

Interviews with leading UK architects suggest the continued relevance of traditional techniques in the age of CAD draughting and modelling systems.

The use of drawing in architectural design: some recent experiences from UK practice

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The objective of architectural design is the creation of form, and the task of drawing is to give that form some shape or expression.¹ Hence the traditional view is that the design sketch is both an organisational tool and formal device in the search for a best-fit solution, aesthetically and programmatically.² Increasingly, the architectural sketch interacts with other media such as models and CAD.³ As a consequence, the combination of freehand drawing, models and CAD allows architectural ideas to be developed from different perspectives and at different stages in the design process. The question addressed in this paper concerns the relative importance of sketching as a design tool; this is examined through the drawing techniques employed by 10 leading architects and their methods of interfacing with models, formal drawing and CAD. In this investigation the focus is upon the initial stages of a project up to RIBA Stage 'C'.

Thinking through drawing is what traditionally has been thought to distinguish the architect from others in the building design process.⁴ These views were, however, expressed before the almost universal employment of CAD in architectural practice. The question addressed here is whether drawing still retains this central position in the face of other investigative design tools, and if so, what types of sketches are employed by the architects interviewed for different scales of project. Since it is claimed that many architects find it difficult to undertake the development of a design idea without recourse to drawing⁵ it is assumed that sketches still play an important role in the genesis of architectural concepts even in the twenty-first century. However, some architects such as Ron Arad and Neil Spiller, prefer to undertake design development almost exclusively using CAD, arguing that new tools create new formal solutions. Others such as Zaha Hadid, Will Alsop and Frank Gehry have exploited art-based practices to generate new ways of viewing architectural production. Of these, Alsop's work is examined here with his views and design methods set alongside more orthodox practitioners.

The research described here stands in contrast to the more theoretical perspectives on architectural

drawing which have been the primary concern of scholars over the past decade.⁶ The drawing has tended to become an object of interest in its own right rather than a vehicle to develop ideas and engage in design dialogue. In spite of this recent interest, the drawing can never assume equivalence to built architecture. This paper investigates the changing role of drawing as a design tool under the impact of ever more sophisticated computer-aided design software and modern methods of model-making such as CAD/CAM, rather than the examination of drawing as architectural art. Hence, this paper has a practical bias aimed at widening the debate about the role of drawing in architectural practice and, as a consequence, in architectural education. It is considered timely, for the architects whose drawing methods are examined are of a generation educated before the impact of digital media on design became essential. Today 'communication', and as a consequence proficiency in drawing and CAD, are central to ARB prescription. Moreover, the measured drawing which is alluded to in certain of the interviews is currently out of favour in architectural education in spite of the investigative nature of such sketching practice.

Testing the ideas: the structured interviews

Ten leading architects were selected for interview, six with medium to large London practices, three with smaller practices based in Edinburgh and one in Glasgow. The selection of architects was based upon geographical spread, diversity of educational background and the presence of public recognition through the award of design prizes at national or local level. The process consisted of a general survey of published material and drawings on each architect followed by a semi-structured interview conducted over about an hour. The architects interviewed were in each case the senior partner of a large- or medium-sized practice, and hence the person most likely to be the originator of the design concept. They were chosen also because they represented both high profile and mainstream practice, and reflected a spread of typical age profiles for senior partners. No architects were selected from

outside the UK because the research questions were set against the framework of the RIBA Plan of Work. The nine questions put to the architects were divided into three types – those dealing with the relationship between drawing and abstract thought processes, those dealing with drawing and practical problem solving, and those dealing with drawing techniques and communication. In each case there was a discussion of the media and content of drawing (or sketching), particularly how they contributed to the design process.

<p>Drawing and abstract thought processes</p> <ul style="list-style-type: none"> • Can you think without drawing? • Can you design without drawing? • Can you draw without designing?
<p>Drawing and practical problem solving</p> <ul style="list-style-type: none"> • What type of drawing do you begin with? • How do drawing, model-making and CAD interrelate? • How does sketching inform designing?
<p>Drawing tools and techniques</p> <ul style="list-style-type: none"> • What do you draw with? • What do you draw on? • How does the drawing become shared?

Table 1. Structure of research questions

The first group of questions sought to tease out the cerebral role of drawing not just in terms of organising and solving abstract problems but in relaying something of the thought processes of the designer. The second group aimed to discover the specific nature of drawing in the more practical areas posed by design problems, the type of drawings used at different points in the design process, and the relationship of drawing with CAD and model-making. The third group sought to investigate the tools and techniques employed, particularly how and when drawing becomes a shared design tool. The questions posed dealt only with the early stages of a design project: the research had no interest in the drawing prepared as part of the ‘information package’ aimed at the construction process.

Needless to say, the limited sample size was a problem in terms of extracting wide conclusions from the work. However, 10 architects was the number employed by Bryan Lawson in his survey of design methods and thought processes published in the book *Design in Mind*.⁷ Ten lengthy interviews had the benefit too of delving more deeply into processes which larger numerical sampling sometimes overlooks. Qualitative research depends also upon removing bias, hence the adoption of the framework of the RIBA Plan of Work, the selection of practices from a wide geographical area, and a diversity of practice size (see Table 4). The mixture of qualitative, quantitative and contextual analysis provides a triangulation for the reaching of conclusions.

Drawing and abstract thought processes

All of the architects questioned acknowledge the important relationship between thinking, sketching and designing. However, not all thought that drawing was a prerequisite for design: many architects including Edward Cullinan, Nicholas Grimshaw and Norman Foster often had an initial design concept in

their head before they had committed a line to paper. These early design ideas were arrived at spontaneously, perhaps while jogging, in Foster’s case, or cutting logs in Cullinan’s. The subsequent drawings prepared, often the merest of sketches, give physical form to cognitive processes already partly undertaken in the mind. As Cullinan puts it, ‘drawing allows me to express what is already in my mind’s eye’ and the role of drawing (often initially of a rough building section) is to ‘put down some idea about light and space which is beginning to gel in my imagination’. Likewise, Grimshaw admits that he not only generally draws an idea already partially formed in his head but he uses drawings to clarify spatial patterns or structural arrangements previously lodged in the imagination [1 & 2]. Similarly Will Alsop states that drawing tests an idea which is already in his head, but to make sure he is thinking conceptually (rather than just problem solving) he prefers to paint initially rather than to draw too soon. Painting has the advantage he claims by giving priority to the eye rather than the intellect which tends to favour drawing. This view (but not the process) is shared by Terry Farrell who states that design is a mental process which remains more fluid in your head than on paper. He too likes to delay setting his thoughts down, arguing that although line is fluid it is not as fluid as an idea. At the conceptual stage, certain types of drawing can be limiting and Farrell adjusts the timing and type of sketch drawings to fit the nature of the project in hand.

