) during the 1960s (Chisholm, 1969, p21; Cleaver, 1973, p.60). Having been developed by BASF in the 1930s, HIPS was a fairly brittle, opaque, and cheap plastic that came in a variety of thicknesses down to less than 1mm, was very easy to cut with a scalpel, and being able to be sanded and heat bent, was a far more durable material than card that could take cellulose paint well. The ability to spray-finish architectural models further increased their levels of quality and realism.

Perspex also opened up entirely new methods of model construction, and as a consequence, allowed architectural models to express elements of designs that had been previously impossible. As early as 1949, the architectural practice ARCON made use of a largely clear Perspex model to show the interior arrangement of floors and spaces in a proposed church design (Figure 5.36), while in 1958, Thorp produced a remarkable concept model for a proposed design for the Barbican in London that used stacked layers of Perspex sanded to give a frosted appearance, the first known example of what was then a startlingly modern take on the traditional wooden block model (Figure 5.37), and which today has become a commonplace method of representing building masses during early design stages for planning or competition purposes. Nick Quine, whose career was noted in the introduction to this chapter, made extensive use of Perspex from the very start, including in a model

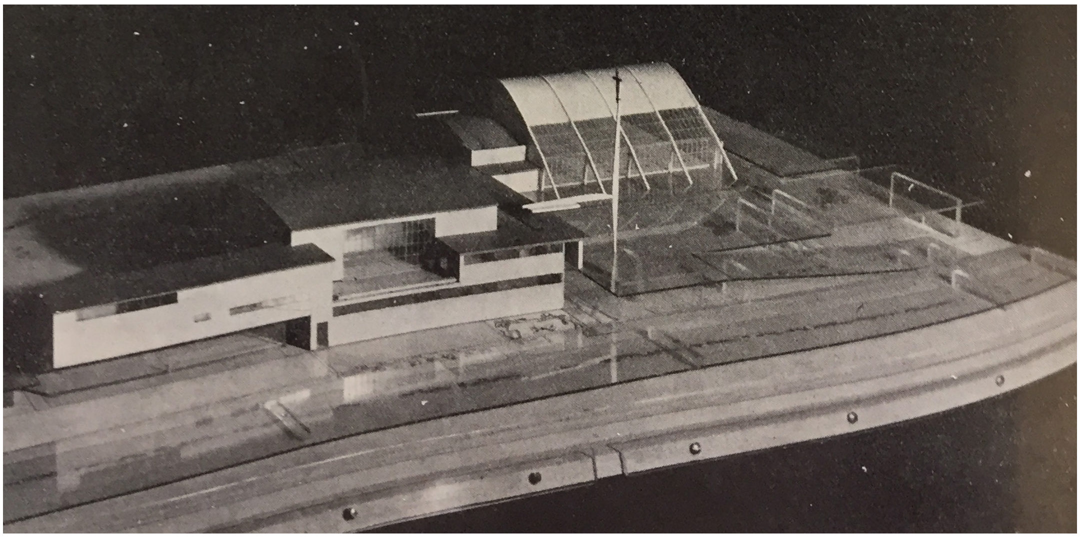

Figure 5.36: Model of a proposed church with clear Perspex floors, 1949. Modelmaker unknown

Figure 5.37: Abstract block model using stacked frosted Perspex, made by Thorp, circa 1958

of a proposed office tower for Brussels made in 1960 (Figure 5.38). In 1957, Thomas Hendrick further commented on the development of fluorescent Perspex, sheets of which had a characteristic neon glow when left unpolished, further opening up new possibilities for highlighting surfaces in cutaway sections of models (Hendrick, 1957, p.223), and which later led to the development of new creative styles in the 1990s with the introduction of the laser cutter (see Chapter Seven).

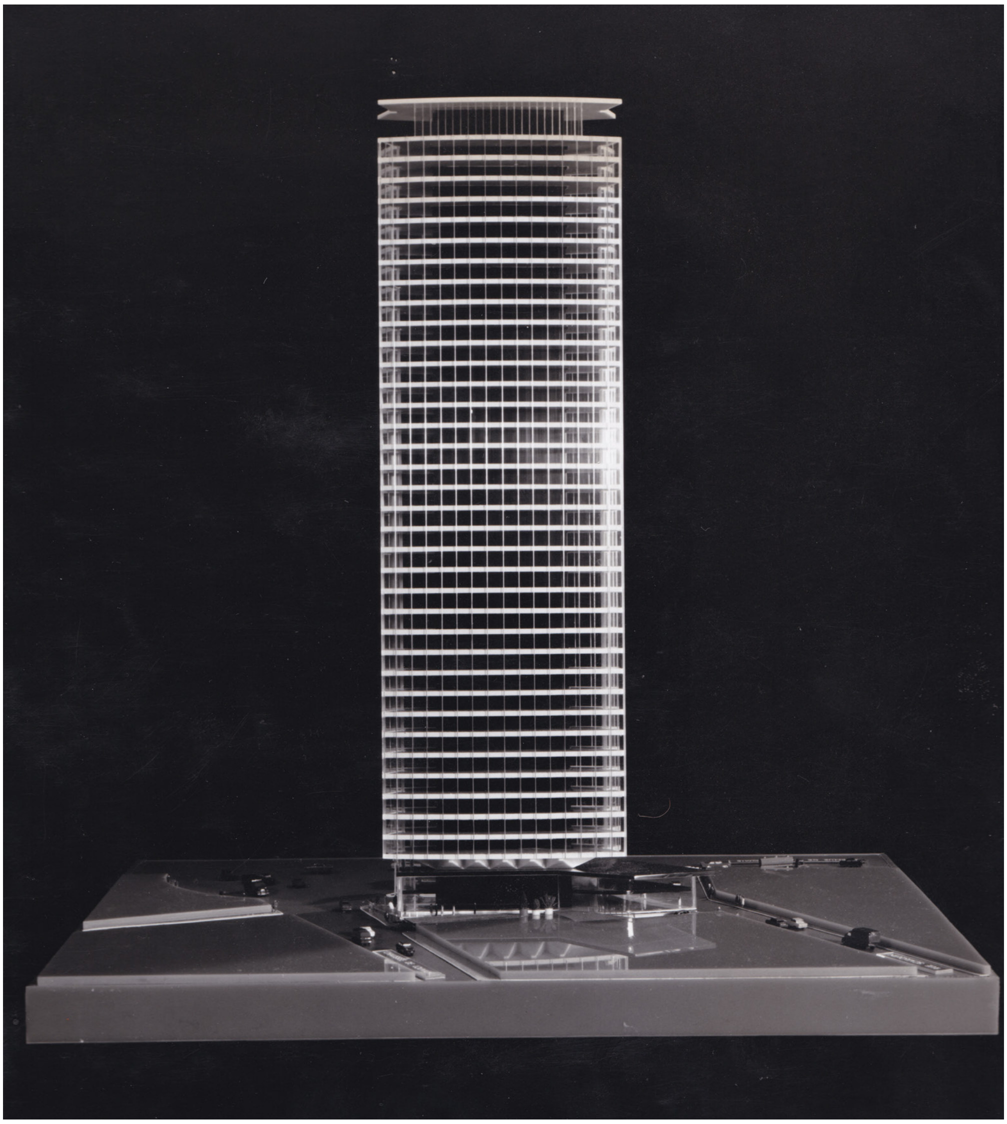

Figure 5.38: Perspex model of a Brussels office tower, made by Nick Quine/AMI, circa 1960

While the use of Perspex in creating more abstract models such as Thorp's frosted stack block model would not be fully exploited for several decades, Perspex's main consequence for the architectural model during the 1950s and 1960s was to enable the new more lightweight and open forms of modernist architecture to be realistically portrayed while at the same time keeping the weight, cost, and time needed to construct a model down to an affordable level. Perspex's transparency and sheer adaptability, being able to be machined in a variety of ways and finished through moulding, engraving, painting, and laminating to represent a diverse range of other materials, meant that by the end of the 1950s it was the principal material used by professional architectural modelmakers in Britain. The mixing of materials that had been the hallmark of the first generation of professional modelmakers such as John Thorp and Ernest Twining, had, during the post-war era, settled down into a suite of materials that could be applied to different purposes, but less often within a single model. Differing rates of thermal expansion and contraction encouraged modelmakers to limit the number of materials used in a single model, especially given Perspex's impressive dimensional stability compared to timber. Balsa, plywood, and hardboard were still used for baseboard construction, with beech, sycamore, and mahogany strips used for facings (Hendrick, 1957, p.27), while Perspex, polystyrene sheet, and card became the dominant materials used for the buildings themselves.

With the adaptable approach of the modelmaker having been matched by an adaptable material – Perspex – and one that also so ideally matched the requirements of representing modernist architecture in model form, the standard materials of model construction remained remarkably consistent throughout the rest of the twentieth century, as did the basic principles of construction until the arrival of CAD/CAM technologies during the 1990s (see Chapter Seven). Alec Saunders, who started his modelmaking apprenticeship with Thorp in 1973, noted that 'the stock material back then was Perspex and [poly]styrene sheet...it's the same today really, because nothing has replaced them at all' (Saunders, 2018). This is not to say that materials and processes did not advance, or that the modelmaker's enthusiasm for exploring new materials and methods grew stale, however. The use of polystyrene sheet opened up the prospect of vacuum forming complex shapes, and when Ray Pfaendler took over Thorp after Leslie's death in 1966, he invested in an entirely new suite of wood and metal working mills and lathes, vacuum forming machines and pantograph engraving and scaling machines (similar to a key cutting machine), which Alec Saunders remembers with fondness:

> You could make copies and change the scale of objects. If we did an airport, for example, we would take an Airfix jet and we would put half of it on a panel and follow this roller over it, and it would produce half in a block of [Perspex], then register it and turn over the other half of the fuselage and create the other side. You'd get a perfect scaled aircraft (Saunders, 2018).

In 1972 it was noted that within modelmaking 'modern plastics – in only twenty years – have usurped the roles of many ancient materials' (Newman and Newman, 1972, p.1). Just a few years later, plastics manufacturers were keen to note that 'modelmakers have developed construction methods in which plastics materials are used almost to the exclusion of all others' (Beetle Bulletin, 1976, p.6); Ray Pfaendler at Thorp having commented in 1966 that 'the wide variety of thermoplastics and thermosetting plastic materials now available have greatly increased the scope of modelling techniques, and made possible the production of almost any free form shape or pattern' (Pfaendler, 1966, p.5). The sheer versatility of plastics such as Perspex and polystyrene sheet was such that modelmakers rarely found themselves looking for additional materials, and instead could focus their attention on improving the quality and detail of models. For the architectural modelmaker, the plastics revolution was taking place at a time when, as the plastics industry journal *Beetle Bulletin* observed:

> Plastics materials are impinging on almost every art and craft, [and] it is not surprising that the professional modelmaker – who is both artist and craftsman – is making more and more use of them to satisfy exacting demands for both accuracy and realism imposed by architects and planners (Beetle Bulletin, 1976, p.2).

The resultant improvements in quality and realism in professionally-made architectural models during the 1950s and early-1960s is clearly evident in photographs from the period. Nick Quine's 1962 model of Tolworth Tower (Figure 5.39) was made almost entirely from Perspex, with card only being used for the shop signage, illustrating the high level of detail possible through the use of accessories such as injection-moulded vehicles and scale figures to animate a model. While Quine was making his own accessories, most modelmakers took advantage of the model shop that fronted Thorp's premises at 98 Gray's Inn Road. Thorp's shop had begun as a place to hold stock material needed by the modelmakers in the workshops behind the main building, with Thorp casting their own figures, vehicles, and other accessories including various types of model tree. By the mid-1950s it was supplying modelmaking materials including Perspex and polystyrene sheet to other modelmakers and architects across London, and Thorp's designs of figures and vehicles in particular, produced

Figure 5.39: Model of Tolworth Tower, made by Nick Quine/AMI, 1962

at various scales due to the application of the pantograph scaling machine, began to be seen on almost every architectural model made in the country. By the 1990s, the shop had become so successful as to be a distraction to Thorp's actual business of making models, and was eventually taken over by its staff and became 4D Modelshop, still the largest supplier of modelmaking materials and accessories in Britain today.

With the added availability of pre-made scale model trees and flock powder during the 1950s, as well as softer plastic foams that could be carved and shaped with hand tools, more realistic natural landscapes could also be modelled (Figure 5.40). The availability of such accessories also greatly increased the efficiency of model construction. Whereas a model such as Twining's 1934 model of Bournemouth (as described in Chapter Four) involved the hand-making of two thousand vehicles, it was now possible to purchase these ready-made, vastly reducing the time needed to complete a model to such realistic standards. This was particularly important, as not only did it keep costs down, making the model more affordable for a wider range of clients, but it allowed clients to see their money being spent where it

Figure 5.40: Model for Vickers Engineering, made by Nick Quine/AMI, circa 1965

was visible to the people – planning committees or the general public – that the model was intending to illicit support from.

The use of Perspex revolutionised the construction of architectural models and opened up new possibilities for the levels of quality, technical precision, and realism that could be achieved, all of which drove further demand for models during the post-war boom; Thorp Director Ray Pfaendler, who took over the company after Leslie's retirement in 1964, noting the benefits of the 'considerable advances over the last twenty years in the techniques of precision [that modelmakers] can bring to bear' (Pfaendler, 1966, p.1). Ultimately, Perspex enabled the model to remain highly relevant to both architects and the public at large by allowing modelmakers to successfully adopt new methods of construction that captured the feel of modernist architecture during the expansive demand for architectural models during the post-war boom. The consequences of this shift, however, were to outlast both the boom and modernism itself, as while Perspex was ideally suited for modernist architecture, the approach of building a hollow Perspex core clad with layers of card or polystyrene sheet was suitable for almost any form of architecture – modernist or otherwise. The profound effect the introduction of Perspex had on the model, combined with the enormous demand for models during the post-war rebuilding efforts, and the availability of a newly-expanded profession due to the influx of ex-RAF modelmakers trained in the pursuit of accuracy and realism, had resulted in a period of significant advancement for the professionally-made architectural model in Britain during the 1950s and early-1960s. By the time Nick Quine made his impressive 1963 model of Centre Point featured at the start of this chapter, the post-war modelmaking boom had led to a plastics revolution that firmly established Perspex as the dominant material used in architectural model construction.

With the benefits of Perspex helping to fuel a continued demand for architectural models, after an initial period of post-war austerity, the cost of architectural models once again started to become an issue, however, threatening a repeat of the problems of the inter-war years; the modelmakers at Thorp finding themselves increasingly working in smaller scales to offset the general rise in costs that the greater complexity of models brought about (Pfaendler, 1966, p.4). Despite these concerns, and with demand high, the profession continued to grow. Alongside Thorp, McCutchon Studio, Cockade, Preview, Twining Models, Nick Quine's company Architectural Models International, Partridge's Models, Hunting Aeromodels, and the Models Section of the LCC Architects' Department all continued to expand, the larger organisations employing over twenty modelmakers each (Hendrick, 1957, p.13). Further companies began to open around the country, sometimes just single modelmakers working on their own, taking advantage of a demand for models that was beginning to spread beyond just London. Mike Karslake, having set up on his own after leaving the Basildon Development Corporation in 1956, quickly found work making models for the oil industry, the discovery of the North Sea oil field sparking the need for models of both oil rigs and land-based processing plants (Karslake, 1981). By the end of the 1960s, Karslake was employing seventeen modelmakers and had won the Queen's Award to Industry. Writing at the end of the 1950s, Thomas Bayley also observed a change of emphasis in the role of the modelmaker, noting that:

> [W]hereas in the past little more was expected of the model maker than that he should produce a true to scale model of whatever was presented to him, one can now expect, and indeed demand, models

> which are both artistically designed and of superb craftsmanship (Bayley, 1959, p.5).

Throughout the post-war boom the architectural model itself continued to prove its worth as an indispensable tool for both the architect and planner alike; local authorities having begun to insist that any scheme submitted for planning approval be accompanied by a model (Pfaendler, 1966, p.5). Nick Dunn has suggested that the post-war period saw the architectural model consolidate its position as a powerful method of communication (Dunn, 2007, p.31), and it is clear that by the 1960s, contemporary appraisals of the model were even more strongly in favour of their utility than they had been before the war (see Taylor, 1959, p.xi; Pfaendler, 1966, p.5). Thomas Bayley noted in 1959 that ‘considerable progress has been made in the craft of model making: not only has the demand for models greatly increased but a more informed appreciation of their qualities is being shown’ (Bayley, 1959, p.5).

Central to the success of the architectural model during this period, however, was the ability of plastics to be worked and finished to mimic so many other materials in model form, perfectly complementing the architectural modelmaker’s ability to adapt one material to represent another, and by the end of the 1950s, Robert Hoyt’s observation of ‘ingenious adaptation’ as a crucial element of architectural modelmaking had been independently expressed several times, Thomas Hendrick writing in 1957 that:

> New and improved materials and methods are evolved daily and the eager hunter of information will be rewarded by discoveries which will save him time and money in addition to improving the construction and appearance of his models (Hendrick, 1957, p.26).

Just two years later, Norman Taylor remarked that ‘all true model makers...are usually noted for their ingenuity and ability to adapt unusual materials to their own particular requirements’ (Taylor, 1959, p.23). Though unacknowledged at the time, however, a significant change had occurred to what Hoyt’s notion of ‘ingenious adaptation’ was now referring to. Having himself focused on recognising adaptability as an intentional act of the modelmaker in their 'quest for new methods, tools and materials' (Hoyt, 1939, p.420), as a result of the introduction of plastics, however, the adaptability so central to modelmaking had expanded to incorporate the intrinsically adaptable properties of plastics as well, emerging from the combined agency of the modelmaker's imaginative and ingenious intentions and the inherent adaptability of their newly-adopted materials.

5.6. Conclusion

This chapter set out to examine the professionally-made architectural model's post war development in Britain, while also tracing the origins of the plastics revolution that followed the widespread adoption of Perspex to modelmaking during the 1950s. In charting the complex interactions between people, materials, and ideas that shaped the model during this period, this chapter has revealed how the convergence of an influx of highly trained ex-RAF modelmakers into the profession shortly after the Second World War, an enormous demand for models during the post-war rebuilding and modernisation efforts, the challenge of representing new modernist architectural styles, and the introduction of Perspex led to the emergence of an unprecedented architectural modelmaking boom in which both the model and the profession were radically transformed.

With Chapter Four having established the influence of new material developments in the form of card and paper models influencing the formation of the very profession of architectural modelmaking (see pages 80-84), as Chapter Five has outlined, the model's post-war development was once again heavily shaped by the adoption of a new material, Perspex. Chapter 5.2 charted the first tentative uses of plastics by architectural modelmakers shortly before the outbreak of the Second World War, where Perspex's potentially revolutionary consequences for model construction, despite having been almost immediately identified, were delayed due to its production being restricted to military uses during the Second World War.

By the time of Perspex's eventual return to widespread commercial availability during the late-1940s and early 1950s, the profession of architectural modelmaking in Britain had been greatly expanded due to the entrance of a significant number of highly-trained ex-RAF modelmakers into the profession after the end of the war who had been trained to make exceptionally accurate and highly realistic landscape models at the top secret V-Section modelmaking section at RAF Medmenham, as Chapter 5.3 outlined. Coinciding with an enormous demand for planning models during the rebuilding and modernisation of Britain in the late-1940s and early-1950s (pages 150-164), these ex-military modelmakers were able to apply their skills in bringing about significant improvements to the levels of realism in architectural models in the immediate post-war era. As the need for models for the New Town projects such as Harlow gathered pace during the early-1950s, the Festival of Britain made a clear statement to both the public and to architectural modelmakers that new buildings constructed to grace the new towns and redeveloped Britain were going to be quite different to what had gone before; architects and planners having fully embraced the principles of modernist architecture (pages 165-170).

As described in Chapter 5.4, however, the additional demand for models to describe the merits of this new architectural style to an often sceptical public was compounded by the additional challenge of how to effectively represent it, with the then established materials and methods of model construction unable to do so to the high levels of realism and accuracy that the model had then reached. With the introduction of entirely new forms of building such as high-rise tower blocks, and the extensive use of glass, steel, and concrete, a pressing need emerged to adopt new modelmaking materials and methods (see pages 170-173). As Chapter 5.5 revealed, Perspex provided the solution, its use bringing about revolutionary changes to the ways in which architectural models were constructed, shifting to hollow constructions that enabled light to shine into, and out from, architectural models, while at the same time allowing for much higher levels of realism through its ability to be shaped, painted and textured (pages 176-181). Perspex's transparency, stability, ease of working, and ultimately its transformability suited both the practical demands of architectural modelmakers and the stylistic demands of modernist architecture. The combination of Perspex and the high standards of realism that had been established by the ex-military modelmakers after the

Second World War ultimately allowed modernist architecture to be represented highly effectively, securing the model's relevance and further expanding is positive perception and standards of quality.

With this chapter having revealed the convergence of elements that gave rise to the post-war boom in architectural modelmaking in Britain, and as a consequence, traced the origins of the plastics revolution that transformed the architectural model during this period, it has also highlighted how the very notion of 'ingenious adaptation', observed by Robert Hoyt in 1939, expanded during this period to incorporate not just the ingenious and imaginative intentions of the modelmaker, but also the inherent adaptability of their newly-adopted materials, plastics. Thomas Hendrick's 1957 observation of plastics that 'the use of these materials has done more to facilitate the methods of construction and to improve the finish of architectural models than any other substance or method' (Hendrick, 1957, p.34) is one that is revisited several times throughout this thesis, as the sheer adaptability of Perspex, its suitability for laser cutting, and the later introduction of plastics-based 3D printing polymers (see Chapter Seven) extended the legacy of the adoption of plastics in the post-war era far beyond even the levels of realism and detail that modelmakers such as Nick Quine were able to achieve by the early-1960s. As such, the influence of the plastics revolution that emerged from the post-war boom still continues to shape the model today, and it is arguable that the architectural model still resides in its own version of the 'Plastics Age' (Yarsley and Couzens, 1941, p.152) that had so captured the public imagination in pre-war Britain. Just as the utopian shine of plastics was being clouded by cheap and poorly made imported goods during the 1950s, the dream of a 'brighter, cleaner and more beautiful world' (Yarsley and Couzens, 1941, p.152) made possible by plastics found an unexpected surrogate home in the miniature utopia of the architectural model.

The legacy of the plastics revolution that emerged from the post-war boom, in bringing about much improved realism and accuracy, was not altogether welcome, however. The close associations with modernist utopian visions that the model developed during the optimism of the post-war rebuilding efforts, and the realism that Perspex enabled, were to cause significant problems when modernism, realism, and plastics – despite all they had done to improve the quality of the architectural model – began to rapidly fall out of fashion in the late-1960s and 1970s. As the next chapter reveals, the model's success in the post-war era was quickly threatened by a substantial decline in the professionally-made architectural model's fortune that, when addressed in the 1980s, sparked a creative expansion in which the dominant approach of realism in architectural modelmaking was replaced with a diverse range of styles that embraced a newly diverse approach to architectural design.

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6: Contested Realism and the Creative Expansion: The Arup Legacy and the Broadening of the Architectural Model's Stylistic 'Palette', 1969-1991

Figure 6.0: Model of Luton Arts Centre, made by 3DD, circa 1995

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6.1. Introduction

In 1991, an architectural competition was held at the Venice Biennale to design the Venice Gateway, a new bus station for the city. Modelmaker Richard Armiger was commissioned to produce the architectural models for four different British architectural practices that were submitting entries; each of the architects – Eva Jiricna, Harper MacKay, Weston Williamson, and Dixon Jones having produced radically different designs. The challenge for Armiger was to make each model distinctive without imposing his own 'house style', using different combinations of materials together to create visual and textural contrasts in highly abstracted ways that reflected the architects' personalities as much as they did the designs of the proposed buildings. Comparing the models Armiger made for Eva Jiricna and Harper MacKay clearly demonstrate two very different visual languages being employed (Figures 6.1 and 6.2).

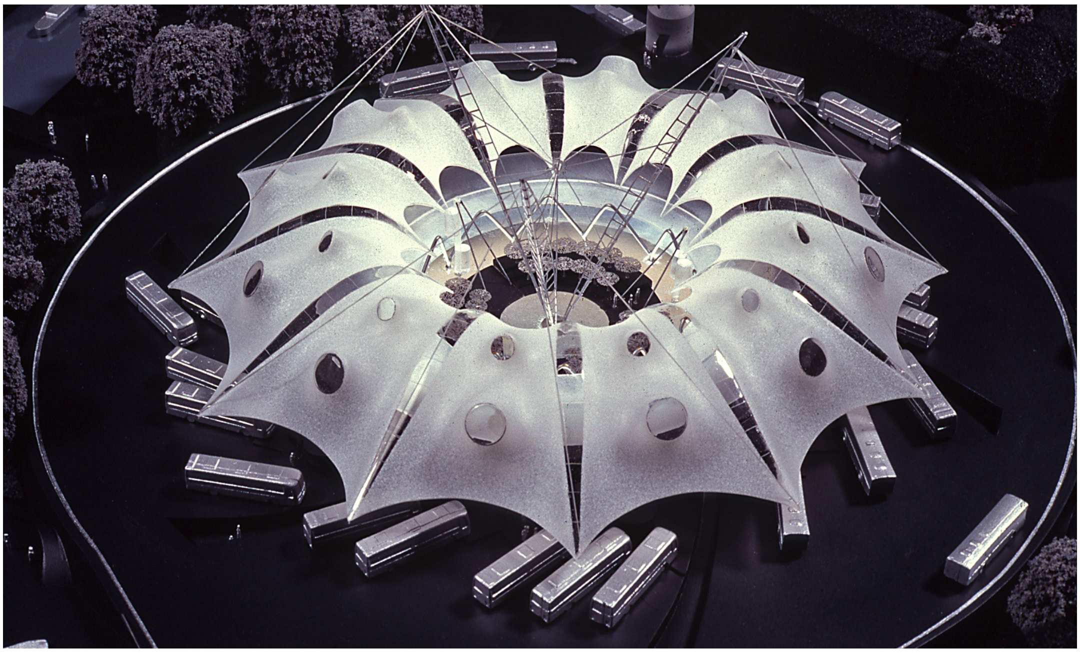

Figure 6.1: Model of Eva Jiricna's entry to the Venice Gateway competition, made by Richard Armiger, 1991. Photograph by Andrew Putler

Figure 6.2: Model of Harper MacKay's entry to the Venice Gateway competition, made by Richard Armiger, 1991. Photograph by Andrew Putler

Armiger's models for the Venice Gateway competition are emblematic of a major development in the history of the professionally-made architectural model in Britain that emerged during the 1970s and 1980s: its expanded stylistic diversity. That one modelmaker was able to produce four abstract models in radically different styles, all of the same site, for the same competition brief, and at the same time, was the result of a broadening of the stylistic palette used by architectural modelmakers to embrace far greater levels of creativity and abstraction than had been the case just a decade earlier when realistic models had largely been the only style on offer. As the previous chapters in this thesis have revealed, the pursuit of realism had from the very start been a strong motivating factor throughout the history of the professionally-made architectural model in Britain, and had been significantly boosted during the post-war era through the arrival of RAF-trained modelmakers and the availability of Perspex. Prior to the 1980s, abstraction in a professionally-made architectural model generally implied simplification – the omission of unnecessary detail, particularly in small-scale planning models such as those that dominated the immediate post-war era (see Chapter Five). As Armiger's models for the Venice Gateway demonstrate, by the 1990s, abstraction in an architectural model involved making visual and material choices designed to be expressive rather than literal depictions of a project's design, with the professionally-made architectural model in Britain occupying a broad spectrum of styles that included both intricately detailed realistic representations of proposed buildings and highly creative abstracted interpretations of architectural designs and concepts.

This chapter traces the emergence of the stylistic diversity of the professionally-made architectural model in Britain by examining the creative expansion that took place during the 1970s and 1980s, a period in which the model's stylistic palette widened to better match the pluralistic approach of architectural practice that had emerged in place of the certainty of modernism, and which allowed for the dual role of the model as both a commercial sales tool and a visionary expression of architectural ideas to be reconciled within a much broader aesthetic range. The changes that took place during this period mark an important stage in the development of the professionally-made architectural model in Britain that saw a notable increase in the use of abstraction, more creative uses of materials, and a resurgence of the use of timber as a modelmaking material as the model underwent a further series of 'ingenious adaptations' in order to meet the conflicting demands of both the architect and the developer. Applying this thesis' conceptualisation of the architectural model as an assemblage, this chapter aims to understand the interactions between the people, processes, materials, and ideas that shaped the model's development during this period.

Drawing further from the Thorp modelmaking archive, this chapter additionally benefits from new analyses of publically-available archival documents and photographs from contemporary architectural journals, practical publications on the making of architectural models, secondary literature charting the economic, social, and ideological changes affecting property development in Britain, and an extensive range of interviews with retired and practicing modelmakers who worked during this period including George Rome Innes, Roger Hillier, Tina Miller, Robert Kirkman, Alec Saunders, Simon Hamnell, Neil Vandersteen, Richard Armiger, Christian Spencer-Davies, Helmet Kinzler, and model photographer Andrew Putler, as well as archival interview recordings of David Armstrong and Mike Karslake held by the British Library and the Essex Records Office respectively. In addition, access was granted to the private photographic collections of Andrew Putler, Architectural Models International (AMI), Robert Kirkman and Associates, former Arup modelmaker Roger Hillier, Network Modelmakers, 3DD, Unit 22, and Pipers Modelmakers.

The chapter begins by analysing architecture's increasingly negative attitude towards the professionally-made architectural model in Britain that took hold from the late-1960s onwards. Centred on a backlash against the improved levels of realism that the post-war plastics revolution had brought about (as outlined in Chapter Five), presentation and marketing models were criticised for too confidently predicting a future that architects were then held accountable for. The chapter then outlines how the contested nature of realism in architectural models stemmed from a growing conflict between the commercial uses of models as sales tools and their position as more visionary expressions of utopian futures; embarrassment of the post-war model's highlighting of the failures of the modern movement; and a fundamental shift in architecture's perception of what an architectural model was actually a model of. Locating this shift of perspective within the wider 'crisis of confidence' (MacEwan, 1974; Harwood and Powers, 2012, p.12) that affected the architectural profession following the end of the modernist consensus, and during a period of drastic changes to both its employment and client bases, the chapter then discusses the deterioration in architecture's relationship with the professionally-made architectural model during the 1970s that created a substantial gulf between the differing expectations of the model held by architects and developers. With architecture increasingly viewing the model as a representation of ideas rather than of actual buildings, the chapter then traces the development of abstract timber models during the 1960s and 1970s as alternatives to the prevailing highly-realistic Perspex models that architects were starting to reject, focusing on the influential Arup Associates modelshop under the lead of David Armstrong.

The chapter then charts Arup's contribution to the broadening of the model's palette during the 1980s as a result of the 'Arup School' of modelmaking being adopted by a new generation of modelmakers taught at the Medway School of Design in Rochester. The work of modelmaker Richard Armiger in applying this approach to competition models during the 1980s 'Big Bang' property boom is then covered in some detail, before examining how a major fragmentation of the dominant commercial architectural modelmaking firms brought competition to the industry and provided opportunities for these more creative modelmakers to establish themselves, adapting the model's visual and material language to allow for a much more diverse range of styles to accommodate the conflicting needs of the architect and the developer. As a result, by the late-1980s the professionally-made architectural model in Britain reflected the changes that architecture itself had undergone, having embraced a multiplicity of styles and ideologies. The chapter concludes by summarising how the combination of the contested nature of realism in models; the Arup modelshop's more abstract and creative approach to modelmaking; and changes in both the architectural and modelmaking professions led to a dramatic broadening of the architectural model's appearance that saw it adapt to accommodate both the highly realistic and the abstract, restoring its relationship with architecture after a tumultuous period of change.

6.2. The Contested Nature of Realism

In February 1969, *The Architect and Building News* published a withering attack on the professionally-made architectural model by *The Daily Telegraph*'*s* architectural correspondent John Chisholm. Written at a time when concerns were being raised about the quality of buildings that had been erected during the commercial boom of the late-1950s and early-1960s, Chisholm put the blame squarely on presentation and marketing models. Noting that 'Hardly a project of any consequence rose from the ground unaccompanied by a prestige model' during this period (Chisholm, 1969, p.24), he argued that 'the apparently infallible honesty of the beautifully executed scale model has seduced planning committee, board of directors and the general public' (Chisholm, 1969, p.24). Chisholm even went as far to suggest that buildings were designed as they were simply because they were easier to make in model form, stating that:

> A cynical theory was once advanced that most of the rash of commercial building of the fifties was designed not by architects at all, but by one of the three or four large model-making companies operating at the time. After all, the repetition of apparently identical buildings clad in large glazed areas...and the acres of flat roofing

> did make their 'model' construction much easier (Chisholm, 1969, p.24).

In Chisholm's view, professional modelmakers, working for commercial clients, were responsible for the poor state of architecture in Britain at the end of the 1960s. Architectural models, Chisholm was adamant, should be made by architects themselves in order to develop their ideas, and not to sell those designs to other people. The problem with presentation models, Chisholm argued, was two-fold: that models were powerful tools of seduction, and that the realities they portrayed were at best unobtainable, and at worst dishonest. In striving for realism, architectural models were in fact being unrealistic. The snapshots of the future they presented were too precise, too clean, and too optimistic.

> Planning committees the length and breadth of the land were sold on the contents of hundreds of Perspex boxes enclosing the dust-free atmospheres of miniature 'true-to-scale' worlds of shopping centre, office redevelopment or point block housing project: A utopian climate where mini bays of exposed aggregate concrete wall cladding, shining sheets of aluminium and brightly coloured infill panels retained their original colouring and texture protected for ever from the corrosive effects of climate and smog ridden air. (Chisholm, 1969, p.24)

What Chisholm had articulated in his article was a realisation that the utopian fiction of the model was always unfavourably contrasted by the reality that followed. As Christophe van Gerrewey later described, the architectural model is ultimately a realisation of 'what architecture promises, yet can never attain' (Gerrewey, 2011, p.36), Chisholm further remarking that:

> Perhaps one of the saddest experiences of present-day life is to see a prestige model on display...as pristine and bright as the day it was proudly unveiled before the board of directors, while about it

> the all-too-familiar reality of the dream stands – stained and tatty (Chisholm, 1969, p.24).

By the late-1960s, the future that the architectural models of the post-war boom had been predicting had become the present, and the reality did not look at all like the models had suggested. By being too concrete in their predictions, in being too realistic in terms of detail, scenery, and inhabitation, architectural models were starting to be seen as giving a false impression of what a proposed building would be like. In capturing the idea of the building in its idealised state, models were creating a fantasy that a real building could never live up to. For Chisholm and others, this was an almost criminal act, and a backlash against realism in architectural models was well underway that was to play a crucial role in the widening of the architectural model's stylistic palette during the 1980s.

The high standards of quality and realism that emerged as a result of the post-war boom in architectural modelmaking had by the 1960s become a hallmark of the professionally-made architectural model in Britain. The introduction of Perspex, in the hands of a new generation of architectural modelmakers who had been trained to make highly realistic models during the Second World War, had proven to be the ideal material to represent the modernist architecture adopted for the rapid rebuilding and modernisation of Britain's war-damaged towns and cities; its transparency and adaptability revolutionising model construction and the levels of detail and technical precision that were possible to achieve. Clear glazing, fine details, complex paint effects to represent brick or concrete, miniature trees and shrubs, and pedestrians and road vehicles all added to a sense of realism that conveyed a more confident prediction of what a proposed development would be like (Figure 6.3).

From the work of John Thorp onwards, architectural commentators had long praised the efforts of the professional modelmaker in achieving increasingly realistic portrayals of future buildings, however there had always been doubts expressed about the wisdom of creating such realistic models, even before the profession was first established. As early as 1859, T. Richardson's book on architectural modelmaking in paper warned the reader to avoid rendering 'what was before a work of art a mere toy' through excessive colouring and detail

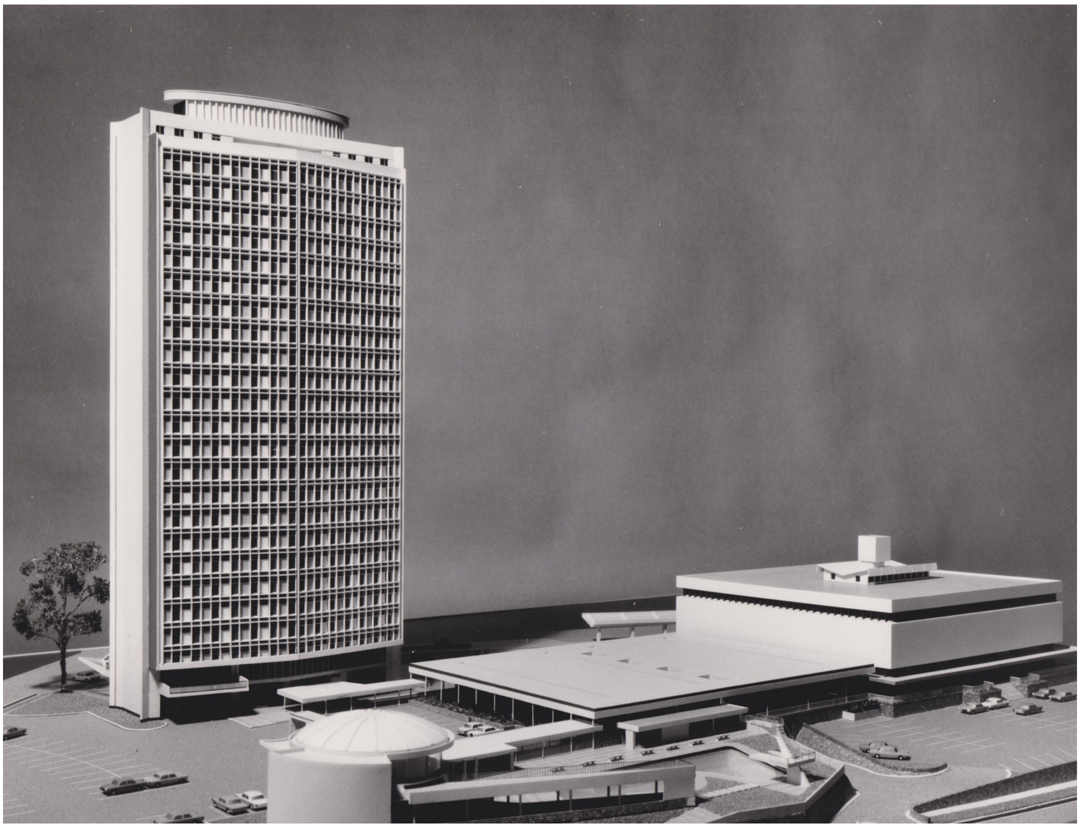

Figure 6.3: Model of a proposed Nigerian office development, made by Thorp, circa 1968

(Richardson, 1859, p.92), while as Chisholm himself had noted, the Renaissance architect Leon Batista Alberti had expressed similar reservations in 1452:

> The presentation of models that have been coloured and lewdly dressed with the allurement of painting is the mark of no architect intent on conveying the facts; rather it is that of a conceited one, striving to attract and seduce the eye of the beholder....Better then that models are not accurately finished, refined and highly decorated, but plain and simple, so that they demonstrate the ingenuity of him who conceived the idea, and not the skill of the one who fabricated the model (Alberti et al, 1988, p.34).

Chisholm's comments did not pass without comment from understandably offended architectural modelmakers, however. J.K. Adams, in a letter to the editor published the following month, wrote that the accusation that modelmakers were dictating the design of buildings that could be easily be made in miniature form was 'the biggest load of rubbish I have seen in print' (Adams, 1969). Adams further pointed out that the purpose of a model is to 'show how expertly the architect has dealt with his brief' (Adams, 1969), implying that architects might better look at their own work than that of the modelmaker when apportioning blame for poor quality architecture. Modelmaker George Rome Innes, who was working at Arup Associates at the time, later reflected on Chisholm's article, noting that it was 'a bit much to blame it on the models' (Innes, 2019).

The broader observations Chisholm made regarding the gap between the utopian vision of the model and the reality that followed were much more difficult to refute, however, and over the following decade, more and more articles appeared that continued his criticism of the professionally-made architectural model. Several contributors to the American publication *Great Models* (Buttolph, 1978) expressed the same concerns, with one architect echoing Chisholm's claim that modelmaking was in effect responsible for poor quality architecture, noting that modelmaking techniques had led to the design of buildings with 'mono-chromatic designs with cut-out elevations' (Hartman, 1978, p.31), while Romaldo Giurgola summarised his concerns about realistic models in that including detail to please the layman's eye turned the model into 'a mockery of the building' (Giurgola, 1978, p.68). In the same year, another architect commented that 'architectural models can tell the truth, but they can also tell partial truths, and even lie' (Abercrombie, 1978, p.79), while Richard Pommer in *Idea as Model* described presentation models as 'propaganda for persuading clients' (Pommer, 1981, p.3).

From the late-1960s onwards, realism in architectural models became a highly contentious issue in a way that had rarely been a concern before. In part this was caused by a frustration of the architect that the model created a better reality than the actual finished building, which meant models could be embarrassing reminders of what they had predicted. Equally, the model's association with the grand modernist projects of the post-war era, and their perceived failure, compounded a sense that the model had over-promised and that architects had under-delivered. Whereas the architectural models of the post-war boom had been confidently predicting a better future, it was manifestly clear by the end of the 1960s that those predictions had been wrong. More generally, there was also the model's growing association with commercial property development, something that was frowned upon by discerning architects of the 1960s, and the reality of the situation whereby the main commissioners of architectural models were no longer architects but developers, with their function having increasingly shifted from one of communication to one of sales.

The role of architectural models as sales tools had been fundamental to their success since their invention, and while models are perhaps more regularly described as communicating architectural ideas, that communication has often been for the purposes of convincing others to back them with either permission or financial investment, and, from the mid-twentieth century onwards, to purchase space in the resultant building. In 1919 an American article championed the architectural model as the most effective means of giving a client a concrete idea of an architect's intentions (Parker, 1919, p.119), with *The Building News* recommending in 1924 that models be used for advertising purposes (The Building News, 1924). A year later, the American architect LeRoy Grumbine described how successfully an architectural model can help an architect sell his design. An architectural model, he wrote, 'creates a desire on the part of the client, who sees a beautiful creation without the exercise of imagination. He wants it. His mind is on the thing itself, not the cost...the client is much better satisfied because he sees what he is buying before he buys' (Grumbine, 1925, p.59). The model, in Grumbine's opinion, had an important role to play in salesmanship, a role that increased as architects began to embrace the potential for model photography as marketing tools in illustrated magazines during the inter-war years (Deriu, 2012b, p.165). Modelmaker Kenneth McCutchon observed in 1936 that the ability of models to sell an idea was 'fully understood by [...] committees, who know that subscriptions and donations come more freely when a model is at hand to give concrete shape to a projected scheme' (McCutchon, 1936, p.459). Clients, he continued, liked to 'know what they are getting for their money – a point that is profitable for the architect to keep in mind' (McCutchon, 1936, p.459). Edward Hobbs wrote the following year that 'whatever one may feel about house models in estate agents and builders' offices, the acid test is, does the model attract clients and help to make sales?' (Hobbs, 1937, p.vii).

The model's success as a sales tool was due to the same reasons that explained its success as a communication device: 'Few people can resist the appeal of a good model' (Wickham, 1945, p.5). As architect Price Nunn commented, 'the architect of to-day has come increasingly to realise the usefulness of the model...to demonstrate to his client his intentions and purposes in a form the latter can easily understand' (Nunn, 1942, p.553). In the post-war era, the role of models to aid with commercial sales came to the fore (Moon, 2005, p.111). By the 1970s it was noted that 'models are excellent tools for public relations [and] fund raising' (Taylor, 1971, p.11), while an article on presentation models in the 1990s reflected on how effective architectural models were in raising money for a scheme (Fisher, 1995, p.80). Realism in such models was seen as a key part of the sales pitch:

> The miniature world is infinitely real and believable: it is easy to imagine oneself down in [...] the clean new environment where it is always summer. It is increasingly necessary to sell ideas; clients need to be persuaded (Rawson, 1990, p.63).

