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## **Introduction**

*While these drawings have the potential to provoke architectural thought, they are abstractions that reveal the mathematical nature of the structure and provide a lesson in composition and careful symmetry.<sup>1</sup>*

Research is defined by the Cambridge Dictionary as, ‘*a detailed study of a subject, especially in order to discover (new) information or reach a (new) understanding*’. It is a revelatory process, illuminating something which had been otherwise hidden or unknown. Creativity, on the other hand, “*..refers to the potential to produce novel ideas that are task-appropriate and high in quality..*”<sup>2</sup> The tools, mediums and mechanisms involved in both these activities vary enormously across the disciplines- from the printed word to the scientific laboratory; from musical instruments to the artist’s studio. Within schools of architecture, these are typically related to drawing and physical model making; traditionally using analogue modes and now in both digital as well as analogue modes. The spectrum of representation and simulation employed by students is an increasingly wide one, ranging from the traditional hand drawn sketch to sophisticated virtual and augmented reality platforms. Whilst it can be claimed that drawings are primarily a means of representation, they nevertheless also have value in their ability to be instruments of research as well.<sup>3</sup>

## **Background**

The means by which drawings are produced by those professions with strong visual characteristics such as engineering and architecture has undergone a major revolution in the last 40 years. By the 1980’s and 90’s, computer-aided draughting (CAD) and computer-based visualisation was beginning to have a profound impact on architectural practice and the beginning of the 21<sup>st</sup> century heralded the even more influential world of simulation, virtual and augmented reality, computational design and Building Information Modelling (BIM). It is perhaps

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<sup>1</sup> Baines, Mark; Barr, John; Platt, Christopher; The Library, MSA Publications, Glasgow, 2015.

<sup>2</sup> Sternberg R.J., What is the Common Thread of Creativity? in American Psychologist, April 2001, p. 360.

<sup>3</sup> Baker, N., Drawing as a Research Process and Drawings as Research Outputs-How Acceptable are they in Various Disciplines? In, TRACEY Journal: Drawing Research 2012, p. 16.

too early to establish their full impact and legacy, but the evidence so far suggests it will be profound.

The sophistication of contemporary digital simulation has never been greater and more widespread in our world than it is now. We employ terms such as ‘digital culture’ and digital revolution’ in everyday conversations without perhaps fully appreciating the enormity of what this really means. The generation of students now entering university or college have had their formative childhood experiences saturated with an unprecedented wave of domestically-available digital gaming. They arrive as undergraduates having completed their ten thousand hours of ‘practice’ in becoming an expert.<sup>4</sup> The expertise they have amassed is the craft of digital manipulation, learned primarily through the brain/eye/hand coordination of the computer gaming arena. Computer games in other words, have been the seducing agent in developing an entire generation’s digital Fähigkeit and in most cases, now outstrips the knowledge and skill base of their parents’ generation. That youthful digital expertise and agility is unsurpassed in the 21<sup>st</sup> century. Our societies are immersed in digital technology at home and work and nowhere more so than in the professions of design, science, contemporary art, medical visualisation and the construction and engineering industries.

### **Digital Tools in the Design Process**

Within a design process, the role of any representation is to illuminate aspects of what is being designed-the ‘reality-in-waiting’. Whether generated by analogue or digital means, the resulting image of the un-constructed artefact is a coded piece of information, just like a painting or musical score.

Those with the knowledge to unlock the graphical code of a 2D plan of a building for example, will, at a glance, be able to understand the overall distribution of the spaces in relation to each other, without the need for further data. In a similar way, those who can unlock the code of musical notation, will understand the structure, rhythm and melody of music represented by the marks on the musical score in front of them. The term ‘reading’ a plan or ‘reading music’ accurately describes the immediacy of understanding that occurs when glancing at the coded page or drawing. When so much sophisticated 3D virtual reality is available, is there still a role for 2D hard line visualisation in the architectural design process? Hard line draughting, emphasises line and form in contrast to the more surface and atmosphere-emphasis employed in digital simulation. Surely such an historical means of representation has now been superceded forever by the seemingly infinite means of representation which digital visualisation and virtual reality offers? Given that the aim in architecture is usually to construct a

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<sup>4</sup> Sennett, Richard, *The Craftsman*, Penguin Books, 2008, p. 247.

3D object, should the tools we use not always be 3D-orientated and digital in character? Much contemporary focus within Higher Education Institutes and the professions rests on new developments such as BIM, digital simulation and virtual and augmented reality questioning the purpose and relevance of drawings of any kind.

