Chapter One
Theory and Architectural Technology

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Why theory, what has theory got to do with architectural technology and why worry about it? One answer suggests that it needs a differentiating design theory to reinforce its position as the primary technical design authority in the modern construction industry. In saying that, however, it also raises a whole host of further questions such as what is technical design, what position is being referred to exactly and why a differentiating design theory? This chapter is placed at the beginning of the book because it poses some of the principal questions that need to be addressed as the subject of architectural technology develops into a mature academic and professional discipline. Considering architectural technology historically in terms of alternative theories, through theories of technology and also by means of complementary design theories, allows the reader to reflect on architectural technology in its many expressions, be they historical, physical or even metaphysical. In addition, simply establishing and documenting its existence, confirming a theoretical and historical foundation to the discipline, permits continuing deliberation and development, providing a focused context for further relevant research.

Introduction

Why do we need a theoretical approach to architectural technology? Firstly, to answer this question we need to have some understanding of what we mean by theory. *The Concise Oxford Dictionary* offers three enticing descriptions:

- the sphere of abstract knowledge or speculative thought,
- exposition of the principles of a science, etc.,
- collection of propositions to illustrate principles of a subject.

Architectural Technology: Research & Practice, First Edition. Edited by Stephen Emmitt.

While the last two can have a significant role to play in many aspects of architectural technology, particularly those related to building physics and architecture generally, it is primarily the first, speculative thought, that gives us the catch-all definition we require, namely theory as ideas as opposed to practice and theory as thinking rather than doing. Most practising technologists, however, will know intuitively that all doing is preceded by thinking and sometimes very long and hard thinking. Calling it theory (e.g. this is all very well in theory but how will it work in practice?) simply gives us a framework and space to structure our thoughts.

Therefore a theoretical approach is already tied to many aspects of the practice of architectural technology but is particularly closely related to its existence as an academic discipline and how we take the subject forward in a controlled and managed way. In academic language, architectural technology is a vocational subject, meaning it is intended to lead on to practice as a professional. This is different to more academic disciplines where there is no closely related occupation. However, even vocational subjects need to be established as having strong academic principles or they exist merely as training programmes. Architectural technology now functions as both a professional discipline and also as an academic discipline and, as with most vocational subjects, these two aspects are very closely aligned (Wienand, 2011a). Although it may be possible to exist as a professional discipline without academic support, architectural technology is now predominately a degree level entry profession. It is taught as an academic subject throughout the UK and is supported by significant areas of research, all hallmarks of an established academic discipline. That is quite an achievement for a discipline of such comparative youth, and the next requirement is to bring what is a wide ranging research base into some form of recognisable arrangement.

This observation leads nicely on to the next set of questions, namely: why research, what is it aiming for, what exactly is architectural technology research, what for that matter is architectural technology? These questions can continue with: is architectural technology just detailing or is it technical design in architecture or perhaps much more than that, and what exactly are architectural technologists?

Leaving the research questions to others for now, we still have to ask: what is technology, what is theory, and therefore what is architectural technology; and what about theories of technology? All of these questions are fundamental to understanding the discipline of architectural technology and theorising allows us to consider these questions and many more in an attempt to provide a stable academic foundation for this exciting and immensely rewarding discipline.

Why we need theories

The concept of theory comes in many forms, from the everyday good idea to the verifiable scientific theory that takes on the mantel of 'fact' until proven conclusively otherwise, using scientific method. What they are all about, however, is ideas, and that is precisely why we need theories. Theorising can just be about ideas, making us think and see things in a different way, leading potentially to new innovative ideas. Essentially, though, it is about providing a structure to our thinking and a framework for our conclusions. For the discipline of architectural technology, viewed from either the academic or professional perspective, theories also allow us to use that framework to give some meaning to the past, the present and, in particular, the future. By taking that open and variable philosophical interpretation of what we mean by theory, we can use the simple form of 'ideas'. In this abstract or speculative sense, the strength of ideas comes from their very nature and therefore, as concepts, they are there to be considered in depth rather than any notion of being deemed factual.

Why exactly does architectural technology need theory? It could be argued (a theory) that it does not actually need theory and exists quite satisfactorily in its present form. That view suggests that it is a constant task based profession, that once mastered remains static for all time, which is clearly not true. The reality, as we all know, is that keeping abreast of change is a vital function of the practising architectural technologist, which leads us to two further questions: how does theory help us master change and, more fundamentally (we keep coming back to this), what exactly is architectural technology? The rest of this chapter attempts to confront this dilemma by using the concept of theorising to provide routes to the answers. For example, understanding how the discipline has got to the position where it exists today will help to provide some insight into what exactly it is. A deeper theoretical understanding of what architectural technology actually is may also help us to understand and grasp the present, predict the future and maybe also allow us to define that future.