The aim of a good marketing model, the author continued, was to be able to produce a photograph that was indistinguishable from the real thing (Rawson, 1990, p.69). Architectural models, as had been the accepted intention from John Thorp onwards, were supposed to be as close representations of actual buildings as was possible. They were, after all, aimed at communicating architectural information to non-architects, their strength being their almost universal comprehension as a miniature representation of a proposed reality. A significant change that took place during the 1960s, however, was that it was no longer principally architects who were commissioning architectural models to aid with such salesmanship. By the time Chisholm launched his broadside against the professionally-made architectural model, the developer had become the main client of commercial modelmakers such as Thorp and McCutchon Studio.

During the inter-war years, cheap land prices had fuelled the rise of large building firms such as John Laing, Costain, George Wimpey, and Taylor Woodrow, while commercial estate agents began to open branches across the country, instigating a private building boom

(Marriot, 1989, p.13). Crucially, the RIBA had banned speculative architectural practice in 1920, leading to the bulk of new homes built in the inter-war years being designed by unqualified assistants or copied from pattern books (Hall, 2002, p.76). Models of these developments for display at exhibitions such as the *Daily Mail Ideal Homes Exhibition* were therefore ordered directly by the developers; architects having been largely bypassed in the design of privately-funded housing developments. Most architects remained happy to work within the public sector, and after the Second World War, the rebuilding efforts provided plentiful work for an entire generation of eager modernist architects (see Chapter Five). By the 1960s, however, the abandonment of building controls in 1954 had set the stage for a speculative property boom funded by private finance (Marriott, 1989, p.1). One New Change, Centre Point, and Paternoster Square – all these prominent developments required multiple architectural models, keeping the commercial modelmakers busy as developers sought to promote their schemes (Figure 6.4). The developer became a key source of funding and architects found themselves subservient to their commercial aims.

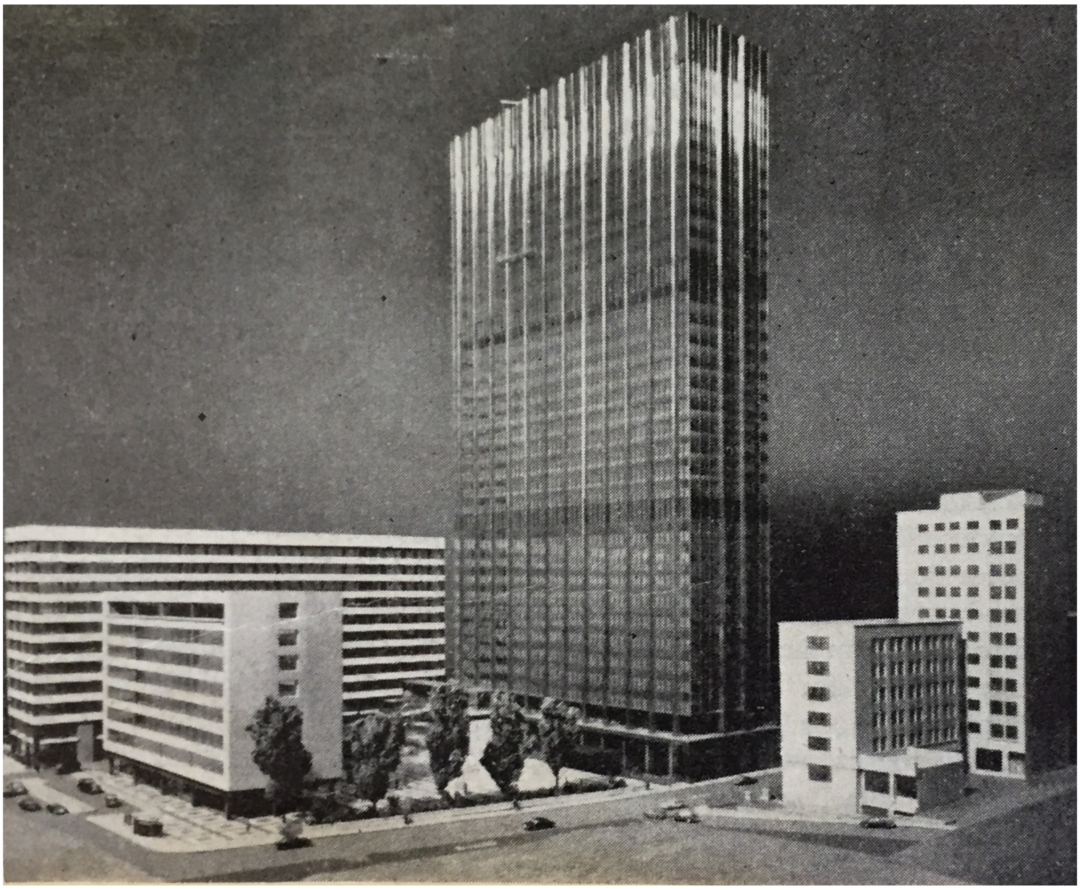

Figure 6.4: Model of Moorfields office development, 1963. Modelmaker unknown

Few developers at this time were primarily concerned with the aesthetics of the buildings they commissioned, being instead focused on extracting the maximum possible profit from the land they had purchased. ‘What developers want from architects is a service. They need functional buildings designed to a certain price, usually the lowest possible’ (Marriott, 1989, p.28). For idealistic post-war architects, this was not a particularly attractive market to be operating in. For ambitious young architects who wanted to get things built quickly, however, commercial development was an appealing option (Powers, 2007, p.144), as architects who did work for developers found themselves responsible for enormous numbers of new buildings. Peter Marriott has estimated that between fifty and seventy-five percent of all speculative office blocks built in London after the Second World War were designed by a mere ten firms (Marriott, 1989, p.27). Of the twenty-two thousand registered architects in Britain in 1969, fewer than five thousand were in private practice; local councils being the principal employers at the time (Marriott, 1989, p.27). Leading the design of speculative commercial buildings was the architect Richard Seifert, his partner George Marsh, and the developer Harry Hyams. By 1966, Seifert and Partners had designed such developments as Centre Point, Magnet House, and the Tolworth Tower. As was discussed in the previous chapter, modelmaker Nick Quine built his business producing many architectural models of their designs, and became notable for his dramatic all-Perspex realisations (Figure 6.5).

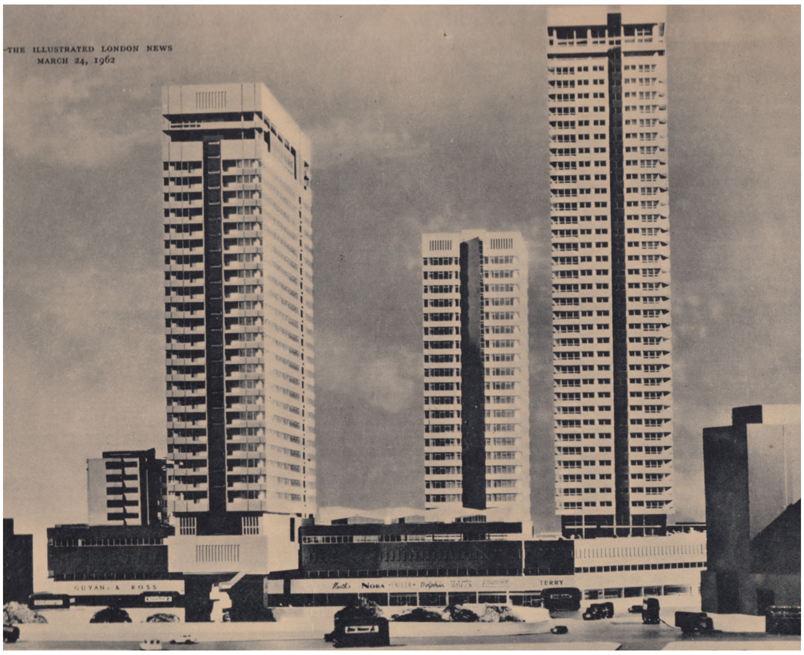

Figure 6.5: Model of Knightsbridge redevelopment. Made by Nick Quine/AMI, 1962

During the post-war boom, architectural models had rapidly become a central marketing tool for the developer, both to sell space in their buildings to prospective clients, and to secure the initial investments needed to build them. Peter Marriott quotes Douglas Tovey, an estate agent for one of the major 1960s developers on how he sold a site to his employer: ‘I usually have a model made. He loves a model, you see. When he sees it, he usually says “I like that”. I’ve almost never known him to say he didn’t like one’ (Tovey, cited by Marriott, 1989, p.28). As large-scale commercial developments such as the first covered shopping centres built by Arndale, Hammerson, and Laing took shape in the mid-1960s, models began to appear once more in town centres just as they had done to explain the post-war rebuilding programmes. This time, however, the developments were commercially-led, and being sold for the financial benefit of the developer rather than for the benefit of rebuilding a community. As a result of the model’s success in communicating the developers’ plans, commercial development became an increasingly large proportion of professional modelmakers’ business. Shopping centres such as Brent Cross and Eldon Square led to model commissions for Nick Quine (Figure 6.6), while Thorp found extensive work making models of proposed commercial developments in both Britain and abroad (Figure 6.7).

A consequence of this change towards developer-led model commissions was a substantial shift in the relationship between modelmakers and architects, and between architects and the model. Even while criticisms of highly realistic sales models such as Chisholm’s were being aired, the professionally-made architectural model was moving further away from architects’ control; modelmakers simply responding to the needs of their increasingly dominant clients, the developers, who continued to order highly-realistic models that the general public could easily understand. Such models soon became associated with gaudy colours and what architects quickly termed a ‘model railway’ aesthetic. As Karen Moon has noted, however, ‘the response of architects’ reaction to realism is usually in direct proportion to their conception of themselves as artists’ (Moon, 2005, p.131), a situation that increased through the 1970s as architecture underwent an internal shift away from the certainty and rationality of modernism, as this chapter will outline. High levels of realism in a model seemed not to reflect the creative work of an architect (Deriu, 2012a, p.169), and instead were deemed to be aimed at cultivating associations with childhood miniatures in order to

Figure 6.6: Interior model of Eldon Square shopping centre, made by Nick Quine/AMI, circa 1976

Figure 6.7: Model of office development, made by Thorp, circa 1975

sell property. As architects tried to distance themselves from the commercial realities of property development, 'the less palatable realism in models became' (Moon, 2005, p.132). The innovations and improvements to the model that had achieved such realism in order to communicate the post-war rebuilding plans and the nature of modernist architecture were now being put to purely commercial uses, and this was a situation that many architects were uncomfortable with, as for many architects and planners, models held much stronger visionary and utopian associations as expressions of their ideas of a better future. With competing demands from both developers and architects, the challenge facing the architectural model by the 1980s was how to reconcile two very different expectations.

6.3. Problems of Utopia and the Architectural Model in the Post-Modern Crisis

During the 1970s, the architectural profession's attitude towards the architectural model radically changed. Chisholm's 1969 broadside against the realism of presentation and marketing models merely marked the beginning of the model's involvement in a much wider 'crisis of confidence' (MacEwan, 1974; Harwood and Powers, 2012, p.12) that saw architecture grapple with the collapse of the post-war modernist consensus, and a dramatic shift in both its employment and client bases from the public to the private sector, extending architecture's conflict between commercial sales and utopian vision far beyond just the architectural model. Having embraced the 'linguistic turn' which brought a much greater focus on concepts of language and symbolic representation, new forms of architecture emerged in modernism's wake, while the architectural model itself underwent a critical re-evaluation that questioned its very nature. By the end of the decade, a situation had arisen whereby the architect's relationship with the model, and with the modelmaker, had been severely dented. While the professionally-made architectural model in Britain had become too readily associated with commercial property development for many architects' tastes during the post-war boom, by the 1970s its equally strong association with modernist utopian visions had also become problematic. As the utopian dreams of the post-war era were deemed to have failed, architects continued to look to the model as a surrogate for their idealistic visions, and the gulf between the expectations of the model held by architects and developers solidified.

Architectural models have been long recognised as having strong associations with concepts of vision, utopia, and the ideal (Lahti, 2000, p.163; Brejek and Wallen, 2018, pp.14-15). 'They are the natural territory of vision, perfectly adapted for projecting futuristic, visionary proposals, however intrinsically unbuildable they may be' (Moon, 2005, pp.103-4). Architectural modelmaker Richard Threadgill described how 'a model is architecture at its purist, untouched by building regulations and door handles. It is the ultimate expression of an architect's intentions' (Threadgill, 1987). As a favoured medium of modernists such as Le Corbusier and Mies van der Rohe, models also quickly gained strong associations with that particular ideological and architectural movement. For the visionary architects behind these designs, the model was often as close to reality as they could get; the world not yet fully prepared to embrace their ideas. Almost all architectural models project an architect's vision of the future, and in many cases, it is the only physical manifestation of that future that is realised – records of proposals that were never built. The model, as architecture in an ideal state, is therefore utopian by its very nature. A visitor to Thorp's workshop in the 1980s remarked that they were 'struck immediately by the fact that the world one is entering is illusory; a perfect, miniaturized version of the world as it should be' (Knights, 1980, p.6). Presenting a much tidier and clear-cut version of the world (Holtrop et al, 2010, p.120), architectural models 'free architects from the pressures of reality' (Moon, 2005, p.28), operating without the constraints and demands that real construction brings about (Schilling, 2018, p.119), and provide 'an illusion of reality without being compromised by it' (Pommer, 1981, p.3).

The connection between the architectural model and ideas of a better future can largely be traced to the inter-war years when modernism grew to become the dominant ideological force within architecture. Driven by a 'clear and pure vision' (Blake, 1976, p.iv), modernist architects saw architecture as the language through which they could express their ideas of a better world (Blake, 1976, p.xv). 'Hope was invested in architecture's ability to bring the emerging condition of the world under control and rescue it from disaster' (Powers, 2005, p.10). With a strong moral and social purpose to their designs, modernists saw that it was their duty 'to harness modern knowledge and modern technologies to build that better world' (Gardiner, 2011, p.327). From John Thorp's model of Edwin Lutyens' plans

Figure 6.8: Architectural Model for F. R. S. Yorke and Marcel Breuer, made by Twining Models, 1936

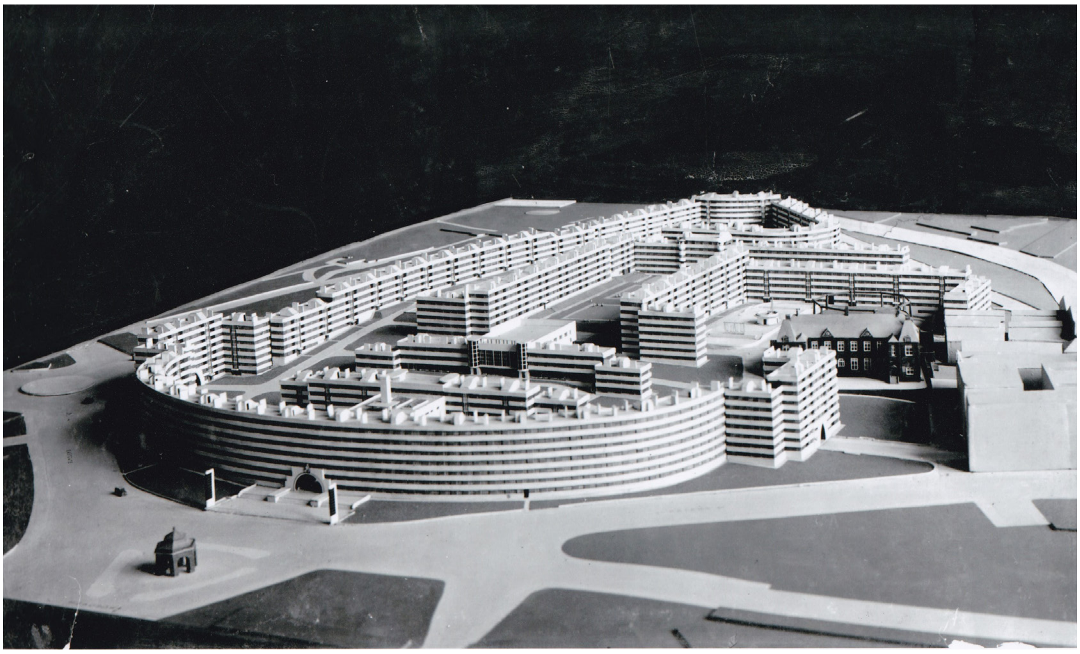

Figure 6.9: Model of Quarry Hill Estate, Leeds, made by Partridge Models, 1935

for Charing Cross (see Chapter Four), Ernest Twining's model of F.R.S. Yorke and Marcel Breuer's proposal for a concrete city of the future (Figure 6.8), and Partridge's model of the Quarry Hill Estate in Leeds (Figure 6.9), the inter-war years saw an intensive period of utopian models gracing magazine covers and featuring in exhibitions; the model becoming a surrogate for eager modernist architects frustrated by a lack of opportunity to build in a Britain still sceptical of their ideas.

In Europe, the city model became an increasingly politicised arena for 'ideological games of strategy' (Oswald, 2008, p.24) with Albert Speer's use of models to publicise his plans for the building of a Nazi capital in Berlin, while modelscapes – large city-scale architectural models built mainly for entertainment purposes rather than to communicate actual proposals – became a common feature in exhibitions and films in both Europe and the United States to project utopian views of the future, further embedding the model's association with such ideas into wider culture. In the United States, the use of modelscapes reached its peak with the models built for the 1939 New York World's Fair, with Henry Dreyfuss' Democracity model (Figure 6.10), built by the Diorama Corporation of America; and Norman Bel Geddes' Futurama (Figure 6.11), a thirty-five thousand square feet model with over half a million

Figure 6.10: Democracity model, designed by Henry Dreyfuss and made by the Diorama Corporation of America, 1939

buildings, a million trees, and fifty thousand model cars, built at an expense of over $7 million by a crew of three thousand modelmakers, carpenters, and engineers (Maffei, 2018, pp.153-159). Futurama showed the public a utopian vision on an extraordinary scale, and the model seemed a natural choice of media through which to present it. British modelmaker P.R. Wickham commented in 1945 that ‘how for instance, could the “city of to-morrow” at the New York World’s Fair of 1939/40 have been portrayed, but by a model?’ (Wickham, 1945, p.5).

In the post-war era in Britain, architectural models became intimately bound to the enthusiasm of building a better country and to move away from the memories of war. The town planning models made to communicate the post-war reconstruction plans (see Chapter Five) were all fundamentally utopian in nature, projecting visions of an ideal future. During the late 1950s and 1960s, Thorp was commissioned to produce a number of widely publicised models of highly speculative architectural projects including Geoffrey Jellicoe’s Motopia in 1959 (Figure 6.12), Sea City in 1968 (Figure 6.13), and several models for the Glass Age

Figure 6.11: Futurama model for the 1939 New York World’s Fair, 1939

Figure 6.12: Model of Motopia, made by Thorp, 1959

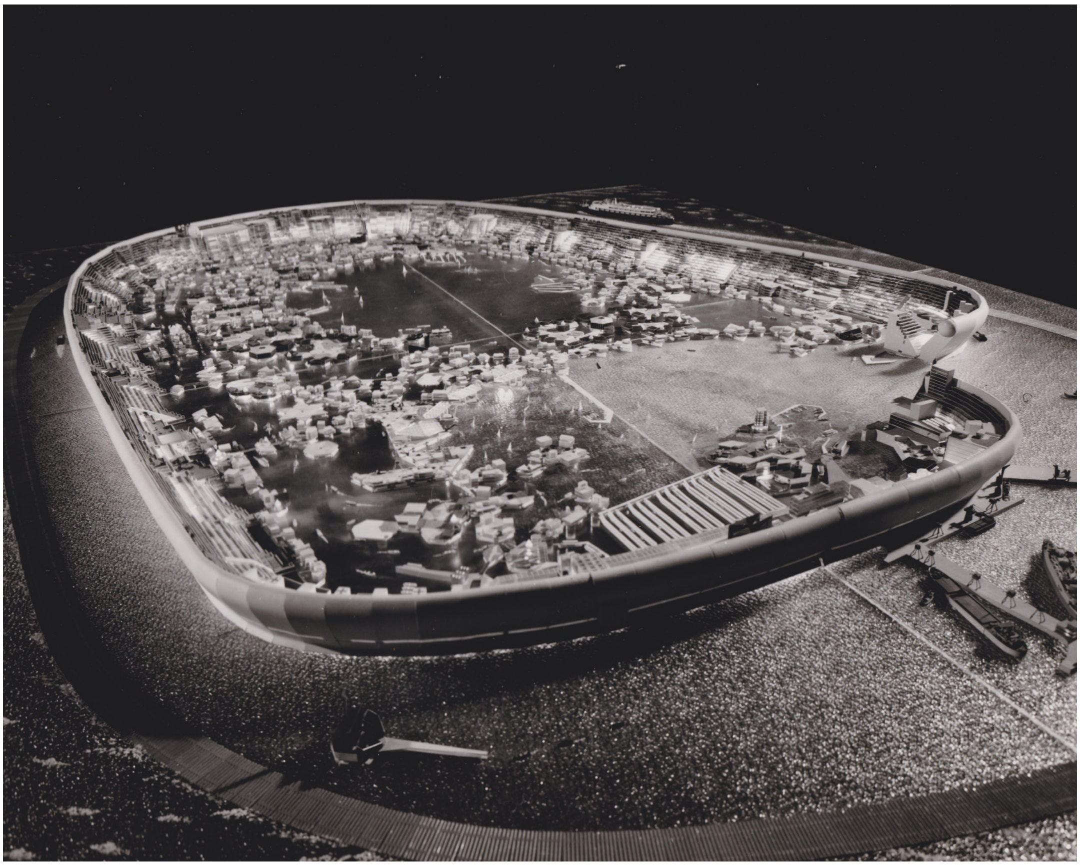

Figure 6.13: Model of Sea City proposal, made by Thorp, 1968

Committee such as one of the Crystal Tower in 1961 (Figure 6.14). Visionary and utopian in nature, these were schemes that were never actually intended to be built, rather being concepts for discussion and inspiration.

By the late-1960s, however, as John Chisholm's criticisms reveal, the utopian associations within the architectural model were causing as much concern as their association with commercial development. As a safe playground in which architects could project their ideas of a better future, the model world was seductive to both architects and the public at large. For many modernist architects, more models were made than actual buildings, leading to suggestions that they had lost touch with the complexities of reality through their occupation of the utopian worlds their models afforded. Arthur Drexler in his criticism of modernist architecture commented that the 'model generated its own truth' (Drexler, 1977, p.15),

Figure 6.14: Model of Crystal Tower, made by Thorp, 1961

describing how the world of the model became a surrogate for reality and the focus of their attention. Actual buildings, he claimed, became superfluous copies of models (Drexler, 1977, p.27). The reality of the modernist project also quickly proved it couldn't live up to expectations. As modelmaker George Rome Innes has observed, many modernist buildings, such as those designed by Le Corbusier, worked far better as models than they did in real life. 'They leak, they fall apart. It's the same with all the multi-storey blocks; they look lovely on the model' (Innes, 2019). The sense of deception and betrayal that Chisholm expressed in his article was perhaps less to do with the model itself, and more with the faith architects had held in their own abilities to actually deliver the perfect world models portrayed. For Chisholm and others, the architectural model was an uncomfortable reminder of their own failures, and worse, with the use of models as commercial sales tools by developers, the potential dishonesty of the model that architects had uncovered by accident was now being used deliberately for financial gain. By being so confidently precise about how a future building would look, surrounded by clean streets and green trees, realistic architectural models left no room for ambiguity or interpretation. The models constructed by Thorp, McCutchon Studio, Nick Quine, and the local government modelmaking departments such as at the LCC were pinning architects down to a very detailed vision of a future that could never possibly come about.

The backlash against realism in professionally-made architectural models that took hold within the architectural profession during the 1970s was therefore as much to do with the model's ability to expose the flaws in utopian modernist ideology as it was a general distaste for commercial architecture and property development. Yet the allure of the model as an idealistic realisation of an architect's vision remained strong, as did the demand for highly realistic presentation models for developers. As Karen Moon has commented, architects have long held an urge to represent abstract ideas, and the realism achieved by professional modelmakers led many architects to question the purpose of the model and what it should be conveying (Moon, 2005, p.103). This questioning was taking place in the background of the wider crisis in architecture caused by the collapse of the modernist consensus, and a radical commercialisation of the architectural profession that was to have wide-ranging consequences for the architectural model by the end of the decade.

For much of the 1970s, the architectural profession in Britain had been in turmoil; the end of the modernist consensus having brought about ‘an insurrection mounted from inside as well as outside their profession’ (Stewart, 2013, p.262). From the outside, architects were facing both critical and economic pressures, while from within, the 1970s saw a major period of self-reflection prompted by a deep questioning of the modern movement’s failures. Architects were increasingly being criticised for the quality of buildings erected during the post-war era, the general public having become disillusioned with both modernist architecture and architects themselves (Goobey, 1992, p.28). The failure of the modern movement to deliver the improvements it had promised put the very competence and expertise of architects in the spotlight (Harwood and Powers, 2012, p.11). With the generation of architects behind Britain’s post-war development having been trained to focus on the social concerns of architecture, the profession had notably been lacking any consideration of abstract artistic theory (Harwood and Powers, 2012, p.24). Rational functionalism ruled with little room for debate, and modernism had ultimately come to be seen as inflexible and uncompromising (Stewart, 2013, p.263). By the 1970s, the presumptions of the modernist generation of architects were increasingly viewed as lacking an appreciation of the growing community-centred and environmental concerns of the public.

At the same time, the economic situation in Britain was also forcing major structural changes to the architectural profession. Most architectural commissions during the previous decades had come from the public sector, but by the end of the 1970s, that source of funding had largely collapsed. The property market crash of 1973, the quadrupling of oil prices, soaring inflation, and the three-day week all put enormous pressures on public sector budgets, with the quality of new buildings suffering as a result, for which architects were perhaps unfairly blamed (Harwood and Powers, 2012, p.12). In 1976, the IMF insisted that the Labour government cut its capital expenditure programme, and with further spending cuts under the Thatcher government from 1978, the public sector’s role as a patron of British architecture was severely impacted (Goobey, 1992, p.29; Stewart, 2013, p.264). A consequence of this for the architectural profession was a dramatic shift from public to private sector employment through the late-1970s and early-1980s. Architects were suddenly at the mercy of commercial forces, with a rapid growth in private practice taking place. In 1981 the RIBA changed the code of conduct for architects as a way of dealing with the sudden shrinking of public sector employment, allowing architects to advertise their services and to create publicly listed companies on the stock exchange. Crucially, architects were also allowed to engage in speculative property development for the first time since the 1920s (Powers, 2007, p.197). As such, the profession had been rapidly thrust into a world of free enterprise and capitalism that it was not entirely comfortable with (Marriott, 1989, p.vi). As technological and social changes created demands for new forms of property that were not then widely available, architects were called upon to create entirely new types of commercial property such as open plan offices and out of town shopping centres (Goobey, 1992, p.7). Models of these new types of development were accordingly in much demand for both planning and marketing purposes (Figure 6.15).

Due to the combination of the critical reaction to modernist architecture's poorly-received legacy, the economic collapse, and the shift from public to private employment, by the end of the 1970s, architects were experiencing 'a diminished, if not extinguished, respect' from a public that had turned against the tower blocks and concrete of 1950s and 1960s architecture (Croft, 2012, p.67), and which held little trust in architects' ability to improve the urban environment. Publications such as *Crisis in Architecture* (MacEwan, 1974) and

Figure 6.15: Model of proposed Reigate Shopping Centre, made by Nick Quine/AMI, circa 1980

Why is British Architecture so Lousy? (Silver and Boys, 1980) summarised the state of feeling within the profession. At the same time, a lack of building opportunities during the 1970s saw many architects turn to theoretical and conceptual work (Neilson, 2013, p.2); Nigel Coates having noted how the 1970s forced architects to find ‘other ways of making architecture...the question was, can you be an architect without building? That was the game’ (Coates, cited in Neilson, 2013, p.58). Architectural writing during the 1970s began to increasingly reflect ideas and movements rather than buildings (Harwood and Powers, 2012, p.9), with architects embracing the ‘linguistic turn’ and the ideas of post-structuralist thinkers such as Jacques Derrida and Michel Foucault. As such, architecture adopted a position that was increasingly ‘free from social obligation and unfettered by the habits of culture’ (Coleman, 2005, p.40). As ideas of representation, symbolic meaning, language, and abstraction were adopted (Neilson, 2013, p.4), the writing of Charles Jenks, Philip Johnson, and Robert Venturi promoted a more art-based view of the discipline (Harwood and Powers, 2012, p.19). Architecture itself began to be understood more as a broad cultural field rather than as just the designing of buildings (Davies, 2011, p.11).

In the place of the certainty of modernism, architecture developed an acceptance of pluralism, and a broadening of architectural styles that included high-tech, a classical revival, and postmodernism – its ‘indulgent complexity’ standing in contrast to the puritan austerity of modernist architecture (Goldberger, 1977, p.257). A new generation of architects that included Nicholas Grimshaw, Terry Farrell, Jeremy Dixon, Richard Rogers, and Norman Foster were starting to gain fame in the late 1970s and early 1980s, and they presented a highly diverse range of approaches and styles. Norman Foster’s design for the Willis Faber Building in Norwich in 1975 marked the arrival of the high-tech style, with Richard Rogers and Renzo Piano’s Pompidou Centre in Paris following in 1977. High-tech was quickly praised as being ‘the saviour of modernism’ (Harwood and Powers, 2012, p.27), with postmodern architects such as Terry Farrell embracing a more playful direction, while Quinlan Terry and Leon Krier pursued a neo-classical style. The diversity of these emerging architectural styles once again spurred architectural modelmakers to find new ways to effectively represent them (Figure 6.16).

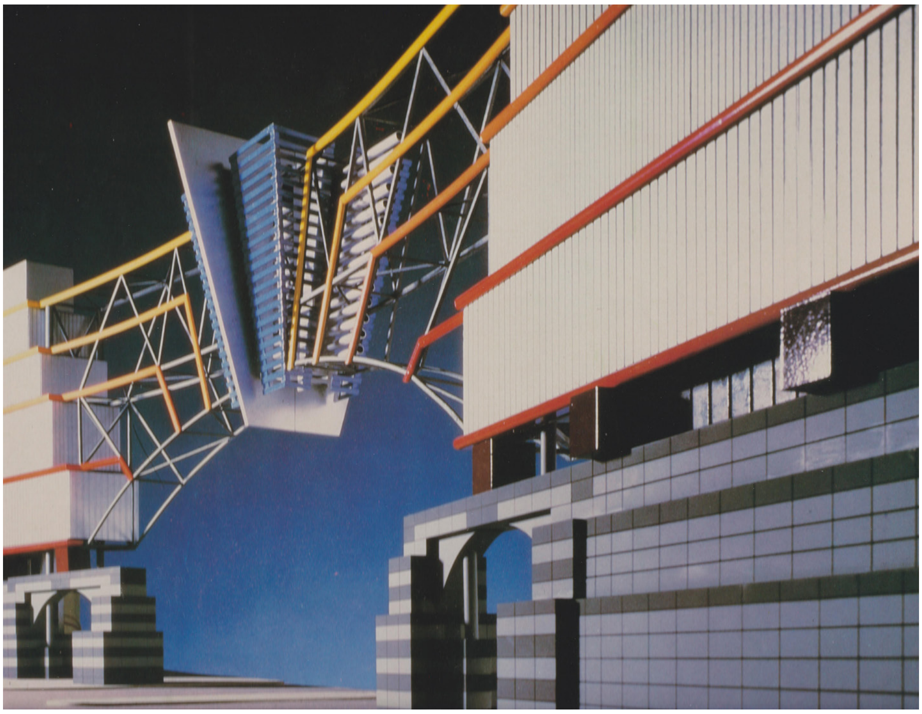

Figure 6.16: Model for Terry Farrell made by Robert Kirkman and Associates, circa 1985

The fundamental consequence of the crisis in architecture on the architectural model, however, extended from architecture's re-thinking of the value of the artefacts it produced, leading to an acceptance of texts, images, and models being considered valid forms of architecture alongside actual buildings. An increased sense of value being assigned to other architectural artefacts was perhaps inevitable during a decade with limited opportunities to actually build, however this new position had an important consequence for architecture's relationship with the model. If architecture was not necessarily just about buildings anymore, then neither, surely, was the architectural model. This line of thinking was encapsulated in the two American publications *Idea as Model* (Frampton and Kolbowski, 1981), and *Great Models* (Buttolph, 1978), which focused on the conceptual nature of architectural models and their ability to transcend ideas of representation (Lauriat, 2011, p.288). Could models be conceptual devices in their own right rather than mere surrogates for buildings? (Eisenman, 1981, p.1). Could they be considered both objects of artistic appreciation and tools for generating ideas within the design process? The shift in thinking that *Idea as Model* expressed was summarised by Peter Eisenman: 'We do not seek to assemble models of buildings as propaganda for persuading clients, but rather as studies of an idea of architecture' (Eisenman, 1981, p.3), while in *Great Models*, the architect Michael Graves was adamant that 'we make models of ideas not real buildings' (Graves, 1978, p.43). By the late-1970s, architectural models were increasingly being understood to be models of architectural ideas rather than of buildings, and as platforms upon which to discuss architectural theory as well as design (Moon, 2005, p.206). For architects, this resolved the question of what architectural models were for; their visionary, idealistic nature being confirmed, with an understanding that models of these ideas did not necessarily represent anything that was intended to be built. The model of Peter Eisenman's House X, included in the *Idea as Model* exhibition, clearly demonstrates this shift in thinking, being a three-dimensional representation of an axonometric drawing that can only be viewed correctly from one angle; the model constructed on a slant and in no way attempting to portray a structure that could actually be realised (Figures 6.17 and 6.18).

By the end of the 1970s, the combination of a general dislike of commercial development and their associated realistic marketing models; the model's ability to reveal the flaws in utopian modernist ideology; and architecture's rethinking of architectural models as models of ideas rather than of buildings ultimately led to architects increasingly seeing professionally-made models as being in some way distant from their concerns. In using realism to project

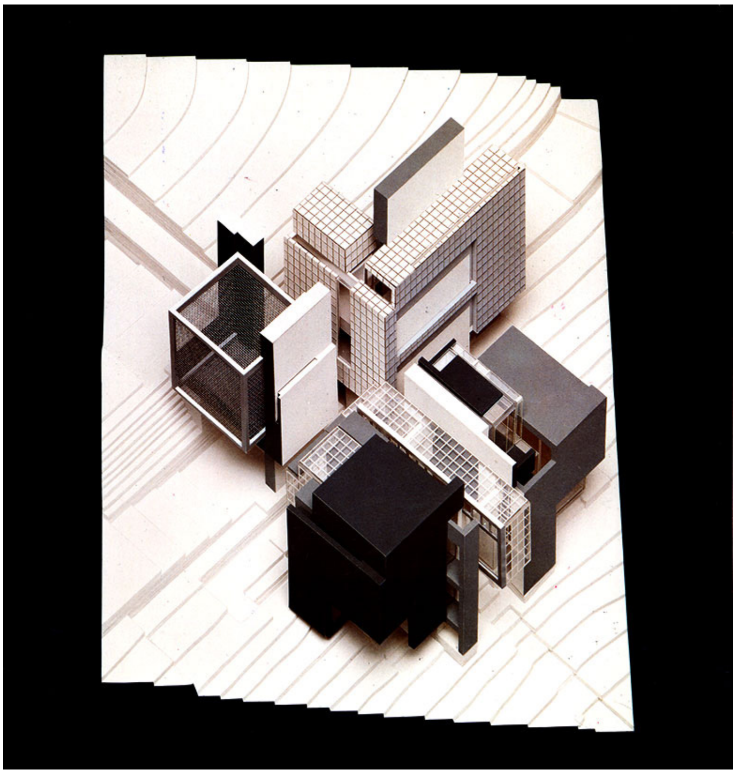

Figure 6.17: Model of Peter Eisenman's House X, made by Sam Anderson, 1975

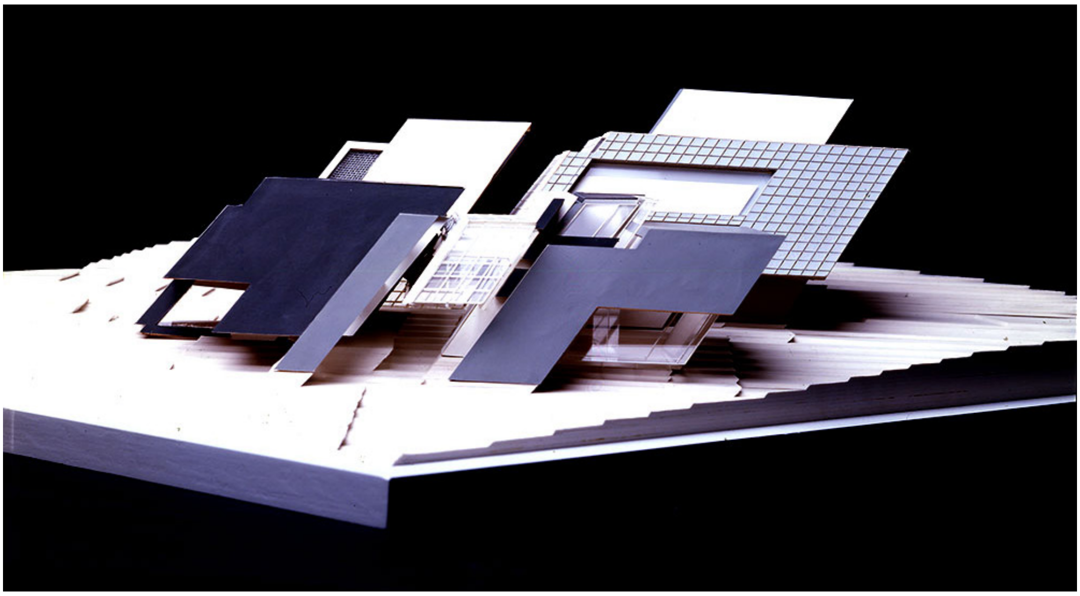

Figure 6.18: Model of Peter Eisenman's House X, made by Sam Anderson, 1975

false ideas about not only how a building would look, but what architecture itself was now considered to be, their ability to seduce and distort was targeted for criticism. By carefully excluding adjacent buildings or showing mature planting that would not reach that state for several decades, models were argued to be manipulating their audiences (Moon, 2005, p.115). Perspex in particular was highlighted as a problem – being clearer than glass, it made buildings look far more transparent than they ever could be (Moon, 2005, p.164). By the early 1980s, Chisholm's view of realism in presentation models, emboldened by the rethinking expressed in *Idea as Model*, had become entrenched within much of architectural discourse; architect Piers Gough describing architectural models as being 'by and large a vehicle for fraudulent seduction. How many clients have been sold garbage, how many town centres ruined by a childlike delight in the twee characteristics of the model?' (Gough, 1983, p.30). Such models were still seen as being ideally suited to the marketing of buildings because of their 'effectively seductive charms' (Scuri, 1985, p.25), however this was not something that architects particularly wanted to be associated with. 'To seduce and to illude [sic]: after all, isn't that the technique normally used by businessmen?' (Scuri, 1985, p.25). A newspaper article on architectural modelmakers in 1988 noted how 'trees, people and street furniture help distract attention from a controversial building' (Abrams, 1988). The author went on to describe how an architectural model was:

> [A]s much a rhetorical device as a watercolour perspective garnished with sunny skies and balloon-toting happy families. The tricks of the trade are more diverse, the persuasive potential extended into three dimensions. Reality is embellished (Abrams, 1988).

Abrams continued, disregarding those attracted to such models as being ‘swarms of grown-ups gawping over cased replicas with the look of enchantment generally observed in five-year-olds playing with a doll’s house or train set’, while modelmakers themselves were disparagingly described as ‘the special effects consultants to the architecture profession’ (Abrams, 1988). By the 1980s, as far as many architects were concerned, professionally-made architectural models had fallen far from the lauded position they had achieved during the post-war boom.

Underlying the vitriol directed at the realistic styles of professionally-made architectural models was a deeply-rooted unease with the commercial aspect of the architect’s work; it being noted at the time that ‘Architects tend to be taught during their training that they are artists and the nasty commercial side of an architect’s life is glossed over or forgotten completely’ (Marriott, 1989, p.29). Modelmaker Alec Saunders experienced this attitude first hand for over forty years: ‘Architects really don’t like selling. You can see that they’re very not in a good place at all when they’re having to deal with it’ (Saunders, 2018). With the 1970s and early-1980s seeing a dramatic shift towards the commercialisation of the architectural profession, criticisms of developers’ models gain further resonance within this context. Such models symbolised not just their failures of the past, but also an uncomfortable reminder that their entire profession was increasingly being forced to rely on the financial patronage of the very developers they had previously denigrated. This goes some way to explain why architects’ concerns about realism in architectural models appeared quite suddenly, having previously been encouragingly in favour of a striving for realism (see Chapters Four and Five). The root cause of their objection to such models appears to have come not just from their commercial nature, but from the conflict between their commercial role in selling property and the architect’s longstanding use of architectural models to sell an entirely different concept – that of a better future. This was a concept that was inextricably associated with the modern movement – the failure of which architecture was attempting to process at the time.

The backlash against realism in architectural models that gathered pace within the architectural profession during the 1970s and early 1980s was therefore predominantly a reflection of architecture's internal deliberations – a dislike of both commercial architecture and the profession's own increasing reliance on property developers as clients; a reminder of the flaws of their utopian ideas; and a consequence of a rethinking of what the architectural model was in an increasingly conceptual manner. What the backlash against realism illuminated was a change in architecture's perception of the model and what it should represent, with realistic developers' models being seen more as models of buildings than of architecture itself. What had also become clear, however, was that the internal changes the architectural profession had undergone during the 1970s meant that the types of models architects wanted were not what were being offered by the major commercial modelmakers. While property developers were seemingly happy with impressive and highly realistic models, architects were not. Having become more pluralistic and critically-aware, the architectural profession now wanted their models to follow suit. Cumulatively, the consequences of these issues meant that realism in architectural models was understandably no longer in fashion; and neither were plastics, the materials that had done so much to improve the levels of realism since their introduction. It was this conundrum that lay at the root of the creative expansion that so radically broadened the stylistic palette of the professionally-made architectural model in Britain during the 1980s.

6.4. New Roles for Old Materials and the Rise of Abstraction

Just as the origins of the problem facing the architectural model by the 1980s had a long history, paradoxically originating from its success during the post-war era; so too can the origins of the solution be traced back more than a decade before they converged to generate the creative expansion from which the breadth of styles present in the architectural model today emerged. Throughout the 1970s, plastics, in the form of Perspex and polystyrene sheet remained the default materials used in professionally-made architectural models; the plastics trade journal *Beetle Bulletin* reporting that it was 'not surprising that the professional modelmaker – who is both artist and craftsman – is making more and more use of [plastics] to satisfy exacting demands for accuracy and realism imposed by architects and planners' (Beetle Bulletin, 1976, p.6). The standard construction approach by 1980 was much unchanged from 1960 – Perspex cores, often clad with polystyrene sheet, spray painted and detailed accordingly. Because the use of plastics had been central to improving the levels of accuracy and realism in models during the 1950s and 1960s, however, the backlash against realism from architects that followed provided an unexpected opportunity for older materials to gain new roles. Through the work of innovative modelmakers such as Robert Kirkman, and the team David Armstrong assembled at the Arup Associates in-house modelshop, high-quality abstract timber models provided an appealing alternative for architects to the realistic Perspex models that were favoured by developers. By the time architecture had reframed its view of the model as expressed in *Idea as Model*, these more stylised architectural models had become recognised for their greater emphasis on the ideas of architecture as opposed to making concrete predictions about the intricate detail of future buildings.