The 10 architects interviewed are admittedly experienced designers, but they all share the facility to construct plans or images in the mind’s eye which they subsequently commit to paper. These images grow from a familiarity with the site, brief or precedent which generally has already been analysed, drawn or photographed but not at this stage resolved into a ‘design’. It appears that Alsop, Farrell and Cullinan (and at times others) deliberately avoid sketching or drawing too soon in an attempt to keep the creative options open. For some architects, sketching appears to be a double-edged sword – it allows design ideas to flow, yet the process of drawing reduces creative options. However, Gordon Murray makes the observation that although he undertakes a lot of visualisation in the brain, he is forced to put ideas down on paper to edit them and to share them with others. In this sense the earliest sketch is the medium of consultation and for Foster what matters is good communication whatever form the design takes [3 & 4]. Herein lies a dilemma for the designer: how is the sketch to be both the basis for solving the design problem and for sharing that problem (and its possible solution) with others? Is the screen a more democratic vehicle for collective design decision-making than the drawn sheet?

If a design can pre-exist its representation in drawn form, all of the architects acknowledge the power of drawing to test and develop a design idea. Richard Murphy thinks it ‘absurd to think you can design without drawing’ and Foster states that ‘design is about ordering and this is expressed and explored through drawing’. To Foster a distinction can be

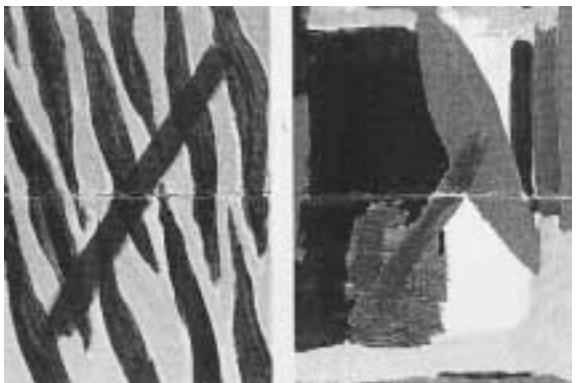
made between thinking and designing, and although he engages in both, 'drawing is essential to the latter but not the former'. A similar view is expressed by Bob Allies who cannot design without drawing since 'drawing is how I understand the problem'. A distinction, therefore, can be made between those architects who see design in conceptual terms, where drawing may become an impediment to deeper cognitive processes, and those who see design as a synthesis of complex factors whose resolution is undertaken through the essential tool of drawing. This differentiation reflects the 'art' approach to design (Alsop, Farrell, Cullinan) and the more rationalist processes of Foster, Allies, Grimshaw, Murphy and others.

Some architects admit, however, that in the initial design drawings lines and words are often combined for there to be a synthesis of spatial, functional and contextual concerns (Allan Murray, Alsop, Farrell). All of the architects questioned thought you could think without drawing (although two admitted its usefulness here too) suggesting that, to the architect, drawing and designing are more closely related than thinking and drawing. This view supports the position of Schön and Lawson where they argue that the spatial creativity of architects is released through drawing rather than the tools used by other

professions. After the initial stage of tentative form generation (some cerebral, some graphic) all the interviewed architects admitted the usefulness of sketching in the development of architectural ideas 'right through the design and construction process' as Allies put it. The layering of design resolution was employed differently, however, with some architects preferring to draw over site photographs (Farrell, Allan Murray), others to use Ordnance Survey maps combined with ground techniques (Allies, Fraser), while others still draw sketch details at 1:5 before the whole form is decided upon at 1:50 or 1:100 (Grimshaw, Murphy, Cullinan). The preoccupations of sketching reflect the preoccupations of designing and hence influence the resulting built architecture [5-7].

Although most of the architects interviewed could, and often did, draw without designing, most were

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|--|---|--|---|
| <p>1 Will Alsop. Initial painting for Cardiff Bay Visitor Centre</p> | <p>2 Nicholas Grimshaw. Fountain pen sketch view of Western Daily News building. The drawing reveals a number of interests of the</p> | <p>3 Norman Foster. Use of sketches and annotation to explain design concepts for unrealised BBC project in London</p> | <p>4 Norman Foster. Sketch of working environment in Commerzbank, Frankfurt. The designer's environmental concerns are evident in the drawing</p> |
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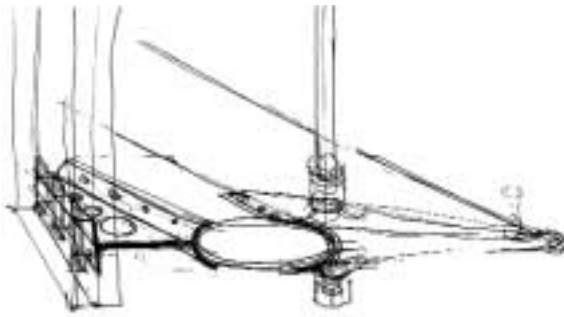
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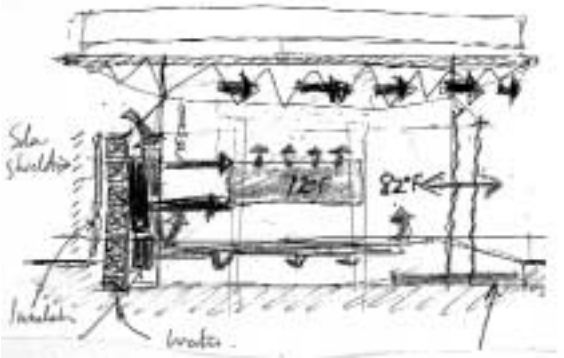
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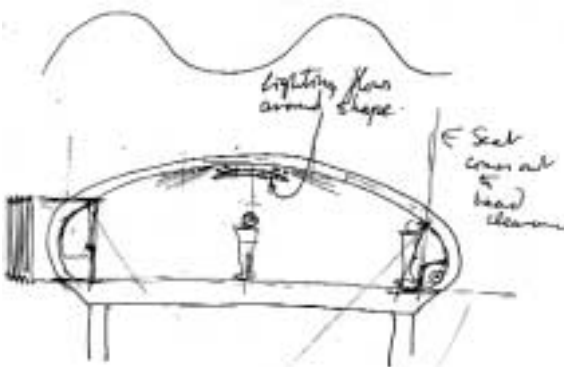
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too busy running large practices to keep the sketchbook tradition alive. The practice of drawing a repertoire of forms and precedents to employ in new designs, what the architect Thomas Jackson in 1873 called ‘the making of careful drawings of existing buildings to inspire the designer later in life’⁸ is not universally employed. However, several of the architects referred to the lessons they drew from undertaking measured drawings while students. Foster, Grimshaw, Cullinan and Farrell all noted the benefits of the discipline of the measured drawing especially, as both Foster and Grimshaw have recorded elsewhere,⁹ where such drawings focus upon the construction of buildings rather than their appearance. Allies noted too the benefits of careful site drawing mixed with archival research as a tool in developing design solutions inspired by his days as a Rome Scholar. Foster, however, keeps a sketchbook ‘whose images influence my design work’ arguing that sketching helps reinforce his visual memory. Also too always travels with a small sketchbook to record images and notes while Farrell thinks that his earlier New York sketchbooks may have influenced his approach to design. However, Farrell sees sketching as a ‘way of seeing rather than a way of designing’ and this view is shared by Cullinan. Four of the architects interviewed (Cullinan, Grimshaw, Murphy and Murray, G.) did, however, admit to using the sketchbook as a method of recording the site and analysing its visual characteristics – these early sketches then being used to test design proposals. The process was one of reaching an understanding of the visual characteristics or geometry of the site through graphic mediation with the brief, then reduced to its spatial essentials and overlaid onto the site plan [8]. Adjustments were then made in plan and section with the embryonic design ideas taken back to the office for further exploration, often using models and sometimes CAD.