Historical perspectives – learning from the past

The claim that theory can help us to understand how we got to where we are and therefore to understand who we are comes with the study of architectural history, and in particular the aspects of architectural theory that place philosophical thinking in distinct historic periods. It is recognised that the constantly evolving world of construction is not a smooth flow from one new idea to another but that just as with biological evolution it moves in a haphazard way, responding to whatever external influences are at play at any one time.

While architectural technology as a professional discipline has much in common with many allied vocational disciplines, such as civil and architectural engineering, building and quantity surveying, service and environmental engineering, it is probably closer to mainstream architecture than any other, especially when viewed from the perspective of the layperson. It can be argued that a study of the shared history of the two disciplines is where the subtle but real differences emerge that allow architectural technology to assume a separate and distinct identity. Both professions will see a significant heritage in the concept of the Master Builder that was so important to the buildings of the Middle Ages, or probably more accurately defined as the Gothic period of the 12th to 14th centuries. The comprehensive role of on-site designer, manager, builder and engineer that was the Master Builder would be entirely familiar to both modern day architects and architectural technologists. The collaboration with fellow craftsman, stonemasons and carpenters in the creation of buildings based on

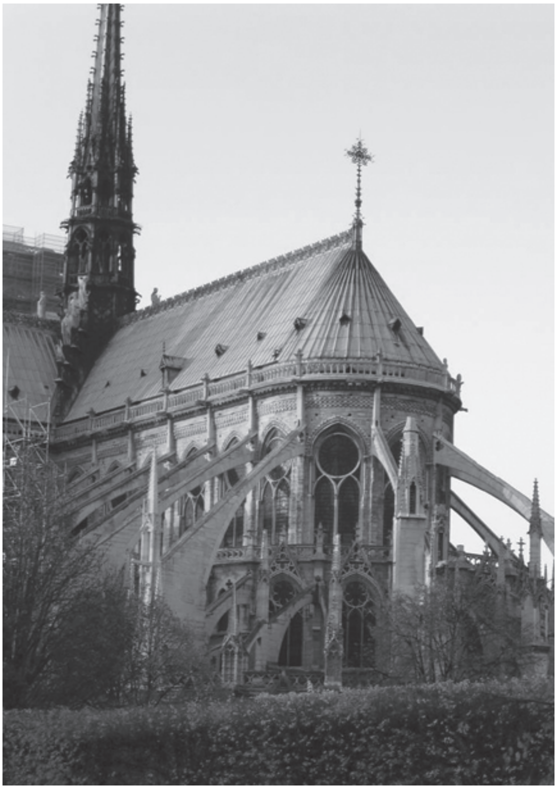

Figure 1.1 Notre Dame de Paris, illustrating the technical mastery, the depth of understanding and the pure technical design genius of the flying buttress.

verbal communication and full-scale layout in the field would also be instantly recognisable (Barrow, 2004). Historical texts that celebrate the triumphs of the Gothic era tend to focus on the architectural features that made it all possible and in particular the architectural legacy it provided for the history of Western architecture (see Figure 1.1). Few, however, really celebrate the technical mastery, the depth of understanding and the pure technical design genius required.

The great Gothic epoch was only possible because the Master Builders were the ultimate technical designers before all else as the seminal work, *Architectural Technology up to the Scientific Revolution* (Mark, 1993) makes abundantly clear. Therefore, by taking a slightly different perspective, it is possible to theorise with some authority that the current professional discipline of architectural technology has very firm roots in the Middle Ages and we could be tempted to go even further back. However, by taking this particular moment in history and assuming a common heritage we can also then trace a lineage that supports but equally differentiates architectural technology from architecture.