The initial resurgence in the use of timber in professional architectural modelmaking in Britain was a consequence of the juxtaposition between concepts of old and new within a model that timber offered in opposition to plastics. As early as 1964, models such as that of the Economist Building (Figure 6.19) were starting to make use of both timber and plastics in new ways. With the choice of timber for the existing buildings adjacent to the proposed building, and plastics for the development itself, a clear distinction was made between what was old and what was new. The eye is drawn to the plastic, realistically-painted buildings, while the simpler, more abstract timber buildings recede into the background. This shorthand, of timber for existing buildings and plastics for new ones, has remained in the modelmaker's toolkit to the present day, the contrast between the two materials' qualities symbolising the difference between the existing urban context and the excitement of the new building (Figure 6.20). As Enzio Manzini has observed, plastics challenge our relationships with existing materials (Manzini, 1986, p.33), and for the architectural model the reassigning of the associations held with timber opened up new avenues of expression.

Figure 6.19: Model of the Economist Building, 1964. Modelmaker unknown

Figure 6.20: Concept model made by Base Models, circa 2015. Photograph by Andrew Putler

Despite their dominance in professionally-made architectural models, plastics were not favoured materials for architects who were making their own models during the 1960s and 1970s. On a symbolic level, plastics were not only associated with the by then negative connotations of the highly realistic developer's model, but also broader cultural associations with mass-production and cheap, poor quality goods. Polished timber, on the other hand, had come to signify quality and exclusivity. Compared to more traditional materials, the synthetic plastics, in contrast to their utopian associations of the inter-war years, had come to be seen as being of inferior quality (Sparke, 1990b, p.8). Rather more practically, plastics such as Perspex were difficult to cut without workshop machinery and required painting to achieve even the simplest single-colour finish. This meant the making of models using plastics within an architect's office required a significant investment in equipment. As a result, balsa wood became the material of choice for many architects starting their careers in the 1960s and 1970s, including James Stirling and Norman Foster. Easy to cut and assemble, the simple, abstracted style it presented quickly became fashionable, a return to a less detailed and more ambiguous form of architectural model that spoke more of the process of design than it did a finished building. As publications such as *Making Models in the Drawing Office* (Brown, 1971) and the discussions featured in both *Idea as Model* (Frampton and Kolbowski, 1981) and *Great Models* (Buttolph, 1978) make clear, architects on both sides of the Atlantic during the 1970s were encouraging the use of sketch models during the design process. Balsa was well-suited for this purpose, and provided continuity between design development models and final presentation models that were attractive to architects engaging with theories of representation and language following the critical introspection of the profession that was taking place. Karen Moon has noted that it was within architect-made design development models that abstraction first gained a foothold, likely in response to the pressure to make presentation models highly realistic, with design models becoming increasingly expressive and personal (Moon, 2005, p.95). Over time, these private models began to be shown in public, as ambitious young architects began to commission presentation models that echoed their own personal styles of modelmaking.

Timber models successfully offered an alternative to the contested realism of fully-painted Perspex models that were being used for commercial purposes by developers during the 1960s. Modelmaker Simon Hamnell talks of a strong divide between the '[F]ull expression of a textured, painted [Perspex] model and an abstract timber model. By pulling back information, the timber model speaks more about architecture and its phenomena: light, shade, volume and the relationship between components' (Hamnell, cited by Nielson, 2013, p.83). Without having been expressed as such at the time, the growing use of timber models by architects themselves was a clear sign that they had already found the solution to their concerns regarding realism and the changing nature of what an architectural model should be. As the 1980s would later prove, however, it was not so much timber as a material that was the solution, but the abstraction and ambiguity it engendered.

A pioneer in the revival of timber architectural models was Robert Kirkman. In 1964, Kirkman began his modelmaking career working for the architect Denys Lasdun, who had just been appointed to design the new National Theatre in London. With limited workshop facilities available in Lasdun's offices, Kirkman applied his previous experience in advertising and a keen eye for photography, intending to produce models primarily for publicity shots. 'We did everything with balsa wood. No machines, everything done with a steel straight edge and scalpel' (Kirkman, 2019). The models Kirkman produced in the three years he worked for Lasdun included many of the National Theatre (Figure 6.21), as well as other notable projects such as Christ's College, Cambridge (Figure 6.22). Photographed in black and white, the models appeared more monumental and focused purely on form, suiting their brutalist designs. Made from a single material and without any use of applied colour, Kirkman's models were clear to understand despite eschewing any attempt to represent the specific textures and materials the real buildings would employ. Moving to the architect's department

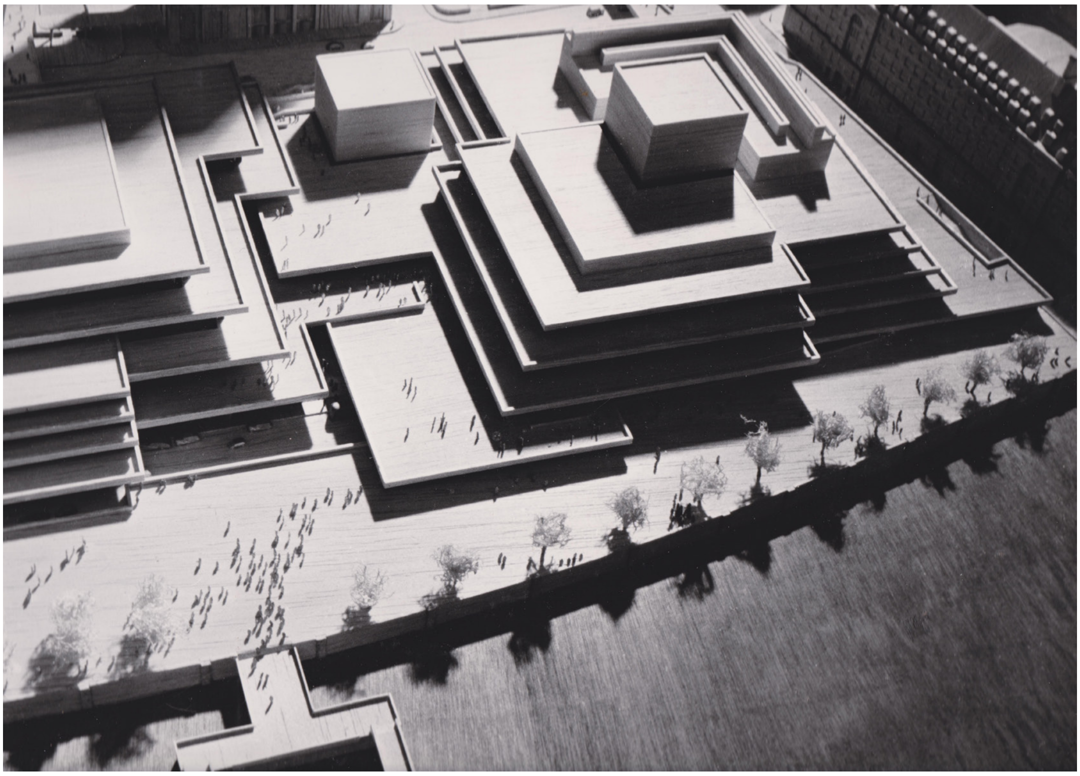

Figure 6.21: Model of Denys Lasdun's National Theatre, made by Robert Kirkman, 1965

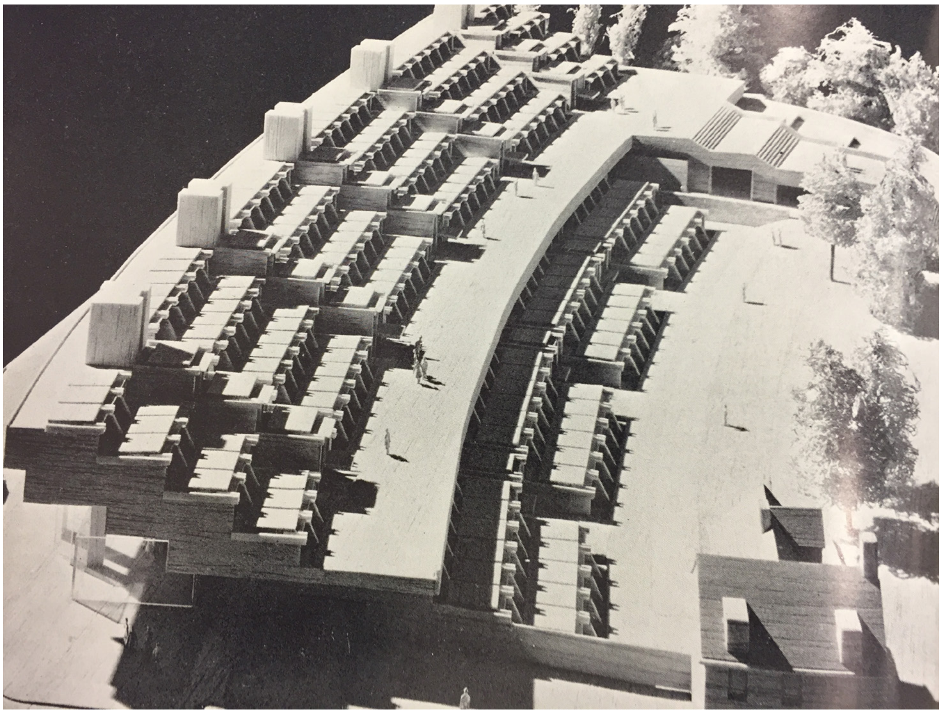

Figure 6.22: Model of Denys Lasdon's design for Christ's College, Cambridge, made by Robert Kirkman, 1967

of Southwark Council for seven years before setting up as a commercial architectural modelmaker, Kirkman became notable for offering such timber models to architects and developers as alternatives to highly realistic Perspex ones. From the start, his clients were predominantly architects rather than developers.

> I saw it as an art form, and I wanted the models to be fairly artistic, expressive. I couldn't stand those model railway models, but I made them from time to time because you had to pay the rent, but I preferred the more expressive stuff (Kirkman, 2019).

During the 1970s, an increasing number of architects began to commission models from Kirkman specifically because they wanted something different to what the established firms such as Thorp were offering. 'The architects liked to have quite nice models, but the developer would say they were not interested in a work of art, they just want to sell this building' (Kirkman, 2019). At the time, it was taken for granted that a realistic model would sell to the public, while a more abstract model would not. For one particular project, Kirkman had made ‘a very aesthetic Perspex and wood model, and just before the weekend [the architect] said “could you make it look more realistic for the developer?” I disowned it, took my name off it’ (Kirkman, 2019).

While Kirkman deliberately kept his business on a small scale, the 1960s saw the establishment of a large in-house modelmaking workshop at Arup Associates whose abstract timber models would become highly influential. In 1961, David Armstrong, a sculptor used to working with timber, was hired by Ove Arup and Philip Dowson to establish their modelshop (Figure 6.23). During the 1960s, very few architectural practices other than the county council architects’ departments had in-house modelshops, mainly due to the fact that few private practices were large enough at that time to warrant one, with most architects still working in the public sector. As noted above, Denys Lasdun followed suit in 1964, but it was not until the late-1970s and early-1980s that architects such as Hugh Casson, Norman Foster, and Richard Rogers begun a trend that has continued to the present day. David Armstrong remembered his original brief from Philip Dowson: ‘Philip wanted beautiful things made out of lovely woods. And in that he was quite right; the finished [realistic] model can look quite stark and dead’ (Armstrong, 1999). Dowson was adamant that Arup’s models should be hardwoods, not balsa, which meant a fully-equipped workshop was required. Armstrong was initially resistant to this, preferring to maintain a hand-made feel to the models, however he

Figure 6.23: David Armstrong in the Arup modelshop, circa 1980

rapidly embraced the benefits of machine tools, if only for their increased efficiency as the modelshop's workload grew (Armstrong, 1966, p.2).

Armstrong favoured a palette of rich timbers that included yellow and red cedar, pine, and sequoia. Perspex was reluctantly used wherever glazing was required, as well as for fine detailing and structural support where needed. Strips of Perspex were applied to create the facade of the otherwise timber model of Leicester University's Attenborough Building shown in Figure 6.24, for example. Without the correct machine tools, however, Armstrong found Perspex a difficult material to work with. 'You have to score across it with a knife and then jump on it in a jig so it will break in the right place' (Armstrong, 1999).

Arup didn't want to employ any existing architectural modelmakers as they specifically wanted to avoid anyone who had 'come through the kind of model railway aesthetic' (Miller, 2018), and so Julian Thompson, an ex-RAF fitter, librarian Tina Miller, graphics graduate Roger Hillier, and architectural clerk George Rome Innes joined during the first ten years as the modelshop grew. This helped preserve the particular approach to architectural modelmaking that Armstrong had established. Noting that the commercial modelmakers in London were almost exclusively working in Perspex, Armstrong was acutely aware that their models were a departure from what was going on elsewhere (Armstrong, 1999), demonstrating a highly nuanced artistic understanding of both the model's purpose and the

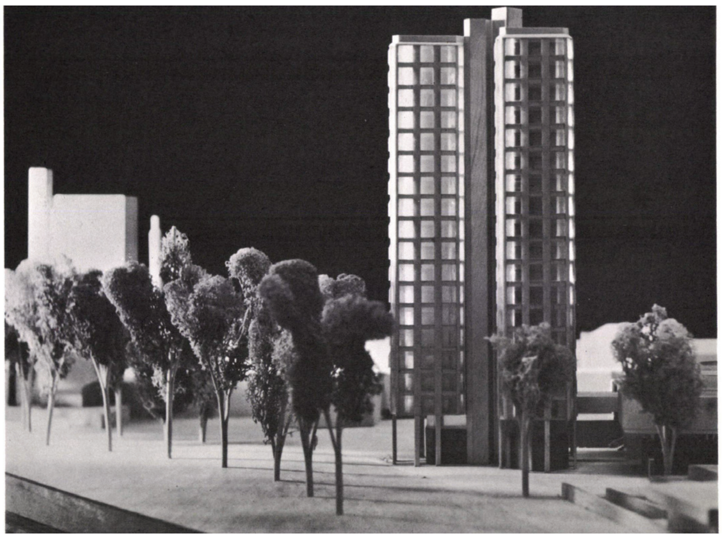

Figure 6.24: Model of Leicester University, made by the Arup Modelshop, 1966

visual composition required to make it a success. He resisted including too much detail on their models, noting that some architects couldn't bear to see anything left out. 'This has the effect of mixing too many colours together: the result looks like mud' (Armstrong, 1966, p.3). Observing that most models were designed to communicate a specific point, he recommended that 'any detail which does not contribute to this point weakens the impact of the model. We try to avoid all unnecessary detail' (Armstrong, 1966, p.3). With an on-site materials library, modelmakers could compare different timbers, plastics, and metals, opening up new avenues of experimentation when composing the appearance of a particular model (Armiger, 2018a).

In reflecting on the modelshop's success, architect Philip Dowson explained that timber models, in his view, 'did not attempt to produce a false reality but to represent the underlying form and nature of the architecture itself' (Dowson, 1990). Referring to their models as 'beautiful objects in their own right', Dowson noted how a 'whole genre has developed, and the quality of both imagination and craftsmanship that has been brought to this area of Arup's work has in turn influenced what we have done as designers' (Dowson, 1990). George Rome Innes recalls that there was also a less-well acknowledged practical reason for favouring timber models – they were much easier to alter than a model made from Perspex. With much of the Arup modelshop's work being a constant dialogue with architects and engineers, final models were rarely that. With a timber model, however, 'if you use water-based glues, you just spit on it and it falls apart' (Innes, 2019).

> It was a matter of being able to modify things because they were always design models to a degree. They may have developed into presentation models, but often you were making a model whilst the architect was doing the drawing (Innes, 2019).

Not all models were bare timber, however. Innes remembers Philip Dowson asking for a white model of Goodwood racecourse, but the team instead produced a painted model with very pale accents of colour. Upon seeing the model, 'Dowson said "lovely white model", because he knew what he wanted but it was not what he said' (Innes, 2019). Roger Hillier recalls an intense dislike of painted models, however. 'If anyone wanted anything painted, we usually had a hissy fit' (Hillier, 2018).

The use of abstraction in architectural models that Arup adopted was in no way a new concept; a model produced by the American office of Mies van der Rohe of the architect's design for the Resor House from 1937 was carefully designed to mimic the architect's use of photomontage in his drawings, however in Britain, architectural models throughout much of the twentieth century tended to be far less ambitious in that respect. A notable exception is a model by an unknown modelmaker of James Stirling's design for Dorman Long Headquarters made in 1965 (Figure 6.25). As far as George Rome Innes is concerned, the difference at Arup was that it was a design firm. 'It was totally different [to Thorp or Pipers]. Absolutely different. You have to remember Arup was an extraordinary set up which had not really happened before' (Innes, 2019).

For over thirty years the Arup modelshop continued to produce thousands of creative and abstract models for projects such as the Sydney Opera House and the Aldeburgh concert hall (Figures 6.26 and 6.27). As with Robert Kirkman's models, Arup treated their models

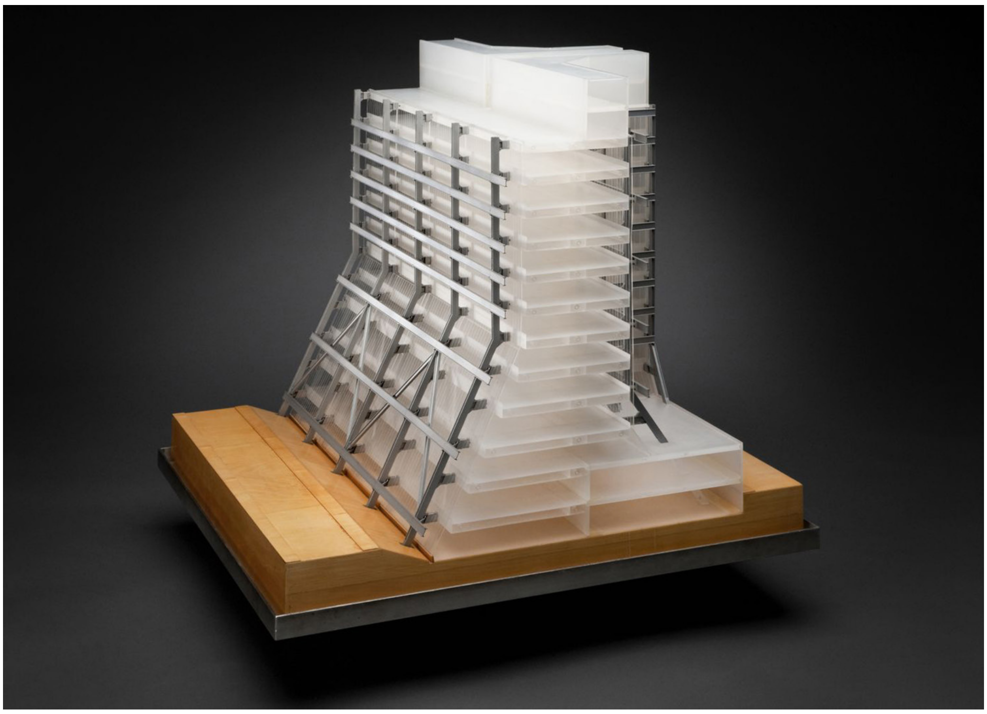

Figure 6.25: Model of Dorman Long Headquarters. Modelmaker unknown, 1965

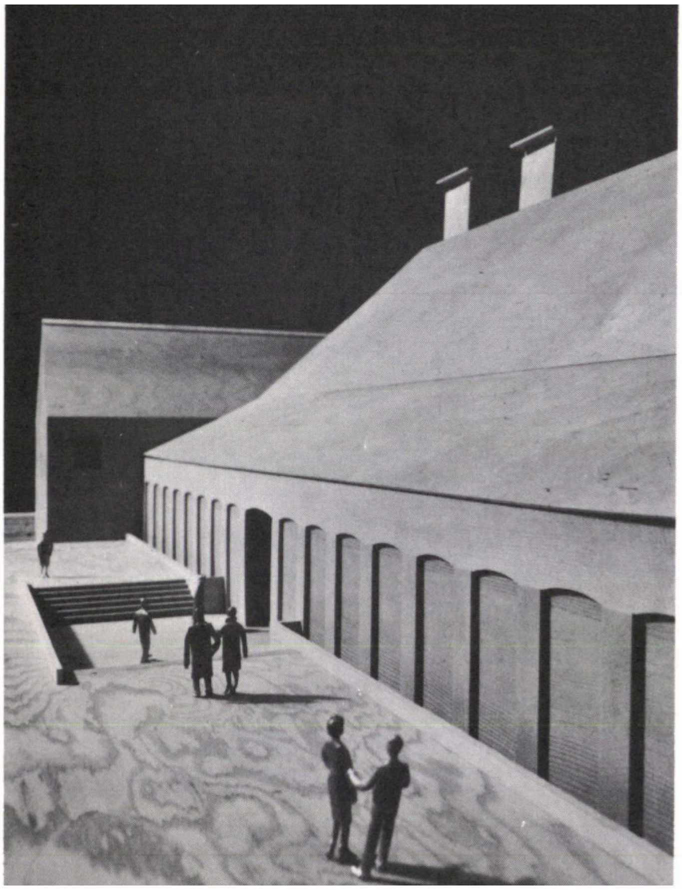

Figure 6.26: Model of Aldeburgh concert hall, made by the Arup Modelshop, 1966

Figure 6.27: Interior model of Aldeburgh concert hall, made by the Arup Modelshop, 1966

as objects in their own right, attending to the aesthetics of what they were making as much as to those of the proposed building. With the engineering arm of the firm employed by many of the leading architects during the late-1970s and early-1980s, the modelshop also produced many models for architects such as Richard Rogers, Renzo Piano, and Norman Foster before they had established their own dedicated modelshops. A consequence of this was that the Arup in-house style began to be circulated among a much wider audience, leading to architects enquiring if they could obtain models from the Arup modelshop on a commercial basis (Armiger, 2018a).

What both Arup and Robert Kirkman were separately offering was an alternative language for architectural models that simply wasn't available elsewhere, and it was one that directly appealed to architects' evolving understanding of what an architectural model should be. 'If an architect did go to Thorp or Pipers with a concept, it was either all-colour or an all-white model. When you photograph [a white model], the light doesn't fall right, it just bounces back, looks very alien. They are not expressive of architecture in any way' (Armiger, 2018a). The abstraction that timber models engendered, while still finely-made and complex creations, turned them into more ambiguous suggestions of what was to come, expressions of ideas, impressions rather than promises. The artistic creativity that the Arup modelmakers embraced was ideally suited to architecture's revised understanding of what architectural models were, and provided a potential solution for the re-engagement of architecture with the professionally-made model in the aftermath of the intense criticism of realism that had been building since John Chisholm's 1969 polemic article. Being an in-house modelshop, however, the Arup approach remained very much limited to their own architects throughout the 1960s and 1970s, but by the start of the 1980s, the 'Arup School' of architectural modelmaking had been adopted by a new generation of formally-educated professional modelmakers who were to embrace abstraction and creativity and broaden the model's palette in a way that would both meet the changing demands of a new generation of architects, and reinvigorate the entire modelmaking profession with their return to a spirit of 'ingenious adaptation' during a period where both creativity and adaptability became vitally important as the model became a decisive factor in winning architectural competitions.

6.5. The ‘Arup School’ and the Demand for Competition Models

Until the 1960s, the only way to receive any form of training in architectural modelmaking was through employment. Commercial modelmakers were actively on the lookout for hobbyist modelmakers who could make the sometimes difficult transition to working to tight deadlines and with much greater efficiency than a pastime allowed (Hendrick, 1952, pp.42-43); Robert Kirkman having secured his position with Denys Lasdun having made balsawood model aircraft in his spare time (Kirkman, 2019). Thorp began a three-year apprenticeship that offered on the job training during the mid-1960s, but by the start of the 1980s, a three-year HND in modelmaking at the Medway College of Design in Rochester was offering a well-established educational route into the profession. Through the direct employment of Arup modelmaker George Rome Innes, the ‘Arup School’ approach to modelmaking became the template for the architectural modelmaking component of the course. Graduates emerging from Medway in the early-1980s took with them an appreciation of the creative potential of architectural models, and through modelmakers such as Richard Armiger, the model’s stylistic range adapted to embrace much higher degrees of abstraction and creativity. By 1986, the political and economic policies of Margaret Thatcher’s Conservative government had sparked a phenomenal growth in the British property market that provided ample opportunity for Innes’ graduates from Medway to establish themselves and meet the growing demand for creative models as architectural competitions became a crucial arena for up and coming architects to establish their names and garner commissions.

John Gaylard, who set up the modelmaking course at Medway, had been teaching the modelmaking components of the display and exhibition design, three-dimensional design, and woodworking diplomas at the college since the early-1960s, and by 1969 a specific modelmaking course was being offered within a vocational crafts diploma, the first of its kind in Britain (Houghton, 2018). By the mid-1970s, the Industrial Modelmaking diploma, as it had become, was looking for a specialist architectural modelmaker to join the team of tutors, and Gaylard advertised the position. At the same time, a downturn in architectural work had led to Arup informing its staff that it was considering making job cuts, encouraging them to begin to consider alternative employment in case business didn’t improve. Arup modelmaker Tina Miller saw the advert for the teaching position at Medway and showed it to her colleague George Rome Innes, who duly applied (Miller, 2018). ‘I didn’t even think I particularly wanted the job; it was interview practice,’ Innes recalled (Innes, 2019). Innes was offered a two day per week contract, and despite the downturn in work, Arup agreed to release him for those hours while still paying him his full-time salary. ‘Arup’s attitude was that we must give back to the world, so I went down to Medway and started teaching’ (Innes, 2019). By then a highly-skilled architectural modelmaker with a decade’s experience, Innes was clear that he wanted his students to appreciate the artistic skills of modelmaking as well as the technical processes of operating machinery, and to explore the creative potential of architectural models.

> I have always actively derided the model railway style, actively. You just have to look at them, bricks that are gigantic and bright red. It is about really thinking about what scale means, you edit things out as you go down through the scales, and colours change (Innes, 2019).

The Thorp apprenticeship scheme offered only one or two places available each year, while Medway was able to take between ten and fifteen students per year, and for those interested in pursuing architectural modelmaking, they graduated having been taught in the ‘Arup School’ (Hamnell, 2018). Throughout their studies, placements were also available for students to work at Robert Kirkman and Associates, further exposing them to the creative side of modelmaking.

As a result of George Rome Innes’ teaching at Medway, the late-1970s and early-1980s saw a new generation of architectural modelmakers enter the profession who had been taught to develop their artistic skills rather than just their technical proficiency in making models.

> We had come up through the Arup school, so [favoured] monochromatic, as in single material models, like timber, or what we did develop later on was using palettes of timbers. You

> were always adding techniques and materials but always with the aesthetic starting point of the Arup period (Hamnell, 2018).

Having embraced the creative potential of materials, their arrival was ideally timed, and the Medway graduates were perfectly suited to take advantage of the opportunities presented by both the impending property boom and architecture's desire for a less-realistic approach to modelmaking that better reflected a revised understanding of what architectural models should be representing. 'There was a wave of people who came out of Medway into [architectural] modelmaking,' Head of Modelmaking at Foster + Partners Neil Vandersteen recalls (2018), with Richard Armiger gaining his diploma from Medway in 1978, and after a period of working at Arup and then establishing an in-house modelshop for Hugh Casson, started his own company Network Modelmakers in 1982. Soon after, he himself began a period of teaching architectural modelmaking on the newly established modelmaking course at St Albans College of Art and Design (now the University of Hertfordshire), further spreading the 'Arup School' approach. Graduating in the same year as Armiger were Nick Grace, who worked at Arup for many years before moving into teaching; and Tim Price, who established his own architectural modelmaking company in Kent. In 1981, Robert Danton-Rees graduated from Medway, setting up the major London architectural modelmaking firm Capital Models in 1994. Neil Vandersteen graduated from Medway in 1985, and after freelancing for a number of firms, including with Robert Kirkman, joined Foster + Partners in 1989, where he consciously pushed to make 'really beautiful models. Up until that point, that was my background' (Vandersteen, 2018). The following year Ben Moss graduated from Medway, and having moved into teaching set up the modelmaking HND at Bournemouth and Poole College of Art and Design (now AUB) in 1992.

Through these modelmakers, the Arup approach to architectural modelmaking instigated by David Armstrong in their in-house modelshop in the 1960s began to percolate through the wider profession. When Neil Vandersteen joined Foster + Partners, the modelshop had been run by Chris Windsor for over twenty years, but who had recently moved to a second dedicated workshop at Norman Foster's home, leaving a small team of five working at Foster's offices in Portland Place. None of those working there had a formal modelmaking background, and with the most experience, Vandersteen was placed in charge of the team, where he was able to apply his own creative talents that had been honed under both Innes and Kirkman. Most of the models being made at Foster + Partners were sketch models using polystyrene sheet, Perspex, plywood, and Rohacel – an expanded acrylic foam (Vandersteen, 2018). Over time, however, the modelshop developed a range of creative approaches that it applied to its presentation models. 'It gives you a much broader range of things to do and it does spark the individual when you can do something really creative that is unique' (Vandersteen, 2018).

While Arup had favoured timber over plastics in its models, the legacy of Innes' teaching at Medway was to open up the stylistic palette of architectural models by re-introducing timber alongside Perspex, and to embrace the abstract potential that timber allowed. As such, this brought about a return to the open and adaptable attitude towards materials that had been embraced by John Thorp and others at the turn of the century, and which had seemingly been lost after the introduction of Perspex in the post-war era. Whereas plastics had become the default choice of material by post-war modelmakers in their pursuit of realism, the modelmakers emerging from Medway in the early-1980s were making much more considered choices as to which materials suited the needs of a particular model. With realism no longer a necessary criterion for models commissioned by architects, both the construction approaches and styles of architectural models became much broader.

The leading modelmaker to apply the lessons of the 'Arup School' of modelmaking, and to set a new standard for architectural models over the next two decades, was Richard Armiger and his company Network Modelmakers. While working at the Arup modelshop after his graduation from Medway, Armiger had observed a string of young architects, 'all Knighted or Lords now' (Armiger, 2018a), entering competitions where they had teamed up with Arup for the engineering work.

> Jump ahead and the same young architect is doing another project and he knocks on the door of the modelshop and says "remember me? I have this project..." but if it's not under the Arup umbrella,

> we can't make it. But maybe Richard can, he's a freelancer... (Armiger, 2018a).

Through these kinds of introductions, Armiger began to pick up work from architects such as David Chipperfield, Nicholas Grimshaw, Jan Kaplicky, and Jeremy Dixon. Crucially, Armiger noted that each architect's work was extremely different to each other's, and so no single style of model would suit all of them. As a result, Armiger established Network Modelmakers with the idea of replicating the Arup experience, but for a variety of different architects each with their own unique styles.

> I could be like an in-house modelshop for all of them, so David [Chipperfield] with all his timbers and occasional use of colour, and Jan Kaplicky with the super automotive finishes, and Eva Jiricna and her black models. And so I went on to develop a model vocabulary for all these people (Armiger, 2018a).

The differing approaches required by Armiger's clients meant he was constantly adapting his own methods to suit their needs, and rather than developing a single style of modelmaking that was defined by a particular visual signature or material choice, Armiger's work came to be defined by adaptability itself. Whereas an architect commissioning Thorp or Pipers for a model would do so knowing exactly what they wanted and what they would get, architects who approached Armiger were generally less certain about what they wanted stylistically, while what they really wanted was Armiger's skill in developing a style that was right for their project. Experimenting constantly and adapting to meet the needs of each client, Armiger's individually-styled abstract and creative models perfectly matched their desire for models that represented looser concepts and ideas rather than finished buildings (Figures 6.28 and 6.29).

In architectural model photographer Andrew Putler's opinion, Richard Armiger had 'one of the best palettes of all modelmakers' (Putler, 2019), while Christian Spencer-Davies has noted the strong Arup influence on Armiger's work: 'I would say what came to the Network

Figure 6.28: Model of Glyndebourne Opera House, made by Network Modelmakers, 1990

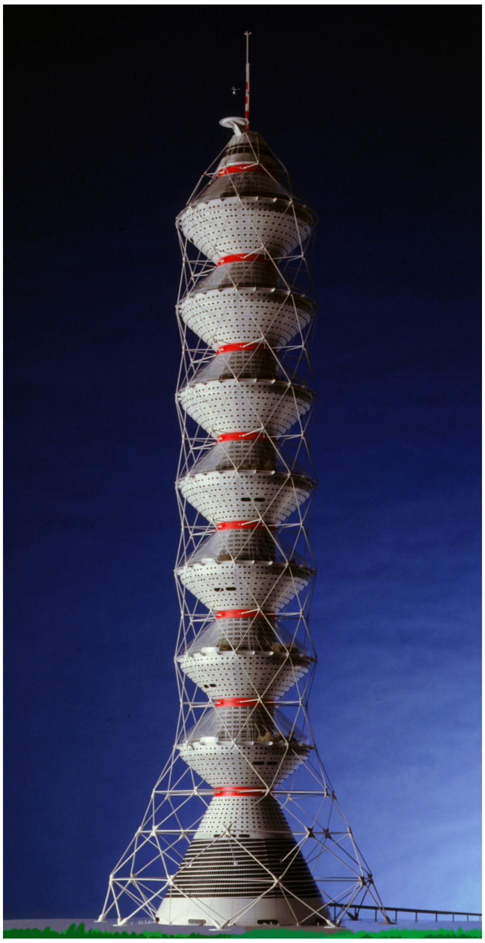

Figure 6.29: Model of Co-existence Tower, made by Network Modelmakers, 1986

was very high quality models with a super strong influence from Arup historically, who had just established an amazing quality of modelmaking' (Spencer-Davies, 2019). Putler began to work with Richard Armiger to photograph Network's models for his architect clients looking to use images either in their competition submissions, or to send to the architectural journals as publicity. Putler remembers this as a fascinating time, noting that for architects, 'the only way they could get their head above the parapet was to enter international competitions, and they needed photography and they needed models' (Putler, 2019). Putler's model photography quickly became highly sought after (Figure 6.30) and within a few months, he had several covers under his belt. As the more creative models made by Network and photographed by Putler began to be featured in architecture journals, so their visibility increased further. The possibilities were not lost on other modelmakers. 'Modelmakers are

Figure 6.30: Model of proposed Poole Harbour bridge, made by Unit 22, 1996. Photograph by Andrew Putler

very interested to know how other modelmakers are carrying on...and so they saw a big variety of different vocabulary being displayed' (Putler, 2019). Through Armiger's work, the 'Arup School' approach to architectural modelmaking quickly spread, just as the demand for models was about to dramatically increase as the British economy suddenly upturned after the doldrums of the previous decade.

In 1986, the 'Big Bang' – the deregulation of the London stock markets which rapidly turned London into a global financial capital – brought about a wholesale change to the fortunes of the property market. Enormous levels of foreign investment in London property, combined with a need for additional office space for the growing financial services, generated a phenomenal property boom. The total volume of office space in London doubled between 1985 and 1993 (Powers, 2007, p.223), creating an extensive demand for both the services of architects and for architectural models (Figure 6.31). As part of their wider economic plans, the government had also established sixteen Enterprise Zones in 1981 to stimulate regional development. Exempt from land taxes and the majority of planning constraints, these provided attractive investments for property developers with land prices deliberately kept below market value (Hall, 2002, p.394). In 1982, the Isle of Dogs Enterprise Zone became the semi-private London Docklands Development Corporation (LDDC), which spent £800 million on land purchases, reclamation, and transport links. Three years later, SOM's masterplan for Olympia and York's Canary Wharf development was unveiled, adding 2.6 million square feet of office space to the capital, with developments in the city of London contributing a further 16 million square feet (Hall, 2002, p.396). Further projects such as Broadgate, Ropemaker Place, Albion Gate, London Wall, plus the demand for out of town shopping centres such as Lakeside and Merry Hill, provided excellent opportunities for young architects seeking to build their reputations and to test out the new architectural styles that had emerged in the wake of modernism. Capitalism had become the great new patron of architecture and there was considerable competition between architects who were all seeking architectural models to help them stand out. At the same time, private property developers and organisations like the LDDC required multiple models for sales and marketing purposes (Figure 6.32).

Figure 6.31: Model of Marylebone Station redevelopment, made by Nick Quine/AMI, circa 1986

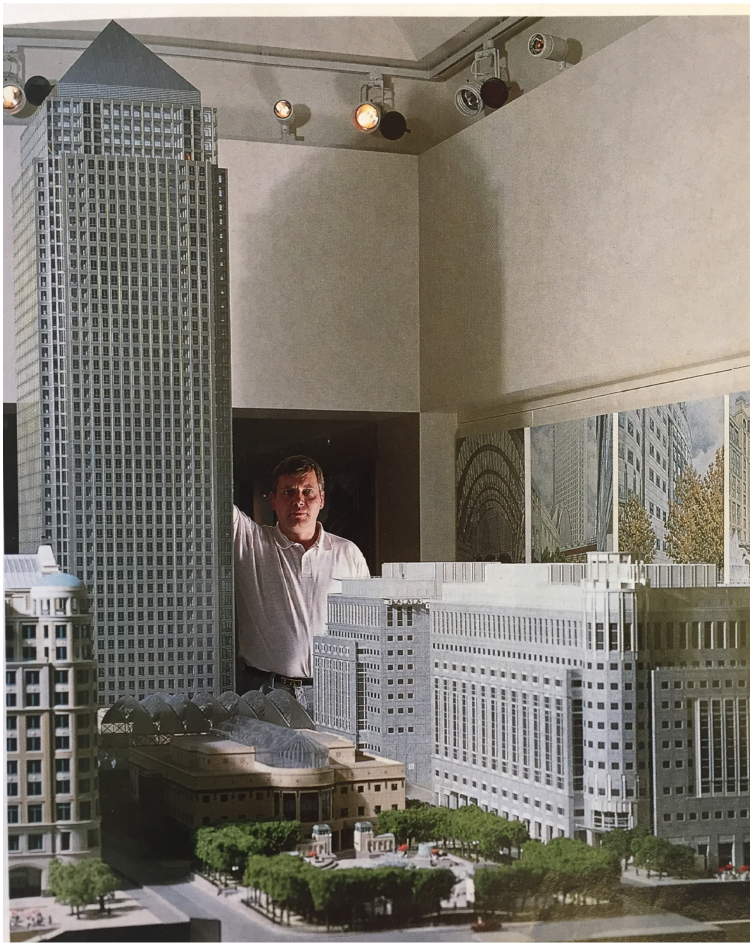

Figure 6.32: Model of Canary Wharf, made by Presentation Unit, circa 1990

As such, by the mid-1980s the circumstances were right for another boom in architectural modelmaking. A problem, however, was that by the start of the decade, most of the major post-war architectural modelmaking firms had ceased trading. Partridge's Models had closed in the 1960s, as had Twining Models, with McCutchon Studio following in 1975. The LCC/GLC models section was disbanded in 1984, leaving only Thorp and Pipers – purchased from John Piper by Barry McKeogh in the late-1970s – as the dominant firms in London, alongside smaller companies such as Nick Quine's AMI, Robert Kirkman and Associates, Thurloe, Mike Karslake, and Robert Seaton. The decline in building construction during the seventies had inevitably reduced the demand for architectural models, although a number of firms had taken advantage of architectural and structural commissions for the burgeoning North Sea oil industry by opening in Scotland and the North of England (Beetle Bulletin, 1976, p.2; Karslake, 1981). With little UK work during the 1970s, Thorp had switched its attentions to the Middle East, which accounted for three quarters of its annual turnover by the end of the decade, few of its thirty modelmakers working on British-based projects (Thorp Modelmakers, 1983, p.11). The consequence of the profession's decline during the 1970s was that by the start of the 1980s Thorp and Pipers held an effective monopoly on the market, and there were not enough architectural modelmakers to meet the demand generated by the Big Bang property boom, providing the ideal circumstances for the 'Arup School'-trained Medway graduates such as Richard Armiger to go into business.

During the early-1980s, a further change in government policy created an additional demand for architectural models through the active encouragement by Michael Heseltine as Minister for the Environment to run architectural competitions as a way of fostering competition between architects, and to drive both innovation and value for money. Making models for architectural competitions required a great relationship of trust between an architect and their chosen modelmaker to understand and interpret their vision. Such models were by necessity very creative and highly abstract, and competition models offered an ideal opportunity to explore the role of models as expressions of ideas rather than of proposed buildings. For Armiger, they were an 'epicentre for creativity' (Armiger, 2018a); the design so ill-defined at such an early stage in the process that a realistic model was usually not an option. Often there would be no drawings at all to work from, sometimes just a conversation with the architect (Spencer-Davies, 2019), and so abstraction was partly a way of covering the fact that the design had not been completed, while also appealing directly to the architect's vision in a more abstract manner without tying them to a concrete prediction of a building. With the actual material choices of the building rarely being determined so early on either, this often dictated the use of either polished or frosted Perspex, unpainted timber, or monochromatic white models for most competitions (Spencer-Davies, 2019). Additionally, the competition organiser would usually set a specific scale for the models submitted, which made it all the more imperative that each architect's model stood out. Such commissions were strong drivers of creativity for modelmakers during the 1980s, where architectural models became crucial factors in persuading the judges.

In 1982 Robert Kirkman produced the competition model for Terry Farrell's design for the BBC Radio building extension. 'Farrell did a nice scheme and I did the model, but he was tight for money, so I made a small model of just the site. I think it must have been about a £3000 fee for the model' (Kirkman, 2019). The competition came down to two finalists, Farrell, and Norman Foster, who ultimately won. For Kirkman, it was clear why Foster had won – his model was spectacular (Figure 6.33). 'He had modelled from Oxford Circus right down to Regent's Park, all of that street, the buildings going out for three rows either side' (Kirkman, 2019). The model included the whole of the existing BBC building, with

Figure 6.33: Model of the BBC Radio Centre, made by Foster + Partners, 1982

Foster's glass extension 'sitting like an absolute jewel. It was under-lit and must have cost something like thirty or forty thousand pounds. It was sheer presentation; Foster didn't mess about' (Kirkman, 2019). The following year, Kirkman made the model for ABK's winning submission to the competition to design the extension to the National Gallery in London (Figure 6.34). Made in Sycamore and balsa wood with Perspex glazing, the model quickly became an unwitting lightning rod for intense criticism of the design by the Prince of Wales in his notorious 'Carbuncle' speech to the RIBA (Stewart, 2013, p.268; Kirkman, 2019). Several years later, the competition was re-run, Kirkman again making a model for one of the submissions, this time for CZWK, which again was ultimately rejected. A third competition was then won by Robert Venturi, and it was his design that was actually built.