Also took the opposite view stating that he never draws the site, preferring to use digital cameras which produce images that can be scanned and used to interact with the emerging graphic designs that usually flow from his paintings. Also’s position is perhaps unique in British architectural practice and differs from Hadid’s in the use of painting as a route into architectural design. Also prefers (so he claims) not to predict what a completed work will look like until quite late in the design process whereas the penetrating abstractions of Hadid’s paintings seem to carry the essence of a design solution right from the start. Also fosters an artistic atmosphere in his London office by providing a weekly life class ‘not just for the enjoyment of drawing but to influence us as designers’.

5 Nicholas Grimshaw. Construction sketch for Operations Centre, British Rail

explained in the context of climatic design

8 Nicholas Grimshaw. Initial site plan for Berlin Stock Exchange. Notice how the structural rhythm is established at an early stage

6 Nicholas Grimshaw. Design sketch for British Pavilion at Seville Expo. Notice the process

7 Nicholas Grimshaw. Sketch section of Satellite Pier at Heathrow. The handwritten notes reinforce the lines

Architect	Does design idea exist in head before the first drawing	Type of first drawings made	Drawing tool used	Paper used	Is site sketching undertaken as design generator	Main design development tool at stage 1 (RIBA Plan of Work C)	Main design development tool at stage 2 (RIBA Plan of Work D)	Main design development tool at stage 3 (RIBA Plan of Work E)
Bob Allies	Yes	1. Site observational drawing 2. Site plan and building diagram combined 3. Layering of functional patterns and contextual references	2 sizes of black felt-tip pen to reflect major and minor orders	Sketch pad, tracing paper roll	Sometimes yes, especially in plan	Freehand drawing and site sketches	Drawing and model	Model and CAD
Will Alsop	Yes	1. Abstract painting 2. Ideas plan 3. Process diagram	Oil paint, watercolour, coloured markers, soft pencil or charcoal	Large cartridge sheet, canvas, sketchbook	Not usually	Painting and mark making combined with freehand drawing	Drawing and model	CAD
Edward Cullinan	Yes	1. Sketch 2. Overhead axonometric 3. Section	Black and coloured felt-tip pens	Sketch pad and tracing paper	Yes	Sketch/drawing	Drawing	Drawing
Terry Farrell	Yes	1. Context analysis plan 2. Sketch section 3. Object view	Black felt-tip pen	Layout paper	No	Sketch/drawing	Model and CAD	CAD
Norman Foster	Yes	1. Masterplan sketches 2. Urban plan 3. Section	Pencil and then black felt-tip pen	Cartridge paper	Yes	Sketch/drawing	Drawing model and CAD	Drawing model and CAD
Malcolm Fraser	Yes	1. Site plan 2. Section diagram 3. 3D sketch	Black felt-tip pen	Narrow white tracing roll	Yes	Drawing	Drawing	Drawing model and CAD
Nicholas Grimshaw	Yes	1. Masterplan 2. Sketch details 3. Section	Blue broad gauge ballpoint pen	A4 sketchbook	Yes	Sketch/drawing	Model	Drawing and model
Richard Murphy	No	1. Plan 2. Section 3. Three-dimensional juxtaposition	Black felt-tip pen	A3 tracing pad	No	Sketch/drawing	Drawing	CAD
Allan Murray	No	1. Site analysis 2. Masterplan 3. Building diagram/plan	Pencil then pen	Narrow detail paper roll	Yes	Drawing	Drawing and model	Drawing and CAD
Gordon Murray	Yes	1. Site analysis 2. Plan diagram	Pencil then fountain pen followed by fine felt-tip pen	Sketchbook then narrow yellow tracing roll	Yes	Drawing	Drawing model and CAD	CAD

Table 2. Main responses to the research questions

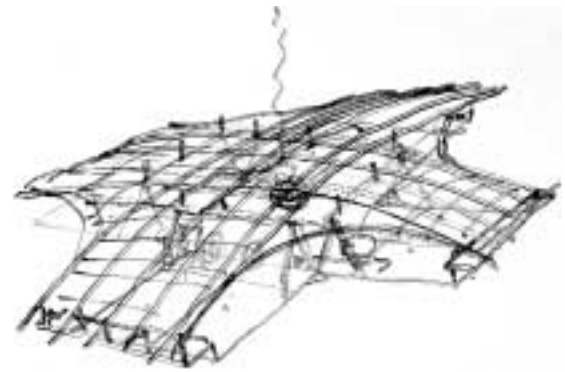
Drawing and practical problem-solving

As noted, the type of drawing first employed often depended upon the nature of the architectural problem posed. Six of the architects talked about the primacy of the plan as the main generator of built form, often combining a sketch site plan with an embryonic diagram of building functions drawn to scale. Order in plan and its correspondence with the characteristics of the site appears to be the main concern. However, in the case of Richard Murphy and Malcolm Fraser the first drawing was frequently a marriage of plan and section, explored on a single sheet and incorporating a great deal of existing fabric. For Edward Cullinan, on the other hand, the

first drawing was generally a section or overhead axonometric which allowed the marriage of light, structure and space to be tested simultaneously [9 & 10]. For Farrell, the diagrammatic section followed quickly on the heels of a plan diagram and a sketched image. Farrell, however, made the useful distinction between place-making and artefact-making drawings. Different starting points inevitably flow from the nature of the project in hand and this is reflected in the type and size of sketches undertaken. Urban masterplanning, as Foster also noted, requires different drawing tools in order to understand the problem of city form. Farrell talks about big drawings being required in order to



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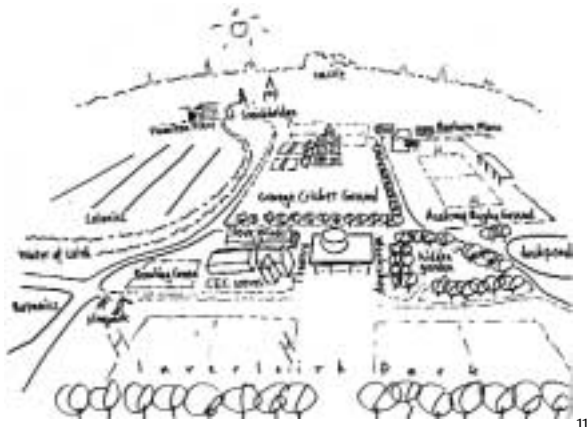
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9 Edward Cullinan. Sketch explaining the logic of the section of his own self-built house in London. Notice the mixture of drawing tools and weights of line