It does not take long to move from the Middle Ages into the Renaissance (14th to 17th centuries), which witnessed a separation of the architectural design process from on-site technical design of construction and as such triggered an

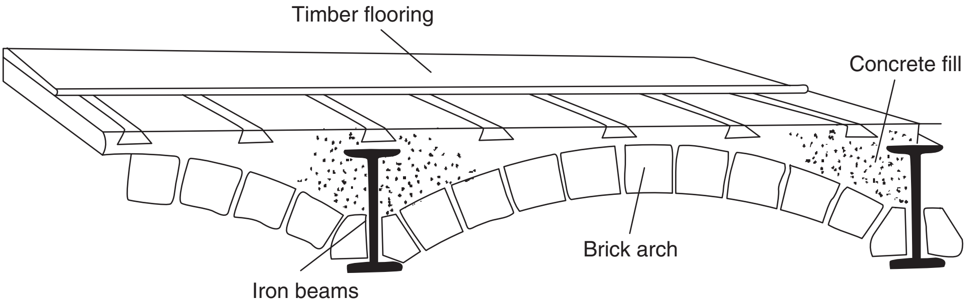

Figure 1.2 The Jack Arch of the Industrial Revolution, illustrating the fusion of the 'new' materials in wrought iron beams with the traditional brick arch providing larger spans of fire resistant suspended floors.

elevation of artistic and architectural design, leading eventually to the now familiar role of the modern architect. Other major developments followed as a consequence, such as the need to produce discrete depictions of their concepts; in other words, drawings. The complex philosophy of communication through drawing is interesting and continues to evolve today as new drawing tools and methods become available. The separation that came about in response to the need to impart specific construction information to builders as opposed to a drawing that depicted the final appearance of the building was another factor that helped to define a division between technical and representational illustration. Indeed, it is no surprise that two Renaissance architects, Brunelleschi and Alberti (Edgerton, 2009), are credited with the clear formulation of perspective drawing, a magnificent method for providing a three-dimensional appearance that from a technical standpoint has little use because, as it is 'not to scale', it is not possible to transfer dimensions. Again these historical observations can be used to support a theory that this division of drawing styles helped to precipitate another divergence between the two professions, with technical drawing traditionally the realm of the architectural draughtsperson having a clear lineage all the way to building information modelling (BIM) and an artist inspired façadism with the concept that creativity can exist universally (Wienand, 2011a).

While the architecture of the Middle Ages relied on and celebrated the impact of building technology and technical design on the final built form, the Renaissance delivered major advances in architecture that were not related directly to technology, with some notable exceptions. It was not until the Industrial Revolution that building technology took another major evolutionary surge forward, although this time probably under the command of the engineering profession. The technologies unwrapped during this period allowed the creation of many more wonderful architectural achievements and can also in theory be linked directly to current building design, where much cutting edge architectural design can be claimed to be 'technology enabled' (see Figure 1.2).

We have briefly examined distinct historical periods where the impact of technology on the ensuing architecture is markedly different. The Middle Ages was very much constrained and controlled by technical limitations, the Renaissance and beyond saw architectural exuberance unhindered by technical shortcomings and now we have technology essentially driving architectural innovation. Any theoretical exploration of the role of technology in architecture must also examine the role of architectural technology on building and therefore whether it is the 'technology to build' or the 'technology of building'. The answer is clearly both, depending on the circumstances, and is also potentially related directly to the role of an architectural technologist, but the relationship is also a lot more complicated as historic developments illustrate.

In the concluding chapter to his historically significant and remarkably inclusive work, *Construction into Design*, covering the period from the beginnings of the Industrial Revolution to the latter stages of the 20th century, James Strike (1991) contrasts external drivers on the introduction of architectural technologies such as fashion and war with the spirit of innovation and the potential for failure. He summarises these relationships as involving changing viewpoints, the nature of change and evolutionary themes and in so doing illustrates the apparently capricious world that governs the adoption of new technologies. In discussing changing viewpoints he points to differing views on the value of technology such as 'one generation reacting against its predecessor' or straightforward disagreements over the value of industrial technology in the production of architecture – an issue we still struggle with today when using state of the art technology to produce retro-styled buildings. The next point, closely related to changing viewpoints, is recognising in the nature of change that humans are slow and unpredictable when it comes to accepting the value of things new. Here Strike demonstrates this with the considerable time lags between the inventions of cast iron (Abraham Darby with smelting iron in 1709) and concrete (Joseph Aspdin with Portland cement in 1794) and their eventual use in building, let alone enthusiastic adoption. He also points to a discernable pattern in suggesting that: 'the story line for each material or technique is never identical, but the recurring stages often include: inception of the idea, testing of prototypes, trial use, failure, gestation on the shelf, reinvention, retrial, success through the construction of a seminal building, adoption, misuse, rejection due to failure or a change of fashion, introduction of legislation to control its use, gradual improvement of the material or technique, and finally general acceptance' (Strike, 1991).