*“A drawing is not there to represent reality as accurately and completely as possible. It is not a simulation....Simulation has displaced representation in architecture and society at large.”<sup>5</sup>*

It is increasingly common now in architectural practice for ideas to be manipulated and concretized in digital 3D reality at a much earlier stage than was previously the case in drawing-based design processes. The evolution of BIM has exacerbated this phenomenon and created an appetite for detail decision-making at an increasingly-early stage in the gestation period of an architectural project. This trend towards more certainty earlier, to be more definitive as swiftly as possible, risks obscuring the enduring truth that an image (even a hyper-realistic virtual one) is still an abstraction of a still-to-be developed-reality. The natural leanings of digital draughting is to be millimetre perfect to a degree never to be seen on a building site.

Too much detailed information hinders the push and pull process at the early stage of a design. As Juhani Pallasma has written, *“A sense of certainty, satisfaction and finality that arises too early in the (design) process can be catastrophic.”*

### **The Development of Technical Drawing**

However, within this accelerating landscape, the sustained tradition of the hard line orthographic projection drawing continues to provide a perhaps surprising, but nevertheless highly effective tool for research exploration. The clarity and unambiguous character of the simple hard line drawing recalls the engineering draughtsmanship of the recent past. The evolution of technical drawing as we understand it, developed as a response by scientists in the sixteenth century requiring accurate drawings in the fields of astronomy, navigation, military engineering and land-surveying. Orthogonal drawings, that is drawings where all elements are drawn to scale, became the established method of illustrating building and architectural works around this time. Much later as a result of industrialisation in the 19<sup>th</sup> century, systems of minimum tolerance

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<sup>5</sup> Scheer, David, Ross; *The Death of Drawing: Architecture in the Age of Simulation*, Routledge. 2014, p.20.

generated a need for detailed drawings of mechanical parts.<sup>6</sup> The tradition of what might be described as rational, 2D and 3D draughting within the architectural, mechanical, aeronautical engineering and shipbuilding professions developed to serve the specific needs and requirements of design, construction, fabrication and manufacture. Within the engineering and construction professions, the particular characteristics of unambiguous, hard line drawings proved vital for the making of precise, complex three dimensional physical objects, components and machinery. This type of drawing was the *lingua franca* of all industrial manufacturing processes.