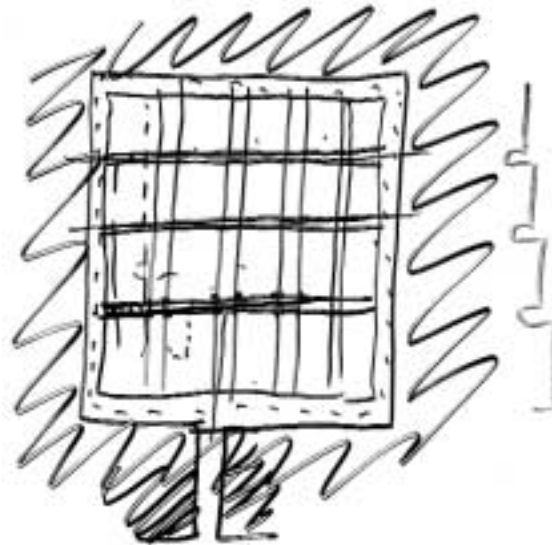
10 Edward Cullinan. Axonometric sketch design showing the structural potential of green oak drawn in a lyrical fashion

Architect	Design Stage 1 (RIBA Plan of Work C)	Design Stage 2 (RIBA Plan of Work D)	Design Stage 3 (RIBA Plan of Work E)
Allies	Drawing 5 Model 3 CAD 1	Drawing 4 Model 4 CAD 1	Drawing 2 Model 4 CAD 4
Alsop	Drawing 5 Model 3 CAD 2	Drawing 4 Model 4 CAD 2	Drawing 3 Model 3 CAD 4
Cullinan	Drawing 5 Model 1 CAD 1	Drawing 5 Model 2 CAD 3	Drawing 5 Model 3 CAD 4
Farrell	Drawing 5 Model 3 CAD 1	Drawing 2 Model 4 CAD 4	Drawing 2 Model 3 CAD 5
Foster	Drawing 5 Model 3 CAD 3	Drawing 3 Model 3 CAD 3	Drawing 3 Model 3 CAD 3
Fraser	Drawing 5 Model 2 CAD 2	Drawing 4 Model 3 CAD 3	Drawing 3 Model 3 CAD 3
Grimshaw	Drawing 5 Model 4 CAD 1	Drawing 4 Model 5 CAD 1	Drawing 4 Model 4 CAD 3
Murphy	Drawing 5 Model 2 CAD 2	Drawing 5 Model 2 CAD 3	Drawing 3 Model 2 CAD 5
Murray, A.	Drawing 5 Model 3 CAD 1	Drawing 4 Model 4 CAD 2	Drawing 4 Model 2 CAD 4
Murray, G.	Drawing 5 Model 3 CAD 1	Drawing 4 Model 4 CAD 4	Drawing 3 Model 1 CAD 5

Scale: 5 very important, 4 important, 3 less important, 2 occasionally used, 1 rarely used
Table 3. Relative importance of drawing, models and CAD at different stages of design evolution



11 Malcolm Fraser. Bird's-eye perspective to test the urban relationships in design of theatre (centre) for Inverleith, Edinburgh



12 Richard Murphy. Diagrammatic sketch of roof design at Computer Centre, Napier University. The diagram combines elements of plan and section

13 Richard Murphy. Exploratory sketches showing the layering of construction for two houses in Edinburgh

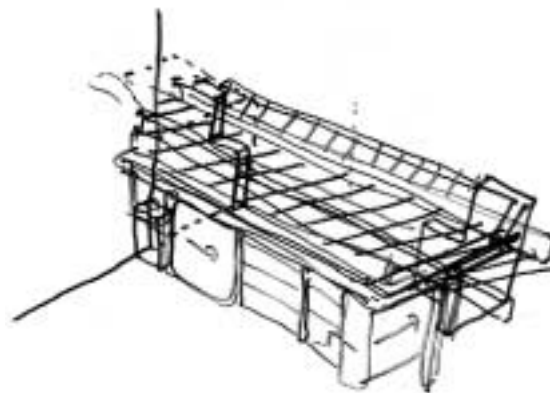


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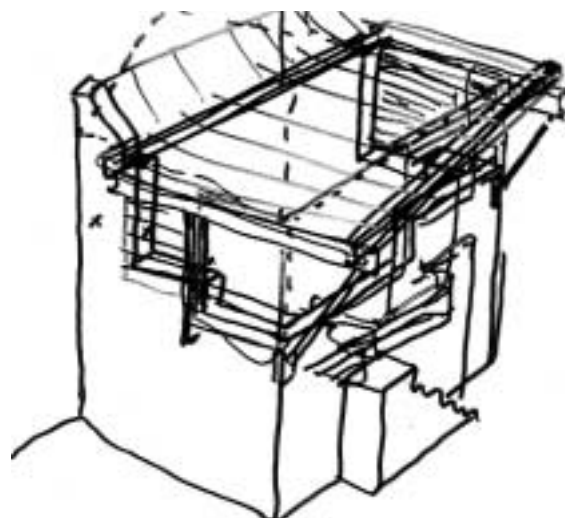
connect with the inevitable collage and complexity of the city.¹⁰ However, in Foster's opinion techniques such as space syntax are no substitute for creativity.¹¹ Sketches, he maintains, are helpful in the analysis of urban grain and spatial structure.

For Will Alsop, the first drawing he makes after painting is often an abstract composition of lines and marks in soft pencil or charcoal which encourages him 'to see something in interesting and unfamiliar ways'. Alsop talks about mark making rather than the use of conventional architectural drawing techniques but after this explorative stage the first drawing is a plan. There comes a point, he admits, when order in plan is necessary to confront matters such as construction. Conversely, Nicholas Grimshaw approaches the design problem from both ends (plan and construction detail) allowing technology and materials to influence his thinking right at the beginning. Grimshaw, like Alsop, has a particular interest in the quality and meaning of materials but from quite different perspectives. Grimshaw stretches materials to their limits expressing their innate properties through attention to detail (a quality shared by Cullinan and others) while Alsop is more concerned with the 'optical properties of construction' as he puts it. Hence his drawings are less about assembly than exploring the 'dialogue between surface, image and form'.