Design projects that buck this trend are rare and Norman Foster's Willis Faber Dumas Headquarters in Ipswich (1975) is an example of the pure genius or luck required to succeed when challenging the current technical boundaries. Foster (2007), speaking about the project noted that he himself had written, 'But we don't have the time, and we don't have the immediate expertise at a technical level.' Perhaps the genius here is recognising limitations and rising to the challenge, fully aware of the risks. Returning to Strike's final topic, evolutionary themes, we enter the more predictable world of material and component developments; the scientific and research supported development of reinforced concrete or steel frame buildings for instance, following the earlier themes, but the high precision prefabrication of components is another significant factor, the Pilkington glass spider (planar system; see http://www.pilkington.com/) connector of Foster's building being a prime example.

Historical study allows us to examine previous scenarios with the advantage of hindsight and although normally written in authoritative styles, there is usually sufficient space to permit some degree of theorising of what might have been concluded to provide some otherwise unforeseen answers. A very noticeable omission so far in this historical overview is the exceedingly important impact of the Modern movement of the 20th century, on technology and architecture and by association also the building and design professions. An interesting example surrounds the comments and thoughts of Charles-Édouard Jeanneret, Le Corbusier, possibly the most influential architect of the period, who stated that 'Architecture is not building. Architecture is that cast of synthetical thought in response to which the multiple elements of architecture are led synchronically to express a purpose. And as this synthetical purpose is absolutely disinterested, having for object neither to make durable, nor to build rapidly, nor to keep warm, nor to promote sanitation, nor to standardize the domestic usefulness of the house, I would say, since it is above any utilitarian objective, it is an elevated purpose. Its objective is to bring us benefits of a different nature from those of material usefulness; its aim is to transport us to an inspired state and thus bring us enjoyment' (Le Corbusier, 1929). Corbusier's architectural theory does something very important and unforeseen here in that it helps to illustrate what could be a defining feature of architectural technology, namely the pursuit of that *utilitarian objective* (see Figure 1.3).

The great advantage of architectural theory in this instance is that it does not have to be verifiable or even particularly sensible, primarily it has to be inspirational and a motivating force for the individual architect or, as described earlier, a collection of propositions to illustrate principles of a subject. In a similar vein, a theoretical notion could assert here that while all aim to design buildings, architects aim to produce great architecture, engineers to produce sound structures and architectural technologists to produce high performance buildings, in that utilitarian form.

An interesting proposition from another of the 20th century's most prominent architects, Frank Lloyd Wright (1901), also illustrates the very subjective nature of some architectural theory when he lambasts the Renaissance, suggesting 'It is the setting sun which we mistake for dawn.' He stated that 'with the beginning of the sixteenth century, the malady of architecture is visible. It becomes classic art in a miserable manner; from being indigenous, it becomes Greek and Roman; from being true and modern, it becomes pseudo-classic. It is this decadence which we call the Renaissance' (cited in Braham and Hale, 2007).

There is little doubt over the considerable impact that Frank Lloyd Wright has had on 20th century architecture yet his comments above are significantly slanted and a personal observation that needs to be described as highly subjective. An architect can therefore theorise quite freely in a philosophical sense without it necessarily affecting the quality of his or her design outputs. Architectural theory in this case is based on the blurry concept of theory that directs the subsequent design process, the concept of 'isms', schools of thought and philosophical movements that thinkers believe to be true as opposed to being provable (Wienand, 2011b). Although architectural theory is most often seen in