For Richard Armiger, the 1991 competition held at the Venice Biennale for the design of the Venice Gateway bus station proved just how broad the architectural model's palette had become at Network, and why it was such an important development. As was described in the introduction to this chapter, Armiger was commissioned to produce the models accompanying the submissions of four different architects: Eva Jiricna, Harper MacKay, Weston Williamson, and Dixon Jones. For each submission Armiger created an entirely

Figure 6.34: Model of ABK's proposed design for the National Gallery Sainsbury Wing extension, made by Robert Kirkman and Associates, 1984

unique look using different materials. 'Weston Williamson...had a tiny budget, and asked how we could do the model for hardly any money' (Armiger, 2018b), and so the architects made the context buildings for the model while Armiger produced the base and the model of their entry, a high-tech design that required a lot of vacuum-formed polystyrene and metal etchings (Figure 6.35). For Harper MacKay's design, Armiger made use of Rohacel, birch veneer, and frosted Perspex with realistic trees to offset the model's yellow colour (Figure 6.36). With Eva Jiricna's model, Perspex was back-sprayed a dark grey to create

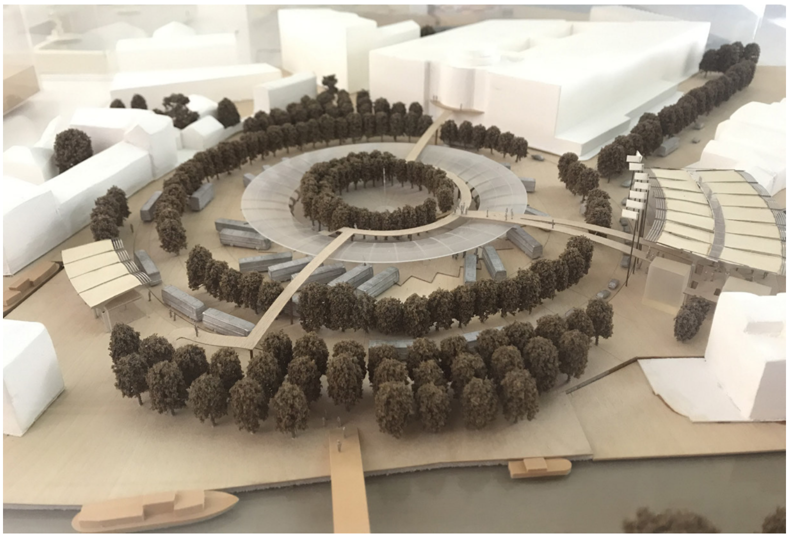

Figure 6.35: Model of Weston Williamson's entry to the Venice Gateway competition, made by Network Modelmakers, 1991

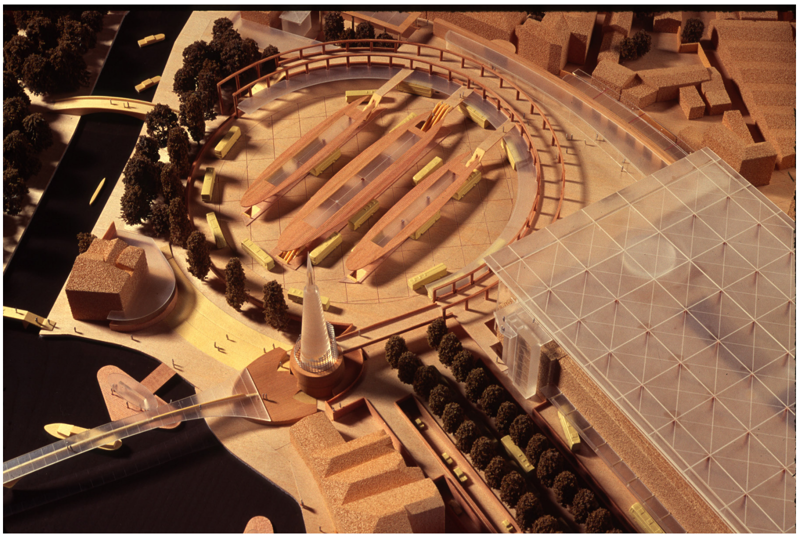

Figure 6.36: Model of Harper MacKay's entry to the Venice Gateway competition, made by Network Modelmakers, 1991. Photograph by Andrew Putler

the effect of water. 'Hers was a steel and glass intense structure and so we did this model all in black with silver details' (Armiger, 2018b). Armiger created the complex roof structure using heat-bent Perspex carefully masked and sprayed silver (Figure 6.37). For Dixon Jones' competition-winning entry, Armiger used a simple all-timber palette to blend the design into the surrounding buildings, which also served to draw attention to the stainless steel roof details (Figure 6.38). The different creative approaches evident in the Venice models stand in stark contrast to the all-or-nothing realism that had dominated the previous decades. While the basic materials – Perspex, polystyrene sheet, and timber – were the same, the approach was utterly different. Venice demonstrated a need for a much broader palette of styles in professional architectural modelmaking that was not being met at the time, and encompassed a much more diverse and adaptable approach as to how materials were applied. Plastics, as well as timbers and metals, were all being used in more creative and expressive ways, rather than merely to simulate reality, an approach that quickly became highly sought-after. After the late-1980s recession, business for Armiger really took off. 'I was suddenly asked to make Big Blue in Marseilles for Will Alsop (Figure 6.39), Glyndebourne Opera House...you go

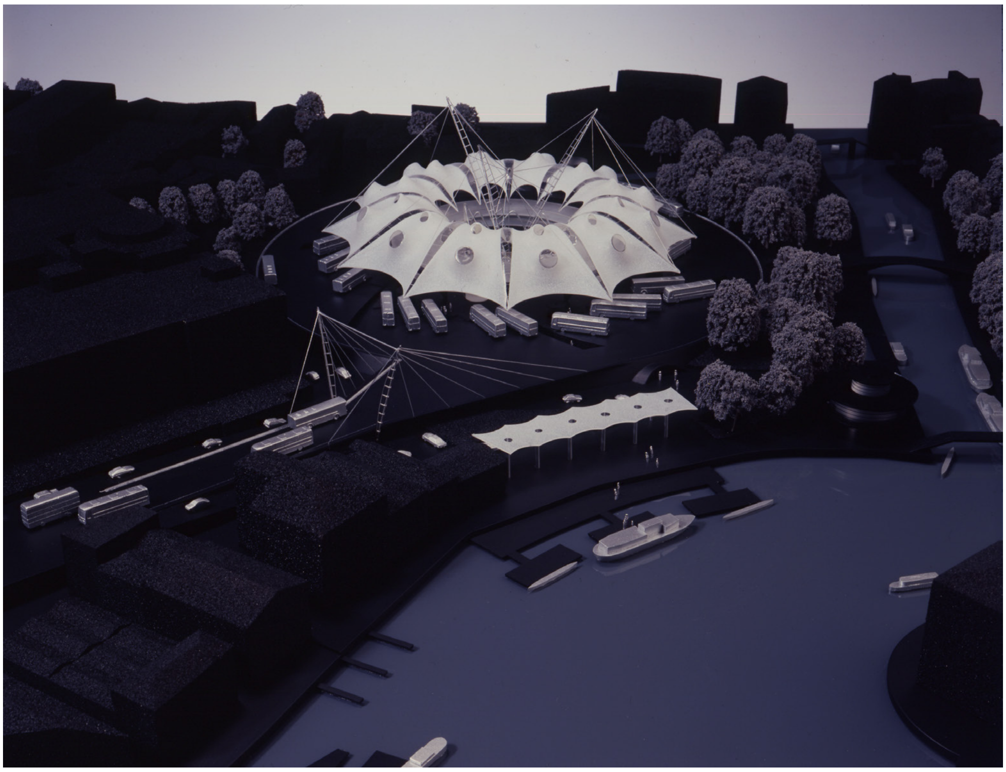

Figure 6.37: Model of Eva Jiricna's entry to the Venice Gateway competition, made by Network Modelmakers, 1991. Photograph by Andrew Putler

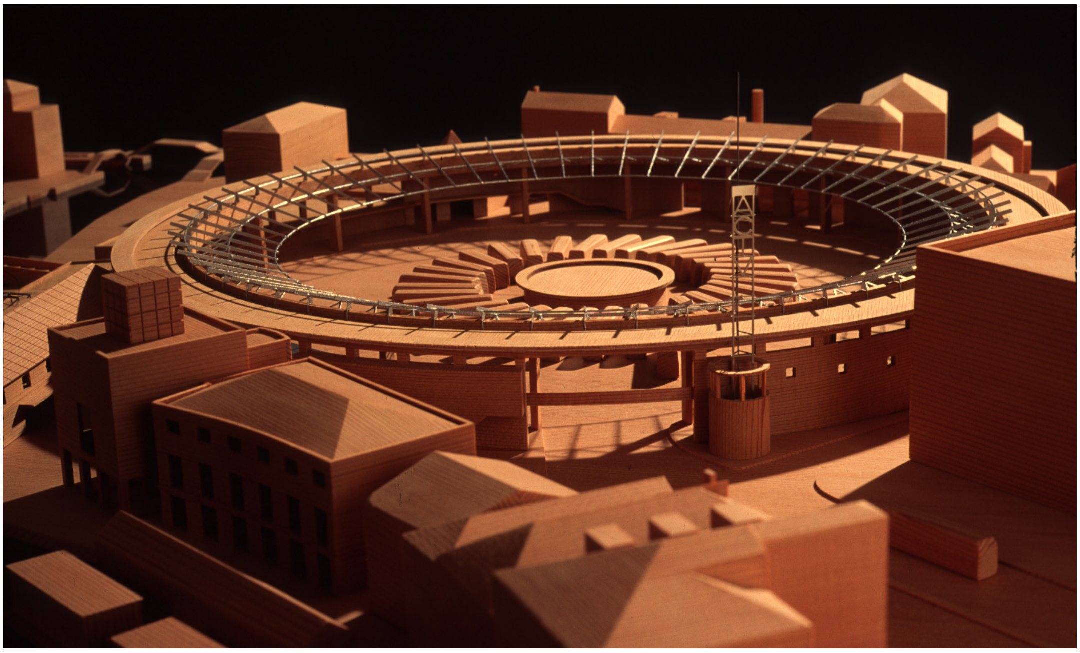

Figure 6.38: Model of Dixon Jones' entry to the Venice Gateway competition, made by Network Modelmakers, 1991. Photograph by Andrew Putler

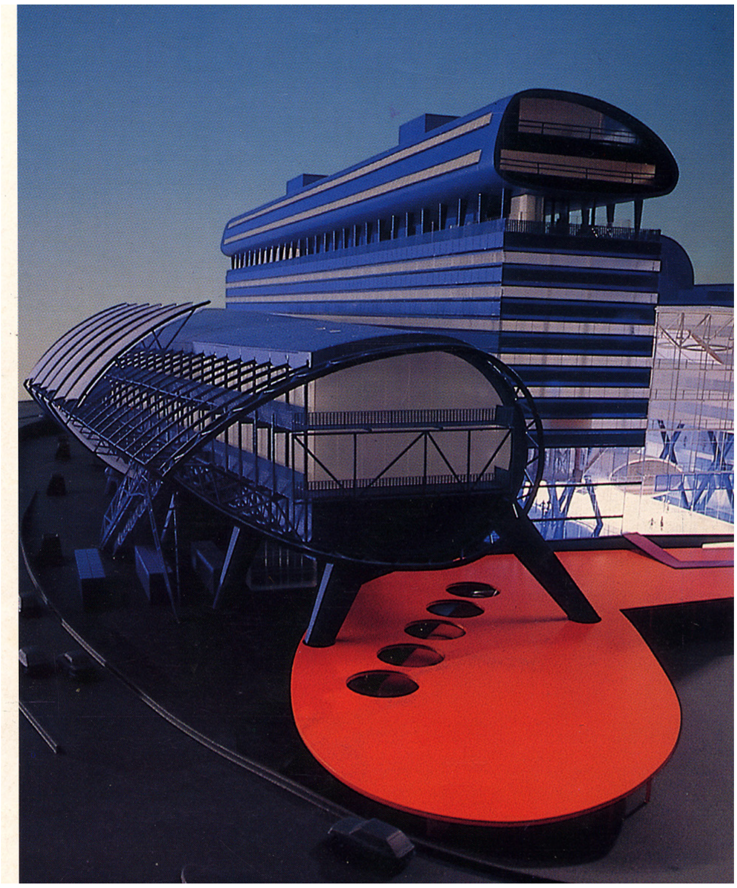

Figure 6.39: Model of Will Alsop's 'Big Blue', made by Network Modelmakers, 1992. Photograph by Andrew Putler

from having two projects and a team of five, to having six projects and twelve modelmakers' (Armiger, 2018a).

Through Richard Armiger's company Network Modelmakers, the Arup approach to modelmaking had been refined and introduced to a much wider circle of architects who were eager to express their designs with strongly stylised architectural models, but whose practices were not large enough to justify an in-house modelmaker. Network, and later Millennium Models and A Models – their founders having been trained by Armiger (see Chapter Seven), provided just the kind of creative collaboration that they were looking for, all drawing from the 'Arup School' of modelmaking. At the same time, the dominance of Thorp within the profession was finally broken when the company underwent an acrimonious split that led to the creation of a close rival, Kandor Modelmakers, and which provided the opportunity for new firms such as Armiger's Network Modelmakers to establish themselves. 'It started a snowball effect, you know, from that one action. What it did is spawn this sort of feeling among modelmakers that they could be a bit more adventurous [and start their own businesses]' (Saunders, 2018). Timed as it was to coincide with the Big Bang property boom, this renewed sense of entrepreneurialism led to a resurgence of the profession, with multiple new modelmaking companies setting up business as the decade progressed.

At Pipers, which had continued to expand since Barry McKeogh's purchase of the company from John Piper, a further split occurred. Lee Atkins, Martin Giddons, and Kevin Mullane, all modelmakers at the firm, left to set up 3DD in 1988. The firm quickly gained a reputation for producing high quality models at a low price and within very tight deadlines. Richard Armiger recalls 3DD charging £8 an hour when his own charge out rate was closer to £25 (Armiger, 2018a). Early clients included architects such as SOM, Swanke Hayden Connell, and Terry Farrell (Figure 6.40), before the directors made a conscious effort to specialise in working for developers rather than architects as the time pressures were far more manageable. In the same year that 3DD launched, Tetra Modelmakers was formed by three architecture graduates from the AA (Architectural Association), quickly becoming known for their creative and impressive models that appealed to the same market that Richard Armiger had tailored his efforts towards. By the middle of the decade, Unit 22, established by architect

Figure 6.40: Model of Terry Farrell's design for The Peak, Hong Kong, made by 3DD, circa 1992

Don Shuttleworth in 1983, was growing into a distinguished maker of competition and concept models, including many notable projects for Jan Kaplicky at Future Systems (Figure 6.41), a relationship that continued until the late-1990s, and whose models were a far cry from the realistic marketing models that had dominated the post-war era.

Directly, or indirectly, by the start of the 1990s, the 'Arup School' of architectural modelmaking had become deeply embedded within the profession. After his retirement, David Armstrong reflected on the Arup modelshop's legacy being that: 'Old fashioned firms like Thorp would make the painted plastic model extremely well, and then a few younger people took on our wooden thing...and still it goes on' (Armstrong, 1999). George Rome Innes is adamant that much of the widening of the palette of models during the 1980s stems from the Arup influence. 'The re-introduction of timber models changes the idea of what a model should look like, from being a railway model to being abstract expressions of what a building is' (Innes, 2019).

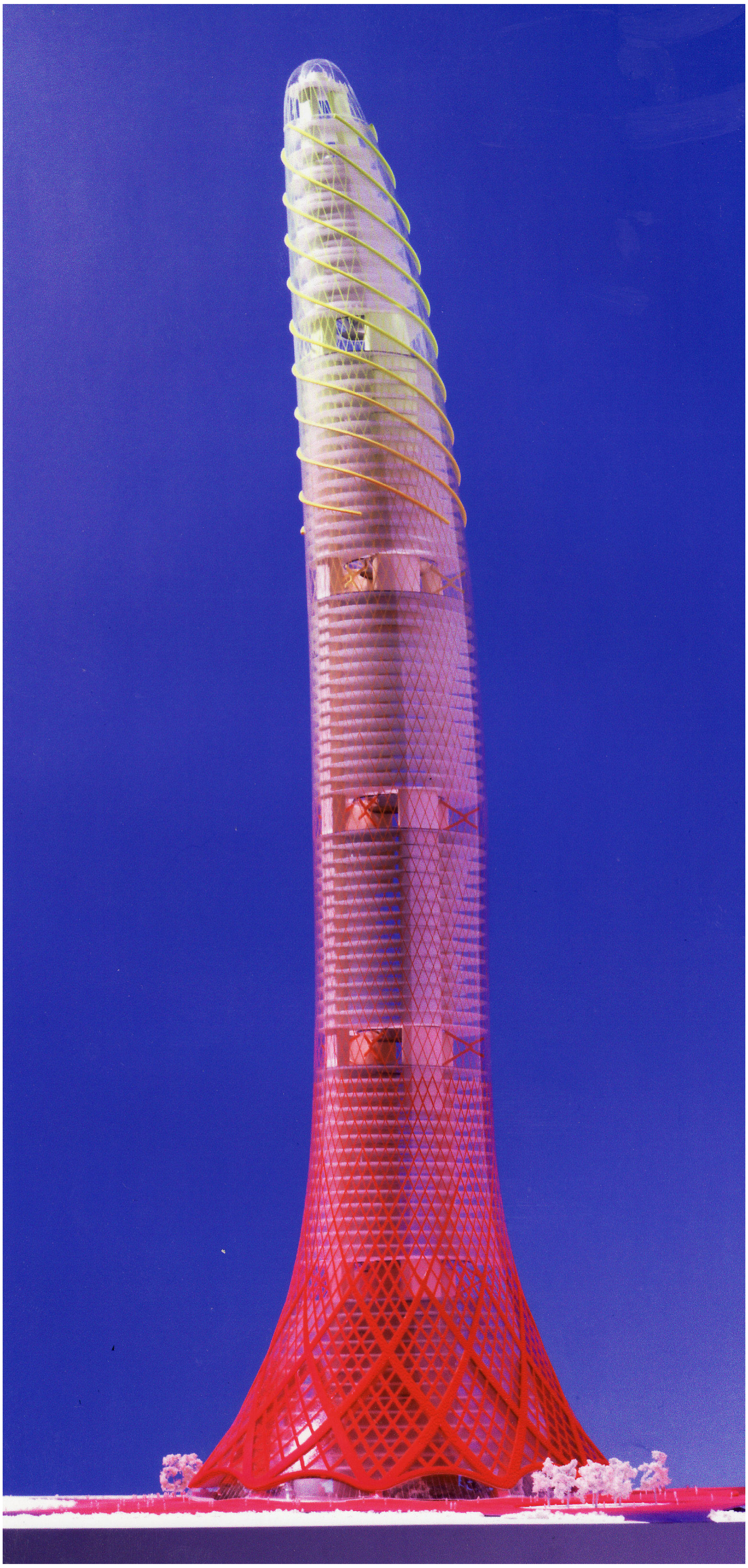

Figure 6.41: Model of Future Systems’ Big Bird, made by Unit 22, circa 1998

> The old material comes back and changes the view. Then plastics come back in again and you are now not spraying your buildings brick red, you are spraying them a monochrome colour. You are looking at the form not the colour and detail (Innes, 2019).

Due to the adoption of Arup's creativity and abstraction through George Rome Innes' teaching at Medway, graduate Richard Armiger's success in applying that approach to architectural competition models during the 1980s property boom, and the new generation of modelmakers who followed him, the range of styles present in professionally-made architectural models in Britain expanded significantly. With architects having largely rejected realistic models, and yet developers continuing to find them extremely successful, it was vital that for the model to remain relevant to both sets of clients, architectural modelmakers could not simply provide either highly realistic painted Perspex models or abstract timber ones – the demand existed for both. In addition, purely timber models, such as had become the hallmark of the Arup modelshop, presented a distinct style of their own, and for commercial modelmakers this created an additional challenge as the new generation of architects attempting to make their name in the early 1980s were in fierce competition with one another, and they all wanted models that reflected their own style rather than the modelmaker's. The legacy of the 'Arup School' was ultimately a reinvigoration of the professional architectural modelmaker's creative and adaptable approach that would enable them to meet the intensive demands of the following decade as the Big Bang property boom fuelled the need for both creative and abstract models for architects, and more realistic marketing models for developers.

By the early-1990s, both the professionally-made architectural model in Britain, and the profession itself, had been radically changed. A clear divergence had taken place, with Thorp, Kandor, Pipers, 3DD, and Nick Quine's AMI dominating the market for developers' marketing models; and Network Modelmakers, Unit 22, Robert Kirkman, and Tetra gaining a strong reputation for their more expressive competition models. Larger architectural practices such as Foster + Partners, and Richard Rogers expanded their in-house modelmaking workshops, and by the middle of the decade, modelmaking courses were being offered not just by Medway, but at Rycotewood College, Hertfordshire College of Art and Design in St Albans, Sunderland Polytechnic, Barking College, Northbrook College in Sussex, Hounslow College, Bourneville College, and Bournemouth and Poole College of Art and Design (Owens, 1987), with the Arup approach to architectural modelmaking dominating the curriculum.

Two schools of thought now existed within the profession – the Thorp, Pipers, and 3DD approach of producing models for marketing and sales purposes that drew from the long tradition of pushing the boundaries of technical precision and realism that plastics had enabled in the post-war era (Figures 6.42 and 6.43), and the 'Arup School' employed by Network Modelmakers, Robert Kirkman, Unit 22, and others, that embraced a creative drive for experimenting with materials and abstraction that ideally suited architects' revised view of the model as an expression of architectural ideas, and the highly stylistic requirements of competition models (Figures 6.44 and 6.45). Both approaches proved to be equally valid, the professionally-made architectural model in Britain having adapted to serve the now differing demands of architects and developers. Both approaches also stayed true to Robert Hoyt's description that the 'success of the modelmaker depends upon his imaginative use and ingenious adaptation of available tools and materials' (Hoyt, 1939, p.420). With the

Figure 6.42: Housing estate model, made by Nick Quine/AMI, circa 1990

Figure 6.43: Marketing model by Pipers, circa 1990

Figure 6.44: Model of Milton Keynes theatre, made by Robert Kirkman and Associates, circa 1990

Figure 6.45: Presentation model by Network Modelmakers, 1996

previous chapter having outlined a period in which the definition of adaptability expanded to incorporate the intrinsically adaptable properties of plastics as well, emerging from the combined agency of the modelmaker's imaginative and ingenious intentions and the inherent adaptability of their newly-adopted materials, the creative expansion of the 1980s marks the era in which adaptability expanded to encompass the very nature of the model itself. No longer pursuing a single desire for ever-increasing realism, architectural modelmakers had come to recognise the importance of tailoring and adapting every process to a specific model's – and a specific architect's – needs.

Despite the use of timber in Arup's models, and its suitability for quickly enforcing a high degree of abstraction in a model, plastics – particularly Perspex – continued to be the most commonly-used material by professional architectural modelmakers during the 1980s. A difference was that in more abstract models, Perspex was being left unpainted, in either clear or frosted block form. Architect Zaha Hadid's collaboration with modelmakers such as Richard Armiger, Daniel Chadwick, and Ademir Volic helped popularise this trend (Figure 6.46), before Helmet Kinzler set up Hadid's in-house modelshop during the late-1990s. Hadid had always favoured the use of Perspex and resin models due to their transparency allowing her to see in the internal spaces of the designs (Kinzler, 2017), and which reflected the same fluidity of her paintings (Figure 6.47). The high levels of publicity these models generated led to further model commissions by other architects seeking a similar aesthetic, although the creative use of Perspex was not fully realised until the introduction of CNC-machining and laser cutters in the mid-1990s (see Chapter Seven).

By the end of the 1980s, the professionally-made architectural model in Britain was no longer clearly defined by a single style, having adapted to occupy a spectrum that extended from the highly realistic at one end and to the abstract and artistic at the other. This broadening of

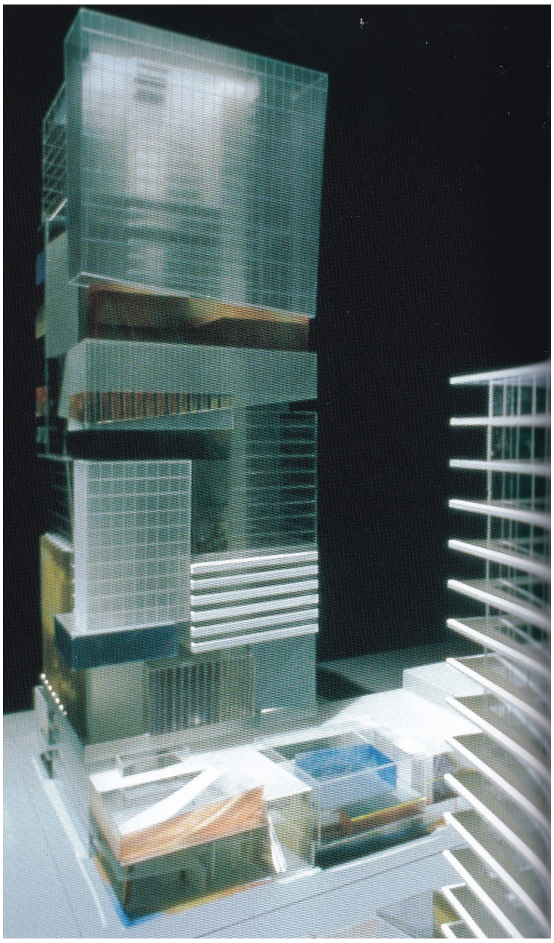

Figure 6.46: Presentation model by Network Modelmakers for Zaha Hadid Architects, 1995

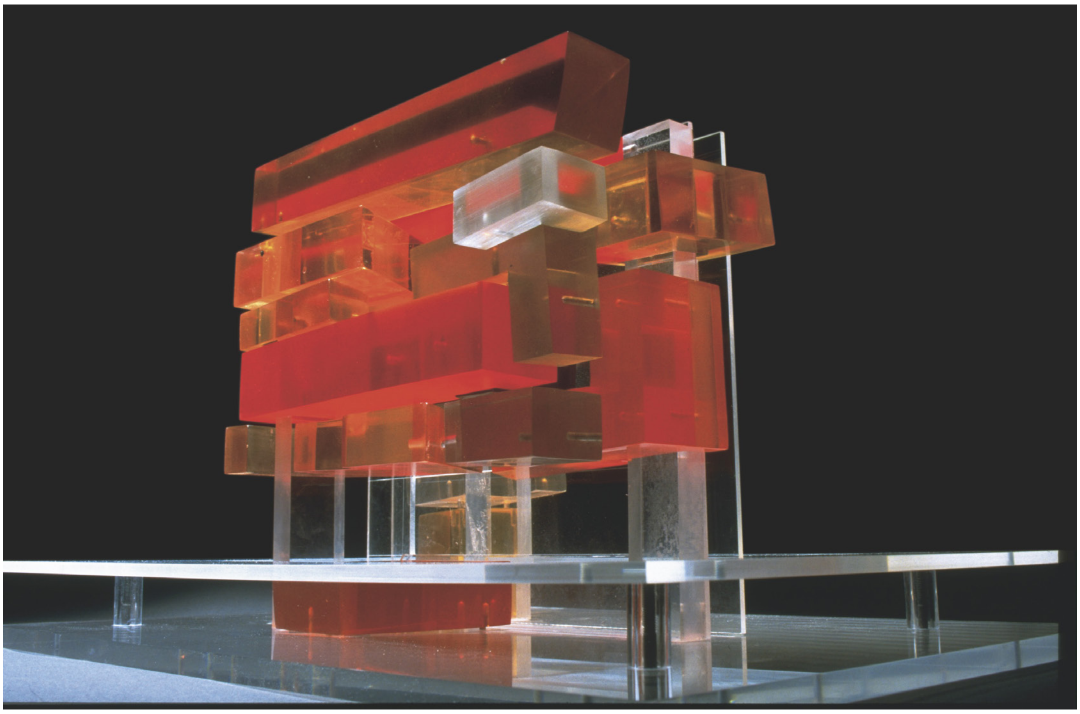

Figure 6.47: Perspex and resin architectural model made by Zaha Hadid Architects, circa 2000

styles required greater levels of creativity from its makers. 'Good architectural modelmakers need to be inventive with an obsessive interest in detailed work' (Rawson, 1990, pp.64-65). Modelmaker Christian Spencer-Davies describes how the process of modelmaking had become more like that of cookery and the art of mixing two things together that 'suddenly make something that's greater than either of them' (Spencer-Davies, 2019), in effect describing an emergent phenomenon. Selecting a contrasting mix of materials, colours, and textures such as timber and Perspex had become crucial to the success of a more abstract model (Spencer-Davies, 2019). Noting that the model came of age in the 1980s, Karen Moon has remarked that the presentation model regained the respect it had lost among architects during the post-war era, and that its dented confidence had done it some considerable good (Moon, 2005, p.122; p.137). As a result, we are left today, Moon observes, with very sophisticated presentation models 'layered with meaning and full of messages' (Moon, 2005, p.135). The inquisitive and adaptable spirit of the first generation of professional architectural modelmakers such as John Thorp had returned, and combined with the technical precision achieved by the post-war generation with the adoption of plastics, a third generation of modelmakers was setting the standard for the quality and diversity of architectural models that would continue until the present day.

6.6. Conclusion

This chapter set out to trace the emergence of the stylistic diversity of the professionally-made architectural model in Britain by examining the creative expansion that took place during the 1970s and 1980s, aiming to understand the complex interactions between the people, processes, materials, and ideas that shaped the model's development during this period. What this chapter has revealed is how the professionally-made architectural model in Britain not only expanded its relevance to incorporate the diverging requirements of architects and developers, but was also reinvigorated by the inquisitive and adaptable relationship between modelmakers and materials that had been a defining characteristic of the profession since the days of John Thorp. The broadening of the model's stylistic palette served to better match the pluralistic approach of architectural practice that had emerged in place of the certainty of modernism, and allowed for the dual role of the model as both a commercial sales tool and a visionary expression of architectural ideas to be reconciled within a much wider aesthetic range.

Beginning with a discussion of John Chisholm's polemic attack on the model in Chapter 6.2, this chapter has charted the unanticipated fall from grace that the professionally-made architectural model in Britain experienced during the late-1960s and early-1970s, a period in which the high standards of quality and realism that emerged as a result of the post-war boom became highly contested (pages 201-207). As revealed in Chapter 6.3, this conflict was largely the result of architecture's reassessment of the success or otherwise of modernism, and a growing realisation that architectural models were predicting too concrete a future that architects were then held accountable for. Outlining deeper ideological concerns regarding the role of the model as a commercial sales tool for developers as opposed to being a visionary expression of utopian futures for architects (pages 213-219), the chapter then contextualised the changing agenda of architectural practice within wider economic and ideological concerns, identifying a fundamental shift in architecture's perception of what an architectural model was actually a model of (pages 223-224). With architecture increasingly viewing the model as a representation of ideas rather than of actual buildings, Chapter 6.4 then traced the development of abstract timber models during the 1960s and

1970s as alternatives to the prevailing highly-realistic Perspex models that architects were starting to reject, focusing on the influential Arup Associates modelshop under the lead of David Armstrong (pages 233-238).

Chapter 6.5 then charted Arup's contribution to the broadening of the model's palette during the 1980s as a result of the 'Arup School' of modelmaking being adopted by a new generation of modelmakers taught at the Medway School of Design in Rochester. The work of modelmaker Richard Armiger in applying this approach to competition models during the 1980s 'Big Bang' property boom was then covered in some detail (pages 242-246), before examining how the Arup legacy of more abstract and creative modelmaking converged in a period where a new generation of architects were exploring a hugely diverse range of styles, and where the dominance of the post-war modelmaking firms had been broken, providing opportunities for more creative modelmakers to establish themselves, adapting the model's visual and material language to allow for a much more diverse range of styles to accommodate the conflicting needs of the architect and the developer.

What this chapter has ultimately shown is how by the late-1980s the professionally-made architectural model in Britain had adapted to reflect the changes that architecture itself had undergone since the 1960s, having embraced a multiplicity of styles and ideologies. In revealing how the combination of the contested nature of realism in models; the Arup modelshop's more abstract and creative approach to modelmaking; and changes in both the architectural and modelmaking professions led to a dramatic broadening of the architectural model's appearance this chapter has highlights how this period saw the model adapt to accommodate both the highly realistic and the abstract, restoring its relationship with architecture after a tumultuous period of change. By the end of the 1980s, the professionally-made architectural model in Britain had become a creatively as well as technically sophisticated class of objects. Plastics, which had previously only been utilised in the pursuit of realism, were now also being put to use in more abstract ways alongside more traditional timbers. Throughout the 1980s, however, there had been hints that another major shift in the making of architectural models was approaching as new digital tools threatened to make the professional modelmaker, and potentially even the architectural model itself, redundant. The transformative effects of computer-aided design (CAD) were faintly visible on the horizon, and as the next chapter reveals, the notion of 'ingenious adaptation' was to be tested to its extremes.

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7: Digital Adaptations: The Drive for Efficiency and the CAD/CAM Tools of Contemporary Architectural Modelmaking, 1996-2020

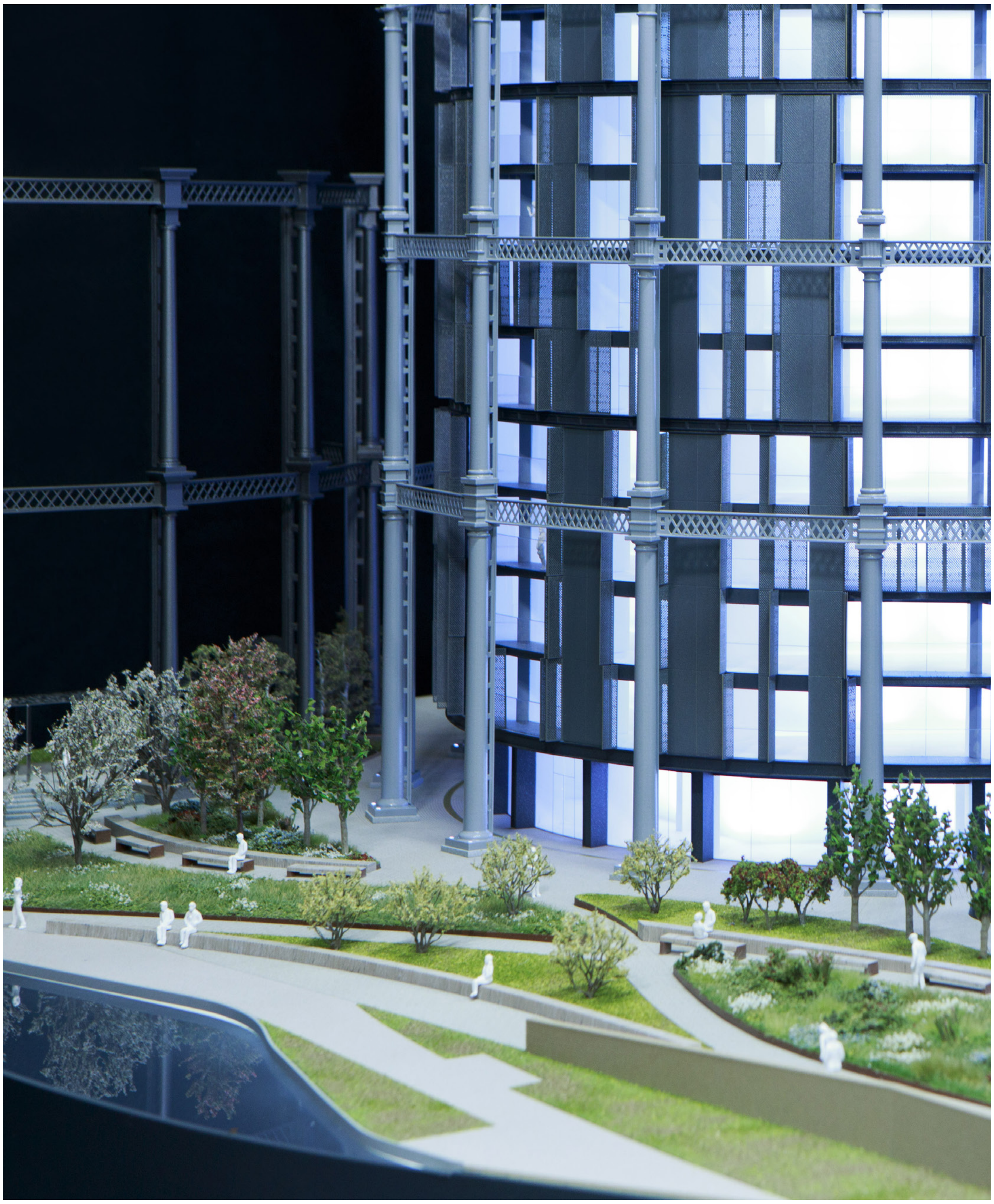

Figure 7.0: Presentation model made by Pipers, 2015

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7.1. Introduction

By the middle of the 1990s, over a century of development since John Thorp first opened his business at 98 Gray's Inn Road had dramatically altered the professionally-made architectural model in Britain. Made by a flourishing profession supported by HND courses in Modelmaking at Bournemouth, Hatfield, Rochester, and Sunderland; constructed to ever-increasing levels of accuracy and realism through the use of Perspex; and embracing a diverse range of styles as a result of the creative expansion of the 1980s, throughout much of the model's history, the tools and processes of the architectural modelmaking had remained remarkably consistent. Whether working with timber or plastics, machine tools such as the band saw, circular saw, sander, and pillar drill were necessities in any modelmaking workshop. Even the daily use of the scalpel by hand continued for over a century, transferring from cutting card and paper to soft plastics such as polystyrene sheet. Improved motor-driven machine tools, particularly during the inter-war years, had brought about improvements to the quality of architectural models (see Chapter Four), but fundamentally the equipment in a commercial modelmaker's workshop in the early-1990s would have been recognisable to anyone working in John Thorp's workshop in the 1920s. By the start of the new millennium, however, the standard tools used to make an architectural model had radically changed, with new digital manufacturing technologies such as laser cutting and 3D printing sweeping aside many traditional making processes. Over the course of just a few short years, the construction of architectural models shifted away from purely analogue ways of working through the adoption of the suite of advanced CAD/CAM tools and processes that are used today.

Twenty-first century architectural models such as 3DD's model of the Neo Bankside development (Figure 7.1) illustrate the rapid and sweeping changes that took place during the late-1990s and early-2000s. The detail in the model is crisp and accurate, the construction

Figure 7.1: Model of Neo Bankside, made by 3DD, 2015

precise, and the paint finish well-executed, all characteristics found in many architectural models already featured in this thesis; however this model was made using a range of tools that had mostly not even existed just twenty years before, and yet which are considered the standard ways of working for a professional architectural modelmaker today, having made use of CAD (computer-aided design) programs to prepare files for use by laser cutters, 3D printers, and CNC (computer-numerically-controlled) milling machines.

This chapter examines the introduction of digital manufacturing technologies to architectural modelmaking from the late-1990s through to the present day, and considers the consequences for the making, appearance, and functionality of the architectural model that they brought about. Revealing a period in which adaptability came to the fore, this chapter charts not only the establishment of the digital tools used in the making of today's architectural models, but also their role in consolidating the dominance of plastics and in further advancing the creativity, precision, and technical sophistication of the professionally-made architectural model in Britain. In covering the model's more recent history, this chapter draws from a number of interviews with practicing and retired modelmakers, including Tina Miller, Roger Hillier, Stephen Fooks, Lee Atkins, Neil Merryweather, Will Strange, Alec Saunders, Richard Armiger, Robert Danton-Rees, David MacKay, Helmet Kinzler, Cameron Kiani, Simon Hamnell, Mike Fairbrass, Christian Spencer-Davies, Adam Burdett, Matt Driscoll, Neil Vandersteen, Bruno Gordon, Paul Miles, and Daniel McWilliam. Further examinations of the Thorp modelmaking archive and the private photographic collections of Millennium Models, 3DD, Unit 22, Pipers Modelmakers, Network Modelmakers, Farrells Architects, A Models, Base Models, Mike Fairbrass' personal collection of RSHP model photographs, and Architectural Models International (AMI) were supplemented by new analyses of publically-available archival documents and photographs from contemporary architectural journals, and practical publications on the making of architectural models.

Beginning with a discussion of the perceived threat of digital manufacturing to architectural modelmaking during the mid-1990s, this chapter then outlines the time-consuming and repetitive nature of much of the basic work of architectural modelmakers prior to the adoption of digital manufacturing processes, highlighting the need for increased efficiency that the introduction of CAD/CAM processes such as the CNC and the laser cutter brought about. The adoption of these technologies is then traced, and by revealing how in taking digital tools that had initially been seen as potential threats to their profession and adapting them to their own requirements, the chapter highlights how professional architectural modelmakers defied the expectations of the time, and in greatly improving the precision and detail of architectural models, demonstrated the model's resilience against purely-digital alternatives. The chapter then charts the adoption of 3D printing, a process that had so concerned the profession during the 1990s, with the use of CAD in architectural design generating more complex and organic forms that were beyond the ability of traditional hand-making process to efficiently represent in model form. The integration of the 3D printer as a tool under the command of the modelmaker, rather than as a potential replacement for their work, is then examined, as is its role in expanding the use of in-house modelmakers within architectural practices.

The chapter then reveals how the efficiencies digital manufacturing technologies brought about freed the modelmaker's time to be further spent on the more creative aspects of architectural modelmaking, and outlines how the benefits of their new digital tools spread beyond the technical processes of making, enabling a rapid consolidation of earlier developments in architectural modelmaking that had emerged during the twentieth century. Advances in both realism and creative abstraction, a further embedding of the dominance of plastics as the principal materials of architectural modelmaking, and a maturation of the notion of adaptability being central to the modelmaker's nature quickly followed. The chapter then discusses how the use of technology was extended to the functions of the model, with an increased demand for lighting effects and interactivity creating new types of high-end marketing models, before outlining how efficiency once again became a driving force behind the continued adoption of digital technologies as the initial efficiency gains of CAD/CAM processes became countered by the increased technical complexity that their application generated.

The chapter concludes by summarising how this most recent period in the model's history marks the era in which the emergence of the architectural modelmaker's digital tools enabled the professionally-made architectural model in Britain to become the diverse and technically sophisticated class of objects it is today, with the ongoing application of the notion of 'ingenious adaptation' allowing it to navigate the multiple threats of the emerging digital age and to thrive in the midst of a digital transformation of architectural modelmaking that continues to unfold.

7.2. Digital Anxieties and the Drive for Efficiency

On the 22nd March 1996, the University of Hertfordshire held a conference to discuss the future of modelmaking. While the presented papers adopted a fairly upbeat tone, the conference was taking place during a period of notable anxiety for the professional modelmaker working across a number of industries – product, film, heritage, and display, as well as architectural modelmaking – and this was reflected in the dominant subject that was discussed: rapid prototyping.

While the introduction of computer-aided design and computer-aided manufacturing (CAD/CAM) to architectural modelmaking had been slowly gathering pace over the course of the previous decade, the second half of the 1990s saw the wholesale change of many of the established processes of the profession, with new automated tools replacing a significant proportion of manual work, bringing dramatic increases in efficiency, and opening up new possibilities in the making of architectural models. Computer numerically-controlled (CNC) machining and laser cutting were rapidly being adopted as standard processes, and while any period of major change is likely to cause some anxiety, it was the arrival of commercially-affordable 3D printers and other forms of rapid prototyping that generated the most concern. The availability of machines that could produce fully-assembled scale models from CAD files raised legitimate questions about the future role of the modelmaker across a number of industries. For modelmakers involved in product design in particular, the question was quite simply whether they would be needed. In his opening speech to the conference, Brian Holder outlined a range of potential futures that included the disappearance of modelmaking altogether; the marginalisation of small firms unable to afford new technologies; models being replaced by screen-based media; and what he felt to be more likely, 'nothing much changes at all, but a few small things change a lot' (Holder, 1996, p.2).

The perceived threat of rapid prototyping, and the increased quality of digital screen-based models were also causing considerable concern in the architectural profession, and as was noted in Chapter Two, this contributed to a sudden increase in the critical study of all forms of architectural representation, including the architectural model. For both the modelmaker and the architect, the late-1990s was a period of opportunity, uncertainty, and most of all, change. As Angar Oswald has remarked, 'no advance in technology has had a more lasting and far-reaching impact on the work of the architect and the modelmaker than the arrival of the office computer' (Oswald, 2008, p.9). The analogue processes of architectural design, including drawing and modelmaking, appeared to be under imminent threat as CAD swept through the architectural profession, the computer 'turning the tools that served generations of architects and were a hallmark of their profession into antiquated museum pieces' (Shilling, 2018, p.196). Drawing by hand on paper was quickly replaced by drawing on a screen, and architects began to ask themselves whether physical models were about to be replaced by virtual ones (Oswald, 2009, p.9). For architects, the transition from analogue to digital working was a 'brutal and all-encompassing upheaval. From conception to implementation, no part of the architectural design process remained unchanged' (Hauschild and Karzel, 2012, p.7). The critical re-evaluation of modelmaking that took place within the architectural profession during this time is evident in the publications that followed (see Porter and Neale, 2000; Morris, 2004; Moon, 2005), with American architectural writer Thomas Fisher writing in 1990 that:

> One of the storm clouds on the horizon for both renderers and modelmakers is the computer, and [...] some in the profession, however, see it only as a matter of time, perhaps within a decade or so, before computer technology advances to the point where it can surpass the quality of what is now done by hand (Fisher, 1990, p.14).