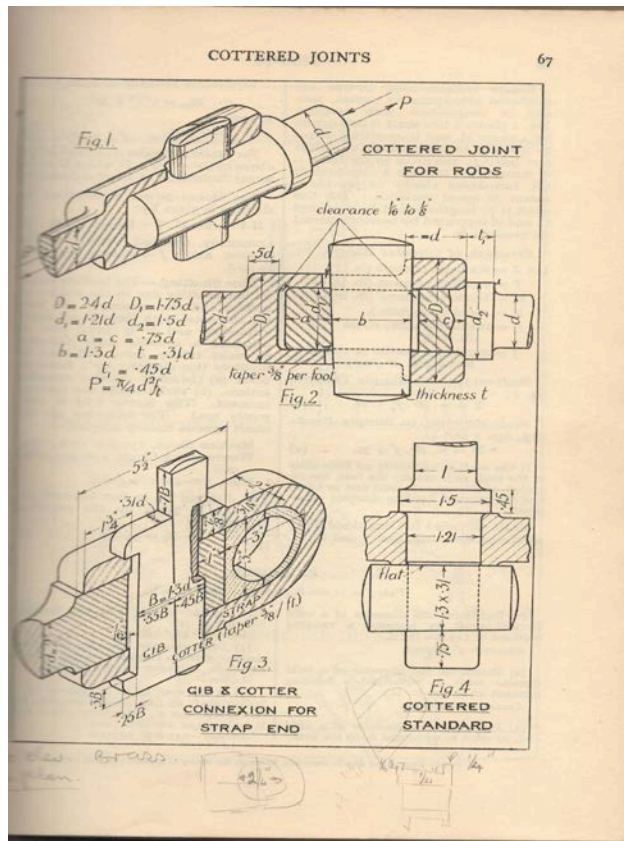


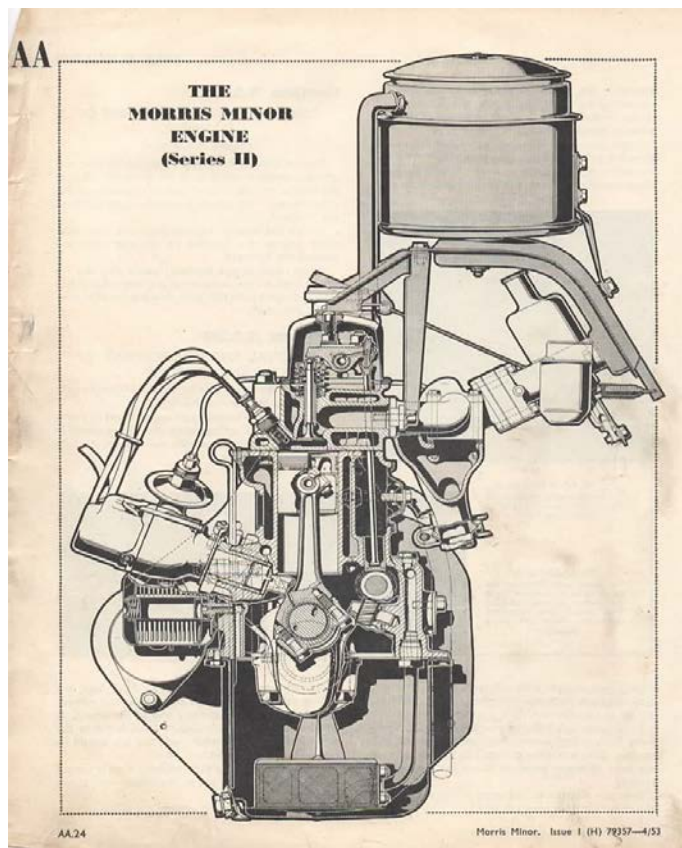
Figure 1: Cottered Joints

Source: Abbot, W., *Machine Drawings and Design: A textbook of Intermediate Standard for Engineering Students*, Blackie & Son Ltd, 5<sup>th</sup> Edition 1947, p 67.

<sup>6</sup> Hambly, M. *Drawing Instruments 1580-1980*, Sotheby's Publications by Philip Wilson Publishers, London 1988, p.11.

Technical Drawing as a subject was taught in secondary schools before its more recent post-war evolution into the less defined field of 'graphic communication' was established.

Technical drawings can be understood to have one singular intended meaning. The need for precise communication in the preparation of a functional document has always distinguished technical drawing from the expressive drawings more often associated with the visual arts. Artistic drawings are subjectively interpreted; their meanings are multiply determined. Technical drawings on the other hand require to be rational and unambiguous. They are designed to guide precise actions not to invite multiple interpretations. Those drawings used in the creation of for example, car maintenance manuals, DIY Guides, model aeroplane kits, construction and fabrication details, are there to help the reader understand a proces or object or to carry out a required task in a clear and sequential manner.



*Figure 2: The Morris Minor Engine Series II*

*Source: The Morris Minor Series "MM" and Series II Workshop Manual Issued by Morris Motors Ltd. Cowley Oxford.*

The drawing must function as a navigation device, not a destination in itself and has a very different purpose than a drawing created for the purpose of artistic visualisation. That particular unselfconscious, matter-of-fact quality, devoid of artistic pretensions has nevertheless certain intrinsic aesthetic characteristics which have become clearer to appreciate now that we live in a world saturated with visual simulation and virtual reality. Within the field of drawings, they have that character which Le Corbusier described as ‘the Engineer’s Aesthetic’ when he documented the anonymous vernacular structures of early 20<sup>th</sup> century industrial complexes. Such drawings have also served as an inspiration for architects and designers, such as the late Sir James Stirling, RIBA Gold Medallist and Pritzker Prize recipient, who has written about the ‘elegance of functional draughtsmanship’ which he discovered from his own nautical engineer father’s engineering drawings.. I share such an appreciation and my own father’s engineering drawing books illustrating machine parts drawn in sectional axonometric also embedded in me an intrigue for such technical drawings.