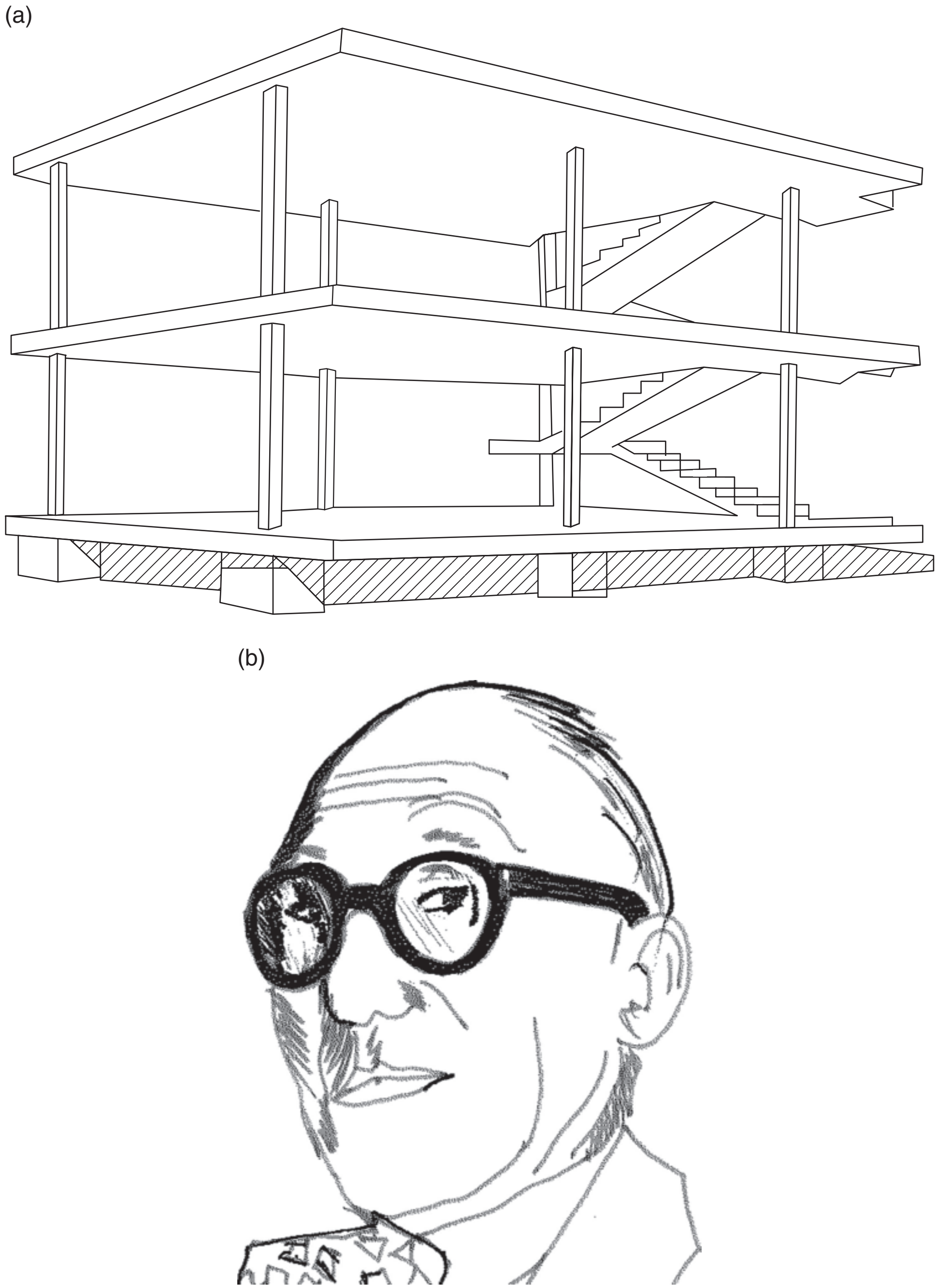

Figure 1.3 (a) The domino house by Le Corbusier – the pure simplicity of utilitarian design, approaching the aesthetic of Quaker plainness with its functionality. (b) Le Corbusier.

philosophical form – as manifestoes, historical essays, etc. – aspects of social and cultural study and the fundamental principles of proportion still require the application of scientific method. The difficulty these observations present is the inference that architectural technology as a design profession and being 'not architecture' is somehow beyond subjectivity and purely objective. However, can it be totally objective? Theoretically it can, but it certainly presents an interesting concept for further consideration and future propositions.

By taking this tour through architectural history we have highlighted the issue that architectural technology exists as an integral technical element in building design that either produces architecture or complements architectural design, but it also exists as a clearly defined professional discipline with a discrete and demonstrable pedigree, complete with contradictions and subsequent uncertainty. So just as with other professional occupations such as medicine, engineering and indeed architecture, the practice and products assume the same designation but describe quite distinctly different aspects; studying medicine is different to practising medicine and also quite distinct from taking medicine.

Separate disciplines have been described as being distinguishable by the way they present themselves and above all have been depicted as 'seeing things differently when they look at the same phenomena' (Del Favero, 2011). From this observation, another theoretical notion that helps to support the distinctive natures of architecture and architectural technology, and has some grounding in experience, is that when considering the 'phenomena' of architectural detailing, the two disciplines have a tendency to see things very differently; architects see the surface details that make up the architectural narrative of the building whereas architectural technologists see the technical design of joints that is mostly hidden and shapes the critical narrative around buildability.