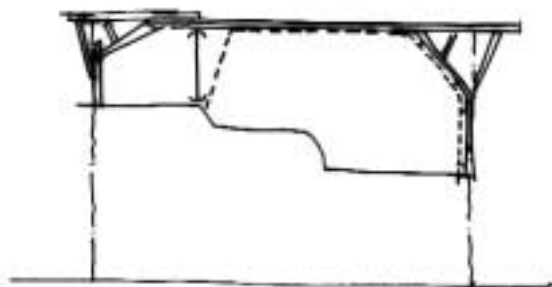
All of the architects interviewed drew first and then somewhat later interacted with models and CAD. For them CAD remains, in spite of considerable software development, a drawing and testing tool rather than a design aid. Foster, like most architects, is interested at the start of a project in how things work rather than how they look, and this he thinks



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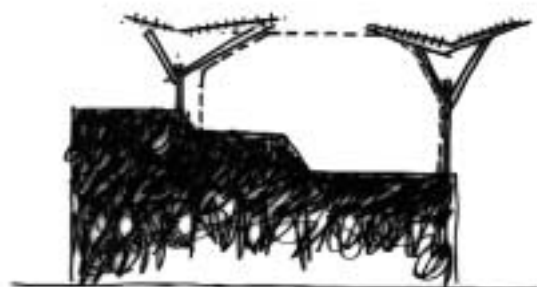
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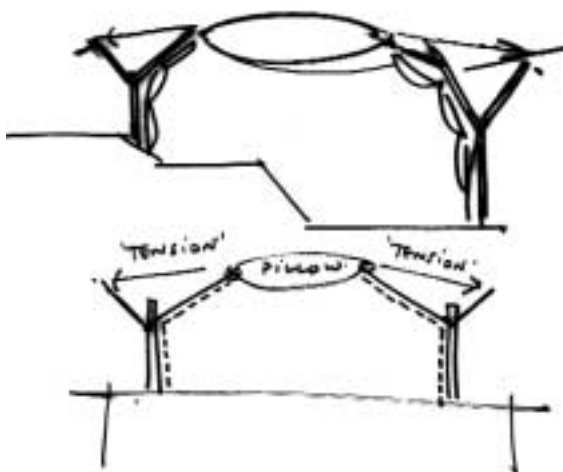
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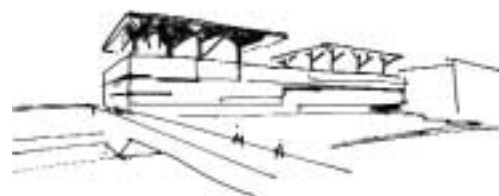
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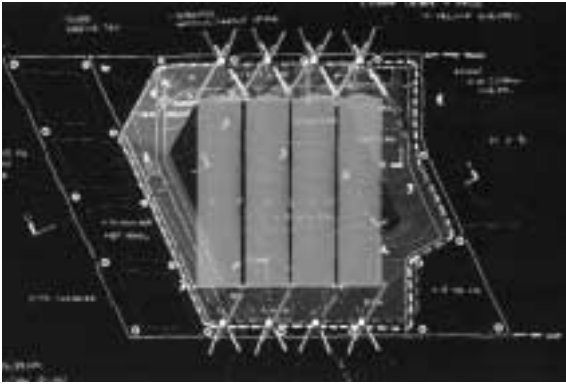
14 Terry Farrell. A sequence of drawings and cad images used to investigate and develop the design of the unrealised project for the London

Aquarium. The initial sketch section was tested against a number of technical and aesthetic parameters using different drawing tools

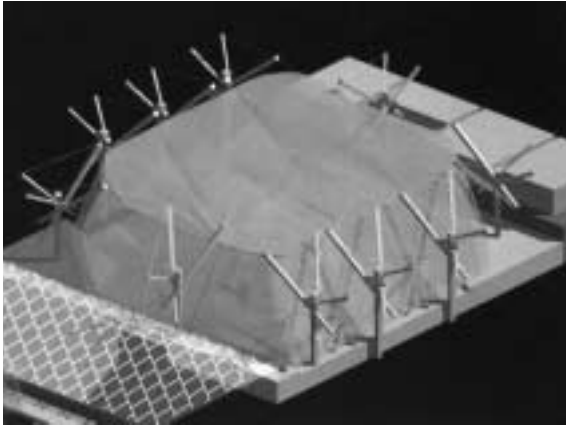
is better explored through freehand drawing than CAD. Also, since he spends a great deal of time re-shaping projects developed by others, the drawing allows for the ready identification of key design features in a fashion which is interactive. Foster, Gordon Murray and Fraser talk about drawings as diagrams that communicate key ideas in relatively simple terms, thereby encouraging design collaboration [11]. In Murphy's view the role of drawing is to 'test the mental diagram that solves the problem rather than represent the object in full which is what CAD is good at' [12]. Foster too talks about the value of CAD in testing the technology and environmental aspects of a design but questions its value as a conceptual tool.

For all 10 architects interviewed, the traditional drawing is the main design development tool,

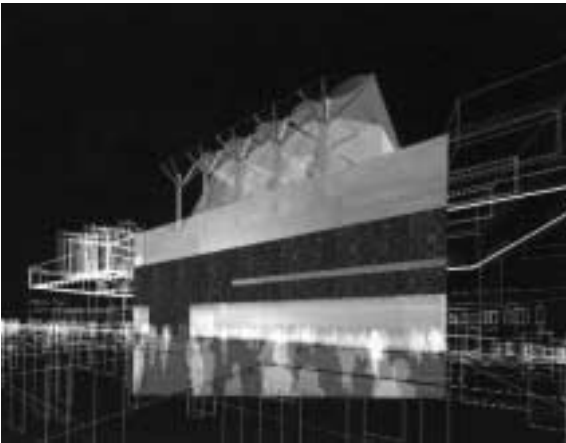
with models and then CAD employed at later stages (Table 3) [14]. Models tend to be used to test the form of a design and to explain ideas to clients, and CAD becomes essential when engineers become involved. The sequence of initial concept sketches, followed by more formal drawing, then development by model and then CAD is employed by seven out of the 10 architects interviewed. The use of the term 'drawing' in Table 3 is used generically and embraces sketching, plan making and freehand drawing using a draughting table or board. The use of the term model also embraces rough card or balsa wood models as well as more finished models presented to clients or planning officials. A typical example is that of Farrell's design development of the passenger interchange at Seoul Airport. Here the initial image of a flying bird (in fact a crane) sketched on a



14g



14h



14i

restaurant napkin by Farrell was roughly modelled in card and wood, then cut into slices and scanned onto computer. These images were then mapped digitally and became the basis for the initial design drawings that in turn (after environmental and technical analysis) evolved into the working drawings. A similar sequence of sketches, testing model, prototype details and CAD was followed by Grimshaw at the Eden Centre.

The main variation in the sequence of tools used in design development concerns whether CAD emerges significantly in the second rather than third stage of design evolution. Younger practices seem to introduce CAD at an earlier stage, although there was the general view that CAD can deceive the designer and alter the quality of the built product by removing some of the rigour associated with

traditional drawing techniques. In Alsop's opinion, CAD can 'produce a believable building too soon' and his preferred method is that of 'painting, drawing, model and CAD' with the latter used essentially for 'technical drawing'.

The increasing employment of complex forms means that CAD inevitably becomes a modelling tool in some projects fairly early on (Foster, Farrell, Grimshaw). The respondents make a useful distinction between CAD as a design tool and CAD as a means of visualising ideas developed by other means. In Grimshaw's office, for example, rough models are made at an early stage in design development (rather than using professional model-makers) because these can be integrated more readily with freehand drawing and through digital scanning with CAD. It is important, he notes, that the architect has control of all the graphic media before there is consultation with manufacturers. Grimshaw has reservations concerning the ability to develop sketch designs on the screen, believing that drawings and models used together are better ways of 'understanding the visual tensions and weight of architecture'. The point made by all 10 architects interviewed is that CAD is rarely used as the first design tool (i.e. right at the start of a project), and when it is there are concerns over the quality of the resulting architecture. Gordon Murray talks about the importance of the 'unconscious direction of design thought' which is rarely compatible with CAD. A similar point was made over a decade ago,¹² suggesting that in spite of improvements in software technology, mainstream architectural practice in the UK relies upon CAD as a drawing tool rather than a design one.