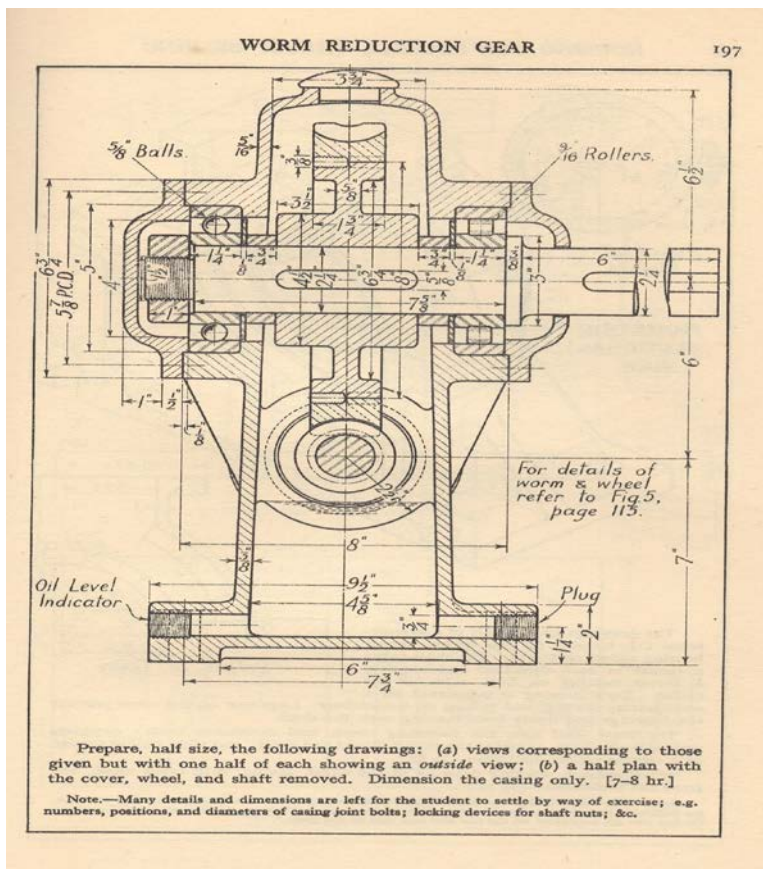


Figure 3: Worm Reduction Gear

Source: Abbot, W., *Machine Drawings and Design: A textbook of Intermediate Standard for Engineering Students*, Blackie & Son Ltd, 5<sup>th</sup> Edition 1947, p 197.



two case study projects carried out by two small groups of undergraduate students at the Mackintosh School of Architecture in the Glasgow School of Art in 2014 and 2015 who both utilized this medium and examined its relevance as a research tool within an expanding and increasingly-sophisticated digital 3D landscape. Their work explored particular characteristics of two neighbouring buildings of architectural distinction on the GSA campus. The Glasgow School of Art Library, designed by Charles Rennie Mackintosh and the more recently completed Reid Building, by Steven Holl architects and JM architects face each other across Renfrew Street in Glasgow and are the result of very different procurement, design and realization processes. The Reid Building project examined the overall building while the Library project examined a single space.

### **Case Study 1: The Reid Building at the Glasgow School of Art**

The Reid Building was already well-known before its construction through well-published watercolour studies by Steven Holl. Apart from these and some digital images of the design in its urban setting, no detail drawings were released by the practice prior to completion. Given Holl's emphasis on phenomenology in his work, the theme of detail, particularly those details which the public experienced when they came face to face with the architecture, seemed a pertinent topic to examine. The drawings undertaken by the students examined both key construction details as well as certain important architectural elements which visitors touch or come close to in their everyday usage of the building. They conducted their own measured studies on site which were augmented by access to some of the architects' construction drawings in the preparation of their own work.

In concentrating solely on line, outline and form, these drawings illuminate particular relationships between the parts and the whole at a macro and micro stage. The character of the construction detail drawings produced is similar to those traditional engineering drawings previously referred to. Three dimensional, cut-away studies make clear the layered construction of the external envelope, from the 'secretly-fixed' glass cladding externally, to the painted concrete walls internally.