For architectural modelmakers, however, the concerns over physical models being replaced by virtual ones were relatively short lived. With the arrival of high-quality computer generated images (CGI), the initial assumption had been that architects and developers would commission these instead of models, however as Patrick McKeogh at Pipers recalls, the reality turned out to be far less damaging; their clients quickly realising that digital images and physical models served different purposes (McKeogh, 2018). Several architectural modelmakers including Pipers, Thorp, and 3DD experimented with offering virtual models and animated fly-throughs to brace themselves for a potential loss of demand for physical models during the early-1990s, but few modelmakers ever seriously pursued the idea, as they had been hearing the same arguments for over a decade. In 1981, the modelmakers at Arup had been invited to watch a presentation about computer-generated imagery and 'were told with a gleam in some people's eyes that this would replace modelmaking' (Miller, 2018).

By the time of the Hertfordshire conference in 1996, concerns had shifted from the possibility of models being replaced by computers to concerns about models being made by computers; rapid prototyping and 3D printing seemingly technologies that might ultimately make the professional modelmaker redundant. In 1992, the Association of Professional Model Makers (APMM) had been established in the United States specifically to address this threat, and yet as the presentations at the Hertfordshire conference illustrate, the mood in Britain by 1996 was, perhaps surprisingly, cautiously optimistic. Ian Mitchell, a lecturer on the HND in Modelmaking at the university, had just returned from the third APMM conference and noted that in the United States 'advances in technology are being embraced, rather than being seen as the death knell of the model making profession' (Mitchell, 1996, p.1). Summarising the mood of both the APMM conference, and that of the Hertfordshire gathering, Mitchell continued:

> If we look back less than a decade ago when CAD/CAM and CNC mills seemed set on usurping the role of the modelmaker or at least to bring about a re-skilling, it is easy to see how this was a natural scepticism about change. We can now see that the worry was over the damage these systems might do to us rather than, how can these new developments be used to our advantage and create more opportunities for the future? (Mitchell, 1996, p.3).

Modelmaker Trevor Crout also spoke optimistically at the conference that 'the future of modelmaking I believe will make the best use of new materials and technologies to speed up and enhance the traditional hand crafted model' (Crout, 1996, p.1), commenting that he felt it unlikely that computers would ever fully replace the human element of the process.

This optimism is in contrast to the more existential fears expressed in literature about the architectural model published at the time, and it is important to note that the writers discussing the future of the model during this period were not modelmakers themselves, with those actually working in the profession recalling a far more welcoming attitude towards CAD/CAM than has otherwise been documented (Fooks, 2018; Atkins, 2019; Merryweather, 2019).

The reason for such optimism in the midst of the enormous upheaval of the digital revolution of the 1990s, and with rapid prototyping looming on the horizon, was that architectural modelmakers had already realised that the new CAD/CAM processes being introduced were simply new tools for them to adapt to their own purposes. The imaginative and adaptable nature of the modelmaker meant new technologies were generally approached as something to be explored rather than feared. While there was still a concern that rapid prototyping might ultimately replace the modelmaker in some industries, in 1996 this was a prospect that remained some distance away, and for most architectural modelmakers, their present concerns were getting to grips with the immediate challenges and opportunities offered by the adoption of CNC mills, laser cutters, and CAD drawings.

Despite the complexities involved in learning how to operate these new machines and computer programs, and the high cost of investing in them in the first place, CNCs and laser cutters were immediately identified as enormously beneficial additions to the modelmaker's workshop as they offered a dramatic increase in efficiency, and perhaps just as importantly, provided an escape from the sheer drudgery of much of the architectural modelmaker's day-to-day work. While more creative and abstract models had become increasingly commonplace during the 1980s (see Chapter Six), for the majority of architectural modelmakers working at firms such as Thorp, Pipers, Kandor, and Unit 22, the bulk of their work continued to be fully-realistic marketing models, and these required a large amount of detail, and crucially, a lot of windows to cut out (Figure 7.2), which was one of the most laborious tasks involved in making an architectural model. Modelmaker Lee Atkins remembers the effort involved in cutting just a single window in a sheet of Perspex: 'If you were cutting out windows you were on the pillar drill cutting out a hole for each window and then using a fretsaw with

Figure 7.2: Model of Paddington Basin, made by Unit 22, 1999

V-blocks to hold them and file them out' (Atkins, 2019). Even when using softer ABS sheet and a hand-held power tool such as a Dremel, window cutting remained an incredibly time-consuming task:

> It sounds horrific now, but basically you'd drill a hole in the corner, and then by hanging the piece of plastic over your desk, take a Dremel with a drill bit in it, plunge it up through the hole you had just drilled from above, and just carve out the window shape, and then go back with files and scalpels and tidy up the shape of the window. Now imagine a building with literally hundreds of windows (Strange, 2017b).

The process was made even more time-consuming due to the multiple layers required to make a building's facade. A clear Perspex sheet for the glazing had to be scribed and inked with a ruling pen to create window bars, and then the window apertures in the facade of the building had to be cut out of either Perspex or ABS as described above. High Impact Polystyrene Sheet (HIPS) could only be used for facades if being cut by hand, as the drill bits would melt the plastic (Strange, 2017b). With HIPS, drawings had to be plotted onto each sheet, scored, and then cut out using a scalpel, a process that could take days on a larger model, as Alec Saunders recalls:

> You knew that elevation. You started it in the morning and you were still doing it when you went home, and you couldn't just cut exactly the window, you had to mark that out, and then cut inboard of the window by a millimetre so that when you cut that final slice out it didn't give you a massive burr, and pealed the waste away. Everything was so labour intensive (Saunders, 2018).

If the building had a brick facade, the process was even more arduous:

> You had to cut it and engrave it all by hand. That was an apprentice's job; you'd spray a basecoat and then speckle, put it onto a drawing board and then engrave out a line every one millimetre, then speckle over it to break up the lines, but you might have two three foot square sheets of material to do this for, and it took two or three days (Fooks, 2018).

For taller buildings, floor plates would be made from sheets of Perspex that were taped together, and then the outline of the floors would be scored with a scalpel and ruler onto the top sheet, with the whole stack run through a band saw before being filed and sanded to the precise shape required. For a building with twenty or thirty floors, just aligning the holes in each plate for vertical columns could be an exercise in itself, making sure each hole was drilled vertically through the stack, and rarely was a drill bit long enough to complete the task in one batch (Merryweather, 2019).

Although the introduction of more abstract approaches to architectural modelmaking during the 1980s had widened the stylistic palette of the model, the standard processes of making a realistic presentation or marketing model out of Perspex and polystyrene sheet had been in use since the early 1950s (see Chapter Five). By the 1990s, neither the materials nor the tools used in architectural modelmaking had fundamentally changed in over forty years. Given the time-consuming processes of cutting Perspex and polystyrene sheet with hand tools and workshop machinery, producing large, highly-detailed architectural models was an expensive process. Models such as a 1995 detail model of a Manchester office development made by 3DD displays the impressive levels of detail that could be achieved (Figure 7.3). Models made by hand in this manner were still precise and highly-realistic, but the labour-intensive processes involved made them extremely time-consuming and hence expensive to build.

Figure 7.3: Model of Deansgate office development, made by 3DD, circa 1995

An example of the peak of precision and quality that could be achieved using pre-CAD/CAM processes is the model of Mansion House Square tower in London, made by Presentation Unit in 1982 (Figure 7.4). Mies van der Rohe's design for the building, commissioned by the property developer Peter Palumbo in 1962 and approved for construction in 1969, had remained almost completely unpublicised until Palumbo re-launched his plans for the development in 1982. Built at a scale of 1:96 to match the imperial scale of 1/8th of an inch to 1 foot, the model took over two years to construct. The tower itself was made from Perspex sheet with the glazing bars silkscreened onto each side to an accuracy of 0.03mm (Morris, 2017), while the distinctive bronze-tinted window effect was created using a specially-adapted heated water tank that contained a solution of candle dye mixed to match a sample of the proposed glazing panels of the real building (Morris, 2017) – both being highly innovative techniques at the time. With fully-detailed and lit interiors, the model of the tower demonstrates the exceptionally-high levels of precision that the modelmakers at Presentation Unit were able to achieve (Figure 7.5), however as the two-year construction

Figure 7.4: Model of Mansion House Square Tower, made by Presentation Unit, 1982. Photograph by John Donat.

Figure 7.5: Restoration of the facade detail of the Mansion House Square Tower model conducted by original modelmaker Simon Morris, 2017.

schedule indicates, reaching this level of detail and accuracy working by hand required either a lot of time or a lot of modelmakers, both being highly expensive.

By the late-1990s, the task of the modelmaker was being made even more challenging as the design of buildings began to embrace more organic forms. Models such as those for Future Systems' designs for the Birmingham Selfridges and The Ark (Figures 7.6 and 7.7) proved to be extremely difficult to make, The Ark requiring several hundred individual roof segments to be vacuum-formed, cut out, filed and sanded, sprayed, and then attached to the model (Strange, 2017b). Richard Armiger at Network Modelmakers was faced with a similar problem in making the model for Nicholas Grimshaw's design for the National Space Centre (Figure 7.8), the complex shape of the bubble-like tower requiring the preparation of a hand-shaped master that was then vacuum-formed in clear PETG sheet (a form of polyethylene) (Armiger, 2019), a process that took considerable time and which at best could only ever be an approximation.

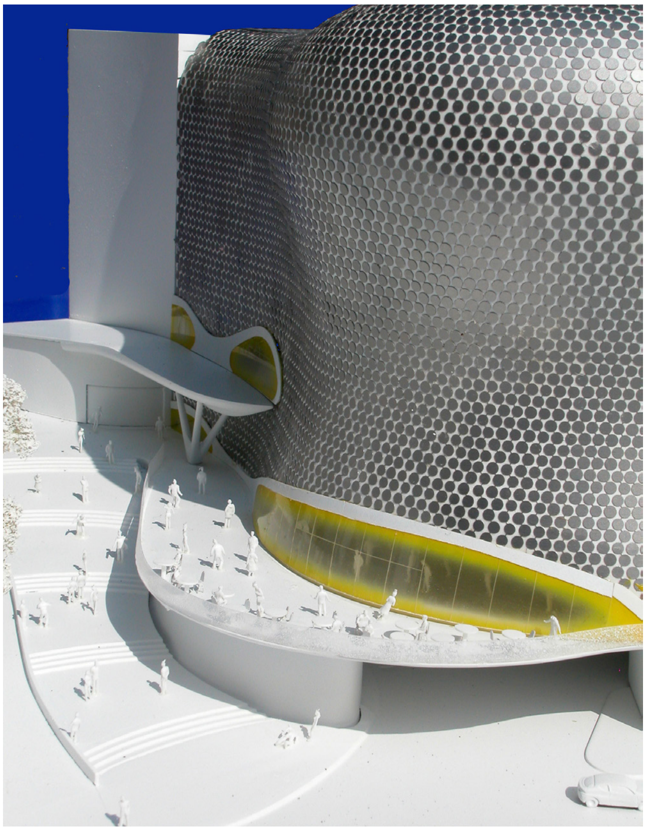

Figure 7.6: Model of Future Systems' Birmingham Selfridges, made by Unit22, 1999

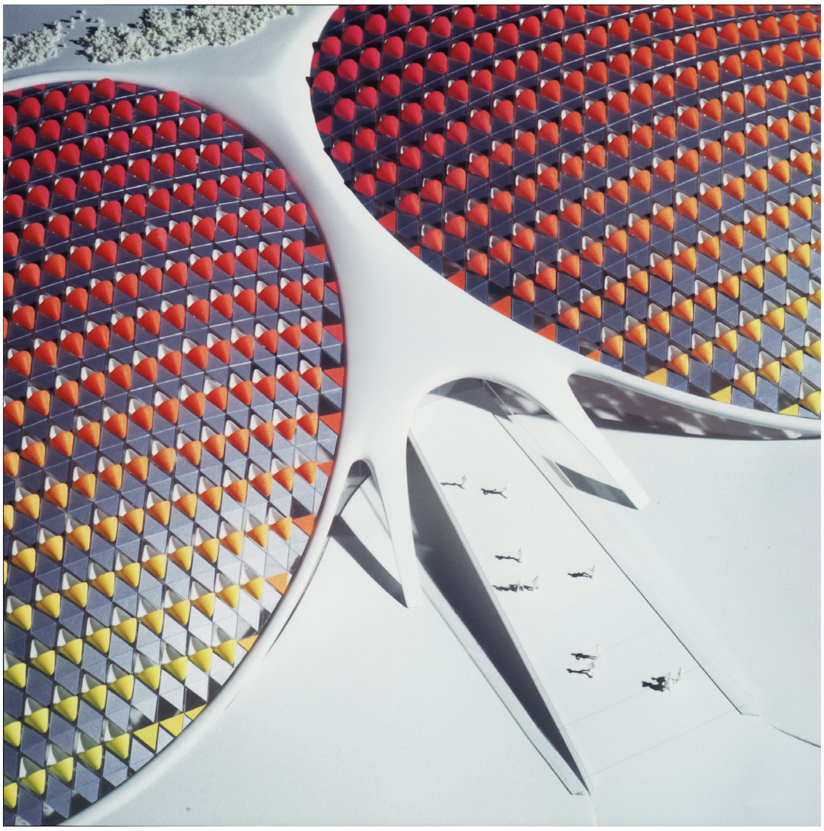

Figure 7.7: Model of Future Systems' The Ark, made by Unit 22, circa 1997

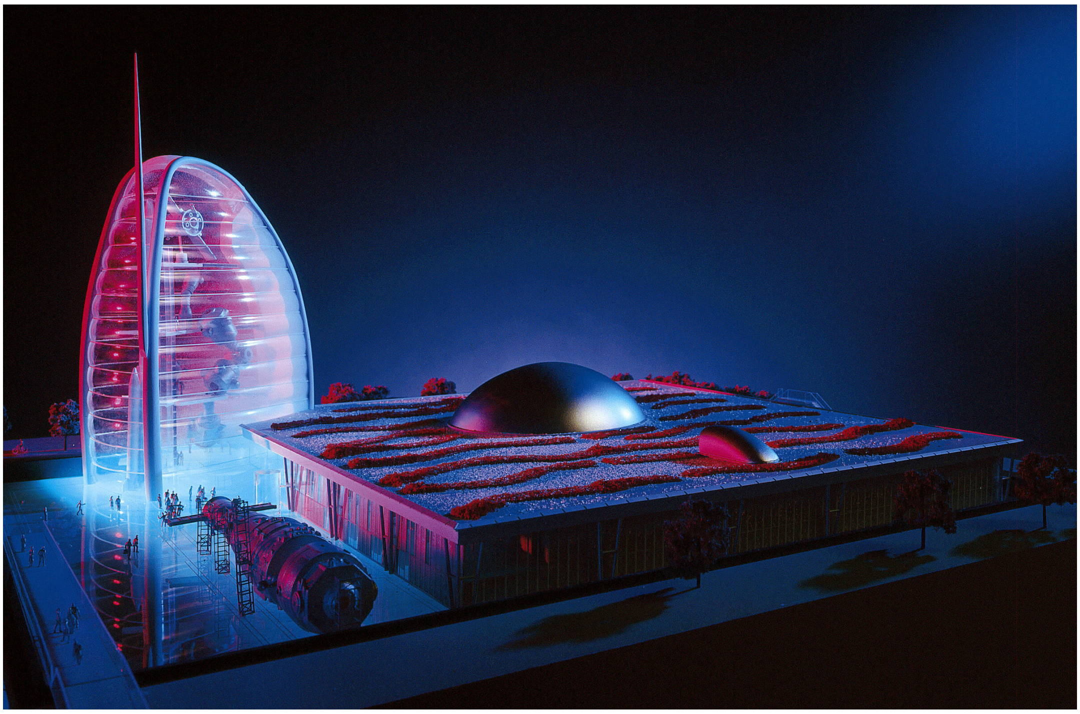

Figure 7.8: Model of Nicholas Grimshaw's design for the National Space Centre, made by Network Modelmakers, 2000

With the digital revolution sweeping through architect's offices, and computers beginning to appear in modelmaking workshops to handle business accounts and basic word processing tasks, there was an increasing sense that the processes involved in architectural modelmaking were outdated and inefficient. While rapid prototyping was as yet a long way off being able to produce anything near to the quality of the models being made by hand, the speed with which 3D printers could produce components stood in stark contrast to the analogue methods of the modelmaker's traditional tools. Ultimately, it was a hunger for increased efficiency, and a desire to be released from the drudgery of repetitive processes that first attracted architectural modelmakers to CAD/CAM processes. As Ian Mitchell noted during the middle of this transition in 1996:

> The great advantage...is that these model makers free themselves to create beautiful models that are extremely accurate, and they can spend far more time finishing the model to a higher standard than they ever had time to do before (Mitchell, 1996, p.4).

To gain those efficiencies and freedoms, however, meant investing in highly expensive computer-controlled machines and learning to use complex computer-aided design software, applying the adaptable nature of modelmaking to new extremes in embracing a wholesale shift from analogue to digital ways of working that revolutionised both the model and the profession.

7.3. The Introduction of CNC Machining and Laser Cutting

With a need to improve the efficiency of architectural modelmaking having first drawn modelmakers to the potentials of digital technology, few at the time could have predicted either the challenges involved in adopting them, or the scope of their benefits; the sweeping changes digital manufacturing processes brought about extending far beyond merely automating repetitive and time-consuming processes. Initially through the adoption of CNC machining and laser cutting, and subsequently with the integration of 3D printing into the modelmaker's workshop, these new digital tools enabled the professional modelmaker to push the boundaries of the architectural model in almost every way. From new standards of precision and efficiency, to hyper-realistic detailing and dramatic abstract creativity, architectural models could be made to much higher levels of quality, in less time, and as a result, at a lower cost. The introduction of these new technologies had begun during the mid-1980s, however between 1996 and 2000, an intensive period of change saw the widespread adoption of CAD/CAM processes such as the laser cutter all but replacing the scalpel and steel rule as the primary tools of the architectural modelmaker, with the already dominant Perspex being ideally suited for use with the new digital machines (Figure 7.9).

While computer numerically-controlled workshop machinery had been available since the mid-1970s, their high costs proved to be a significant barrier to many architectural modelmakers. Initially only the largest firms could countenance their purchase, and in 1984, Thorp spent £12,000 (some £40,000 today) on a computer numerically-controlled Bridgeport milling machine. Operated using a built-in panel and computer monitor, the movement of the machine's bed could be programmed by entering a coded set of coordinates (Figure

7.10). Thorp had purchased the machine to assist with engraving brickwork and cutting window openings out of Perspex, and it made an immediate difference:

> When I first started programming it, you could suddenly machine a sheet of Perspex, and it was so accurate, you could get so much more detail in it than you could do by hand. It wasn't necessarily quicker, but it was the accuracy of it (Fooks, 2018).

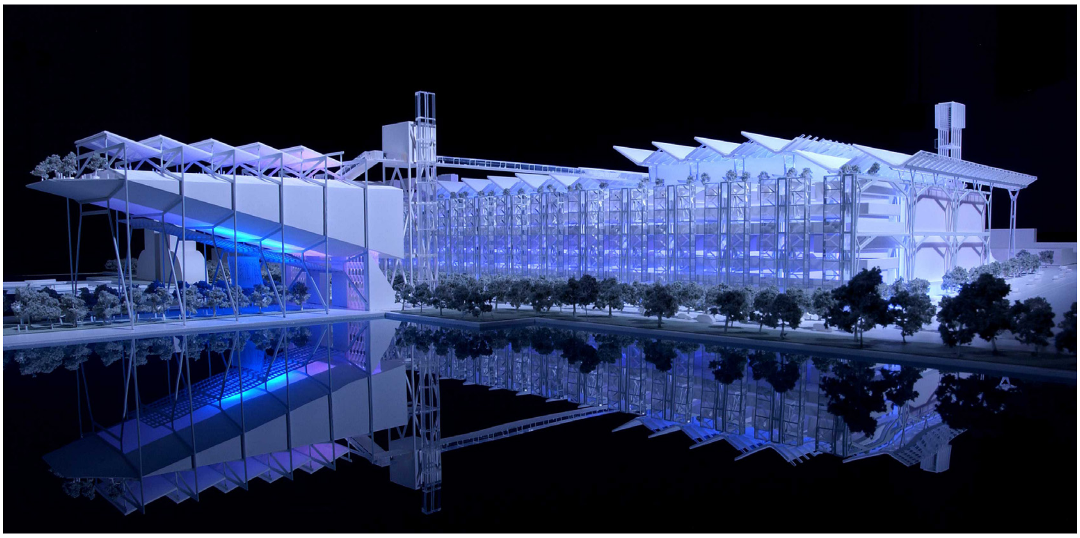

Figure 7.9: Perspex presentation model of the Javits Centre, made by RSHP, 2007

Figure 7.10: Control panel of a Bridgeport Series 1 CNC milling machine

Early CNC milling machines had to be carefully programmed, and could be extremely complicated to use, however their advantage was that once programmed, the machines did all the cutting and engraving automatically, freeing the modelmaker's time to be spent on other tasks.

At Pipers, a hand-operated Newing-Hall pantograph machine – a form of engraver often used by key cutters – was converted to computer control in 1988, and was put to work cutting out windows and engraving surface details in both Perspex and polystyrene sheet (Danton-Rees, 2019), and by 1989, desktop CNC machines such as the Roland CAMM3 series (Figure 7.11) were offering 0.1mm cutting precision; Trevor Crout, the in-house modelmaker at the architectural practice GMW purchasing one to replace the hand-scribing of brick and window details entirely (Crout, 1996, p.2). Nick Quine at Architectural Models International bought a CNC in 1994 for £26,000 (MacKay, 2018), while in 1995, the Bridgeport machines at both Thorp and Kandor were converted to operate from CAD files produced on a desktop computer, rather than commands needing to be entered into the machine manually. Drawing the outlines of the windows to be cut or brick lines to be engraved in Autocad, the software then converted the drawing into cutting commands, further speeding up the process (Fooks, 2018).

Figure 7.11: Roland CAMM3 desktop CNC machine

CNC milling machines were useful, if expensive, tools for the architectural modelmaker to adopt, as they were extremely accurate, and removed the drudgery of cutting and engraving building facades. With Perspex, ABS, HIPS, and most timbers all able to be machined, the existing materials of the modelmaker could remain constant while the tools used to cut them became automated. As both the CAD programs and the milling machines themselves became more advanced, the process became even quicker. 'We could build in all the different cutters into our program to cut the brickwork, score lines, windows, and another to chop out the window openings. From that point of view, it was invaluable' (Saunders, 2018). With it then possible to draw complex curves in Autocad and other CAD programs that could be accurately machined by the CNC, it also became easier for modelmakers to create models of more complex architectural designs. Ademir Volic's model of Zaha Hadid's design for the MAXXI Contemporary Arts Centre in Rome, for example, used a CNC to machine 20mm thick blocks of Perspex into the distinctive curved and grooved form of the proposed building (Figure 7.12), while Richard Armiger at Network Modelmakers found the CNC invaluable in milling the timber and brass structure required for the model of Nicholas Grimshaw's design for the Eden Project (Figure 7.13).

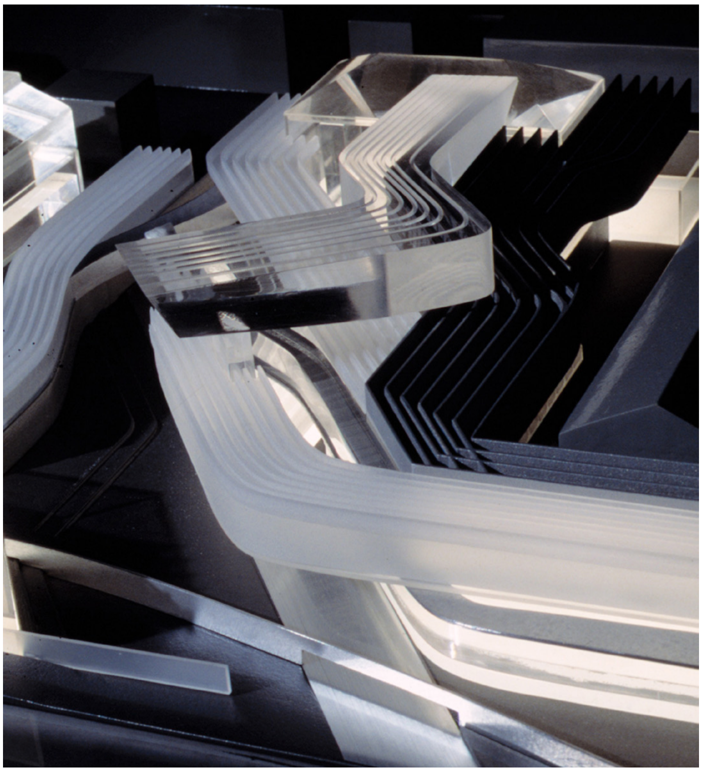

Figure 7.12: Model of MAXXI, made for Zaha Hadid Architcts by Ademir Volic, circa 1998

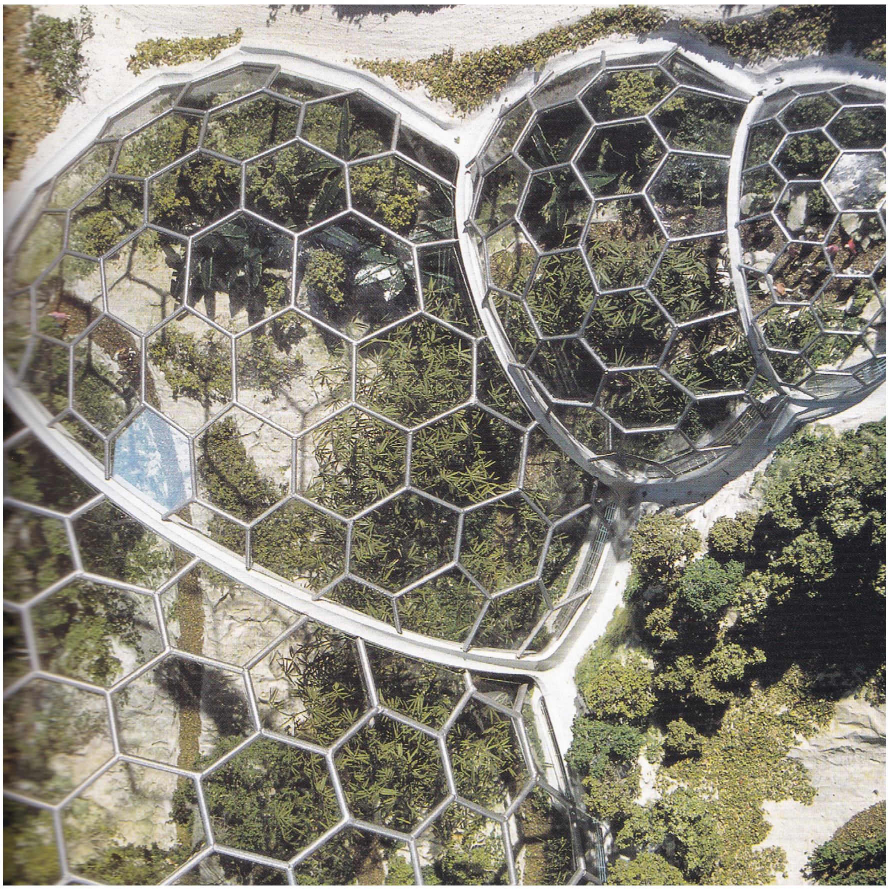

Figure 7.13: Model of the Eden Project made by Network Modelmakers, circa 1997

For those who could afford the huge outlay, CNCs had effectively become the main cutting tool in the workshop, having brought about significant time-savings through the automation of basic repetitive tasks. Early CNCs were effectively manually-controlled upright milling machines that had been automated, however, and were following a basic design that had changed little since the 1940s. It was not until the early-2000s that large flat-bed CNCs started to be used in modelmaking workshops to cut large sheets of timber and to carve foam landscapes, and so upright CNCs were in many ways too cumbersome a piece of equipment for most uses required by architectural modelmakers. Other than very organic shapes that might need to be carved from a single block, most architectural models were assembled from flat surfaces, and so the ideal machine for an architectural modelmaker was one that had as large a cutting bed as possible, with any vertical movement over a few centimetres being largely redundant. It is for this reason that the use of CNCs quite rapidly transitioned into the use of laser cutters, although precisely how they came to the attention of architectural modelmakers remains unclear.

Having been in industrial use since the 1970s, initially within aircraft manufacture, laser cutters are essentially a laser head mounted on a two-axis control arm, and were developed during the 1980s into smaller, more contained units that brought them into the reach of less industrial applications such as the cutting of Perspex lettering for shop front signage (Figure 7.14). The first recorded use of a laser cutter in architectural modelmaking is by the architectural practice SOM in New York during the middle of the 1980s (Tenguerian, 1995, p.42), with the California-based commercial architectural modelmaking firm Scale Models Unlimited developing and selling its own brand of laser cutters, LaserCAMM, in 1989 (Kiani, 2019). Costing over $100,000 dollars at the time, laser cutters were nevertheless rapidly adopted by American architectural modelmakers; Akiko Busch noting in 1991 that it was the 'tool that perhaps has most changed the model maker's trade' (Busch, 1991, p.57). As their use became increasingly widespread, suppliers of computer-driven machine tools also began to sell laser cutters, and this is likely to have brought them to the modelmaker's attention. Neil Merryweather attended a trade show in London in the mid-1990s with the intention of purchasing a CNC machine, but was instead more interested by the laser cutters on display beside them (Merryweather, 2019).

Figure 7.14: Trotec laser cutter

The first known architectural modelmaking firm in Britain to make extensive use of a laser cutter was Presentation Unit, who had previously pushed the limits of hand-made architectural modelmaking with their model of Mansion House Square Tower. Run by the four Morris brothers – Simon, Colin, Peter, and Phil, Presentation Unit considered themselves to be the best architectural modelmakers in the country, with a global reputation to match. Being very technologically savvy, by 1986 the company had invested in their first CNC machine, and by 1990, the firm had a CAD suite with several desktop PCs running a bank of CNC mills and engravers (Rawson, 1990, p.68; Woods, 2019). In the same year, the company followed Scale Models Unlimited and announced plans to introduce their own desktop laser cutter with the aim of selling it commercially (Rawson, 1990, p.66); however while this plan does not appear to have come to fruition, Presentation Unit were certainly using laser cutters for their own models for perhaps as many as five years before the rest of the profession.

Until the mid-1990s, Presentation Unit remained an early pioneering user of laser cutters in architectural modelmaking in Britain, and few others in the profession were even aware they had the equipment. By 1995, however, more and more modelmakers in Britain were hearing about the potential use of the technology. When upgrading their Bridgeport CNC to operate directly from a desktop computer, the modelmakers at Kandor found that the company supplying the equipment was now also selling laser cutters (Fooks, 2018). Simon Hamnell at Millennium Models remembers an engineer they were working with visiting their workshop and asking why they were still cutting plastics by hand. 'He said "make a laser; I'll go and buy the bits and you can do that." That planted the seed; realising we could do it much more easily with a laser' (Hamnell, 2018). For Hamnell, the investment in a laser cutter was ultimately a commercial decision to speed up their processes to match their competitors:

> Already people like Pipers and Kandor had invested in CNC milling, probably some five or six years previously, and where we were bidding for work against them, we would lose out every time. Once you go and see who sells them and they do a demonstration, you see there is no question about it (Hamnell, 2018).

Following Presentation Unit's adoption of the laser cutter, the in-house modelshops in the architectural practices at Foster + Partners, Richard Rogers Partnership (later RSHP), and KPF were the next to follow suit. This was primarily because these architectural practices had the capital to invest in what were still very expensive machines. The modelmaking workshop at the Richard Rogers Partnership had begun as an in-house service provided by Unit 22 in 1990, however by 1993 the modelmakers had become employees of Rogers itself, and investing in a laser cutter quickly became a priority for the team.

> We sort of heard about them, immediately wanted one, and campaigned. Kind of referencing that the practice is going to be cutting edge and all about technology, if you want to follow that thought you need to get one, even though they were tens of thousands of pounds. As soon as we got it, it was a step change (Fairbrass, 2019).

Rogers took ownership of a laser cutter in 1995, and the following year Millennium followed suit, with Kandor, Pipers, 3DD, and Thorp among the many commercial modelmakers purchasing lasers by the end of the decade. For smaller companies such as A Models and Unit 22, the availability of specific laser cutting bureau services proved invaluable, as it allowed them to sub-contract the work on a job-by-job basis. Zone Creations set up as a fabrication bureau in 1999, purchasing two LaserCAMM laser cutters from Scale Models Unlimited in the United States. For Christian Spencer-Davies at A Models, it was an extremely useful service that allowed them to gain use of the technology without the associated capital investment costs (Spencer-Davies, 2019). Don Shuttleworth at Unit 22 was also using Zone Creations until he decided to purchase one for the company in 2000, and many smaller firms continue to use bureau services today, with Robert Kirkman making a conscious decision not to buy a laser cutter specifically because of the availability of laser cutting bureaus (Kirkman, 2019). Robert Danton-Rees at Capital Models remembers sending his early laser cutting jobs to either Pipers or Thorp, but by 2000 had purchased his own; quickly finding other modelmakers were now coming to him with their laser cutting jobs as their popularity spread. A second laser cutter was quickly added that was double the size of the original, and by 2019 the company had six such machines in use (Danton-Rees, 2019).

The rapid adoption for the laser cutter was largely enabled by the suitability of the modelmaker's existing principal materials – timber, and more significantly, Perspex, to be used in the machines. As Simon Hamnell noted, despite the change in cutting tools, 'We used the same materials; we just used three times as much' (Hamnell, 2018). Despite its relatively high cost, Perspex was ideally-suited for laser cutting, and as Adam Burdett describes, remained the ideal versatile material for architectural modelmaking:

> It laser cuts pretty well, machines well, you can table saw it, band saw it, it is rigid enough to be stable when you make a model, and it receives paint well. The key four or five qualities you would look for in a plastic, [Perspex] just has them all...it has everything going for it (Burdett, 2018).

With Perspex enabling the adoption of the laser cutter and its high levels of precision and efficiency, the use of the laser further expanded the dominance of Perspex, as polystyrene sheet (HIPS) was deemed unsuitable for use in the machines due to its low melting point. As a result, the typical construction method of cladding clear Perspex boxes with HIPS facades quickly shifted to being all-Perspex constructions. With CNC machining and laser cutting having been initially explored in order to replace the time-consuming hand cutting of windows out of polystyrene and ABS, the laser cutter not only replaced the work, but to a large degree the materials as well. Building facades were now cut and engraved from 0.5mm or 1mm sheets of Perspex and applied directly to thicker 2mm or 3mm Perspex underneath. While most timber veneers and thin plywood were suitable for laser cutting, the laser left a visible burnt edge on timber that put many modelmakers off using the equipment on plywood, although at KPF darkened edges and engraving lines on timber models became a style in itself (Merryweather, 2019), and due to the ease with which Perspex could be cleanly cut and engraved, the architectural model entered another period where the timber model fell out of favour.

The speed and accuracy of the laser cutter was immediately apparent, having dramatically improved the efficiency of architectural modelmaking, with the weeks spent engraving brick lines and cutting individual windows out by hand reduced to hours or even minutes (Figure 7.15). Richard Armiger experienced an instant time-saving benefit when first using laser cutting bureaus:

> To make all those walls the old way by hand would take this many hours which equates to this much money, and to make them at these guys cost kind of the same, but you could have a conversation on a Monday morning and have it there by Wednesday. The cost was the same as hand making but the new technology was much faster. You got it a week early (Armiger, 2018a).

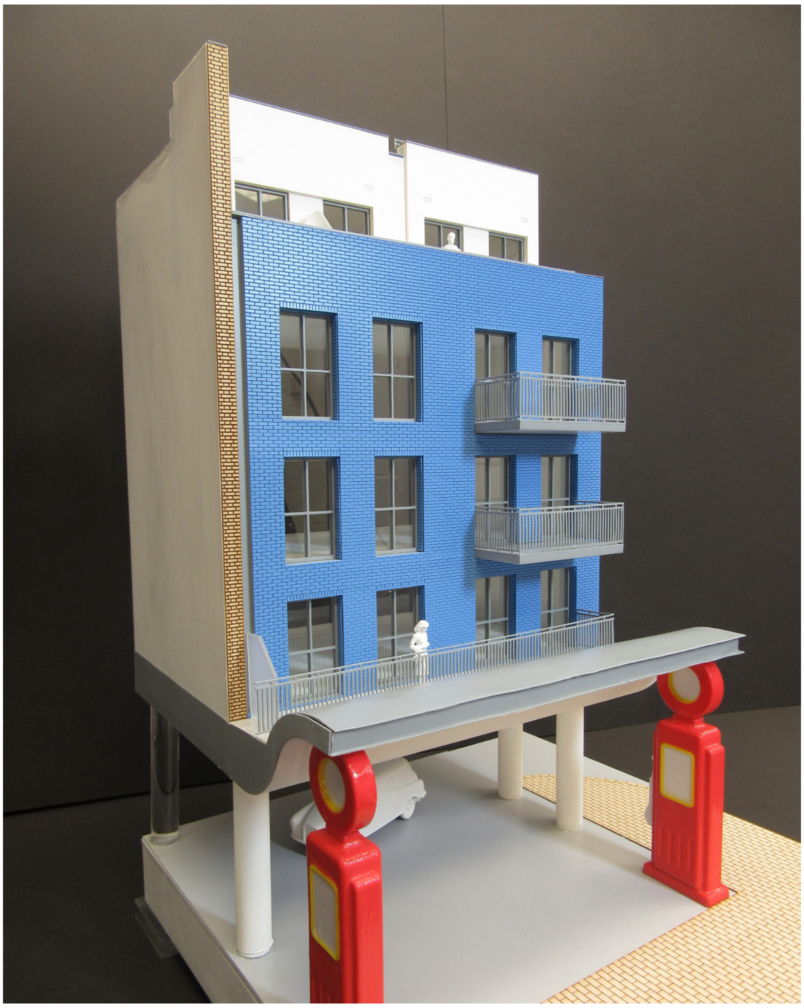

Figure 7.15: Laser cut brickwork facade model made by Farrells, 2016

As the process sped up, so too did the accuracy of the parts being produced, and just as Ian Mitchell had predicted, more time was freed up to spend on finishing models to an even higher level of quality (Figure 7.16). Fears were expressed at the time, however, that the automation of any part of the modelmaking process would put modelmakers out of a job, though these were quickly found to be misplaced. Jackie Hands, then head of the Rogers modelshop, was initially resistant to the idea of purchasing a laser cutter. 'She said it was cheating because she thought it was wrong, but then I said "we can't use a band saw then, that is cheating as well. What are you going to do, chew [the plastics] with your teeth?"' (Fairbrass, 2019). The main concern was over the loss of hand skill from the profession, however when reflecting on the length of time it took to cut out windows and scribe brick lines by hand, modelmakers quickly recognised the laser's benefits, and their initial caution proved unwarranted, Adam Burdett noting that 'it just allowed for better models, made more efficiently' (Burdett, 2018). While automating an intensely dull portion of their daily work, the components that the laser cut out still needed to be sanded, sprayed, and assembled

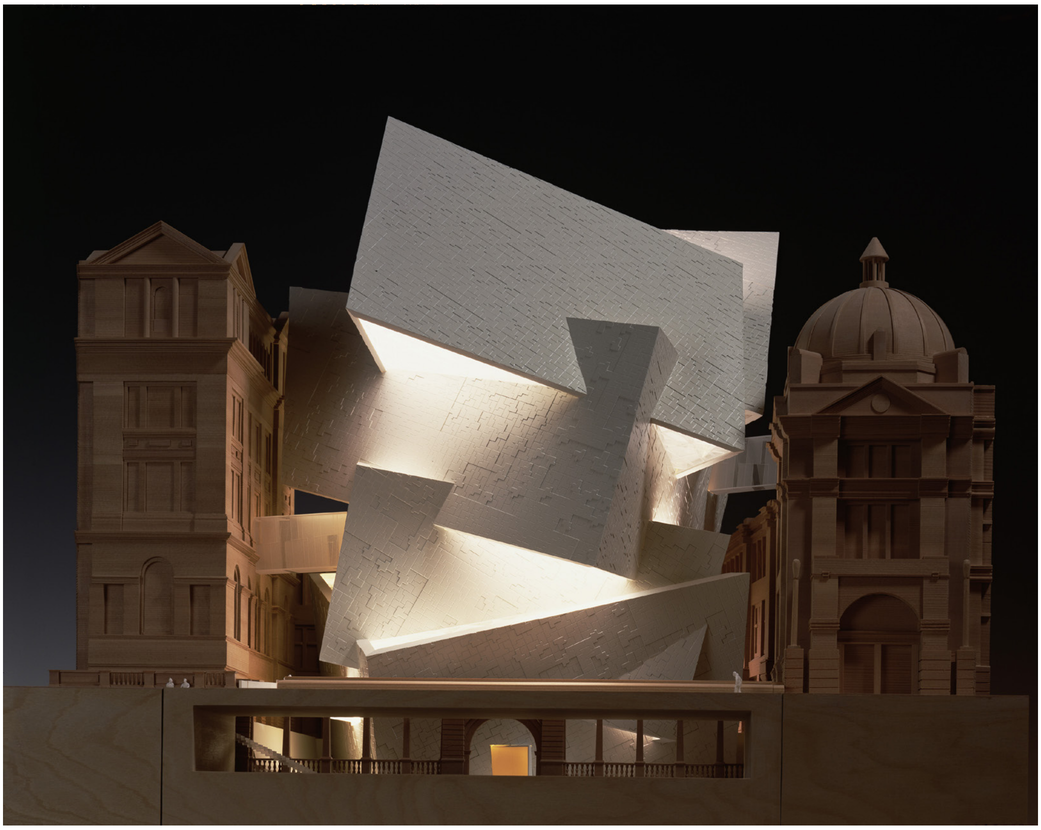

Figure 7.16: Model of Daniel Libeskind's V&A Spiral, made by Millennium Models, 1996. Photograph by Andrew Putler

by hand. The efficiency gain meant that a whole job was now much quicker to complete, with Matt Driscoll at Base models observing that a model that would require eight people working on it for a month suddenly needed only four modelmakers, freeing the others to complete a separate commission (Driscoll, 2018).

At the same time, architectural modelmakers found themselves needing to learn entirely new skills to replace those no longer being called for. Rather than cutting out pieces of Perspex by hand, they had to draw them on the computer first. The shift to using CAD, first for those modelmakers who had purchased CNC machines, and then more generally when laser cutting became widely adopted, was an incredibly rapid change that saw some modelmakers being left behind; Adam Burdett recalling a freelance modelmaker who he had to stop using simply because they couldn't use a computer (Burdett, 2018). Initially, computers were used to receive digital drawings from the architects, first on compact disk, and then later by email, before being printed out to be plotted by hand onto Perspex and timber. This then quickly progressed to editing the original CAD drawings to select the lines that needed to be cut, which were then sent directly to the laser cutter. A further early use of CAD was in the production of etching drawings. At KPF, the first use of CAD in the modelmaking workshop was to replace hand-drawn drawings that were printed as photographic negatives and sent off to be used in photo-etching processes. The speed and accuracy of computer-drawn templates dramatically improved the quality of the etches they received back from the supplier (Merryweather, 2019).

Stephen Fooks witnessed the rapid arrival of desktop computers in the workshop at Kandor: 'Within about a year we'd gone from a couple of computers to having one on each desk' (Fooks, 2018), while at Richard Rogers Partnership it was quickly realised that everyone needed their own computer as queues were beginning to form at the sole workstation used to create the drawings for the laser cutter (Fairbrass, 2019). Learning how to use the software took time, however to become proficient in drawing two-dimensional facades for laser cutting took considerably less time than it did to master the cutting of the same facade by hand. As such, the quality of work from a novice modelmaker was much improved, enabling them to become a more skilled modelmaker in a relatively short space of time (Driscoll, 2018). As the CAD files architects were creating became increasingly more complicated, architectural modelmakers quickly needed to become even more familiar with the software than most architects, in order to prepare the files correctly for cutting. With the expansion of Building Information Management software (BIM), modelmakers began to receive CAD files for the entirety of the full-scale building, including the wiring, plumbing, and every detail imaginable. Navigating the files to switch off unnecessary layers of data became an unexpectedly vital skill for the modelmaker, as did cleaning up Autocad and Revit files where hidden double lines on a drawing complicated the use of the laser.