Freehand drawing interacts with CAD right through the design evolution process. Although sketching is the primary vehicle for testing and exploring design options right at the beginning, it is still used even up to the working drawing stage and sometimes on site to make detailed adjustments. Foster talks about his role in intervening in projects in the office where the pencil and pad draws out alternatives that are already well matured digitally. He does not sketch on the screen but on paper – these ideas are then tested using CAD's graphic and technical facility to relay the reality or feasibility of design ideas. The point is that sketching and CAD are complementary rather than opposing vehicles. Gordon Murray makes a similar point. Although his office in Glasgow has been using CAD for twenty years, 'the concept of brain to mouse as the first line has never happened' but CAD is useful in creating 'quick models for analysis'. These then interact with more freehand drawing, and so the process goes on.

Many of the respondents made an interesting distinction between drawing in design development and its parallel role in communication. For Farrell, the drawing has three functions: problem-solving, communication and persuasion. The problem-solving role has already been discussed, but because design by drawing is an iterative process, many people can become involved at different points in time. This helps the design idea (according to Farrell, Allies, Alsop, and Grimshaw) to become owned by a

wide range of stakeholders including the client. Hence, the process is one of an individually generated small sketch which grows to A3, then A2 and perhaps A1 format as more people run with the idea. In Alsop's case, where inner-city communities are involved, the drawing may be a large shared canvas several metres wide. The main point here is that the drawing increases in size as it moves into shared ownership.

Often early sketches prepared by senior partners are worked up by others at increasing size to accommodate the growing scale of design complexity. What starts as a private drawing quickly becomes corporate as more players become involved. In Grimshaw's office, sketchbooks are provided to encourage visual dialogue on paper rather than screen, and Alsop provides staff with evening life classes to address the perceived lack of drawing skill in recent graduates. Foster talks about the most effective drawings in terms of design generation often being prepared spontaneously in the confines of a design team meeting. Here he alludes to the role of drawing in responding to the perspectives of others – their critical thinking acting as a catalyst for design insights. Cullinan observes that lack of graphic skill can be a serious impediment to the idea of a talking, interactive, drawing involving non-professionals (e.g. users and clients). However, Murphy warns that the loss of ownership of a design drawing through its development via CAD can have an adverse impact upon subsequent quality. For all 10 architects questioned, the initial design stage is an individual task, and although many minds are drawn in later, at the beginning projects were generated by a single mind often on a single sheet of paper [13].

Drawing tools and techniques

The materials, tools and techniques of drawing used by architects have not overly concerned academics of late. The third group of questions sought to discover what drawing tools were employed for architectural exploration. The issue concerns the role of line, its weight and permanence, colour, the type of paper used and the strategies for integrating drawing with other spatial investigative tools. While nine of the 10 architects interviewed designed primarily by line drawing (Alsop being the exception), not all employed the pen. Foster, for instance, designs mainly in pencil (HB) because of its flexibility and textural potential believing that the dogmatic nature of black pen suggests a solution too soon. Allan Murray, who also designs in pencil (2B) on detail paper, enjoys the way a pencil glides over this type of paper giving the author the ability to alter the weight of line in a way that reflects the hierarchies implicit in architectural design. Pencil too, he notes, leads to drawings that, with their many revisions, provide a better narrative of the evolution of a design than more bombastic pen drawings. After the painting stage, Alsop too uses pencil (6-8B) and sometimes charcoal, describing lines which can then be filled in with colour (usually acrylics or watercolour paint) and sometimes mixed with

collage. On the other hand, felt-tip pen is generally the preferred medium for the remaining architects interviewed. For Farrell, the black felt-tip pen has an authority and discipline which mirrors the rigour of design, while Cullinan talks of the way black pen is 'difficult to erase and makes you think well'. Grimshaw, on the other hand, often designs with a blue ballpoint or fountain pen, moving onto black drawing pen later, and Gordon Murray moves from pencil to fountain pen or fine line Pentel as the project develops. Cullinan and Murphy mixed pen with coloured markers especially when communicating with non-architects.

Some of the architects questioned used black lines because they knew they reproduced well in professional journals. Others referred to the ease of scanning unambiguous black lines, while two (Farrell and Cullinan) thought that clients were impressed by the implied confidence of the black pen line. In fact, Cullinan went further and said that he liked to draw in black pen in front of clients, which he thought had helped him win commissions. Malcolm Fraser mentioned the benefit of photocopying and faxing pen drawings to clients and consultants, inviting their contribution to drawings that deliberately had an open framework. Farrell too used faxed sketches to communicate with team members often working overseas, preferring this form of communication to CAD. Even when a design was well developed, sketching was frequently undertaken to explore details or to make modifications on site (Murray, G.).

The abstraction and discipline of pen drawing appears to be a useful means of clarifying design intentions to oneself and others – a point made by Allies who uses two weights of pen (the thicker Pentel and thin Artline 200) to distinguish design hierarchies. Weight of line and its architectural symbolism is noted too by Gordon Murray who (with Murphy and Farrell) likens the blackness of felt-tip pen on white paper to the solid and void relationships in building design. Only three of the architects interviewed (Alsop and Cullinan) used colour in their initial design drawings. Later in the design process Murphy, however, used colour to explain drawings to others, particularly clients, while Farrell warned that the use of colour too soon can undermine the essential rigour of urban or spatial design.

Irrespective of the medium of drawing, all 10 architects questioned admitted the importance of line at most of the key stages of design development. Designs grew by being shaped by lines and planes in the first instance. These lines were edges and demarcations that ordered the abstractions of sites, briefs and structure. Lines in this sense were the delineation of space in both plan and section. Lines and marks (as Alsop calls them) remain the fundamental ordering system of architectural exploration. Often, however, these early generative drawings were combined with words or photographs to evoke an essence of design spirit rather than provide a mere description. In most cases, lines occur before physical models or modelling on CAD [15]. The

lines produced were not usually neutral but infused with meaning – artistic in the case of Alsop, evolutionary and democratic in the case of Allies, Murphy, Fraser, Murray, A., Grimshaw and Foster, and authoritative and assured in the case of Cullinan, Farrell and Murray, G. To increase the significance of line and plane, shadows and colour were frequently employed, especially at Stage ‘D’.