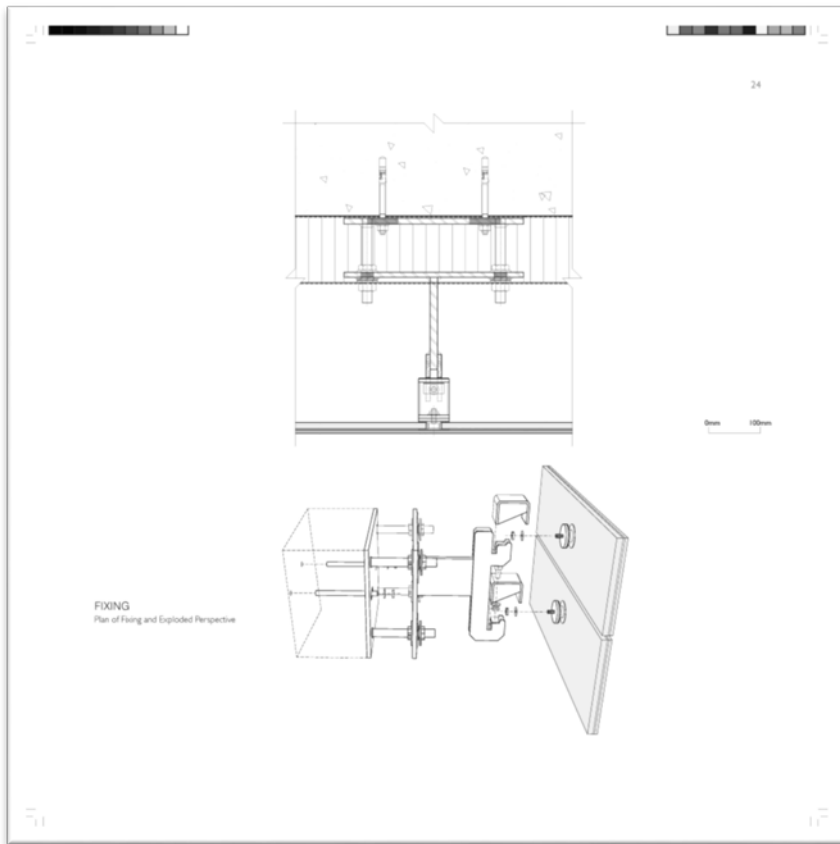


Figure 5: Secret Fixings

Source: Platt, Christopher, Carter, Brian, Baines, Mark; *Form, Fabric, Detail*, MSA Publications, 2014, p.29.

These drawings identify the differing conditions of the overall structure and the building's cladding making explicit how gravity is overcome as well as how a suitable dry and comfortable internal climate is achieved. Like cut-away anatomical drawings, various significant construction junctions were interrogated in this manner.



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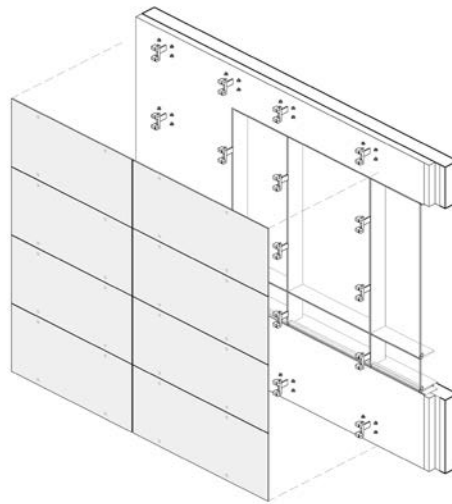


Figure 6: Veiling

Source: Platt, Christopher, Carter, Brian, Baines, Mark; *Form, Fabric, Detail*, MSA Publications, 2014, p.30.

Engineering components such as the glass cladding fixing clamps are revealed as highly significant to the cladding support system, yet are all but invisible to the naked eye. One sequence of studies concentrating on the ‘Driven Voids of Light’ as Holl described them, deliberately illustrated them in a manner to highlight their key role in the building’s structural arrangement, and how they act as monumental hollow columns as well as devices to manipulate sunlight, daylight and natural ventilation. In some drawings, the character of the building recalls the disassembled parts of an engine block- a quality also redolent of James Stirling’s famous all-dimension-true axonometric drawings.<sup>7</sup>

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<sup>7</sup> Iuliano, Marco; Serrazanetti, Francesca; *James Stirling Inspiration and Process in Architecture*, Moleskin SpA, 2015, p.9.