Throughout the early-2000s, more and more architectural modelmakers invested in laser cutters, and despite the initial expense, they quickly proved their worth, with the productivity gains they brought about more than offsetting the cost of the investment (Fairbrass, 2019). With new virtual methods of architectural representation increasingly competing against the model during this period, the leap in efficiency the laser cutter afforded helped the architectural model to maintain its relevance, and to keep up with the increasingly complex architectural designs that CAD programs such as Autocad and Rhino were enabling architects to create. Within just a few years, the laser cutter had become one of the main tools of the profession; it being described as an 'essential tool of modern modelmaking' (Gordon, 2017), having enabled the profession to become much more technically advanced (Vandersteen, 2018). Models could now be produced to a higher standard, more quickly, and at a lower cost; the precision and speed of the modelmaker's new digital tools having more than answered their desire for efficiency. In taking digital tools that had initially been seen as potential threats to their profession, modelmaking's approach of adapting 'numerous tools and materials to purposes for which they were not originally intended' (Hoyt, 1939, p.420), and the intrinsic adaptability of Perspex to be used in the machines, had enabled a relatively smooth introduction of new technologies that brought about much needed efficiency gains. With the CNC and laser cutter firmly embedded as core tools in the making of architectural models by the end of the 1990s, a second digital transformation was to quickly follow as the previously-threatening nature of the 3D printer was inverted and employed to the modelmaker's own advantage.

7.4. 3D Printing and the In-House Modelmaker

By the start of the new millennium, the anxiety around the potential threat of rapid prototyping expressed at the 1996 Hertfordshire modelmaking conference had been somewhat mitigated by the successful adoption of both the CNC and the laser cutter with such positive results. Architectural modelmakers had adapted to the world of CAD drawings and digital manufacturing processes with relative ease, and with the profession experiencing yet another boom due to the PFI-funded government expansion of schools and hospitals, most architectural modelmakers were too busy making models to worry about the increased availability, lower costs, and higher quality of 3D printers that were entering the market. The broader fears, expressed in much of the literature relating to the architectural model published around the millennium that the model might be at risk of being replaced by purely digital models on a computer screen (see Porter and Neale, 2000; Morris, 2004; Moon, 2005), had also proven to be unwarranted, with the ever-increasing power of digital modelling software actually driving a demand for physical models, rather than replacing them. By the end of the second decade of the century, 3D printing had been successfully added to the suite of digital tools available to the architectural modelmaker, greatly increasing the speed and precision with which complex individual components of architectural models could be made, while also finding a niche in the rapid production of more detailed design development models in in-house modelmaking workshops.

The adoption of advanced 3D computer modelling software during the 2000s had enabled architects to develop new forms that would previously have been extremely difficult to conceive, let alone draw, using pen and paper (Dunn, 2012, p.6). Shajay Bhooshan, head of the Computational Research Group at Zaha Hadid Architects noted that ‘Fundamentally, the things we do now would not be possible without computers’ (Bhooshan, 2017). With the ability to create complex organic surfaces, many architects began to experiment with architectural designs that were quite difficult to understand when viewed on a two-dimensional screen. John Blythe, a partner and architect at Foster + Partners has observed that while computers allowed an architect to gain a good overall feel for a design on a screen, the way complex curves are projected is never as smooth as on a model (Blythe, 2018). The use of physical models to test and verify the complex forms computer software had become capable of generating remained a vital part of the design process at many architectural practices, and a significant challenge for architectural modelmakers was how to effectively reproduce these highly-complex shapes in model form (Stavric, Sidanin and Tepavcevic, 2013, p.17). Alec Saunders at Thorp remembers the shift change required as CAD software began to move from 2D to 3D design:

> T.P. Bennett, who had won the contract to refurbish London Bridge Station, their computer had designed the buildings above the station to be supported on these very organic columns that grew out through the platforms and split off, supporting the offices above. They sent us the files, and I was thinking how are we going to make a model of this? (Saunders, 2018).

The increased complexity of architectural geometry was the principal factor that drove the adoption of 3D printing by architectural modelmakers during the first decade of the twenty-first century. Multi-axis CNC machines could carve reasonably complex shapes out of foam or timber, but the availability by 2010 of more affordable 3D printers made a significant difference to what the modelmaker could achieve. As the technology used to design buildings developed, so too did the processes used by modelmakers to represent them: 'Go back ten years or so and [architects] were unable to easily create that kind of sophisticated architecture. The architect's work changed, so therefore we changed' (Driscoll, 2018). As with the initial adoption of the laser cutter, the in-house modelmakers within the large architectural practices had the resources to invest in the new technology; Foster + Partners being an early pioneer in the use of 3D printing during the late-1990s with the complex geometry of the Swiss Re building marking the first time the in-house modelshop made use of the technology (Vandersteen, 2018).

As a process, 3D printing (the now more commonly-used term for various methods of rapid prototyping) had already been in use for a decade before Foster + Partners first adopted it, with the first national conference on the technology having been held in Britain in 1995

(Jelley and Thompson, 1996, p.1). The terms rapid prototyping and 3D printing describe a range of computer-controlled additive manufacturing processes, all of which produce three-dimensional objects by taking a digital model and slicing it into many hundreds of individual layers, each layer then being 'printed' by the machine one layer at a time. SLA machines (Figure 7.17) use UV lasers to cure thin layers of a photo-curable resin in a tank (Bryden, 2014, p.88), with each layer as thin as 0.02mm, resulting in a very finely detailed print. SLS printers operate in a similar way, but use lasers to sinter thin layers of nylon powder, while FDM printers (Figure 7.18) heat thin filaments of a thermoplastic polymer and extrude them through a small nozzle to deposit on a platform below, producing a much coarser but faster printed object. The various approaches to 3D printing were quickly put to use by product

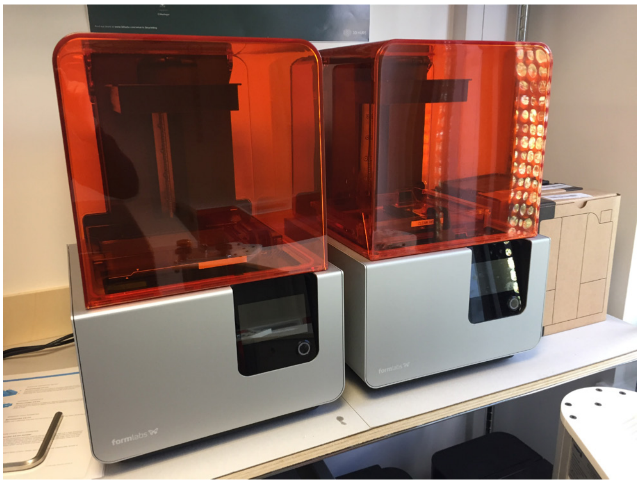

Figure 7.17: Formlabs SLA 3D printer

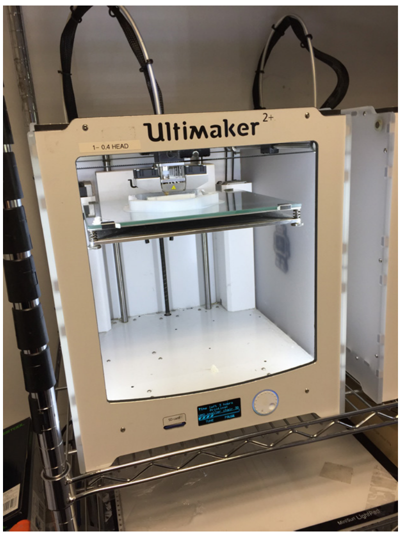

Figure 7.18: Ultimaker FDM 3D printer

designers to produce prototypes of their designs much more quickly and accurately than had previously been the case when made by hand. Modelmakers specialising in product models were therefore the first to raise the alarm regarding 3D printing's potential to make the modelmaker redundant, but for architectural modelmakers their arrival coincided with the increasing complexity of architectural designs that would have been almost impossible to produce accurately by hand.

Just as had been the case with the adoption of the laser cutter, for many architectural modelmakers, their first encounter with 3D printing was through the use of specialist bureaus. Unlike the laser cutter, however, which effectively replaced older ways of working, for most architectural modelmakers the 3D printer was initially used only when specific models required complex parts, and so outsourcing their occasional use was a much more economical approach rather than buying machines themselves. Mike Fairbrass at RSHP began using the Royal College of Art as they had a range of different 3D printers at quite an early stage: 'We would print components and there would be quite a lot of hand finishing of them, and then they would be sprayed and installed into a model and you would never know what had been 3D printed, or lasered, or hand finished' (Fairbrass, 2019). The use of 3D printers dictated that modelmakers learned not just how to draw in two-dimensions using CAD software for preparing drawings for laser cutting, but also how to use three-dimensional modelling software such as Rhino or Solidworks. This provided another challenge for firms looking to use the technology, but it was soon realised that the benefits outweighed the negatives.

For complex shapes such as the roof of the extension to Kings Cross Station designed by John McAslan and Partners, Millennium Models spent several weeks constructing the roof components by hand (Figure 7.19), a process that today would take mere hours using a 3D printer. 'It would be [used] for pieces where previously you would have given it to your most hand-craft excellent person and two weeks later gain this compound curve with vacuum-forming and etching and so on' (Fairbrass, 2019). For smaller details, 3D printers quickly proved invaluable for adding extra realism to marketing models, such as creating scale furniture (Figure 7.20). As 3D printers became even more affordable, more commercial modelmakers began to invest in them, desktop 3D printers becoming almost as common

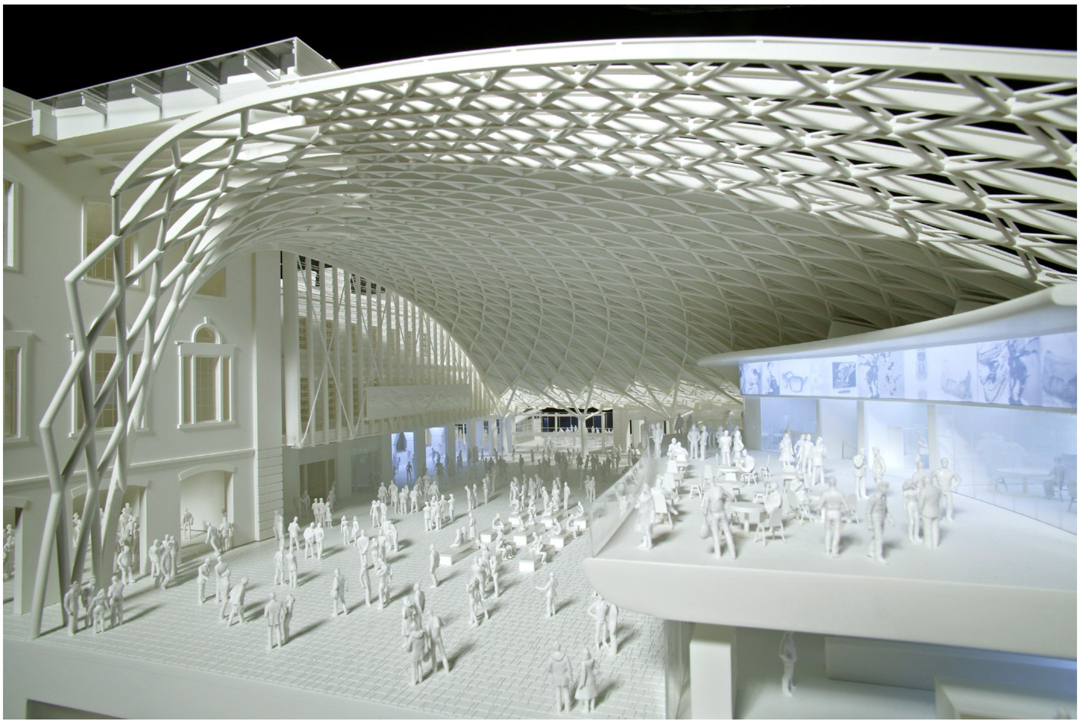

Figure 7.19: Model of Kings Cross Station, made by Millennium Models, 2008. Photograph by Andrew Putler

Figure 7.20: Interior detail, made by Unit 22, 2013

as laser cutters in most workshops by 2015. Rather than replacing the modelmaker, as had initially been feared at the *Future of Modelmaking* conference in 1996, 3D printers ultimately proved to be just another highly useful tool. When combined with the existing suite of CAD/CAM equipment at the modelmaker's command, 3D printing was able to push the quality and realism of architectural models even further, allowing for bespoke details (Figure 7.21), and more organic architectural forms (Figure 7.22).

The use of 3D printing in architectural models quickly became fashionable as a signifier of the latest technology, and architectural modelmakers found clients specifically asking for 3D printed components, or even fully 3D printed models, when other methods were actually more cost-effective. 'When it first started happening there were things we could have done easier and cheaper with a piece of [model board] and needle files, but they wanted it 3D printed' (Driscoll, 2018). While most modelmakers continued to finish the 3D printed parts so they merged seamlessly into the rest of the model, a growing trend emerged whereby architects and even some developers requested the prints remain unfinished, this despite the visual appearance of all but the most expensive 3D printing methods being quite coarse. The

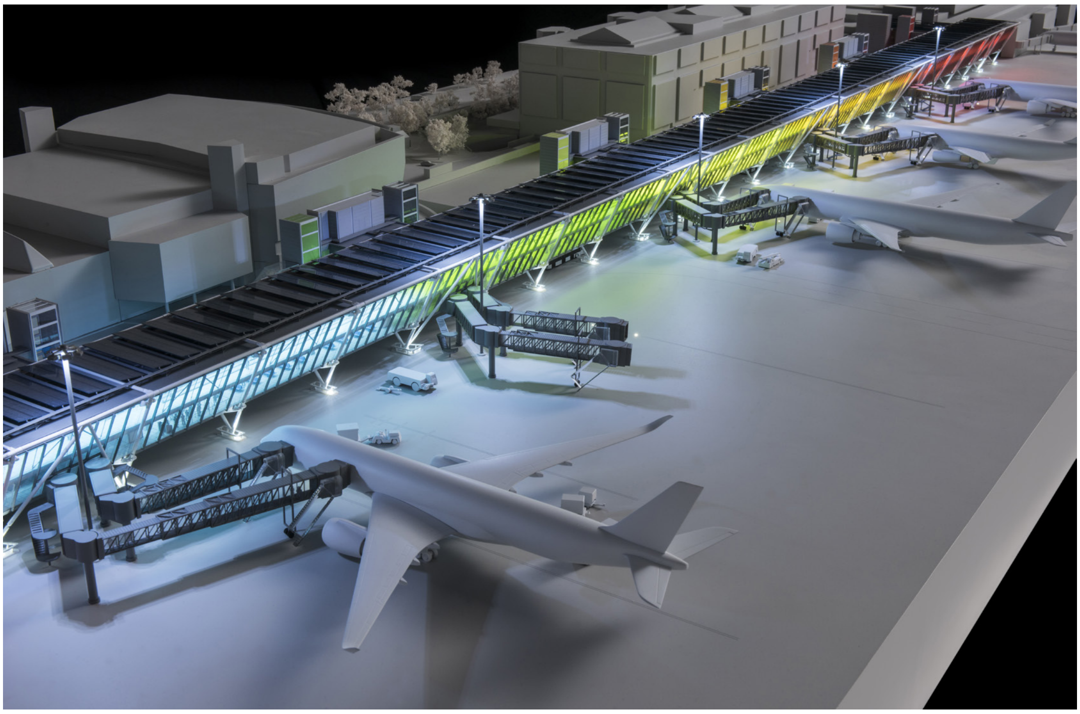

Figure 7.21: Model of Geneva Airport, made by Millennium Models, 2016. Photograph by Grant Smith

Figure 7.22: Model of Baku, made by Millennium Models, 2014

point was to be able to show the inclusion of this new technology, and a fashion for wholly 3D printed architectural models was successfully exploited by dedicated 3D printing firms such as Lee 3D and Hobs 3D (Figure 7.23). At the architectural practice Jestico + Whiles, the 3D printer was kept out in the studio rather than in the modelmaking workshop, on display as ‘a flag of how up to date a practice we are using 3D printers’ (Gordon, 2017).

While the quality of 3D printing continued to improve throughout the 2010s, today there remains a considerable resistance to the use of fully 3D printed buildings on models, partly due to uncertainty around how well the 3D prints would age. Perspex has remained such a dominant material in architectural modelmaking in part due to its long-term dimensional stability; a Perspex model made in 1960 would likely still be in excellent condition in 2020 – with the usual cause for any repairs being the failure of adhesives, or the application of other materials such as timber veneers which are subject to shrinkage. SLS, SLA, and FDM 3D prints, however, were quickly found to be prone to discolouration, crystallisation, and even disintegration after only a few years. For expensive marketing models, this was a risk that few modelmakers were prepared to take. For models costing tens, if not hundreds of thousands of pounds, longevity was an important factor in the choices of materials and processes used in their construction (Atkins, 2019).

Figure 7.23: 3D printed buildings, made by Hobs 3D, circa 2015

Predominantly either white, or for an SLA print, translucent, the visual appearance of unpainted 3D printed models has been described as a 'de-stylised aesthetic' (Rafzlaff, 2016, p.59), in that as an exact reproduction of CAD data, a 3D printed model is 'essentially an output of information, not a created object' (Ratzlaff, 2016, p.59). Fundamentally, it is this exactness of the 3D printed building that has prevented the widespread replacement of their handmade counterparts. Architectural models, as Neil Merryweather points out, are not replicas of building designs, but representations. 'You can't just take your [digital] building model and hit print' (Merryweather, 2019). On a practical level, the reduced scale of architectural models forces a considerable degree of abstraction – while the level of detail possible on smaller scale models dramatically improved due to the use of CAD/CAM processes, there remained a considerable amount of full-size detail that needed to be removed from a 1:100 scale model as it would be neither practical to reproduce, and, on a more artistic level, would distract from the overall message the model was trying to communicate. As Karen Moon has described, every model is a construct that is the 'result of a series of choices about what to show and what not to show' (Moon, 2005, p.12), and it is the lack of a human input that has limited the popularity of purely 3D printed architectural models. Mike Fairbrass has described the look of entirely 3D printed models as being 'really soulless, like ghosts of models' (Fairbrass, 2019), while Christian Spencer-Davies has commented that '3D printing in itself is aesthetically really nasty, so it still needs something else' (Spencer-Davies, 2019).

Even the increased availability of full-colour 3D printers during the 2010s has failed to overcome the objections around the use of fully 3D printed buildings in architectural models. While their speed of making made them an attractive option when timescales are under pressure, even a full-colour print of a building still needs a modelmaker to prepare the CAD files, make a baseboard, clean the print, glaze the model, and add any details such as trees and people (Figure 7.24). Highly expensive, the use of full-colour 3D printed buildings remains something of a niche, if time-saving, application of the technology within architectural modelmaking, and for the overwhelming majority of architectural modelmakers, the use of 3D printing is largely limited to the printing of complex individual building components and details, or where whole buildings were printed, act as context buildings around a laser

Figure 7.24: Full colour 3D printed facade model, made by Lee 3D, circa 2015

cut Perspex model. Even this approach, however, began to fall out of fashion after a peak in popularity around 2015. At Unit 22, Adam Burdett noticed a downward trend in the demand for white models, even those traditionally-made, which he credited to their association with the visual appearance of unpainted 3D prints (Burdett, 2018). As a result, timber models experienced another renaissance during the late-2010s as clients sought models that showed elements of human craftsmanship rather than digital perfection.

Despite such concerns about the appearance of unfinished 3D prints, and the potential longevity of the materials used, 3D printers have become a common sight in most architectural modelmakers' workshops, having proved themselves as incredibly useful machines when applied in the right manner. Resin-based SLA printers such as those made by Formlabs produce very high quality prints that required minimal surface finishing, and have proven popular among modelmakers for producing complex parts to be sprayed and built into an otherwise traditionally-made architectural model: 'We use [3D printing] more for components because the finishing has to be there. It is a very valuable tool, but when you get into a marketing suite, you can't use a 3D printed unfinished part' (Fooks, 2018).

For most commercial architectural modelmakers producing high-quality presentation models, the impact of the 3D printer, despite its seemingly revolutionary potential, has actually been less significant than the introduction of the laser cutter, and while undeniably useful, the concern that the technology would replace the modelmaker had fallen out of most modelmaker's minds by the late-2010s. 3D printing was most enthusiastically embraced within in-house workshops, however, where the ability to print quick yet detailed iterations of developing architectural designs made them a viable alternative to the traditional card and foam sketch model. At Make Architects, modelshop manager Paul Miles describes overseeing a team of four human modelmakers and fourteen robot ones – the practice making extensive use of a suite of Ultimaker 3D printers (Figure 7.25): 'They don't go on holiday or call in sick. It means we can run twenty-four hours a day in effect' (Miles, 2018). The use of 3D printers has greatly expanded the team's modelmaking capacity, especially for the production of early design development models for complex schemes:

Figure 7.25: Ultimaker 3D printers at work in Make Architects, 2018

> Some of these schemes can have five or six hundred options, and now with the 3D printers we have got, you can start the same project at three or four different starting points and each of those can come with different iterations, so you can be working on multiple schemes for a couple of weeks which can produce twenty or thirty options (Miles, 2018).

The 3D printers at Make serve the same purpose as the dedicated sketch model workshop at Foster + Partners, where professional modelmakers support architects making their own design development models. While the use of models are central to both practices' design philosophies, Make's smaller size as a company means it does not have anywhere near the number of modelmakers at Foster + Partners, with the 3D printers providing a highly efficient alternative. Make's 3D printers are normally used to print entire buildings, either iterations of early design ideas, or context buildings for more substantial models towards the end of the design process. The finish of the prints the Ultimakers produce is quite coarse, with visible lines demarking the print layers, but for the majority of Make's models, this is seen as acceptable, given that these are not yet final presentation models (Figure 7.26). The

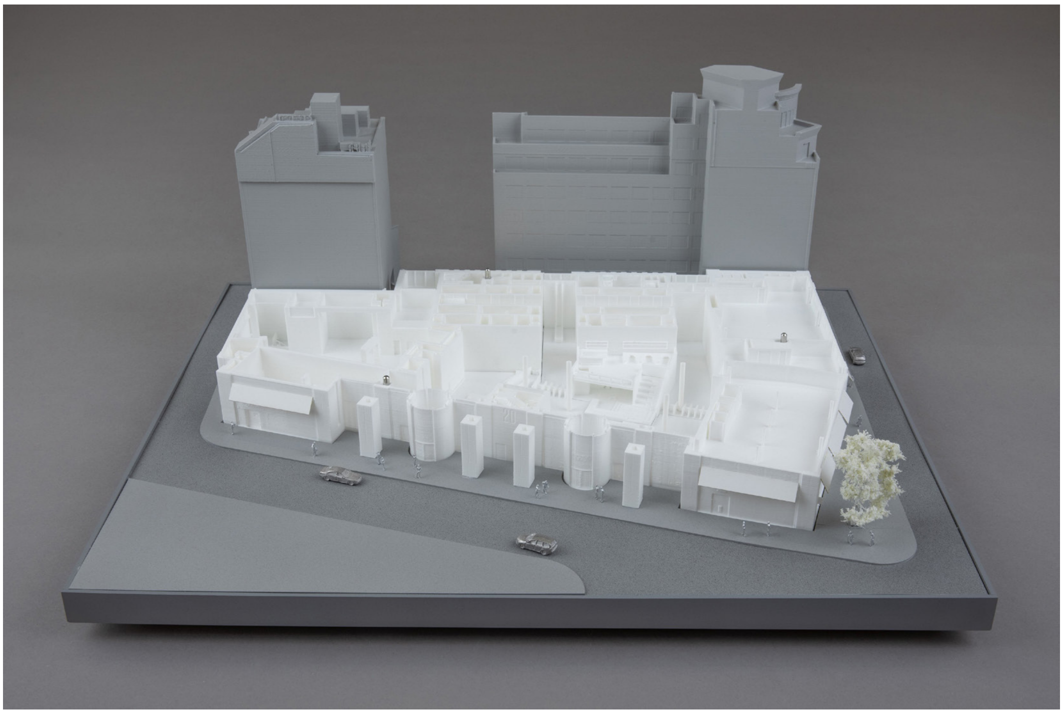

Figure 7.26: 3D printed architectural model, made by Make Architects, 2018

choice between using the 3D printers and making a more traditional laser cut Perspex model always comes down to time: '[Perspex] models are for final presentations; before we get to that there will be lots of 3D prints' (Miles, 2018).

The suite of fourteen Ultimakers at Make Architects is perhaps the closest realisation of the mid-1990s fears that 3D printers would make the professional modelmaker redundant, although no humans have so far been directly replaced by a machine. At PLP Architecture, a similar in-house set up has developed over the past decade, with early-stage massing and study models being printed out overnight on Ultimakers; more traditional modelmaking processes being used the further towards completion the design becomes (Merryweather, 2019). Throughout the 2010s, the increased use of 3D printers to produce sketch models began to give credence to the fears expressed at the 1996 Hertfordshire conference in that rapid prototyping, the quick production of early design options, had indeed moved away from the human modelmaker and towards the machine, while the broader use of 3D printing itself, to create specific parts models, merely added to what the professional modelmaker can do.

Despite the extensive use of fully-3D printed buildings at Make, and those provided by bureaus such as Hobs 3D and Lee 3D, for most professional modelmakers, 3D printers have generally remained limited to the production of specific components that would otherwise be too complex or time-consuming to produce through more traditional means. Within in-house settings, however, offering dramatic efficiency gains, and using relatively clean processes compared to more traditional workshop equipment, the introduction of 3D printers, alongside laser cutters, contributed to an expansion in the number of modelmaking workshops within architectural practices during the early-twenty first century that echoed the use of card helping to shift modelmaking from building construction workshops to architectural drawing offices a century and a half earlier (see Chapter Four). As was the case then, developments in model construction allowed for a cleaner workspace, making the activity more suitable for inclusion in the office environment of an architectural practice (Figure 7.27). The largest architectural firms such as Foster + Partners has maintained in-house modelmaking workshops employing professional architectural modelmakers since the

Figure 7.27: Modelmaking workshop at RHSP, London, 2016

1980s, and while a number of other practices such as SOM, Richard Rogers Partnership, and KPF followed suit in the 1990s, from the millennium onwards, the number of in-house modelshops increased dramatically, reaching over thirty by the time of writing in 2020, with the availability of cleaner, and more efficient digital manufacturing processes a key factor behind this expansion. At Foster + Partners, which employs over fifty professional modelmakers, an additional dedicated sketch model workshop was opened in 2000 to help manage the demand for design development models, and central to enabling this development was the introduction of the laser cutter, which transformed the accuracy with which the sketch models could be made (Figure 7.28): ‘It’s all using the CAD that the architects are familiar with, so it makes it very easy for them to make their own models’ (Vandersteen, 2018). Architect John Blythe is adamant that technology has boosted the use of models across the practice:

> We are doing things now which when I started in the office, to even physically make it, I would struggle to see how you could make a model of it. The process would have been ten times more laborious back in the 1990s (Blythe, 2018).

Figure 7.28: Foster + Partners sketch model workshop, 2018

The increased efficiency and precision that laser cutting, and then 3D printing, brought about also played a significant role in encouraging the inclusion of professional modelmakers working in in-house workshops at a number of smaller architectural practices. AHMM, FCBS, Perkins and Will, and many others, all found that the modelmaking processes of the laser cutter and 3D printer offered a much cleaner and less onerous way of increasing their use of architectural models in their design process. In 2016, Bruno Gordon was hired to establish the in-house modelshop at Jestico + Whiles, and specified a laser cutter as being an essential tool when setting up the workshop (Gordon, 2017). At Farrells, which had already established a long tradition of modelmaking over several decades, the use of technology was greatly boosted in 2013 when Dan McWilliam lobbied for the purchase of a laser cutter, aiming to improve the quality of their design development models, and to bring the production of presentation models in-house (McWilliam, 2018) (Figure 7.29). With the availability of affordable 3D printers such as the Ultimaker and Form series, the digital tools of the professional modelmaker enabled a significant growth in the number of architectural practices producing higher-quality models of more complex forms than the more traditional

Figure 7.29: Presentation model made by Farrells, 2016. Photograph by Andrew Putler

sketch model materials of card and foam could easily represent. Having allowed both commercial and in-house architectural modelmakers to better capture the organic shapes of twenty-first century architecture, and to increase the level of detail in models, and save time in making complex components, 3D printers have proved themselves as useful companions in the making of architectural models rather than the potential replacements as they had initially been feared.

By the time of the 3D printer's widespread introduction to architectural modelmaking, however, the driving force behind the use of CAD/CAM processes had ceased to be one of pure efficiency. As Ian Mitchell had predicted in 1996, the efficiencies digital manufacturing technologies had brought about had freed the modelmaker's time to be spent on the more creative aspects of architectural modelmaking, and the benefits of their new digital tools had begun to spread beyond the technical processes of making, enabling a rapid consolidation of earlier developments that had taken place during the twentieth century. Advances in both realism and creative abstraction, a further embedding of the dominance of Perspex as the principal material of architectural modelmaking, and a maturation of the notion of adaptability being central to architectural modelmaking quickly followed.

7.5. Creative Modelmaking in the Digital Age

By the early-2000s, the architectural modelmaker had become a degree-educated professional with the HNDs at Hertfordshire and Bournemouth being expanded into full undergraduate courses; Perspex, in no small part due to its suitability for laser cutting, continued to be the dominant material used in model construction; the broad stylistic palette encompassing both abstraction and realism had been firmly established; and through the adoption of digital manufacturing processes such as the laser cutter and the 3D printer, the CAD/CAM tools of the contemporary modelmaker were in place. The consequences of the emergence of the modelmaker's digital toolkit, initially driven by the need for efficiencies, had only been partially realised, however. During the first two decades of the twenty-first century, the use of digital technologies in architectural modelmaking began to act as an enabler, amplifying and consolidating previous developments in the model's history. The adaptable nature of the professional modelmaker, the adaptability of Perspex, the desire for both ultra-realistic and abstract models, and the presence of the modelmaker's digital tools combined in a period where the creative application of technology pushed the model's quality, artistry, and complexity to ever-increasing levels.

While the gains in efficiency that the laser cutter afforded were being enthusiastically embraced by architectural modelmakers during the late-1990s, the laser's creative potential was also being explored by a new generation of modelmakers all working in the 'Arup School' (see Chapter Six). Arup's influence on architectural modelmaking had continued to expand despite George Rome Innes' retirement from teaching at Rochester. The Arup philosophy of creative and abstract modelmaking had by this time been firmly embedded into the curriculum, and when Rochester graduate Ben Moss set up the HND in modelmaking at the Bournemouth and Poole College of Art and Design (later AUB) in 1992, the same template was put in place there. Richard Armiger had also spread the Arup approach through his teaching on the modelmaking HND at St. Albans College of Art and Design (later becoming part of the University of Hertfordshire), and through his company Network Modelmakers became the leading conduit for creative modelmakers to establish themselves in the profession.

Christian Spencer-Davies established A Models having learned his trade working for Armiger at Network after switching from a career as a designer for Terrance Conran (Spencer-Davies, 2019), and having seen the negative effects of the early-nineties recession on the architectural modelmaking profession, was determined to combine both the impressive creativity he had seen at Network Modelmakers with a much more cost-conscious sense of efficiency (Spencer-Davies, 2019). A Models quickly established a reputation for making the most expressive and creative architectural models available (Figures 7.30 and 7.31); the photographer Andrew Putler having noted that their models were often art objects rather than models in the traditional sense (Putler, 2019). Simon Hamnell, an early St. Albans graduate who had been taught by Richard Armiger, spent the first decade of his career working at a range of modelmakers including both Network Modelmakers and Arup, and in the late-1990s purchased the workshop machinery of Arup's modelshop when it was being closed down. Continuing to provide models for the practice, Hamnell's company, Millennium Models, was considered by many to be a direct extension of the Arup modelshop's approach, using not just their machinery, but some of their aesthetics and techniques as well (Hiller, 2018) (Figure 7.32). Rochester graduate Matt Driscoll, having worked for both Millennium and Network Modelmakers, set up Base Models during the PFI building boom of the early-2000s, initially renting workshop space from Millennium before finding his own premises and expanding into a twelve strong team known for making highly creative models for

Figure 7.30: Architectural model made by A Models, circa 2010

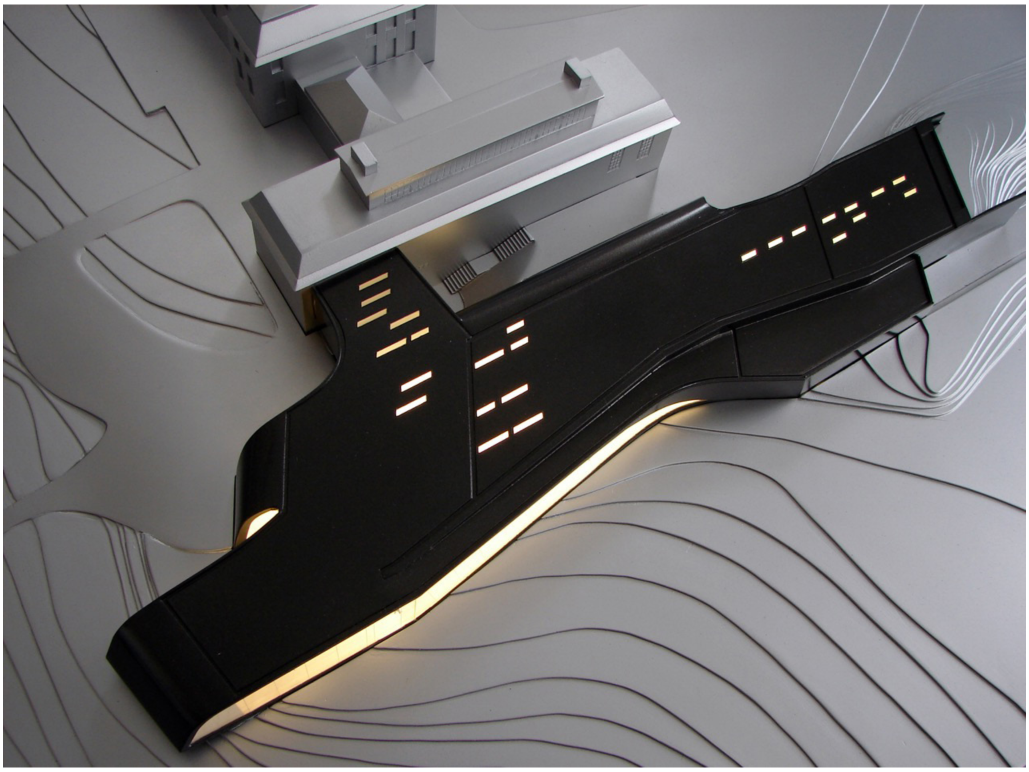

Figure 7.31: Architectural model made by A Models, circa 2015

Figure 7.32: Presentation model made by Millennium Models, 2008

Figure 7.33: Presentation model made by Base Models, circa 2015

architects such as Zaha Hadid, Foster + Partners, and David Adjaye Associates (Driscoll, 2018) (Figure 7.33).

Having all been trained in the Arup School through their connections to Rochester and Richard Armiger, Spencer-Davies, Hamnell, and Driscoll all deliberately set out to avoid making the realistic marketing models favoured by developers, and keen to differentiate themselves from their competition, continued to explore new styles for architectural models, armed with the now standard new tool of the laser cutter. Initially, the Arup tradition of using timber in abstract models was the first to benefit from the ability of the laser to precisely cut and engrave veneers for building facades and contoured landscapes, (Figures 7.34 and 7.35), however it was once the potential of laser cut Perspex was realised that abstract architectural models entered a new era of creativity.

Having been the dominant material in realistic models since the 1950s (see Chapter Five), Perspex had been largely side-lined in favour of timber as the default material in abstract models during the creative expansion of the 1980s. The creative use of Perspex had been explored to a limited extent through the work of modelmakers such as Richard Armiger and Ademir Volic and their models for Zaha Hadid (see Chapter Six), however it was only when the laser cutter was introduced, and its ideal suitability for cutting and engraving Perspex in more creative ways was exploited, that new possibilities were opened up for the use of plastics in representing architecture in more abstract styles. Whereas timber models naturally

Figure 7.34: Laser cut timber veneer model made by Unit 22, 2008. Photgraph by Andrew Putler

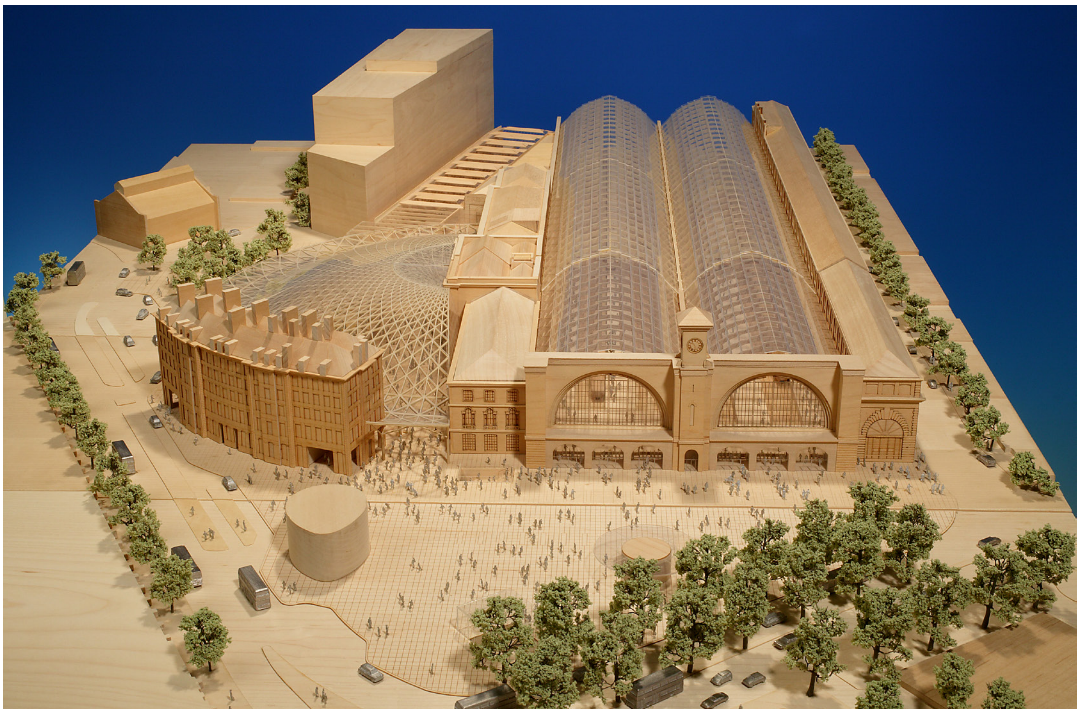

Figure 7.35: Timber and Perspex model of Kings Cross Station, made by Millennium Models, 2006.

Photograph by Andrew Putler

forced abstraction due to their lack of detail and strong intrinsic material associations, timber also carried a warm, traditional feeling that did not sit well with ultra-modern designs such as Hadid's organic architecture or the futuristic industrial shapes of the High-Tech movement. The crispness of laser-etched unpainted Perspex and its light transmitting properties provided a strong alternative that could be used to create dramatic effects such as the glowing block-like forms of Millennium's interior model for Marks & Spencer (Figure 7.36), and Network Modelmakers' masterplan model for the Gardens by the Bay, which employed Perspex to create a highly experimental approach to representing landscape architecture in an abstract form (Figure 7.37), with Chris Barber at Farrells applying both CNCs and laser cutters in a variety of creative ways throughout his career (Figure 7.38).

While the stacking of Perspex to create solid block models was not in itself a new approach, having been used by Thorp as early as the 1950s (see Chapter Five), the ease of creating such a model with a laser cutter saw this method of model construction become a widely-used style during the late-1990s and early-2000s, with the Richard Rogers Partnership (later RSHP) leading the way (Figure 7.39): 'The obvious thing we did with [lasers] was the stacking of [Perspex], which was the easy thing to do' (Fairbrass, 2019). Simon Hamnell

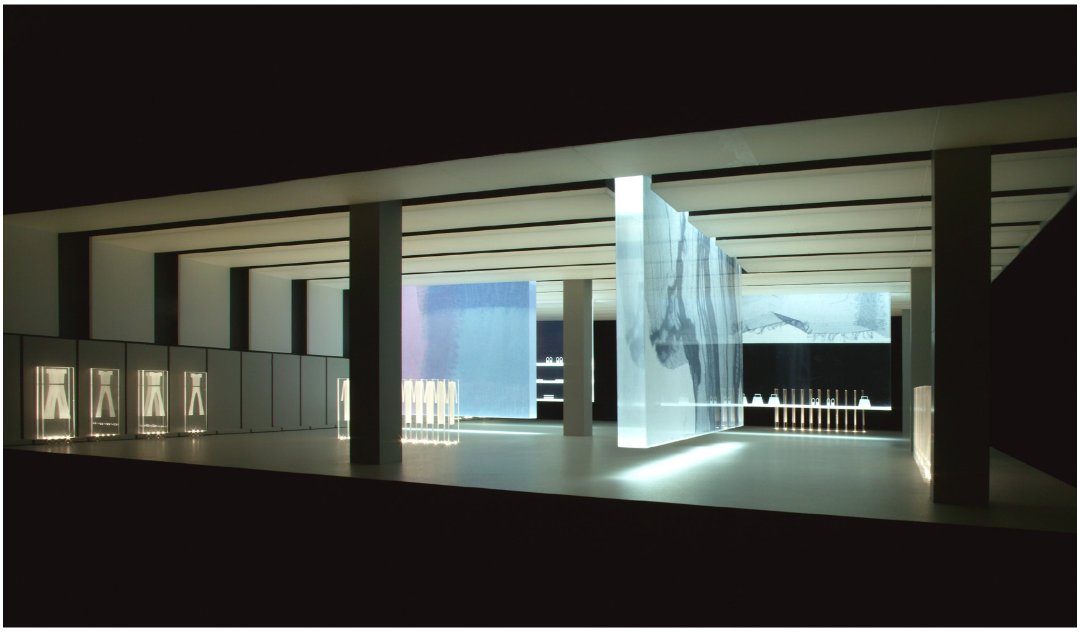

Figure 7.36: Perspex interior model made by Millennium Models, 2006

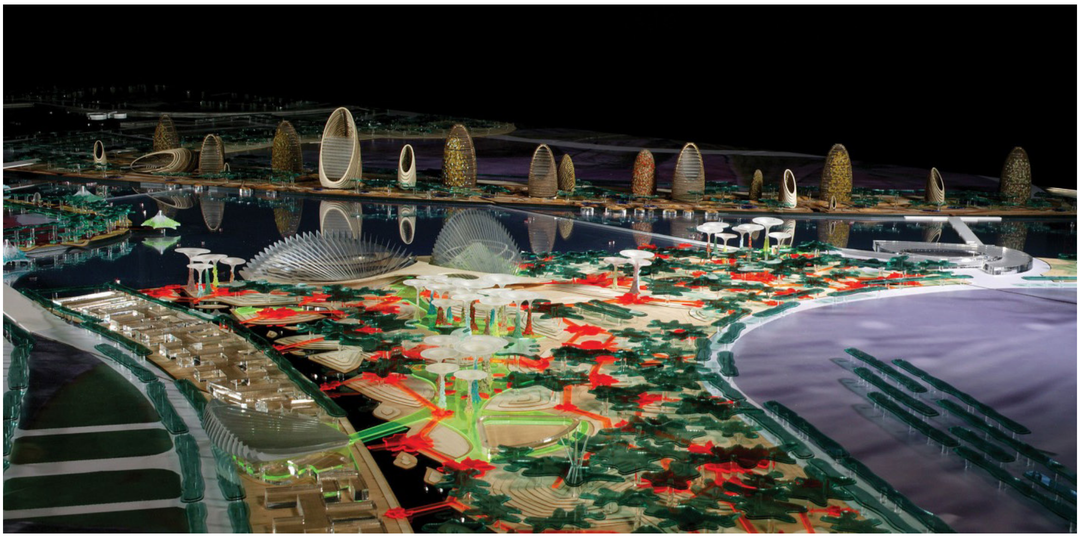

Figure 7.37: Laser cut Perspex model of Gardens by the Bay, made by Network Modelmakers, 2010

Figure 7.38: Model of Terry Farrell's design fo the London Aquarium, made by Chris Barber, 2001.