Related to the question of line is that of paper. Small cartridge sketchbooks are used for design development by Alsop and Foster, larger ones by Grimshaw, Farrell and Allan Murray. Tracing paper in narrow rolls was preferred by Allies who thought that the roll’s endlessness encouraged dialogue and provided a basis for exploring grid distortions and edge layering by the use of complex overlays. Layout and detail paper, often in A3 pads, was commonly employed because of the ability to build up solutions, while the use of transparent paper had both practical and aesthetic benefits (Murphy, Murray, G., Grimshaw). Often there was graduation from small cartridge sketch pads to larger tracing sheets with a corresponding change from early pencil sketches to felt-tip pen and colour marker. It appears that the evolution of design ideas is matched by a gradual expansion in the size and often sophistication of drawing tools or techniques and as graphic means are exhausted models come into play (Cullinan, Murphy, Foster). Traditional drawing boards were only noted in two of the offices visited,



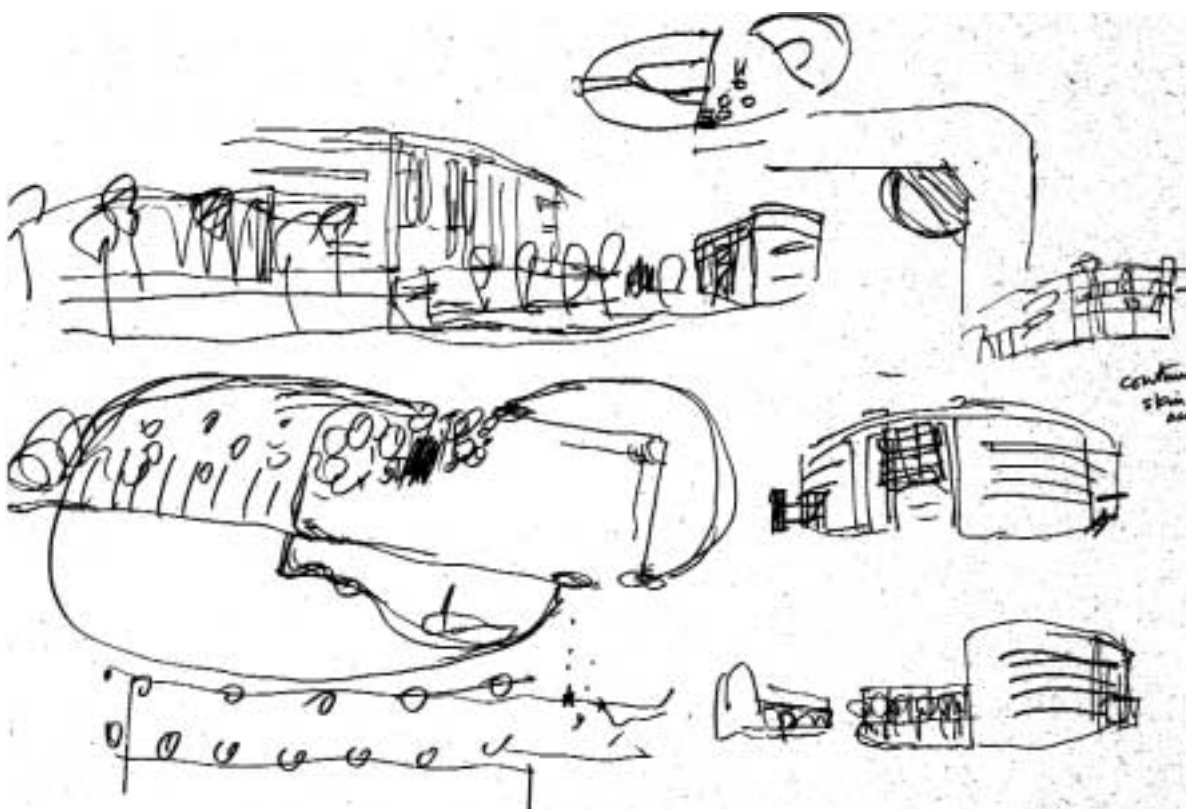
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15a

15 Terry Farrell.
Exploration of
different plan
configurations for
the ICL building in
Newcastle Upon

Tyne which are then
tested visually and
developed further in
b. The drawings
were made on A4
brown envelopes



15b

and their role was rather more social than practical. Allan Murray, for example, shares an Ao board with his partner, the two of them working from opposite sides of the same board to encourage discussion and collaboration in design. The pattern found generally is that of a progression from small freehand design sketches to larger freehand drawings, rough models and then CAD modelling, often in 3D, followed by formal CAD-based contract drawings and, finally, a professionally made client model. The latter is sometimes based upon CAD/CAM methods.

In design investigation, the model was an important supplementary tool for many of the architects questioned. Although sketches always pre-existed models, rough models of whole or parts of buildings were employed to explore spatial arrangements, technology or sometimes facades patterns. For Allan Murray, the model was often made before sections were drawn, believing that in design development, drawings on their own had limitations after the initial stages. Allies talks about two types of plan being drawn (the abstract organisational diagram and site plan) which when combined into the first tentative sketch design were then tested through the vehicle of a model. These rough models in card, plastic, polystyrene or wood (usually made by the office model-maker) became maquettes which are akin to the process of testing followed by sculptors. Bob Allies sees such models as spatial in a formal sense allowing the abstraction of the plan to be tested as an architectural object. These investigations by model sometimes take over as the main drivers of architectural form-making at a stage midway between freehand drawing and CAD. Similarly Grimshaw likes to make his own models in card or balsa wood, using them to test elements of the building as well as the whole. The sense that the model allowed for the investigation of elements that could not readily be drawn or simulated on CAD was a point made also by Gordon Murray and Foster.

The sequence of design generation by the three main vehicles investigated (drawing, model and CAD) varied between architects interviewed. What did emerge, however, was the relative primacy of freehand drawing and the perceived limitation of CAD as a design tool, especially at the beginning of projects. In fact, where CAD was specifically employed for design evolution, some of the architects expressed the view that design quality suffered unless there was also parallel inquiry via freehand drawing or model-making. The poor opinion of CAD is surprising given the development in design software aimed at building designers. Using the RIBA Plan of Work as a guide, all 10 architects questioned use sketching as the primary design tool at the first stage of design conceptualisation. Freehand drawings also remained an important tool at the second stage, but model-making too emerged as a key contributor to design evolution. Although three architects interviewed (Farrell, Murray, A. and Murray, G.) employed CAD significantly at the second stage, its usefulness was mainly in the third stage of design development (Table 3). So in spite of its perceived potential, CAD is not employed for design

evolution by many of the UK's leading architects. Even when CAD is the main vehicle for design testing (i.e. at RIBA Stage E), several architects reported on the continuing reliance upon sketching and rough model-making for exploring assemblies or construction details. An example is Gordon Murray whose copper facade of the SAS Hotel in Glasgow was tested by the construction of 10-12 detail models at 1:20 scale prepared in parallel with freehand drawing and CAD modelling.