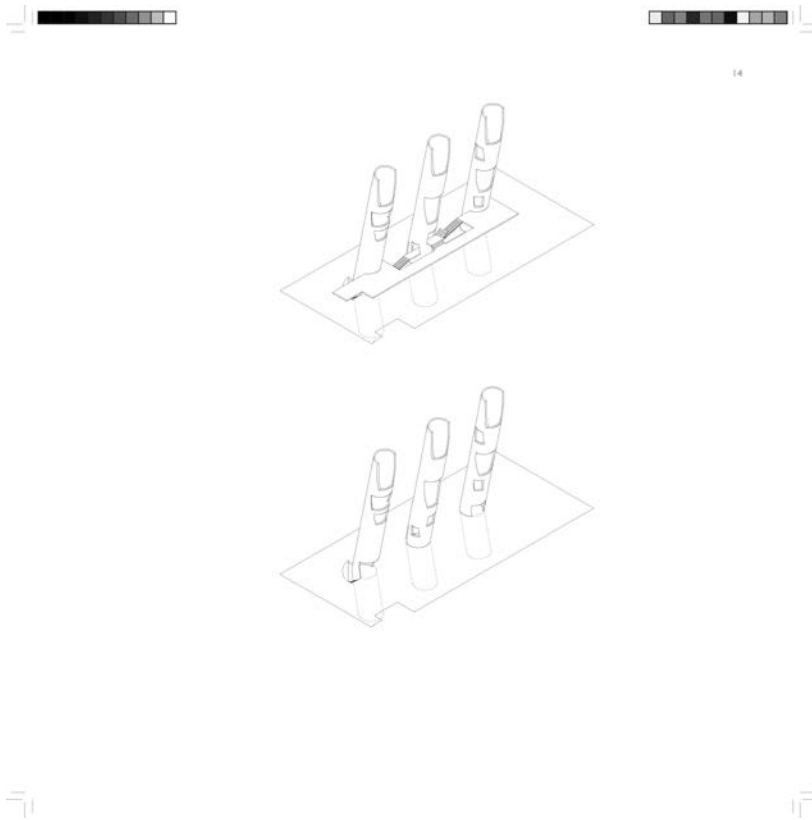


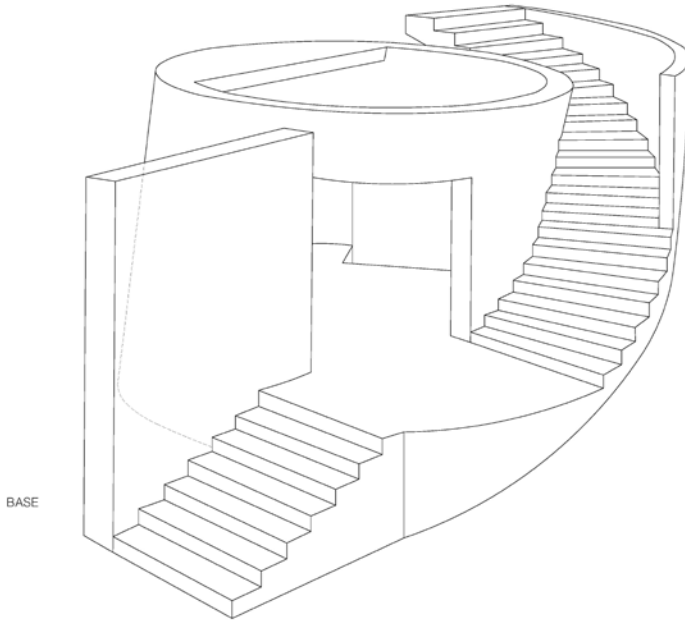
Figure 7: Driven Voids

Source: Platt, Christopher, Carter, Brian, Baines, Mark; *Form, Fabric, Detail*, MSA Publications, 2014, p.19.

A similar debt to Stirling is revealed in the examination of the staircase conditions. Isolated from their normal architectural context, these take on an independent sculptural character in much the way that Stirling's studies of spatial and circulation sequences do in his designs for The Clore Galley in London, The British Olivetti Headquarters in Milton Keynes or the Staatsgalerie in Stuttgart.<sup>8</sup>

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<sup>8</sup> Iuliano, Marco; Serrazanetti, Francesca; *James Stirling Inspiration and Process in Architecture*, Moleskin SpA, 2015, pp 90, 130, 131, 137.



*Figure 8: Staircase Base*

*Source: Platt, Christopher, Carter, Brian, Baines, Mark; Form, Fabric, Detail, MSA Publications, 2014, p.46.*

When it comes to details which the visitor might touch (e.g. door handles, joinery work), the sparseness of the drawing and the minimum use of line work, create a more abstract image, where the aesthetic character begins to obscure the familiarity of the element itself. All these studies formed the basis of the resulting published book.