Before moving on to the next section looking at the current situation with this slightly clearer view of architectural technology as having gained something from the past, it is clear that there are many questions still left to be answered. There are also some intriguing links to explore, such as how Corbusier's utilitarian objective could connect with the concept of buildability, a central tenet of architectural technology, or even more intriguing, as seen above, how the apparently simple concept of architectural detailing can mean very different things to different disciplines (see Figure 1.4).

The here and now

It has been suggested that a theoretical approach can help us to understand and grasp the present, predict the future and also maybe help to define that future. Having briefly considered the past, what is clear is that the discipline of architectural technology is closely linked to the evolution of technology and is, as such, constantly evolving. This poses the question, what exactly is an architectural technologist? This is difficult to answer in one sense but theoretically

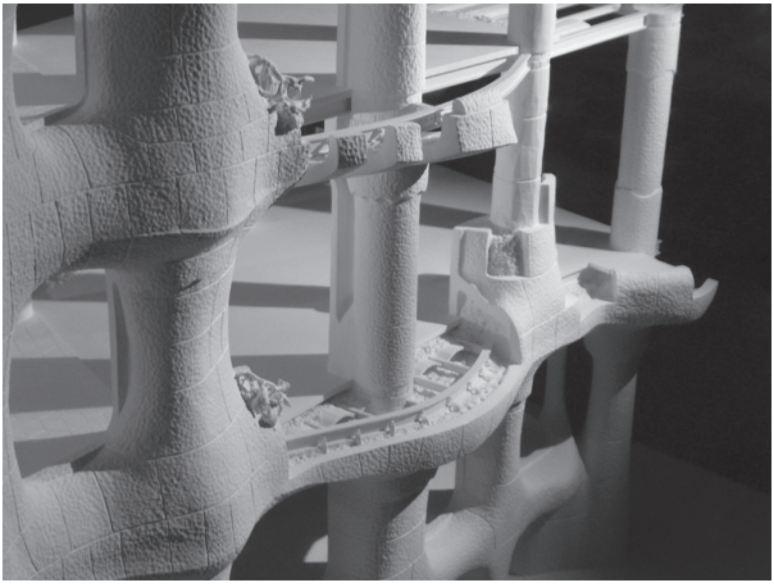

Figure 1.4 Gaudi's detail for supporting the overhanging 'rockface' of La Pedrera's main façade illustrates that for some the projecting stone is the detail yet for others it is the composite construction incorporating the steel frame and 'L' shaped stone units fused together with the concrete infill.

very exciting because the future is still to be written, and therefore anything is possible. This may seem to be an overly ambitious statement but, as noted in the opening section of this chapter, we are simply using theory as a framework and to provide space to structure our thoughts, to speculate and make propositions; there is no harm in thinking.

A reasonable start when considering a theoretical approach to the subject would be to explore any theories that already exist that may be applicable to architectural technology. In reality there are far too many to be considered fully but beyond the philosophical theories of architecture, already referred to, the theories of technology and in particular some transferable theories of design are of genuine interest.

It is useful at this point to examine some thinking around the concept of technology beyond the confines of architecture and building. A great deal of writing on the subject of technology comes in very emotive terms and some interesting theories place technology as just a tool or technology as an uncontainable force, and luckily even technology as having the capacity to save the world. The *instrumental theory of technology* suggests that technology is a tool and deemed to be neutral and 'indifferent to the ends it can be employed to achieve' (Feenberg, 1991). Unresponsive to political control, a hammer is simply used to hit things.

Substantive theory proposes that we are doomed; taking the example of the hammer it suggests that the invention of the hammer leads inexorably, for example, to somebody using it to hit another person, then sharpening the edges to make it more dangerous, leading to throwing it, then projecting it, leading to bullets and before we know it, we have World War Three. Martin Heidegger, an advocate of substantive theory, stated that 'Everywhere we remain unfree and chained to technology, whether we passionately affirm or deny it' (Heidegger, 1954).