Conclusion

The research sought to explore the use of freehand drawing in design by undertaking structured interviews with 10 leading architects in the UK. The focus was upon how they employed sketching and drawing at different stages in the design process, the materials and tools used, and how and when drawing interfaced with CAD and model-making. Inevitably, the interviews relayed both direct personal experience as well as wider understanding of the role of freehand drawing within the architectural offices in question. A limitation has to be admitted: the interviewed architects were all educated within the drawing board and sketchbook tradition. In fact, four of the architects interviewed won prizes for their measured, freehand or design drawing – Cullinan a King George VI Memorial Fellowship in 1956, Foster the RIBA Silver Medal in 1959, Farrell a Harkness Fellowship in 1962, and Allies the Rome Scholarship in 1981. Their interest in drawing is both a bias the author admits and part of the justification for the study undertaken. All those interviewed too are part of the pre-CAD generation, and although they all employ CAD they are arguably the last of a generation of pencil and paper architects. As such this adds to the value of the comments obtained.

Three main conclusions can be drawn. First, in the process of solving design problems the freehand drawing is the pre-eminent tool employed by nine of the 10 architects interviewed. While they tend to use different types of drawing and readily interface graphic with physical and CAD modelling tools, they all rely upon the sketch at the initial design stage and to a degree at subsequent stages. The first drawings are generally 'thinking' drawings, usually private rather than shared, often produced after much inner reflection, and generally in plan form. However, Alsop is the exception employing painting in an attempt to release hidden creative potential. However, after painting comes drawing and then the usual sequence of models and CAD.

Second, architects, especially the more experienced, design in their heads often visualising the form of a building in their imagination before they put pen to paper. Drawing is less an explorative tool, rather more a means of setting down design thoughts already partially developed. Subsequent drawings test and further develop ideas fashioned in the mind's eye and formed often while undertaking unrelated tasks. Hence, in terms at least of the architects interviewed, the progression of design thought consists of images conjured up in the mind,

set down and explored through freehand drawing, then developed via tools such as models, and finally tested and shared with others via CAD. CAD appears to be primarily a draughting and presentation tool at the genesis of a design project, and when it is used later in design development, CAD is mainly employed to undertake technological or environmental analysis. After RIBA Stage E, CAD draughting assumes a primary role in design refinement, but by then the fundamental design decisions have usually been made. Even at this stage the architects interviewed undertake design modification initially via the freehand sketch. There are lessons here for architectural education.

Third, at the early stages of concept gestation, some of those questioned thought that CAD hindered serious design investigation. Three of the architects interviewed deliberately avoided its use until the design of the building had been relatively resolved by other means. The view expressed by some was that the use of CAD too early undermined architectural exploration and had a detrimental effect on the quality of the resulting building. Several of the architects interviewed thought that graduates today from UK schools of architecture were too dependent upon CAD. There was perceived to be a lack of design

skills that was directly related to the neglect of freehand drawing in architectural education. One large Edinburgh practice, for instance, preferred to recruit new staff from Europe because they were still trained to think through traditional drawing.

In reaching these conclusions, the author is aware of the limitations of the research as conducted. The sample size and selection of practices inevitably limits any claims of findings of universal value. However, there remains the sense that for the architects interviewed, the freehand drawing acts as an essential bridge between the imagined and real worlds. After all, it was Alberti who said that the imperfect idea as formed in the mind required to be set down in drawing to allow the architect to exercise judgement and modification of the consequent form.¹³ The question which needs now to be asked is whether these findings are true of the younger generation of architects. By interviewing only senior partners you inevitably arrive not only at those relatively senior in years but those not educated in a CAD environment. In any further study it may be useful to investigate the practices of younger architects and also to set these findings into an international context. You suspect that elsewhere things may be a little different.

Architects	Name of practice	Size of practice	Date interviewed
Bob Allies	Allies and Morrison	74 architects	23 September 2004
Will Alsop	Alsop Architects	40 architects	23 December 2003
Ted Cullinan	Edward Cullinan and Partners	35 architects	28 November 2003
Terry Farrell	Farrell and Partners	40 architects	28 November 2003
Norman Foster	Foster and Partners	174 architects	1 December 2003
Malcolm Fraser	Malcolm Fraser Architects	17 architects	29 September 2005
Nicholas Grimshaw	Grimshaw	34 architects	14 April 2004
Richard Murphy	Richard Murphy Architects	28 architects	22 July 2004
Allan Murray	Allan Murray Architects	24 architects	5 October 2005
Gordon Murray	Murray Dunlop Architects	21 architects	28 September 2005

Table 4: Architects interviewed and their offices

Notes

1. C. Alexander, *Notes on the Synthesis of Form* (Cambridge, MA: Harvard University Press, 1964), p. 15.
2. B. R. Lawson, *How Designers Think*, 2nd edn (Oxford: Butterworth Architecture, 1990), p. 173.
3. E. Robbins, *Why Architects Draw* (Cambridge, MA: MIT Press, 1994).
4. C. M. Eastman, 'On the Analysis of the Intuitive Design Process', in *Emerging Methods in Environmental Design and Planning*, ed. by G. T. Moore (Cambridge, MA: MIT Press, 1970), pp. 42-59; and D. A. Schön, *The Reflective Practitioner: How Professionals Think in Action* (London: Temple Smith, 1983).
5. B. R. Lawson, *Design in Mind* (Oxford: Butterworth Architecture, 1994), p. 142; and J. Bowers, *Introduction to Two-Dimensional Design* (London: John Wiley and Sons, 1999), p. 13.
6. R. Evans, 'Translations from Drawing to Building', in *Translations from Drawing to Building and other Essays* (London: Architectural Association, 1997), pp. 153-94; E. Robbins, *Why Architects Draw*; and J. Hill, 'Hunting the Shadow: Immaterial Architecture', *Journal of Architecture*, 8 (summer 2003), 165-79.
7. Lawson, *Design in Mind*.
8. Royal Academy of Arts, *In Search of Architecture: The Watercolour Albums of Sir Thomas Graham Jackson*, exhibition catalogue (London: RA Publications, 2003).
9. C. Amery, *Architecture, Industry and Innovation: The Early Work of Nicholas Grimshaw and Partners* (London: Phaidon, 2000); and *Norman Foster: Works 2*, ed. by D. Jenkins (Munich: Prestel, 2005).
10. T. Farrell, *Sketchbook* (London: Rightangle Publishing, 1998), p. 13.
11. M. Quantrill, *The Norman Foster Studio* (London: Spon Press, 1999), p. 223.
12. B. R. Lawson, *Design in Mind*, p. 14.
13. H. A. Millon, 'Models of the Renaissance', in *The Renaissance from Brunelleschi to Michelangelo: The Representation of Architecture*, ed. by H. A. Millon and V. M. Lampugnani (London: Thames and Hudson, 1994).

Illustration credits

arq gratefully acknowledges:
 Will Alsop, 1
 Grimshaw, 2, 5, 6, 7, 8
 Norman Foster, 3, 4
 Edward Cullinan, 9, 10
 Malcolm Fraser, 11
 Richard Murphy, 12, 13
 Terry Farrell, 14, 15

Biography

Dr Brian W. Edwards is Professor of Architecture and Director of the Graduate Research School at Edinburgh College of Art, an accredited institution of Edinburgh University. The work described here is based upon the theme of 'Art and Architecture' – a strategic research priority of the College. Brian Edwards is author of several books, including *Understanding Architecture Through Drawing* published by Spon Press.

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