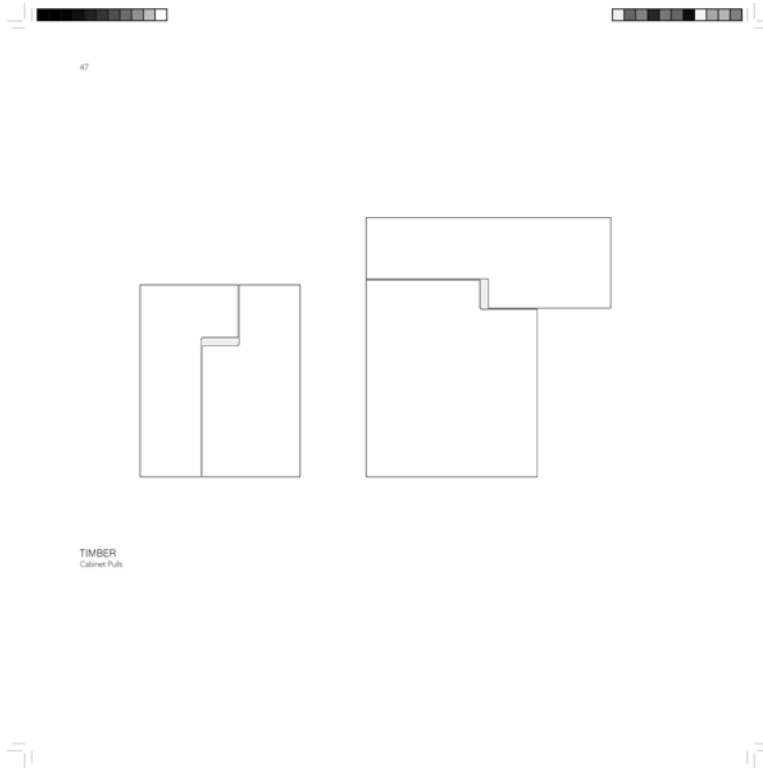


Figure 9: Timber Cabinet Pulls

Source: Platt, Christopher, Carter, Brian, Baines, Mark; *Form, Fabric, Detail*, MSA Publications, 2014, p.52.

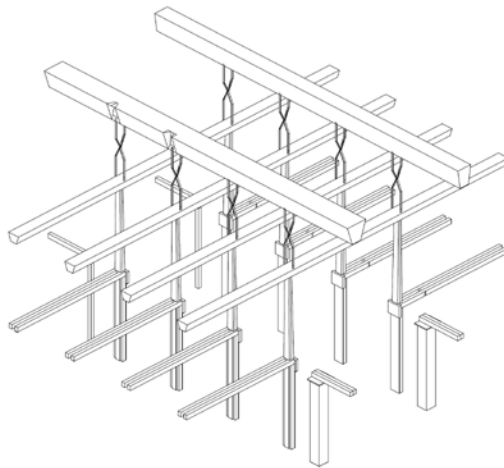
## Case Study 2: The Library at the Glasgow School of Art

With the Glasgow School of Art's Library, the task was almost the opposite to that which faced the students examining the Reid Building. The Glasgow School of Art is a building which had been documented and published extensively given its international significance and its acknowledged place in architectural history. The challenge of using the Library as a case study, was how to take a fresh look at such an extensively-documented space, one of the most significant in the last century. The Library had been previously measured in traditional ways with tape measure and pencilled notes by Paul Clarke for a series of exquisite hand-drawings which were published by Phaidon in a book written by James Macaulay<sup>9</sup>. Paul Clarke's own reflections on this process formed one of the invited essays

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<sup>9</sup> Macaulay, James; *The Glasgow School of Art*, Phaidon Press, Ltd 1992, 2003.

in our own published book documenting the students' work.<sup>10</sup> A key tactical decision that the students made was to conceptually extract the internal timber structure from its stone outer shell, de-constructing it through a series of plans, sections and axonometric drawings, creating a new context from which to view the subsequent drawings.



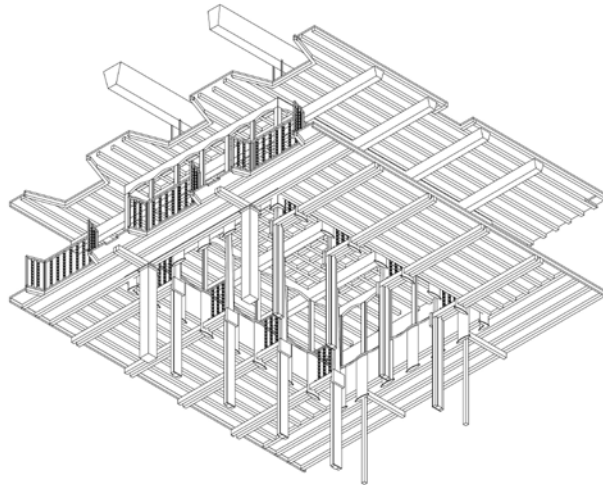
*Figure 10: Primary Structure*

Source: Baines, Mark, Barr, John, Platt, Christopher; *The Library*, MSA Publications, Glasgow, 2015, p.15.