Photograph by Andrew Putler

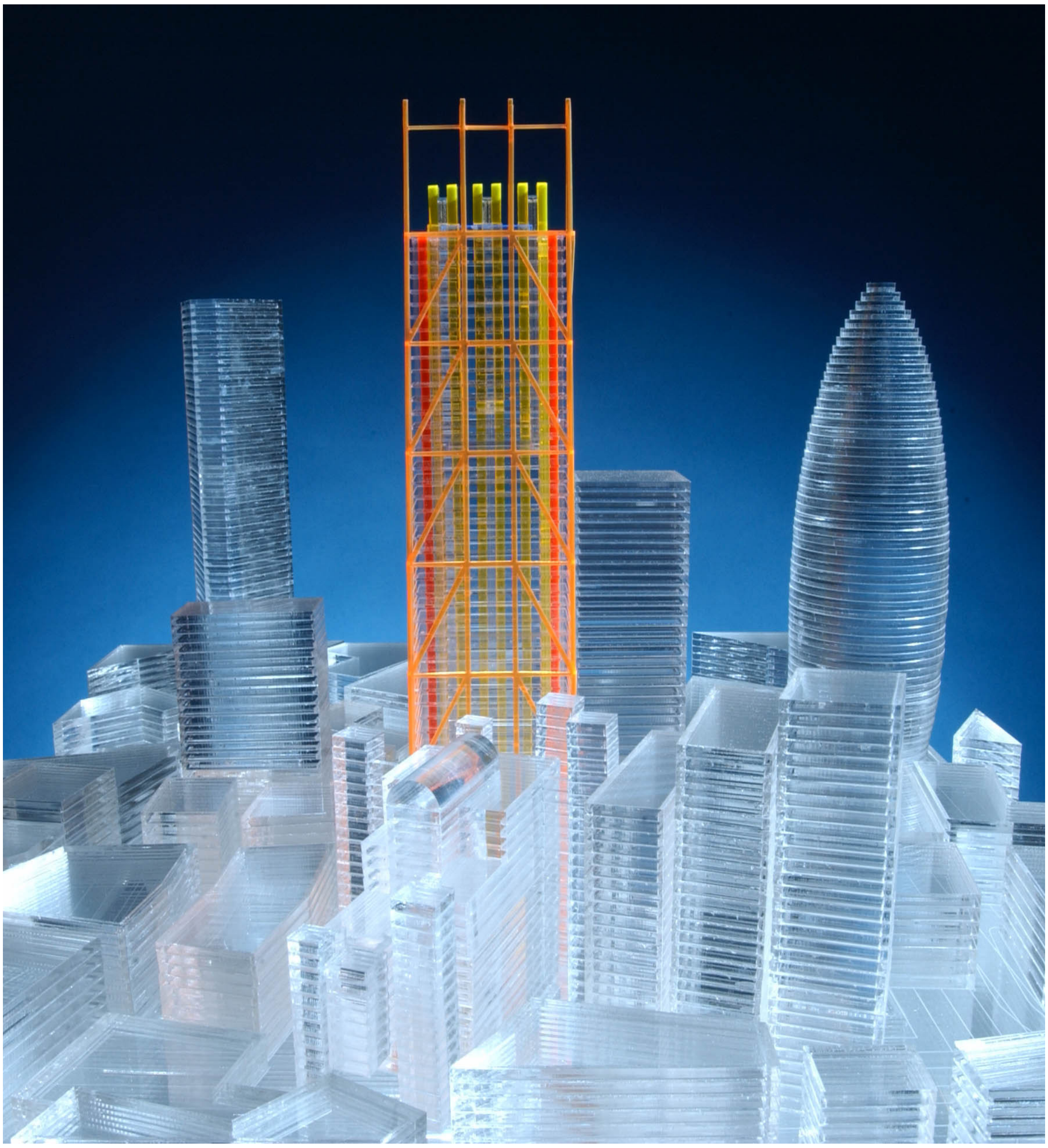

Figure 7.39: Stacked laser cut Perspex model made by RSHP, circa 2007

recalls the ubiquity of the stacked Perspex model, noting that they were ‘for a while just stacked Perspex, and then with elevations on, which I think we did first’ (Hamnell, 2018). The use of laser cut timber veneers to clad stacked Perspex blocks offered a quick and visually appealing way of representing buildings during early design stages (Figure 7.40), while for larger-scale and more highly-detailed presentation models, the combination of laser cut timber veneer and Perspex glazing could be used to produce dramatic contrasts (Figure 7.41)

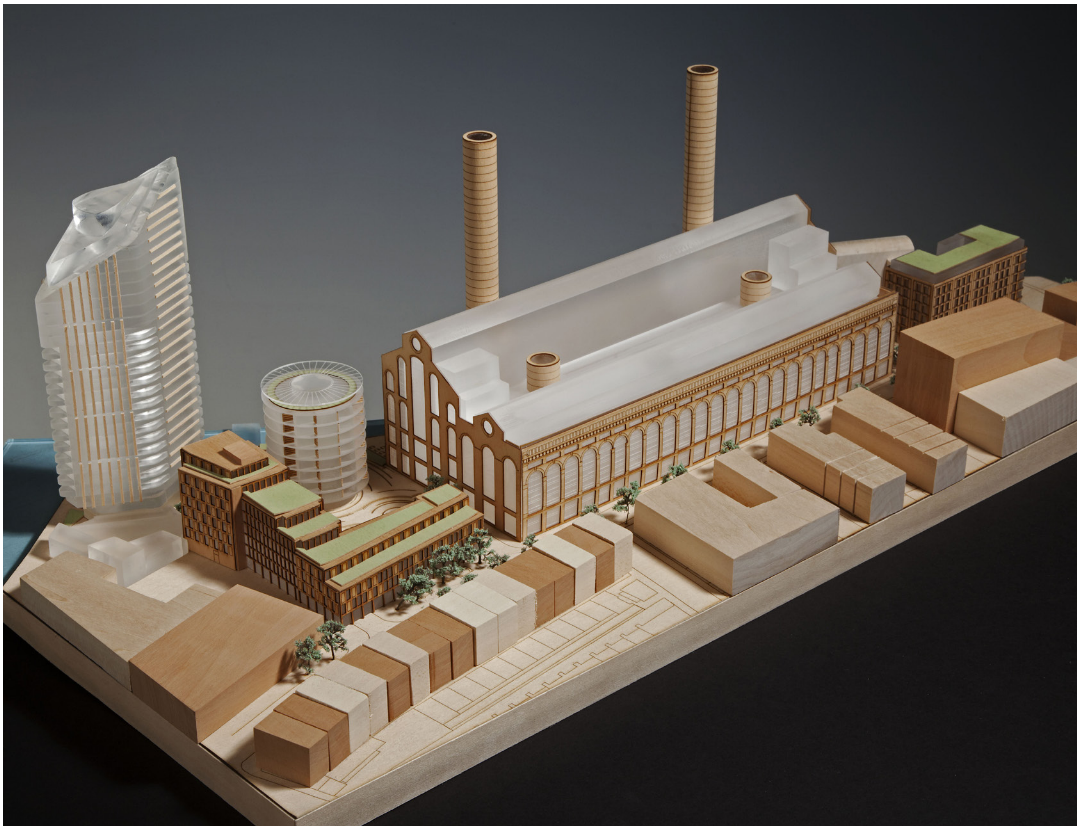

Figure 7.40: Planning moddel made by Dan McWilliam at Farrells, 2016

Figure 7.41: Perspex and laser cut timber veneer model made by Millennium Models, 2010

At the Richard Rogers Partnership, the use of laser cut fluorescent Perspex became a highly identifiable look for the practice's models (Figures 7.42, 7.43 and 7.44), the style emerging through the application of the laser cutter in finding a solution for the need for a visually impressive but quick to produce visual language for concept models (Fairbrass, 2019). With a strong diagrammatic feel that captured the High-Tech approach to architecture that the practice favoured, the style that the team created 'expressed the intent of a scheme and the excitement, and was a bit like a vibrant hand sketch; it had that kind of energy to it' (Fairbrass, 2019). Efficiency and creativity combined with the Rogers style, with the time savings generated by the speed and efficiency of the laser cutter freeing the modelmakers' time to be spent experimenting and developing new creative ways to use both the technology and Perspex together in radical new ways. Working collaboratively, Fairbrass at Rogers and Hamnell at Millennium went on to produce several highly creative laser cut Perspex models for exhibitions (Figure 7.45), including an entirely transparent model of the Leadenhall building that was lit from below to create a ghostly x-ray effect (Figure 7.46).

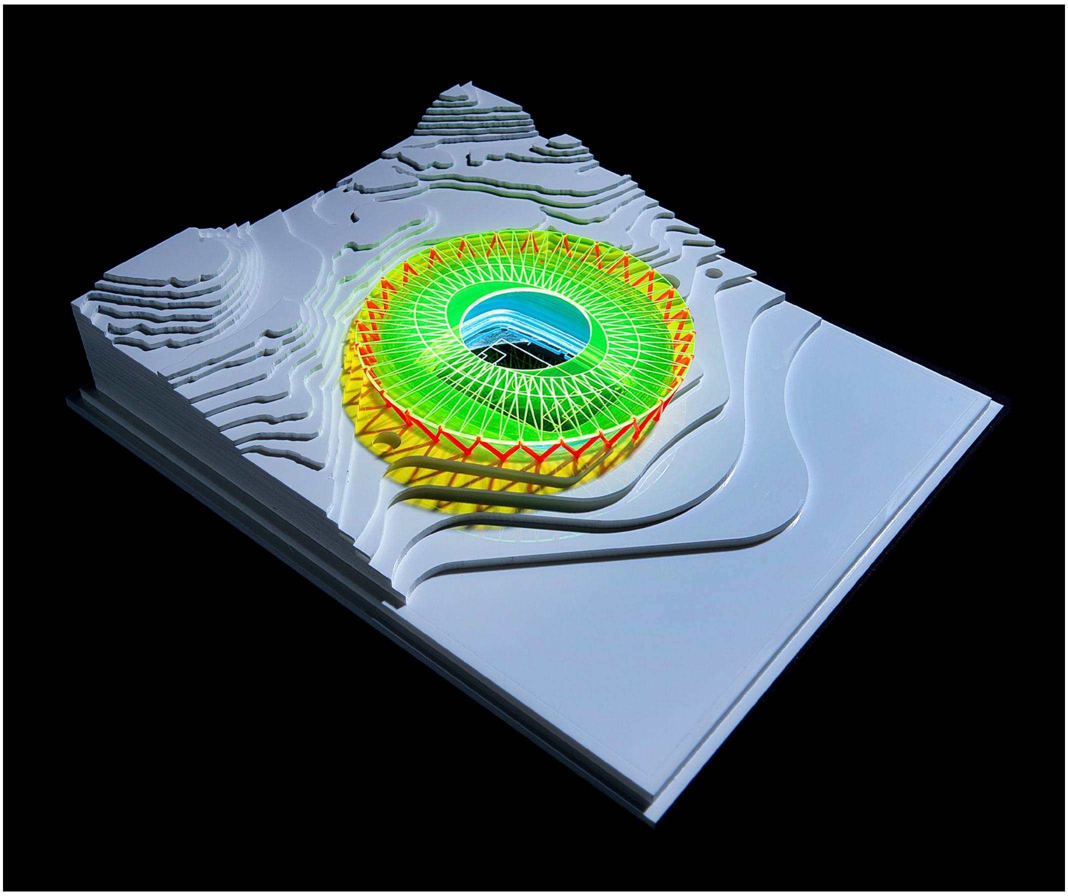

Figure 7.42: Laser cut Perspex model by RSHP, date unknown

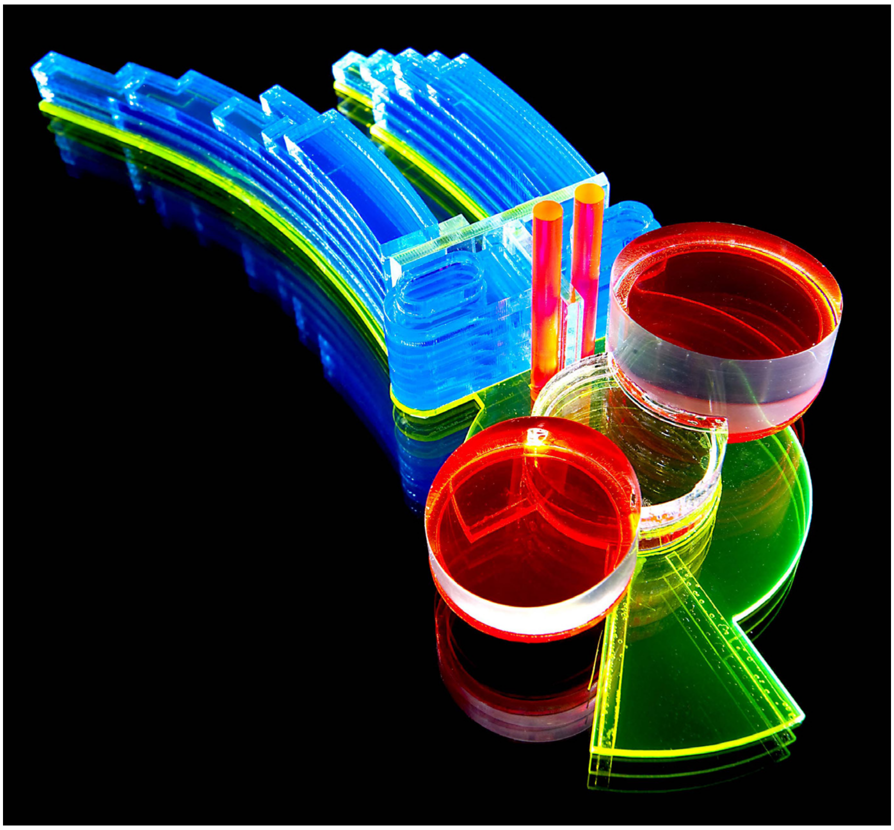

Figure 7.43: Laser cut Perspex concept model by RSHP, date unknown

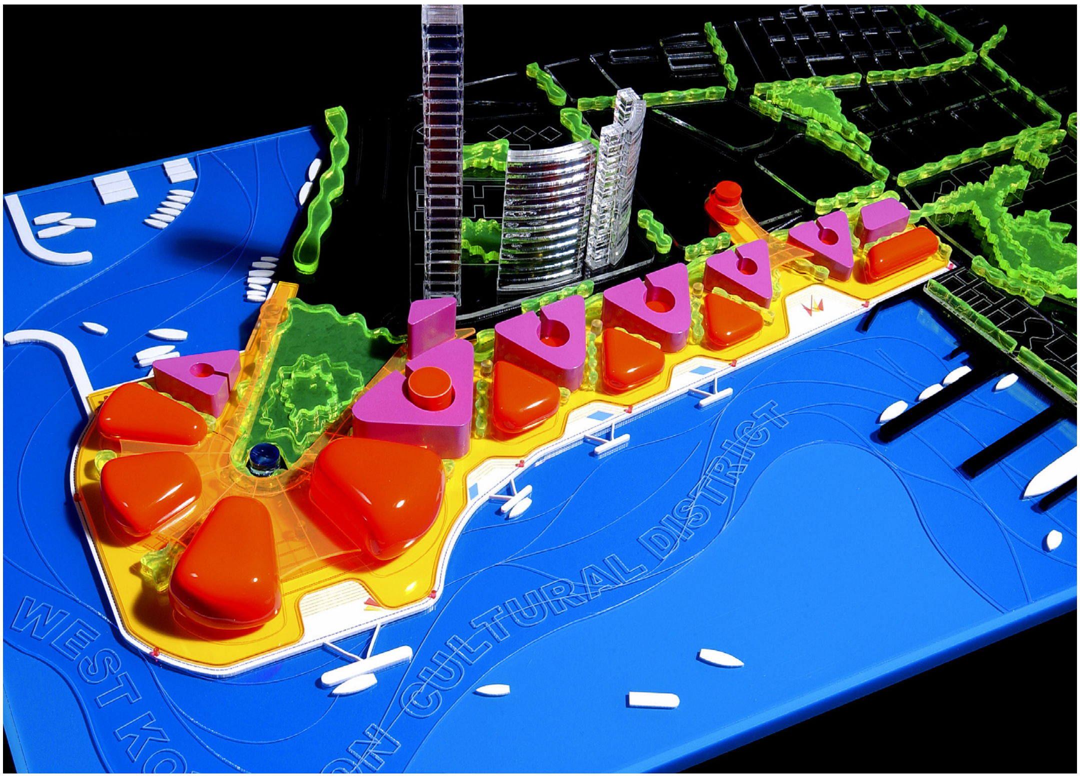

Figure 7.44: Laser cut Perspex model of West Kowloon Cultural District, made by RSHP, circa 2008

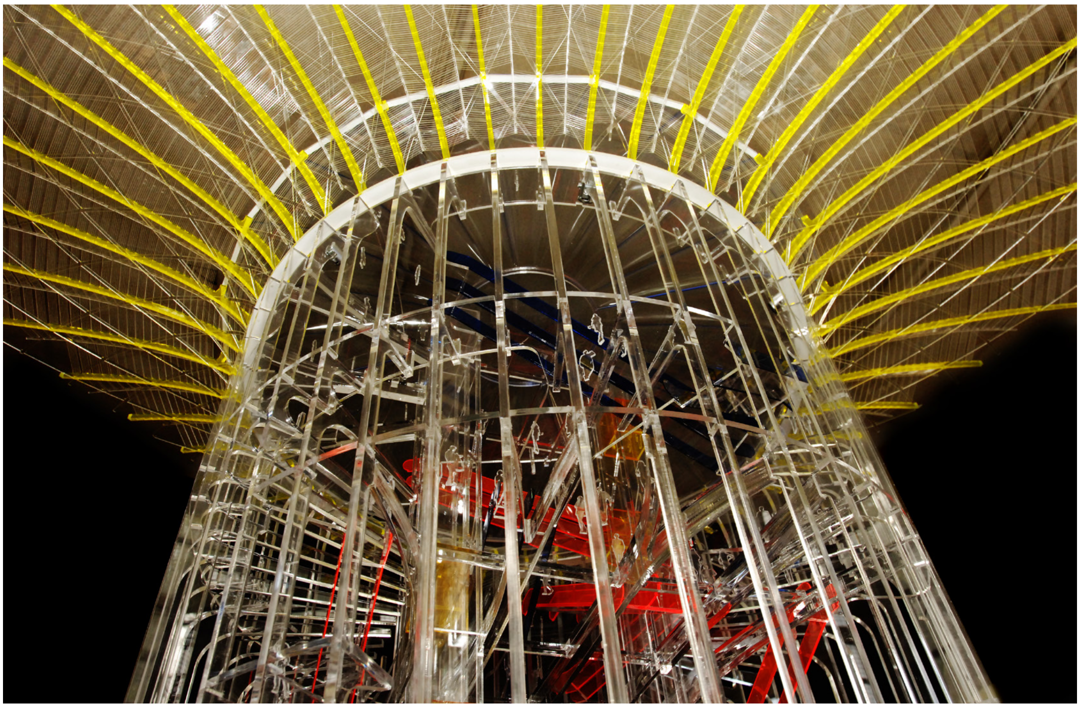

Figure 7.45: Perspex architectural model for RSHP, made by Millennium Models, 2006

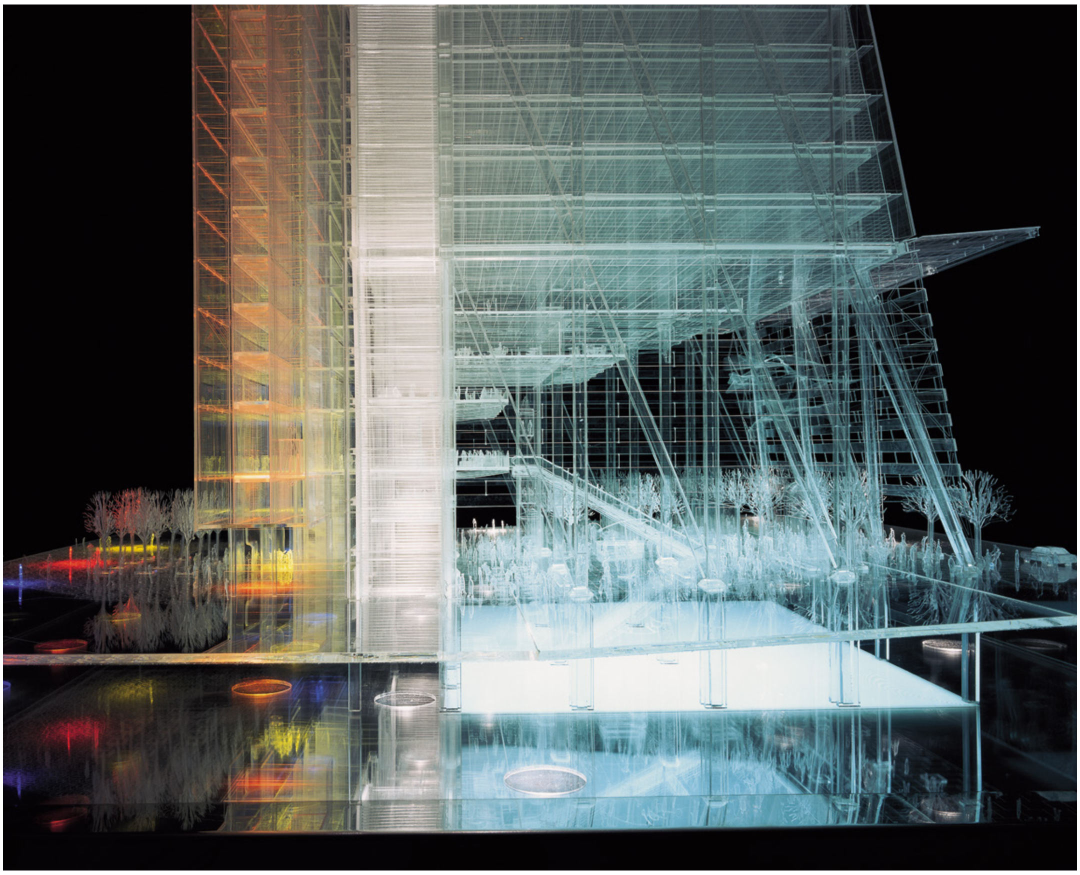

Figure 7.46: Transparent Perspex model of the Leadenhall Building, made by Millennium Models, 2004

From the combination of innovative and experimental modelmakers, Perspex, and the laser cutter, new creative avenues for highly expressive abstract models had emerged, but at the same time that modelmakers such as Hamnell, Driscoll, Spencer-Davies, and Fairbrass were exploring the laser's more artistic potential, it was also being put to effective use in driving an increase in the levels of detail and realism in more traditional architectural models for developers. One of the most significant changes the laser cutter brought was the ability to increase the amount of detail at any given scale. Whereas models below 1:100 scale had previously generally been treated as simple blocks, the laser allowed for the same detail found on a 1:100 scale model to be achieved at much smaller scales, even at 1:1000 (Fooks, 2018). Simple small-scale housing estate models, such as shown in Figure 7.47, could now include brick detail and clear windows, previously having been made as solid blocks. Neil Vandersteen at Foster + Partners is clear that the laser cutter directly increased the complexity of architectural models: 'The technology we have available to us has given us an opportunity to do more details, more animation, to put more into the model. The model

Figure 7.47: Kennel Green housing estate model, made by Nick Quine/AMI, circa 2005

is far more detailed now than it used to be' (Vandersteen, 2018). Presentation and marketing models made using laser cutters rapidly became much more complex and precise, often with internal details that previously would rarely have been included (Figures 7.48 and 7.49).

Of the modelmaker's new digital tools, the laser cutter proved to be the most adaptable in terms of its creative potential; the benefit of 3D printers largely remaining centred on the production of components rather than opening up new visual styles – with the exception of the raw, 'de-stylised aesthetic' (Ratzlaff, 2016) favoured by architectural practices such as Make. In both cases these were tools that had been adopted to aid the construction of architectural models; their creative applications being an extension beyond their originally intended purpose – very much in the spirit of 'ingenious adaptation'. A consequence of the modelmaker's increased digital literacy, however, was that having become proficient with CAD in order to design the parts for laser cutters and 3D printers to produce, other digital technologies that had no direct connection to the construction of architectural models came to be incorporated as design features in high-end marketing models. The influx of foreign investment in luxury residential developments in London after the 2008 financial crash created an intense competition between the major property developers, instigating a push for ever more sophisticated marketing models to help drive sales. As a result, interactive lighting, built-in touchscreens, light projection, and computer animation became common features as architectural models were used as focal points in luxury marketing suites around the world.

The London property boom of the 2010s resulted in billions of pounds being invested in high-rise developments such as The Shard, 20 Fenchurch Street, The Heron, Pan Peninsula, Newfoundland Quay, and Landmark Pinnacle. The scale of these developments was a new departure for the city, with Landmark Pinnacle in Millwall alone standing at seventy-five floors with nine hundred apartments and built at a cost of over £300 million. With such substantial sums of money being invested, the property developers behind these developments were highly incentivised to ensure they were fully occupied, resulting in aggressive marketing strategies with significant budgets. By the late-2010s, Barclay Homes had become the biggest commissioner of architectural models in the country (Atkins, 2019), and competition

Figure 7.48: Presentation model made by Unit 22, 2016

Figure 7.49: Detail of Moor House presentation model, made by Pipers, 2002

between the major developers became a crucial driving force behind a demand for grander and more sophisticated architectural models to be displayed in marketing suites (Figure 7.50).

The presence of models in marketing suites was by no means new, models having been used to sell property in this manner as early as the 1930s (see Chapters Four and Six). A change that took place during the post-crash residential boom in London, however, was that the developers behind these properties were not aiming a local buyers, instead targeting wealthy foreign investors in markets such as Russia, China, or the Middle East, aiming to sell not just a single apartment to an owner-occupier, but perhaps five or six properties to a single investor. With many of these developments being in the high-end luxury market, the models used to sell the properties had to be equally sophisticated as developers were striving to make their own sales pitches better than their competitors', resulting in increasingly high expectations of technological complexity and interaction within the architectural models they commissioned.

Figure 7.50: Heron Tower marketing suite. Model made by Kandor, circa 2010

The ability to interact with an architectural model in some way had been steadily growing since the early-1990s, with simple keypads allowing potential buyers to select the number of an individual house or apartment, and to light it up on the model to see exactly where it was. For developers, the easier someone could envisage themselves living in a specific property, the more likely they were to gain a sale, and with advances in touchscreen technology from 2010 onwards, developers began to demand even more sophisticated means of interaction (Atkins, 2019). The use of lighting in architectural models to increase realism, and to create a sense of spectacle, dates back as early as Ernest Twining's illuminated model of the National Cash Register Factory in 1924 (see Chapter Four), however by the late-1990s, it had become expected that a model in a marketing suite would include some form of interactive lighting. This was particularly challenging to achieve if each light needed to be controlled by a button or keypad. To wire a model in this way, each room had to contain an individual bulb with two wires trailing all the way through the building, hidden behind walls and ceilings, to a junction box controlled by a keypad. The amount of wiring involved could extend to several hundred metres, and models often had to be designed to incorporate cooling fans to prevent the bulbs from melting the Perspex. David MacKay remembers an early interactive model he made at AMI for a residential development in Knightsbridge, and with over six hundred bulbs inside, it melted (Mackay, 2018).

Such interactive lighting was also extremely costly; to wire a model of an apartment building in West London that contained three hundred homes added £6000 to the cost of the model (Danton-Rees, 2019). For one particular masterplan model, Mike Fairbrass at RSHP used over five kilometres of fibre optics to transmit light from fluorescent tubes hidden underneath the baseboard (Fairbrass, 2019). The development of LED strips, and particularly programmable LEDs, where individual LEDs could be controlled in sequence, proved to be significant timesavers for architectural modelmakers. By the early-2000s, the inclusion of lighting in most architectural models had become standard, and not just for marketing models: 'It got to the point where lighting was just routine. If you were making a model, it would have lights in it as a matter of course' (Fairbrass, 2019). One particularly innovative example of the use of lighting was Millennium's 2015 model of RSHP's design for the Antwerp law courts (Figure 7.51) that employed photo-luminescent paper that glowed when a small electrical charge

Figure 7.51: Model of Antwerp Law Courts, made by Millennium Models, 2015

Figure 7.52: Presentation model by Millennium Models, circa 2006. Photograph by Andrew Putler

was applied, providing light to the upper levels of the model (Fairbrass, 2019). Even more abstract competition and presentation models came to incorporate lighting, with coloured gels and tinted Perspex used to create distinctive effects (Figure 7.52).

With LEDs having become the standard method of lighting architectural models by 2010, for marketing models, the next major development was the introduction of touchscreen interfaces to control them (Figure 7.53). By selecting a particular property from a menu, the screen could then show interior views while the model lit up to indicate where the specific apartment was located. 3DD took this concept further in making models that physically rotated to orientate the selected apartment to the viewer, one model even rising vertically to show the specific location of an apartment's underground parking space (Atkins, 2019).

By 2015, high-end marketing models had become hybrids of physical model and digital media with built-in flatscreens displaying additional information, the architectural model returning to levels of extravagance and complexity not seen since the inter-war years

Figure 7.53: Interactive marketing model made by MC Modelmaking, 2017

modelmaking boom (see Chapter Four). International property development trade shows further increased the demand for models designed simply as spectacle in order to secure investments. Often showcasing models of entire cities, trade show models could cost many hundreds of thousands of pounds, and could include a variety of advanced animation techniques to provide moving information overlays. Models such as the Abu Dhabi 2030 masterplan made by Pipers utilised overhead projectors to overlay the model with dramatic computer animations (Figure 7.54), while the use of LED monitors underneath a Perspex architectural model gave rise to a new, highly interactive form of model that used digital animation to illuminate translucent buildings from below (Figure 7.55).

The technical knowledge required to make such interactive marketing models is not inconsiderable, and for Lee Atkins at 3DD, the work involved in making such technically sophisticated models is as creative and imaginative as any other form of architectural modelmaking (Atkins, 2019). Atkins is also clear that the demand for such advanced technology and engineering in the model is being driven by the developers themselves: ‘Clients are prepared to spend extra money. They are prepared to take the punt to push the boundaries of sales and marketing and that is what is driving the [continued adoption of] technology’ (Atkins, 2019).

Figure 7.54: Abu Dhabi Vision 2030 model made by Pipers, 2015

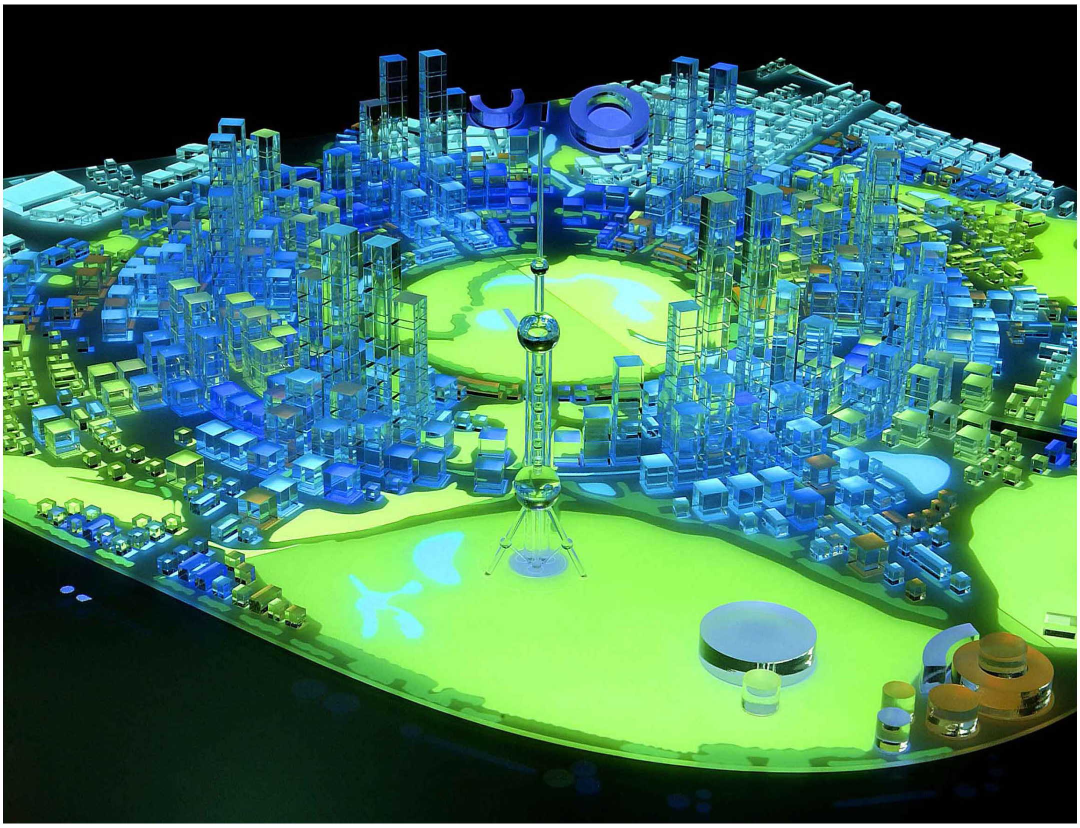

Figure 7.55: Digitally animated architectural model, made by RSHP, circa 2015

The shift in expectations around interactive architectural models during the first two decades of the twenty-first century has been significant, with the advancement of computer technology having both enabled developers to specify increasingly complex features in their models, and architectural modelmakers to deliver them. While the push for interactivity was generally limited to high cost marketing models of luxury developments, simple lighting had become an expected standard of most architectural models during this period, however, and the inclusion of even basic lighting added considerable complexity to the design and construction of an architectural model. As a result, by the late-2010s, cost pressures had begun to outweigh the initial efficiency gains that digital manufacturing processes had brought about. In her 2005 study of the architectural model, Karen Moon, in observing that the model had by that time become highly sophisticated, asked whether it was possible that the model might one day 'become too complex – too clever for its own good?' (Moon, 2005, p.135). The sheer technical complexity that marketing models reached in the decade that followed her statement suggests that Moon may indeed have been right, having noticed early warning signs of what was to come.

The prices of high-end marketing models steadily increased as the requirement for more interactive features intensified after the 2008 financial crash, with 3DD alone receiving five contracts for models worth over £200,000 each in 2018. Foster + Partners' model of their $5 billion design for the Apple Campus (Figure 7.56) was similarly expensive, while the extremes to which high-end models reached during this period are perhaps best exemplified by 3DD's model of Foster + Partners' design for the Bloomberg HQ in London (Figure 7.57), commissioned to occupy the foyer of the completed building during its opening ceremony in 2017. Constructed at 1:50 scale, the model was fully detailed internally, with every workspace realistically portrayed (Figure 7.58). In order to illuminate the model, bespoke lighting panels were ordered from Perspex directly, each 20mm thick sheet cut to the precise shape required, with built-in LEDs around the edges and an etched graduated pattern on their upper surfaces in order to project even light levels across the entire sheet (Atkins, 2019). Floor surfaces were laser etched and then painted to closely resemble real timber, with over £200,000 of 3D printing sub-contracted to various bureaus to create the internal furnishings and the distinctive bronze panels on the building's exterior. The completed four-metre wide model was extremely heavy, with each of its three sections weighing 250kgs, and so in order to support its own weight, the model had to be designed with solid aluminium columns that

Figure 7.56: Model of the Apple Campus, made by Foster + Partners, 2013

Figure 7.57: Model of Foster + Partners' Bloomberg building, made by 3DD, 2017. Photograph by Luke Hayes

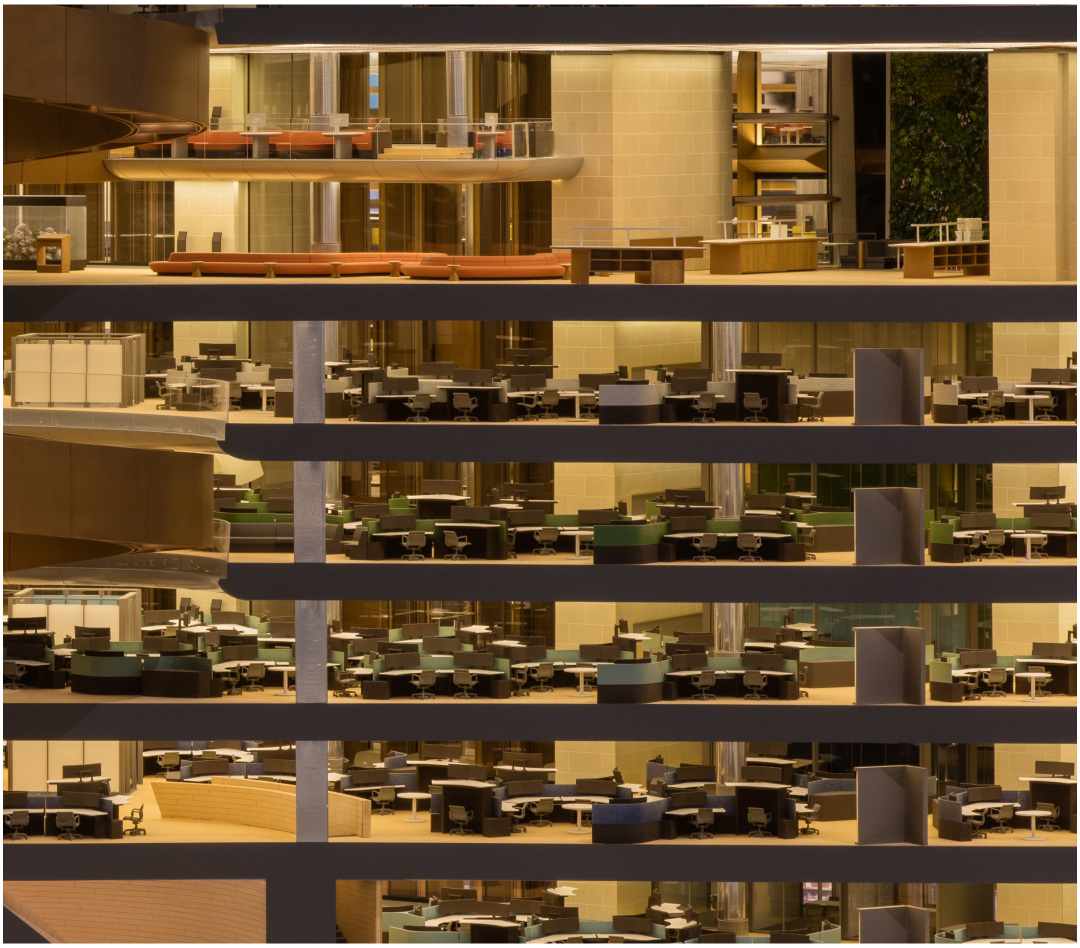

Figure 7.58: Interior of the model of Foster + Partners' Bloomberg building, made by 3DD, 2017

provided genuine structural support. With over thirty thousand separate components, it was the largest and most expensive model of a single building 3DD had ever made (Atkins, 2019), costing well over half a million pounds to build.

While an exceptional example, the Bloomberg model highlights the levels of complexity that architectural models in the early-twenty first century have reached, with the expectation of such spectacle in a high-end marketing model having become the norm. Despite the efficiency gains of the introduction of CAD/CAM processes, the technical possibilities digital technologies have opened up in terms of creativity, realism and interactivity have added increased costs to the making of such models, and with additional pressures from inside and outside the profession, architectural modelmaking in the digital age has become a highly expensive activity. With the use of technology in architectural models having expanded from being tools used in their construction to features included in their functionality and design, by the start of the third decade of the twenty-first century, technology has shifted from being a solution to existing inefficiencies to the creator of new ones.

Today in 2020, the exploration and application of new technologies within architectural modelmaking continues, with innovations such as the seven-axis robotic sculpting arm being used by the architectural modelmakers at Foster + Partners (Figure 7.59) all part of a drive to make better models, and to make them more efficiently. Since the early-1980s, fears that CAD/CAM processes would make the modelmaker's role redundant were continually abated by the modelmaker's ability to put new technologies to good use; perhaps the ultimate realisation of Robert Hoyt's 1939 observation of the 'imaginative use and ingenious adaptation of available tools and materials to meet his own particular requirements' (Hoyt, 1939, p.420). Writing in the middle of the model's CAD/CAM transformation, Mark Morris observed that digital manufacturing technologies had saved the architectural model (Morris, 2006, p.8), and despite the shift in the skills required for architectural modelmaking, the changes brought about by digital technologies were largely recognised as positive: 'People ask what has technology done to your industry, and I kind of feel it has taken a lot of the monotony away' (Atkins, 2019). Adam Burdett agrees:

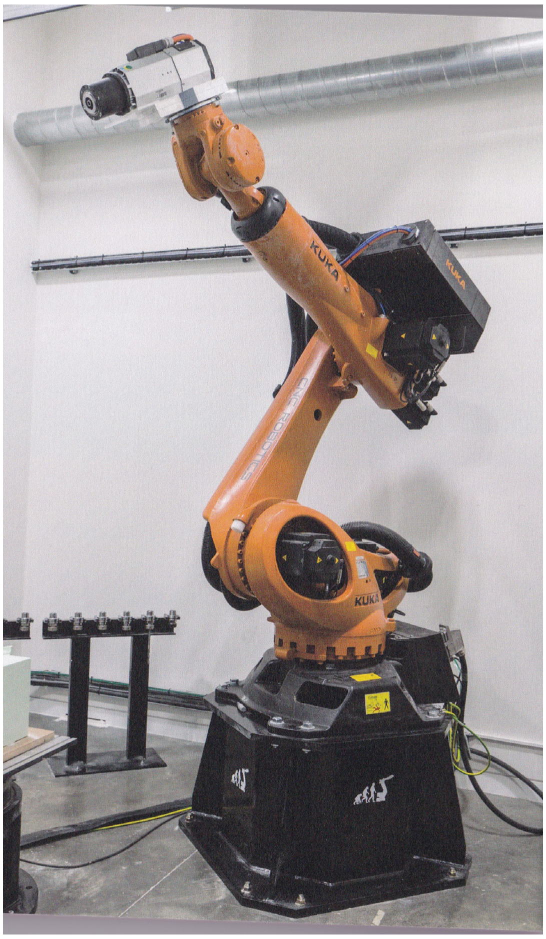

Figure 7.59: KUKA robotic CNC arm at Foster+Partners, 2018

> I don't think any skills have disappeared. You still need to cut with a scalpel. They are still needed, but the average day now for a modelmaker that is running a project of any size that has any detail on it is likely to spend on average fifty percent of their time sat in front of a computer (Burdett, 2018).

Mike Fairbrass has noted the inevitability of the adoption of digital manufacturing processes in modelmaking, observing that 'It is what every craft does…they identify the things that take the longest time and make them faster, and get the same or similar result, or sometimes even better' (Fairbrass, 2019).

The profession today relies on a combination of both digital skills and traditional hand making; Dan McWilliam at Farrells having observed that while 3D printing remains a much-discussed technology, ‘it needs to be hand skills and technology coming together. It is not about using one or the other’ (McWilliam, 2018). By 2018, Adam Burdett at Unit 22 had noticed an increase in modelmaking companies that specialise in 3D printed models approaching them for assistance:

> It’s a lovely feeling. For that company to say we want to be better than our rivals, so can you make this for us? What, with our prehistoric techniques and processes? Yes, of course we can. And very reassuring that even with the most modern technology, it can still be improved by skilled labour (Burdett, 2018).