It can be fun playing with these concepts but they should also make us think very carefully about aspects of our normal professional lives. In choosing a standard detail to solve a particular problem are we simply using the standard and correct tool or are we being driven to a solution by a wave of pressure founded on previous experience and possibly the fear of failure? The *critical theory of technology* comes to the rescue, suggesting that the substantive world view can be altered by human choice and that the instrumental view can also be overly naïve (Feenberg, 1991). Technology can adopt social values in its design as the overtly 'green' technologies demonstrate in making very clear choices to change direction for the common good as well as, for example, the deliberate design of cities for pedestrians and public transport.

Some thinking, slightly closer to architecture, comes from Stephen Kline, writing in 1985 where he defines technology as having four common usages. The first is the idea of hardware (or artefacts), the second uses sociotechnical systems of manufacture, the third usage he describes as knowledge, technique, know-how or methodology and the final usage is sociotechnical systems of use (Kline, 1985). All of these concepts can be related specifically to architectural technology and although not revolutionary in themselves, they do offer us the opportunity to reflect on and catalogue the professional process and in particular the outputs.

The idea of hardware relates to things made by man, the basic materials and components that we assemble in architectural design; sociotechnical systems of manufacture refers to the building and manufacturing process; knowledge, technique, etc., is the knowledge and skill base of all those involved in the design and building process; sociotechnical systems of use is how the building is eventually used. Using this basic theory we can make it more relevant by proposing (theorising) that architectural technology has expressions that can be identified in:

- the components we accumulate into buildings;
- that process of accumulation also known as building;
- the understanding of how to put them together;
- how that building eventually functions.

Returning briefly to the *critical theory of technology* and in particular our ability to have an influence through the use of innovative ideas and technologies, the observation that the rate of technological and social change leaves us unable to optimise current technology is worth some consideration. In the not too distant past, technology changed comparatively slowly and knowledge and efficient use was optimised over significant periods of time; technology changes so quickly now that it is commonly used only to provide the springboard to the next expression (Jonas, 1979). Can this observation have an influence on our approach to architectural technology, particularly when contrasting modern with traditional

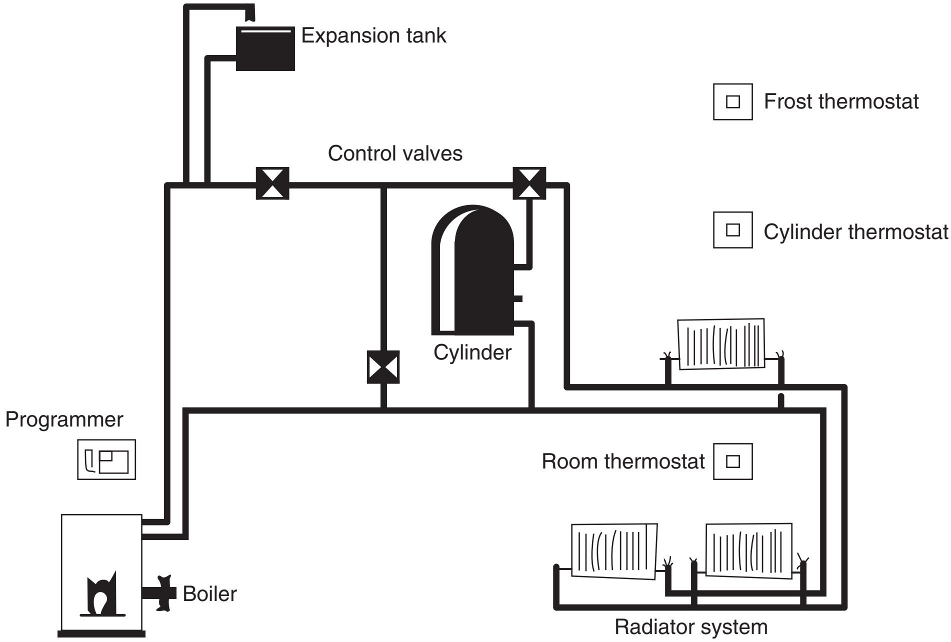

Figure 1.5 With the key caveat that 'if designed appropriately', a conventional wet central heating system has the capacity to be genuinely future proofed where the boiler can be replaced with a better system (wood pellets for oil, for example) and so can the controlling devices or even the radiators for that matter.

technologies? Should this thinking be used to justify a risk averse approach to technology in building, citing the fear that modern is changeable and unproven whereas traditional technology has stood the test of time, or should it inspire a design approach that adopts modern technology in a way that allows change to be accommodated? A good illustration of this would be the very simple instance of comparing fireplaces for heating to an electric heating system. The alternative wet central heating system, where the boiler can be changed to whatever the current 'best solution' is without overly affecting the rest of the system, is clearly a solution with some degree of genuine future proofing (see Figure 1.5).