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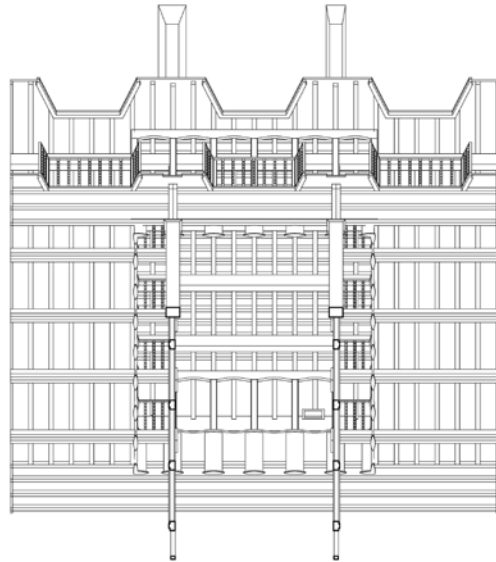
<sup>10</sup> Clarke, Paul, "The Measure of Things", in *The Library*, Baines, Mark; Barr, John; Platt, Christopher; MSA Publications Glasgow, 2015, pp 48-66.

The students then produced 2D and 3D CAD line drawings which deconstructed what was in effect, the timber 'fit out' construction of the Library structure itself. A series of 3D drawings illustrating primary and secondary structural elements highlighted the way Mackintosh discreetly employed fire-proofed cast iron beams as primary and secondary structural elements as well as the everyday joinery elements which he developed to form gridded patterns and layers. These drawings help us understand the process and composition of the timber assembly as well as clarifying the structural elements from the non-structural elements, an issue which has remained ambiguous until now.



*Figure 11: Complexity Through Density*

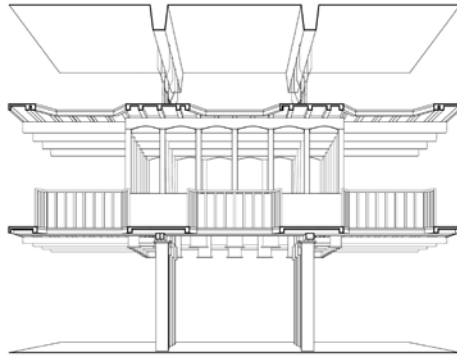
*Source: Baines, Mark, Barr, John, Platt, Christopher; The Library, MSA Publications, Glasgow, 2015, p.18.*



*Figure 12: Canopy*

*Source: Baines, Mark, Barr, John, Platt, Christopher; The Library, MSA Publications, Glasgow, 2015, p.25.*





*Figure 13: Perspective*

*Source Baines, Mark, Barr, John, Platt, Christopher; The Library, MSA Publications, Glasgow, 2015, p.30.*

What is revealed by these drawings is the extraordinary debt that the design owes to traditional Japanese architecture and design as well as Mackintosh's own obsession with grids and squares. Despite the total absence of a sophisticated carpentry culture in Scotland at the time, (something which had been elevated to an art form as well as to the status of a protected practice in Japan), the assembly revealed is a composition of many layers of timber sticks, seemingly laid one against the other like some elaborate trellis work. The overall end result belies the crudity and the reality of its many nailed connections. Whilst this debt to Japan had been well documented by previous authors in comparative texts and illustrations, the ability to experience this aspect of the design through a fresh portfolio of drawings is compelling and memorable.

## **Conclusion**

These simple, modest, low tech drawings vividly communicate the anatomy of the architectural idea at the heart of each building. Whilst produced

using CAD, they nevertheless display characteristics associated with traditional ink hand draughting techniques from previous generations. The drawings are in some ways operating as transparent filters in letting the fundamentals of Mackintosh's and Holl's design intentions shine through them, revealing each building's architectural DNA. Despite being simple line drawings with a functionalist heritage, we can see now that at some scales, there is nevertheless room for alternative readings and interpretations in a similar way to those usually associated with the expressive tradition of fine art drawings. Despite the application of the 'unambiguous' line, we discover that scale and context play an important role in whether the drawings are easily decoded or whether they are also open to interpretation. Paradoxically, in being both unambiguous and open to interpretation, they are also a reminder that whilst they may not have been produced by the handicraft of a pen or pencil, there is nevertheless an informed human sensibility behind the actions, guiding the choice and character of those lines in an attempt to reveal the hidden secrets of each building. Those secrets, in the form of new knowledge, require the application of a coded medium, such as the hard line drawing, before they will reveal themselves.

END

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