As American modelmaker Richard Tenguerian wrote during the peak of anxiety over the introduction of laser cutting and 3D printing in 1995, ‘tools such as CAD/CAM are at the service of the modelmaker, not the other way round’ (Tenguerian, 1995, p.14). Equipped with more advanced and versatile digital tools, the architectural modelmaker’s role shifted further away from the actual construction of models and towards their design. The increased efficiencies in the making of models freed the modelmaker’s time to think more about the visual language and narrative of the models they were making, as well as their technical sophistication. As Will Strange has noted, ‘the biggest change is that modelmaking is no longer a technical service that is producing accurate objects that architects aren’t capable of making. It is much more integrated into the design process, often making much more abstract things’ (Strange, 2017).

Having been initially adopted in response to a pressing need to improve the efficiency of basic architectural modelmaking processes, the use of digital technologies rapidly expanded as they began to act as enablers, further boosting the creativity, realism, and overall quality of models, before eventually driving the complexity of the most expensive architectural models to unprecedented levels. With the early efficiencies then lost as models became more sophisticated due to the capabilities of the technologies in use, efficiency once again became a central concern. ‘Because you can get more detail, you put more details in, so you are making more complex models in the same amount of time’ (Danton-Rees, 2019).

Neil Merryweather has noted that ‘It doesn’t take long before, if you do something quickly, people want more of it, and they want it in less time’ (Merryweather, 2019). The time savings that the technology had initially brought about were quickly absorbed as expectations around the model’s detail and creativity gave rise to an increasing complexity that rapidly became the norm.

With technology having initially improved the efficiency of architectural modelmaking, the steady increases in detail and sophistication has also begun to eat into the modelmaker’s profits, as expectations have started to increase above what clients are prepared to pay (Fooks, 2018). In today’s competitive and pressured market, the importance of identifying efficiencies in the process of making architectural models continues to be a significant priority. With a range of advanced digital manufacturing process at the modelmaker’s disposal, choosing the right method for each task has become an important consideration, and as architectural models continue to become more detailed and technically advanced, modelmakers remain on the constant lookout for new and more efficient ways of making: ‘We are changing things all the time; we are constantly striving to make them faster, but also more accurately and more efficiently’ (Atkins, 2019); the role of technology in architectural modelmaking having gone full circle with the need for efficiencies once again the driving force behind their continued adoption.

7.6. Conclusion

This chapter set out to examine the introduction of digital manufacturing technologies to architectural modelmaking from the late-1990s through to the present day, in order to consider the consequences for the making, appearance, and functionality of the architectural model that they brought about. Initially driven by an urgent and increasing need to improve the efficiency of architectural modelmaking that arose during the late-1980s and early-1990s, this chapter has revealed how the introduction of digital technologies served to increase the speed and precision of model construction, as well as opening up new possibilities for the creative design of architectural models. With the efficiencies digital manufacturing technologies brought about freeing the modelmaker’s time to be spent on the more creative aspects of architectural modelmaking, the benefits of their new digital tools began to spread beyond the technical processes of making, enabling a rapid consolidation of earlier characteristics of the model that had emerged during the twentieth century. Advances in both realism and creative abstraction, a further embedding of the dominance of Perspex as the principal material of architectural modelmaking, and a maturation of the notion of adaptability being central to architectural modelmaking quickly followed.

As Chapter 7.2 highlighted, initial fears that the CAD revolution of the 1990s would replace the role of the professional modelmaker were quickly put aside as architectural modelmakers sought technological solutions to automate some of the enormously time-consuming basic processes of their work. The ability to program the cutting and engraving of window apertures into early CNC machines during the mid-1980s proved a valuable time-saver; however it was not until the widespread availability of desktop computers and the development of affordable laser cutters in the late-1990s that a step change took place that greatly improved the efficiency and accuracy of architectural modelmaking (pages 288-296). As revealed in Chapter 7.3, ideally suited for cutting and engraving Perspex, laser cutters were rapidly recognised as vital tools for the modelmaker's workshop. Chapter 7.4 then charted how advanced 3D computer modelling software aiding architects to develop increasingly complex and organic architectural forms led modelmakers to begin making use of 3D printers to produce individual components that would otherwise be extremely difficult to construct (pages 297-302). Far from being a replacement for the architectural model as had been initially feared, the 3D printer quickly became another useful tool in the modelmaker's workshop, with the relatively clean and efficient processes of the 3D printer and the laser cutter contributing to an expansion in the number of architectural practices making use of professional modelmakers in-house.

Chapter 7.5 then examined how during the early-2000s a new generation of architectural modelmakers began to explore the creative potential of the laser cutter, with a new trend for clear and coloured abstract Perspex models developing (pages 318-324). At the same time, more realistic architectural models saw dramatic improvements in the levels of detail they were able to include, with smaller scale models including individual brick lines, window details, and other features that had previously been reserved for larger scales (pages 325-326). Finally, the chapter revealed how the luxury residential property boom in London that followed the 2008 financial crash and subsequent economic downturn led to an intense competition between property developers that generated an increased demand for interactive features in high-end marketing models, with LED lighting, motion, touchscreen control, and digitally-animated overlays adding new functions to architectural models in marketing suites around the world (pages 328-333).

The digital revolution in architectural modelmaking that first took hold during the late-1990s is still underway at the time of writing in 2020, and the consequences of the dramatic changes that CAD/CAM processes have had on the architectural model are therefore still unfolding. What this chapter has revealed, however, is that the professionally-made architectural model in Britain today demonstrates few characteristics that have remained untouched in some manner by the influence of technology. Today, the notion of 'ingenious adaptation' that Robert Hoyt first observed in 1939 as so central to modelmaking can be described as having emerged from the combined agency of not only the modelmaker's imaginative and ingenious intentions and the intrinsic adaptability of plastics, but also the adaptable and versatile digital tools adopted during the past two decades. From the increased levels of precision and efficiency afforded by the now standard tools of the CNC, laser cutter, and the 3D printer; to the expanded stylistic palette of models through the creative application of the laser cutter and clear or tinted Perspex; and to the extreme levels of complexity and interactivity present in high-end marketing models, the architectural model in the digital age of the twenty-first century is as diverse and sophisticated as it has ever been. At the same time, the automation of many of the labour-intensive tasks of modelmaking has arguably made architectural modelmaking a profession that relies more on problem-solving, design, and the artistic skills of the modelmaker than it does their sheer persistence in completing repetitive and time-consuming tasks.

The principal tools used in the making of the professionally-made architectural model in Britain today have been established for little over twenty years and yet their impact has been profound. With the digital age an ongoing period of technological change, the model will undoubtedly continue to adopt new tools and processes wherever they offer improvements to the precision, creativity, and – most importantly – the efficiency of making professionally-made architectural models. It only remains for architectural modelmaking to continue to embrace the imaginative approach of 'ingenious adaptation' that enabled the professionally-made architectural model in Britain to navigate the multiple threats of the emerging digital age and to thrive, adapting and adopting new tools and processes that resulted in the wholesale shift from analogue to digital ways of working that characterises the making of professionally-made architectural models in Britain today.

8: Conclusion

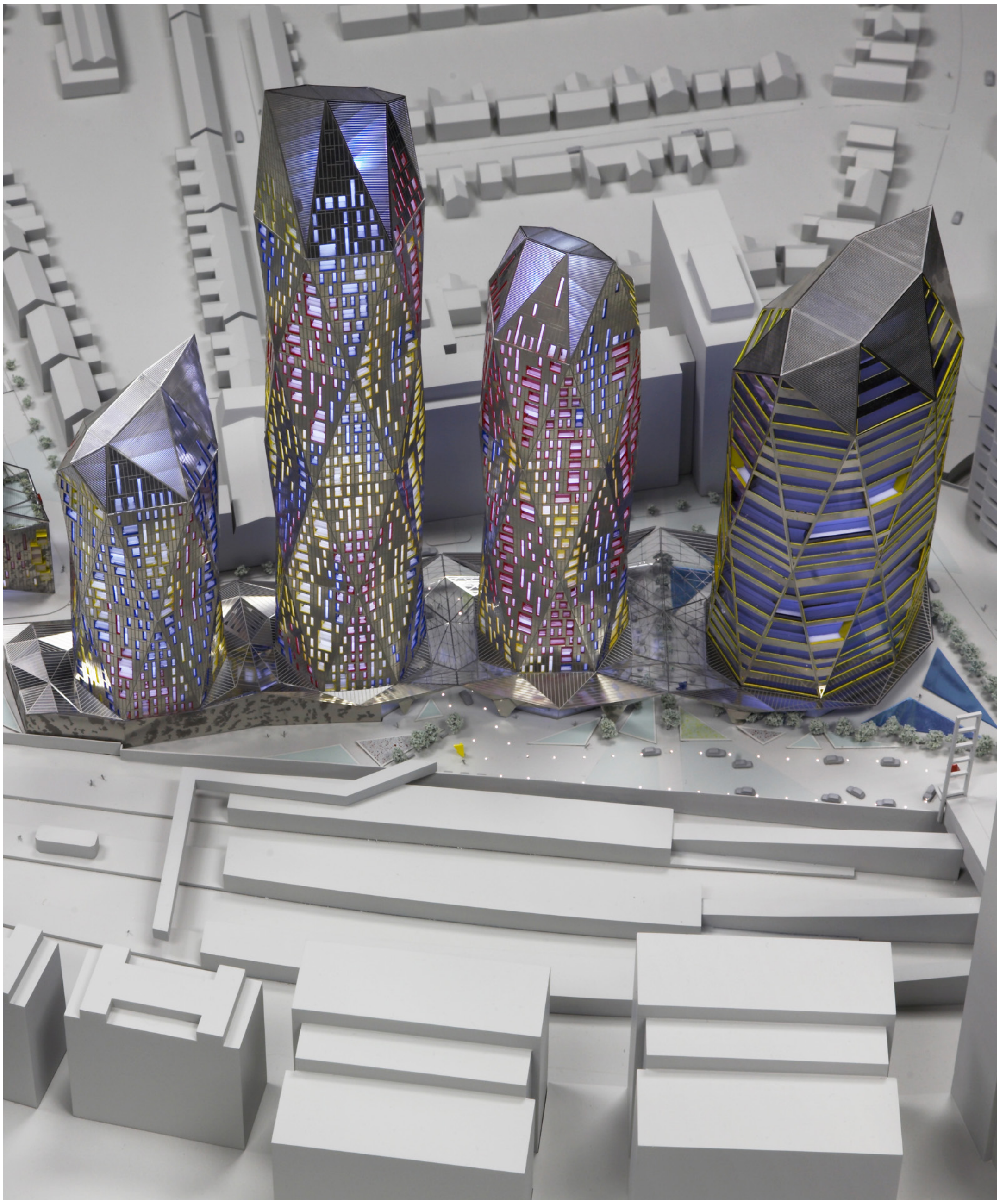

Figure 8.0: Presentation model made by Unit 22, circa 2008

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8.1. Introduction

In conducting a historical study of the development of the professionally-made architectural model in Britain, this thesis has sought to understand how the model came to gain its present form. In approaching the architectural model from within the field of modelmaking rather than architecture, this thesis has considered the model as an object with its own intrinsic characteristics and histories, highlighting developments in the making of architectural models as opposed to the dominant 'post-production' perspective that overlooks the role of the modelmaker and the materials and processes employed. As such, the principal research questions it sought to answer were:

- Question 1: How and when did the professionally-made architectural model in Britain come to gain its present form?
- Question 2: What have been the most significant influences that have shaped its development?

In order to address these questions, the thesis employed Assemblage Theory as the basis for its conceptual framework in order to realise Anna Fariello's call for an alternative position to the 'post-production' form of analysis that largely overlooks the making of objects prevalent in both the existing literature relating to the architectural model and the wider study of objects and their histories (see Chapters Two and Three). Viewing the present form of the architectural model as having emerged from the interactions between the various people, processes, materials, and ideas that have contributed to its history, in order to answer the thesis' questions, the following objectives were established:

- Firstly, this thesis must outline the professionally-made architectural model in Britain today;

- Secondly, it must trace the emergence and development of the model throughout its history;
- Thirdly, the thesis must examine the complex interactions between the people, processes, materials, and ideas from which it emerged.

In bringing the thesis to a conclusion, this chapter outlines how it has answered its research questions and met its overall aim and objectives by summarising its findings of how the contemporary form of the professionally-made architectural model in Britain emerged as a result of developments that took place during four distinct periods in its history, and how the notion of 'ingenious adaptation' that Hoyt observed in 1939 – reinterpreted as emerging from the combined agency of the modelmaker's imaginative and ingenious intentions and the intrinsic adaptability of the materials, tools, and processes employed – has been the most significant influence that has shaped the model's overall development. The chapter then considers the thesis' original contribution to knowledge in the context of existing research, before closing with some final concluding remarks.

8.2. Summary of Findings

In November 2019, after two years of work to secure its preservation, the archive of Thorp Modelmakers, the full extent of which was uncovered during the early stages of this research project, was acquired by AUB, and the long process of conserving and cataloguing twenty-five thousand photographs and documents charting more than a century of the company's history began. In the same month, Will Strange, a fellow Senior Lecturer in Modelmaking at AUB, completed his Master's thesis, a study examining which of the skills and abilities of the professional modelmaker were considered the most essential by modelmakers themselves (Strange, 2019). The views of eighty professional modelmakers were canvassed, assigning weightings to different attributes based on their perceived usefulness. What the results showed was that problem solving, visualisation, and reasoning were consistently ranked as the most essential skills of a professional modelmaker, more so than their ability to use specific tools and processes. As Strange wrote, this closely matched Robert Hoyt's 1939 description of the notion of 'ingenious adaptation' being central to the architectural modelmaker's success.

In asking that 'if the most compelling skill of the modelmaker in 1939 was their ability to draw influence from outside their discipline, to be ingenious and flexible, can the same be said today?' (Strange, 2019, p.5), the resounding answer – according to the study – was yes.

Strange's study was a timely confirmation of this thesis' highlighting of the importance of John Thorp's role in the development of the professionally-made architectural model in Britain, with the inquisitive and adaptable approach that Thorp first demonstrated still viewed as the most important attribute of a modelmaker today. Comparing the findings of Strange's study with the materials held within the Thorp archive illuminates just how much, and how little, has changed since the emergence of the profession. Brian Holder's comment at the *Future of Modelmaking* conference in 1996 (see Chapter Seven) that the then likely future of modelmaking was that 'nothing much changes at all, but a few small things change a lot' (Holder, 1996, p.2), stands perhaps as much as a summation of the model's past as it was intended as a prediction of its future, given that fundamentally, despite all the advances to the architectural model that have taken place during its history, the innovative and adaptable approach to architectural modelmaking that John Thorp first employed has remained remarkably unchanged.

Throughout this thesis the notion of adaptability has been a central theme, however Hoyt's original description of adaptability was primarily focused on recognising adaptability as an intention of the modelmaker – the 'quest for new methods, tools and materials that makes modelmaking [an] interesting occupation' (Hoyt, 1939, p.420). In tracing the historical development of the professionally-made architectural model in Britain today, this thesis has revealed the complexity of the interactions from which its present form emerged, leading to a more nuanced interpretation of Hoyt's statement that acknowledges that adaptability emerges not just from the modelmaker's intentions, but also from the intrinsic properties of specific tools and materials that make them suitable for adaptation in the first place.

In summarising the thesis' findings of how the model came to be as it is today through a process of 'ingenious adaptation', this section of the conclusion addresses each of the research questions in turn, first outlining the chronological development of the model throughout its history, before more broadly discussing the role of adaptability as the most significant influence that has shaped the model's development. Just as this thesis argues that development of the architectural model has relied on the combined interactions of the people, processes, materials, and ideas that have contributed to its history, so too this thesis argues that Hoyt's notion of 'ingenious adaptation' is itself an emergent phenomenon, with adaptability having continually underpinned the model's development over the past one hundred and thirty seven years.

8.2.1. The Historical Development of the Professionally-Made Architectural Model in Britain

The thesis' first research question sought to understand how and when the professionally-made architectural model in Britain came to gain its present form. What the thesis' findings in Chapters Four to Seven have revealed is how the contemporary form of the model emerged as a result of developments that took place during four distinct periods in its history: the initial emergence of architectural modelmaking as a distinct profession during the late-nineteenth and early-twentieth centuries; the adoption of plastics as the principal modelmaking materials during the post-war boom of the 1950s and early-1960s; the turbulent realignment of the model's 'stylistic palette' during the 1970s and 1980s; and the introduction of advanced digital manufacturing technologies from the 1990s to the present day.

As was outlined in Chapter Three, this thesis' drawing from the implications of Assemblage Theory in order to realise Fariello's 'front-end' consideration of objects (Fariello 2005, p.4) resists the temptation to put forward overly-simplistic 'monocausal explanations' (Evans, 2000, p.158), recognising the complexities involved in the emergence of each of the four characteristics that this thesis addresses. Viewing the architectural model as an emergent phenomenon, its present form can be understood to have been generated from the combined interaction of the elements that have contributed to its history; the model as it is today being 'an effect of an array of relations' (Binder et al, 2011, p.14). With the properties of an assemblage being causally generated by the interactions between its parts rather than the parts themselves (DeLanda, 2016, p.9), in answering the first research question this thesis has therefore focused on tracing the processes by which the individual components that contributed to the model's history became involved, and examined how their subsequent relationships with each other brought about change.

The first period that this thesis examined was the emergence of the professional architectural modelmaker in Britain, defined by the working career of John Thorp from 1883 to 1939 (see Chapter Four). Despite the architectural model having been in continuous use in Britain for over four hundred years, the profession dedicated to its making is much more recent; the model as an object being far older than modelmaking is as a profession. As such, this thesis began by charting the developments that led up to the making of architectural models shifting from being an activity carried out within various individual craft trades associated with building construction (see pages 66-88) and into the dedicated 'interesting occupation' that Robert Hoyt referred to shortly before the outbreak of the Second World War (Hoyt, 1939, p.420). With the making of architectural models prior to the twentieth century having largely taken place within strictly differentiated building trades that were restricted to the use of single materials or processes, this thesis has revealed the material influences of card and paper during the early-nineteenth century in enabling a change to who was making architectural models, moving them away from the workshops of stonemasons and carpenters and into the drawing offices of architects themselves (pages 80-86). Effectively freed from any existing craft trade, architectural models greatly benefited from the use of multiple materials in their construction; the removal of architectural modelmaking from the siloed building trades having altered the circumstances in which a modelmaker could operate by bringing together previously separated processes and materials into a singular activity and creating the opportunity for a specialist trade dedicated to their making to emerge.

The first person to make use of this change, and to establish themselves as the first professional architectural modelmaker in Britain in the modern sense was John Thorp, and it is the imaginative and adaptable relationship towards materials that Thorp adopted that remains the template for the profession today (see pages 88-96). With Thorp's successful career as an architectural modelmaker quickly developing into an established business employing over twenty other modelmakers, further architectural modelmaking companies began to set up similar businesses closely following Thorp's approach; the profession expanding significantly during the inter-war years as a result of a construction boom and the increased popularity of architectural models due to their higher quality and availability that the professionalisation of their making brought about (pages 99-113). By Thorp's death in 1939, architectural modelmaking in Britain had become a small but established profession, with concerns about the increasing size and complexity of architectural models having fuelled an eager exploration by professional modelmakers of early synthetic materials as alternatives to timber and card (pages 123-124).

John Thorp's role in establishing the template for the profession that remains to this day is undoubtedly a hugely significant factor in the history of the professionally-made architectural model in Britain, however in many ways Thorp was merely the right person at the right time, able to take advantage of a set of circumstances that had converged to make the creation of a specific profession possible. The influence of materials is strongly evident in the emergence of the assemblage right from the start, with the introduction of card moving the making of architectural models away from the specialist building trades dedicated to single materials and processes; while the professionalisation of architectural practice in the mid-Nineteenth century further consolidated a recognition of the model's utility, creating demand. It was John Thorp who brought these various strands together, however, taking advantage of the fundamental shift in the relationship between the makers of models and their materials that had taken place, with the making of architectural models becoming specialised in terms of its output, but generalised in its approach to making them, distinguishing modelmaking as a pursuit in its own right rather than as an extension of existing craft practices that were involved in the making of actual buildings. Liberated from using any one particular material, modelmakers such as Thorp were able to draw materials and processes from a variety of specialist trades, with Hoyt's 1939 observation of modelmaking as the 'ingenious adaptation of available tools and materials to meet his own particular requirements' (Hoyt, 1939, p.420) succinctly capturing the innovative and adaptable nature that still defines the attitude of the professional architectural modelmaker today.

Following the establishment of the professional architectural modelmaker, the second period that this thesis examined was the emergence of plastics as the principal materials used in architectural modelmaking, having charted the plastics revolution that resulted from the post-war modelmaking boom in Britain during the 1950s and early-1960s that established the widespread use of Perspex (polymethyl methacrylate) (see Chapter Five). With the initial explorations of early plastics having been undertaken by architectural modelmakers seeking potential solutions to increased concerns regarding the weight and cost of their models during the early-1930s, the first use of Perspex within architectural modelmaking occurred just months after its commercial introduction by ICI in 1936. Modelmaker Kenneth McCutchon's innovative application of the material in what was then a radically new method of model construction in making architectural models entirely out of Perspex in 1938 (see pages 137-139) highlighted how Perspex's intrinsic properties – its transparency, ease of machining, ability to be heat bent, and its sheer adaptability in being able to be finished to imitate almost any other material used in building construction – positioned Perspex as an ideal material that matched the adaptable nature of the newly-professionalised architectural modelmaker. With the diversion of all Perspex-production to military uses during the Second World War delaying the full adoption of its potential, by the time of its return to commercial availability in the late-1940s the circumstances had been established for a post-war boom in architectural modelmaking in Britain during which Perspex become the dominant material used in architectural model construction.

The post-war boom itself emerged from the convergence of a number of elements that contributed to an intense period of rapid change for the professionally-made architectural model in Britain, beginning with the influx of highly-trained ex-RAF modelmakers into the profession after the end of the Second World War who had been making exceptionally accurate and realistic landscape models at the top secret V-Section modelmaking section at RAF Medmenham (pages 144-150). With an enormous demand for planning models during the rebuilding and modernisation of Britain during the late-1940s and 1950s, these newly de-mobbed ex-military modelmakers were ideally suited for the work, actively driving forward the levels of realism present in architectural models (pages 150-164). This subsequently led to the challenge of how to represent the new modernist styles of architecture adopted for the post-war rebuilding programmes to the same levels of realism that the ex-RAF modelmakers had established. With entirely new forms of building such as high-rise tower blocks, and the extensive use of glass and steel in building construction, an urgent need arose for new approaches to architectural modelmaking that Perspex fulfilled, ushering in radical shifts in precision, detail, and realism (see pages 165-190).

In identifying the convergence of these elements during the post-war modelmaking boom as the origins of a plastics revolution that brought about dramatic improvements to the model, this thesis has also identified this period as one in which the notion of 'ingenious adaptation' expanded to incorporate the intrinsic properties of plastics as well, emerging from the combined agency of the modelmaker's ingenious and adaptable intentions and the inherent adaptability of their newly-adopted materials. The introduction of plastics further emboldened the influence of materials in shaping the model's development, with Thomas Hendrick's 1957 statement of plastics that 'the use of these materials has done more to facilitate the methods of construction and to improve the finish of architectural models more than any other substance or method' (Hendrick, 1957, p.34) being as true today as it was during the 1950s; plastics – and Perspex in particular – having been a constant driving force behind the development of the model from the post-war era onwards.

The third period that this thesis addressed was the emergence of the model's stylistic diversity during the 1970s and 1980s, inextricably linked to the consequences of the plastics revolution, and instigated by the architectural profession's increasingly negative attitude towards the professionally-made architectural model in Britain that took hold from the late-1960s onwards (Chapter Six). Centred on a backlash against the improved levels of realism that the post-war plastics revolution had brought about, presentation and marketing models faced intense criticism for too confidently predicting a future that architects were then held accountable for (see pages 201-212). With the pursuit of realism having dominated the visual appearance of professionally-made architectural models from the very beginning of the profession, by the 1980s, the circumstances were established for a creative expansion that broadened the model's creative palette to better match the pluralistic approach of architecture that had emerged in place of the certainty of modernism, and which allowed for the dual role of the model as both a commercial sales tool and a visionary expression of architectural ideas to be reconciled within a much broader stylistic range.

The contested nature of realism in architectural models that emerged during the late-1960s and 1970s stemmed from a growing conflict between the commercial uses of models as sales tools and their position as representations of utopian futures; embarrassment of the post-war model's highlighting of the failures of the modern movement; and a fundamental shift in architecture's perception of what an architectural model was actually a model of. Locating this shift of perspective within the wider 'crisis of confidence' (MacEwan, 1974; Harwood and Powers, 2012, p.12) that affected the architectural profession following the end of the modernist consensus, and during a period of drastic changes to both its employment and client bases (pages 212-222), this thesis has charted the deterioration in architecture's relationship with the professionally-made architectural model during the 1970s that created a substantial gulf between the differing expectations of the model held by architects and developers. With architecture increasingly viewing the model as a representation of ideas rather than of actual buildings (pages 223-224), the development of abstract timber models during the 1960s and 1970s provided ideal alternatives to the prevailing highly-realistic Perspex models that architects were starting to reject (pages 227-232).

Initially offering a useful juxtaposition with plastics in clearly indicating on a model what was old and what was new, timber also spoke more of the process of design rather than a finished building. Without trying to mimic the textures and materials that an actual building would feature, timber models forced a level of abstraction and ambiguity that was attractive to many architects wanting to avoid the literal depictions of architecture that realistic Perspex models engendered. Leading the use of such models was the in-house Arup Associates modelshop, with modelmaker David Armstrong and his team becoming widely known for their highly-creative abstract timber models (see pages 223-238). During the late-1970s and early-1980s, the 'Arup School' of modelmaking began to be adopted by a new generation of modelmakers taught by Arup modelmaker George Rome Innes at the Medway School of Design in Rochester (pages 239-242). Graduates such as Richard Armiger then applied Arup's much more creative and innovative approach to competition models during the 1980s

‘Big Bang’ property boom, adapting the model’s visual and material language to allow for a much more diverse range of styles to accommodate the conflicting needs of the architect and the developer. As a result, by the late-1980s the professionally-made architectural model in Britain reflected the changes that architecture itself had undergone, having embraced a multiplicity of styles and ideologies. By the end of the 1980s, two schools of thought existed within the profession – one that favoured precision, detail, and realism; the other embracing creativity, experimentation, and abstraction (pages 254-262). Charting the establishment of new commercial modelmakers such as Network Modelmakers, 3DD, Unit 22, Tetra, and others during the decade, this thesis has shown how by the early-1990s the stylistic diversity seen in the professionally-made architectural model in Britain today was in place; the model having adapted to meet the conflicting demands of both architects and developers through a return to the open and inquisitive relationship with materials that the plastics revolution of the post-war boom had in many ways suppressed.

The final period examined by this thesis was the adoption of digital manufacturing technologies such as laser cutting and 3D printing from the late-1990s onwards (Chapter Seven). Revealing a period in which adaptability came to the fore, this thesis has charted not only the establishment of the digital tools used in the making of today’s architectural models, but also their role in consolidating the dominance of plastics and in further advancing the creativity, precision, and technical sophistication of the professionally-made architectural model in Britain. In identifying that the adoption of the model’s contemporary CAD/CAM tools was initially driven by a singular urgent and increasing need to improve the efficiency of architectural modelmaking that arose during the late-1980s and early-1990s (see pages 273-284), the thesis has outlined how the introduction of digital technologies served to increase the speed and precision of model construction, as well as opening up new possibilities for their creative design.

Within the context of a perceived threat to architectural modelmaking as a result of the introduction of digital manufacturing and visualisation technologies that rose during the mid-1990s, the time-consuming and repetitive nature of much of the basic work of architectural modelmakers highlighted the need for increased efficiency that the adoption of CAD/CAM processes such as the CNC and the laser cutter brought about. Despite initially viewed as potential threats to the profession, architectural modelmakers defied the expectations of the time, and in adapting them to their own requirements, brought about significant improvements to the precision and detail of architectural models, demonstrating the model's resilience against purely-digital alternatives (see pages 284-296). The adoption of 3D printing, a process that had so concerned the profession during the 1990s, was further turned to the model's advantage, with the use of CAD in architectural design generating more complex and organic forms that were beyond the ability of traditional hand-making process to efficiently represent (pages 297-306). The integration of the 3D printer as a tool under the command of the modelmaker, rather than as a potential replacement for their work, then led to a further expansion of the use of in-house modelmakers within architectural practices (pages 307-309).

Having initially been adopted due to the efficiency savings they enabled, digital manufacturing technologies ultimately freed the modelmaker's time to be further spent on the more creative aspects of architectural modelmaking, and the benefits of their new digital tools quickly spread beyond the technical processes of making, enabling a rapid consolidation of earlier characteristics of the model that had emerged during the twentieth century. Advances in both realism and creative abstraction, a further embedding of the dominance of plastics as the principal materials of architectural modelmaking, and a maturation of the notion of adaptability being central to the modelmaker's nature quickly followed (pages 313-326). The use of technology was additionally extended to the functions of the model, with an increased demand for lighting effects and interactivity creating new types of high-end marketing models, and efficiency once again becoming a driving force behind the continued adoption of digital technologies as the initial efficiency gains of CAD/CAM processes were countered by the increased technical complexity that their application generated (pages 329-336).

With the use of digital manufacturing technologies firmly embedded within architectural modelmaking, by 2020 the notion of 'ingenious adaptation' that Robert Hoyt first observed in 1939 as so central to modelmaking had itself further expanded to encompass not only the modelmaker's imaginative and ingenious intentions and the intrinsic adaptability of plastics, but also the adaptable and versatile digital tools adopted during the past two decades. Due to the emergence of the architectural modelmaker's digital tools from the late-1990s onwards, the professionally-made architectural model in Britain has matured into the diverse and technically sophisticated class of objects it is today.

8.2.2. Ingenious Adaptations

The second question that this thesis posed sought to identify the most significant influences that have shaped the model's development throughout its history. Throughout the discussion of the model's history presented in Chapters 4-7, Robert Hoyt's notion of 'ingenious adaptation' has been a reoccurring influence. With adaptability – the capacity to change in order to meet the requirements of circumstance – understood to be a form of agency, this thesis' drawing from Assemblage Theory views agency as the result of performance and effect rather than merely intention (Bennett, 2010, p.viii), allowing for a reinterpretation of Hoyt's description of 'ingenious adaptation' as itself being an emergent phenomenon arising from the combined agency of the modelmaker's imaginative and ingenious intentions and the intrinsically adaptable properties of the materials, tools, and processes employed. As this thesis has demonstrated throughout, the notion of 'ingenious adaptation' has itself expanded and developed over time, initially defining the adaptable approach of the professional modelmaker established by John Thorp, and later encompassing the adaptable properties of plastics and the adaptable and versatile nature of the modelmaker's digital tools.

Throughout its history, the model has consistently embraced adaptation as a means of advancing and ensuring relevance against an ever-changing economic, architectural, and technological backdrop. New technologies that initially posed a threat to the very survival of both the architectural model and the profession were greeted with a curiosity and inquisitiveness that resulted in their adaptation to improve the model rather than replace it; faced with a collapsing reputation among architects revising the theoretical basis of their own profession, professional architectural modelmakers adapted the model's visual language to allow for a much more diverse range of styles to accommodate the conflicting needs of the architect and the developer; and the convergence of the adaptable approach of the professional modelmaker with the adaptable properties of Perspex during the post-war boom revolutionised the architectural model, making it fit for the modernist age; with John Thorp having instilled the open and adaptable approach to architectural modelmaking into the profession right from its very inception.

Adaptability has also been central in meeting the ongoing demands for increased efficiency within architectural modelmaking; beginning with John Thorp's striving for efficient, and hence profitable, processes throughout his career, it was the need for more efficient and less expensive methods and materials that first encouraged the professional modelmaker's exploration of synthetic materials that ultimately brought plastics such as Perspex to their attention. As models became ever more complex and detailed during the second half of the twentieth century, the drive for efficiency then became a crucial instigating factor behind the adaptation of CAD/CAM technologies to the modelmaker's needs during the 1990s, and today remains an important factor in managing the increasing expectations being placed on the architectural model against a reluctance from clients to pay more for additional detail and technical sophistication.

Hoyt's original observation of modelmaking as the 'adaptation of numerous tools and materials to purposes for which they were not originally intended' (Hoyt, 1939, p.42) was primarily focused on recognising adaptability as an intention of the modelmaker, and adaptability in this sense has remained central to the success of the professional architectural modelmaker ever since. Through Thomas Hendrick's observation of the importance of improvisation, versatility, and 'flexibility of the imagination' being the key attributes of the architectural modelmaker (Hendrick, 1952, p.26), and to Will Strange's 2019 study that places problem solving, visualisation, and reasoning as the most essential skills of a professional modelmaker (Strange, 2019), the importance of the modelmaker's adaptable approach shows no sign of abating as twenty-first century modelmakers continue to pursue the 'quest for new methods, materials, tools and materials that makes modelmaking [an] interesting occupation' (Hoyt, 1939, p.420). Following the introduction of plastics to architectural modelmaking during the post-war boom, however, adaptability as a driving influence behind the development of the assemblage expanded to incorporate the intrinsically adaptable properties of Perspex; its transparency and versatility enabling a wholesale revolution in construction methods that better suited the expression of new modernist architectural styles and dramatically increased the levels of detail and realism in architectural models. Perspex's success during this period then directly influenced a backlash against both itself and the realism it engendered that ultimately enabled the broadening of the model's stylistic palette to resolve the conflicting demands of both architects and developers during the 1980s; while its suitability for laser cutting enabled a swift transition to CAD/CAM processes during the 1990s that not only aided the model in combating the threat of digital alternatives to modelmaking, but further boosted its creative potential. Similarly, as architectural designs became increasingly complex and organic in the twenty-first century, pushing the skills of the modelmaker to the limit, plastics-based 3D printing technologies enabled a further increase in the complexity and detail of models, and provided low-cost and efficient means to expand the use of professionally-made architectural models within architectural practices themselves. With each period in the mode's history having also served to expand the assemblage of adaptability itself, adaptability has become inextricably bound to the practice of architectural modelmaking, having nurtured the development of the professionally-made architectural model in Britain ever since John Thorp established the profession in 1883.

8.3. Significance of the Study and Further Research Directions

This thesis makes an original contribution to knowledge through its presentation of a detailed historical study of the development of the professionally-made architectural model in Britain. Situated within the field of modelmaking rather than architecture, the thesis has drawn from extensive archival research and nearly forty interviews with practicing and retired architectural modelmakers to highlight developments in the making of architectural models as opposed to the dominant 'post-production' perspective that overlooks the role of the modelmaker and the materials and processes employed (Fariello, 2005, p.4). As was highlighted in Chapter Two, there has until now been no extended study of the architectural model undertaken from within the discipline of modelmaking itself, and with the making of models falling outside of architecture's normal arena of research, the roles of modelmakers and the materials and processes used in their making have at best been overlooked and at worst ignored.

Having identified a need to examine the history of architectural modelmaking practice from the perspective of the modelmaker rather than the architect, this thesis has responded to Oliver Elser and Peter Schmal's acknowledgment that 'we know too little about modelmakers themselves' in their call for in-depth studies of the architectural model (2012, p.8), and Karen Moon's observation that 'the most significant developments in [architectural] modelmaking during the 20th Century came from the professional modelmaker' (Moon, 2005, p.185). In tracing the significant roles of individual modelmakers such as John Thorp, Ernest Twining, David Armstrong, George Rome Innes, and Richard Armiger, the anonymity of the professional modelmaker within the existing literature has been challenged. By fully charting the process by which plastics became the dominant materials used in professionally-made architectural models in Britain today, the considerable influence of plastics in shaping the development of the architectural model has been outlined here for the first time. Through examining the origins of the creative expansion of the 1980s, the impact of the 'Arup School' of architectural modelmaking has been revealed, as have the consequences of the shifting nature of the triad-relationship between the architectural model, the developer, and the architect. Similarly, in outlining the conflict between the dual role of the model as a commercial sales tool and an expression of utopian visions, the consequences of the model's utopian properties have been explored. In tracing the adoption of digital manufacturing technologies and their influence on the efficiency and precision of professionally-made architectural models, the circumstances of the post-millennial research boom into the history, function, and meaning of the architectural model that resulted from an anxiety around the model's threatened obsolescence have gained additional contextualisation. Furthermore, the specificity of the thesis in attending to the history of the architectural model in Britain has gone some way to counter the distorted global histories of the model that have resulted from the uncritical combination of British, European, and North American histories into a singular narrative, and by emphasising the making of models this thesis has begun to rebalance the existing literature's focus on use of models in the design process that has been the lasting legacy of *Idea as Model* (Frampton and Kolbowski, 1981) and *Great Models* (Buttolph, 1978).

In adding new knowledge to the history of architectural models, and in contextualising contemporary modelmaking practice, this thesis will also enable future modelmaking researchers to further develop their field. Within the specific area of architectural modelmaking covered by this thesis, it has already been acknowledged that there is potentially more about the model that has not been studied than has. As such, there are a number of complementary research topics that naturally follow on from the findings of this thesis. Firstly is the continuation of the unravelling of the confused global history of the architectural model, with similar studies to the one presented here located on North American and European histories of the professionally-made architectural model being of significant potential value, especially given the roles of British professional architectural modelmakers in establishing the profession in the United States, as briefly noted in Chapter Four. The second area of research relates even more specifically to the professionally-made architectural model in Britain, and the continued identification and analysis of historical archival material. Having established a broad history of development of the professionally-made architectural model in Britain, this thesis has established a chronological and critical framework against which more focused studies can be contextualised. With the Thorp modelmaking archive having only recently been acquired by AUB, this thesis has been able to draw from only a tiny fragment of the over twenty thousand photographs and documents in the collection, and further studies of the archive, and that of Twining Models held by Northamptonshire Archives, the V-Section archive held by the Medmenham Collection, and the archive of the London County Council/Greater London Council Models Division held at the London Metropolitan Archives would likely reveal further more detailed information relating to their individual histories and contributions.

8.4. Concluding Remarks

Through its presentation of a historical study of the development of the professionally-made architectural model in Britain situated within the field of modelmaking rather than architecture, this thesis has demonstrated the value of moving beyond a 'post-production' analysis of objects and for studies of the architectural model's history to engage with its making in addition to its use within the design process. In tracing how the model's contemporary form emerged from a complex assemblage of the various people, processes, materials, and ideas that contributed to its history, this thesis has highlighted the previously overlooked contributions of modelmakers, materials, and technologies that a more anthropocentric approach to history would not have revealed, and identified the notion of 'ingenious adaptation' as fundamental to the model's overall historical development.

In providing historical contextualisation to contemporary modelmaking practice, this thesis also establishes a platform upon which further research can be built, and it is for future modelmakers to continue to apply the imaginative and adaptable approach that John Thorp first adopted not only to the making of models, but also to their study. The writing of this thesis further demonstrates the value of Hoyt's description of modelmaking as 'the adaptation of tools and materials for which they were not originally intended' (Hoyt, 1939, p.420), in having borrowed, developed, and adapted perspectives, frameworks, methods, and approaches from a number of different disciplines in establishing the basis for studying that most adaptable of practices and its outputs – modelmaking. As Udale and Evans remarked in 1947, 'there is probably no other craft in which the worker is brought into contact with a wider variety of materials, or in which he may acquire more diverse skills' (Udale and Evans, 1947, p.4). The professionally-made architectural model in Britain today bears the accumulation of one hundred and thirty seven years of ingenious adaptations, and this thesis makes an important contribution in revealing the history of the complex material, social, technological, and ideological developments that have shaped the model into the high-quality, creative, and technically-sophisticated class of objects it is today.

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Appendix 1: List of Interviews Conducted

This appendix lists all the interviews conducted, both in person and via telephone/internet. In-text citations within the thesis relating to these interviews refer to the Harvard bibliographic entries of the same that can be found within the List of References.

Richard Armiger, Owner, Network Modelmakers, Skype interview, October 12th 2018.

Richard Armiger, Owner, Network Modelmakers, Skype interview, December 17th 2018.

Richard Armiger, Owner, Network Modelmakers, email interview, October 10th 2019.

Lee Atkins, Owner, 3DD, interview, June 10th 2019.

John Blythe, Architect and Partner, Foster + Partners, interview, March 26th 2018.

Shajay Bhooshan, Associate, Zaha Hadid Architects, interview, November 13th 2017.

Adam Burdett, Director, Unit 22, interview, January 16th 2018.

Robert Danton-Rees, Owner, Capital Models, interview, August 8th 2019.

Matthew Driscoll, Director, Base Models, interview, January 22nd 2018.

Alan East, former Modelmaker, RAF V-Section, Skype interview, January 29th 2019.

Mike Fairbrass, former Head of Modelshop, RSHP, Skype interview, May 8th 2019.

Stephen Fooks, Business Development Manager, Pipers Modelmakers, interview, May 8th 2018.

Tim Fryer, Medmenham Association, email interview, October 30th 2018.

Bruno Gordon, Modelmaker, Jestico+Whiles, interview, November 14th 2017.

Simon Hamnell, Director, Millennium Models, interview, November 13th 2018.

Joseph Henry, Architect, Jestico+Whiles, interview, November 14th 2017.

Roger Hillier, former Modelmaker, Arup Associates, interview, April 30th 2018.

Claire Holman, Modelmaker and Senior Lecturer, interview, July 11th 2017

Kenneth Houghton, Graduate, Rochester College of Design, email interview, March 26th 2018.

George Rome Innes, former Modelmaker, Arup Associates, interview, April 18th 2019.

Paul Johnson, Modelmaker and Senior Lecturer, interview, July 11th 2017

Kamran Kiani, Co-Owner, Scale Models Unlimited, Skype interview, August 5th 2019.

Helmet Kinzler, Senior Associate, Zaha Hadid Architects, interview, November 13th 2017.

Robert Kirkman, former Modelmaker, interview, April 29th 2019.

David MacKay, Owner, Architectural Models International, interview, January 5th 2018.

Daniel McWilliam, Senior Modelmaker, Farrells, interview, February 19th 2018.

Neil Merryweather, Head of Modelmaking, PLP Architecture, interview, October 8th 2019.

Paul Miles, Modelshop Manager, Make Architects, interview, March 20th 2018.

Tina Miller, former Modelmaker, Arup Associates, interview, April 30th 2018.

Michael Mockford, Medmenham Association, email interview, October 24th 2018.

Daniel Oppenheimer, Co-Owner, Scale Models Unlimited, Skype interview, August 5th 2019.

Emily Oppenheimer, Co-Owner, Scale Models Unlimited, Skype interview, August 5th 2019.

Andrew Putler, Photographer, interview, June 7th 2019.

Alec Saunders, Head of Modelmaking, Thorp Modelmakers, interview, March 13th 2018.

Christian Spencer-Davies, Director, A Models, interview, June 6th 2019.

Will Strange, Modelmaker and Senior Lecturer, interview, July 11th 2017

Will Strange, Modelmaker and Senior Lecturer, interview, December 11th 2017

Neil Vandersteen, Partner and Head of Modelmaking, Foster + Partners, interview, March 26th 2018.

Paul Woods, former Modelmaker, Presentation Unit, telephone interview, September 10th 2019.

Appendix 2: List of Modelmaking Companies Visited

In addition to the interviews conducted, the following is a list of the architectural modelmaking companies visited during the research project.

3DD, Dartford.

A Models, London.

Architectural Models International, Brentford.

Atom Modelmakers, Sunningdale.

Base Models, London.

Capital Models, London.

Farrells, London.

FCBS, Bath.

Foster + Partners, London.

Jestico+Whiles, London.

Make Architects, London.

Pipers Modelmakers, London.

Thorp Modelmakers, Sunningdale.

Unit 22, London.

Zaha Hadid Architects, London.

Appendix 3: List of Archival Material Consulted

This appendix lists all the archival primary research sources consulted. Due to the extensive volume of images examined, most of which belong to private archives and which are subsequently un-catalogued, only abbreviated totals of the photographic collections are included. For a full list of image sources used in the thesis, please see the list of figures on pages VII-XXV.

Architectural Models International, London

250 un-catalogued photographs dating from 1959-2013.

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