There are some very clear theoretical challenges emerging for architectural technology and it is worth spending a little time examining these. Firstly, it is important to establish that architectural technology is a design based discipline and that therefore design theories can potentially have a significant role to play. It was suggested earlier in this chapter that in designing buildings architectural technologists strive to produce high performance construction as opposed to great architecture and core to this task is the production of architectural details, essentially the design of joints; joints to hold structures together; joints to hold materials together in components; joints to control the interface between controlled and external environments; joints to control movement; etc. Detail design is a highly creative process and not a simple technical exercise; it is a 'knowledge-centred activity that bristles with equal creative endeavour as the larger conceptual design phase' (Emmitt *et al.*, 2004) and although it is clearly more than a task based enterprise, it does suffer from the observation made earlier, that it is mostly hidden from view and therefore requires a different form of evaluation.

Visual aspects are important but it is mostly on performance that architectural details will be judged as well designed or not. To illustrate this challenge, consider that the theoretical ambition in design is to produce the perfect solution; in architectural detailing this is often just doing the job it is required to do. The perfect piece of joint technology is assessed on its performance and not on how it was designed, so whether it came from a book of standard details or was derived by a thorough process of design from first principles makes no difference. However, theoretical approaches can be useful in deciding what makes it a perfect solution. Consider the repair of a mortar joint in a 13th century Gothic cathedral where current thinking would suggest that the original lime mortar is copied as accurately as possible. This action would follow current conservation theory and would also come very close to fulfilling the concept of the perfect solution. The simple mortar joint in medieval construction consisted of a pliable material; lime mortar placed between blocks of stone took on exactly the right shape to connect two imperfect surfaces; loads are transmitted evenly, avoiding stress points, allowing tall, heavy, buildings to be held together with nothing more than the force of gravity. Slow drying lime mortar accommodates subsequent movement and is converted through carbonation slowly across many years into a much harder limestone material; a perfect joint? However, could a keyhole type operation that injects some kind of wonder glue, causing minimal damage to the existing structure, not be as good? The arguments against would normally centre on unknown consequences of the 'glue' or a suggestion that the action might not be reversible. Clearly these materials are available and are used in certain circumstances, illustrating that theoretical considerations can be used to arrive at the correct decisions – at least correct within the current sphere of knowledge.

A philosophical challenge poses the question, should architectural technology strive to produce new solutions or should it endeavour to produce a greater understanding of current solutions? Can we expect every detail designer to consider the thoughts of Heidegger (1954), Jonas (1979), etc., or is merely striving for the perfect solution sufficient?

Looking to the future

Design theory is not new and it has manifestations in many academic and professional disciplines. There are some fields, however, where the notion of design is central, yet as with architectural technology it is not necessarily what one first thinks of when considering the work of that discipline. Mechanical Engineering is one such discipline where the idea of function predominates. Writing in 2008, Jonathan Maier stated that until the 1980s engineering textbooks focused heavily on analysis and individual problem solving – the idea that function is mathematical, scientific and measurable. Two important works, *The Sciences of the Artificial* (Simon, 1996) and *Systematic Engineering Design* (Pahl and Beitz, 1996) developed an approach that saw design problems as being part of systems rather than individual components (Maier, 2008). Transposing this view to architecture, it could be argued that a systematic approach was always an integral part of the architectural technologist's attitude to design without them necessarily being aware of the fact. Both the aesthetic and technical concept of the completed building would be apparent when considering materials, technologies and design solutions; a house is conceptually much more than just a collection of materials and components, and so is any other form of building.

Yet as design theory has developed within mechanical engineering, many interesting observations with potentially major consequences have emerged. Describing work with colleagues, Maier (2008) suggests that the functional view of engineering can learn a lot from the design disciplines of industrial design (consumer products) and architecture, where the solution is seen as having much more to contribute than mere function; emotion can be central. They go on to develop the idea of affordance, a term borrowed from perceptual psychology, where 'the affordances of a product are what it provides, offers, or furnishes to the user or to another product' (Maier, 2008). This is different to its function so where a house may function as a shelter from the elements it affords comfort, prestige, investment, etc. The idea in its simplest form suggests that while functions remain constant, e.g. a house and shelter, the affordances are infinitely variable; consider the affordances from a 'house' belonging to a peasant from the Middle Ages, a 21st century pop star or the indigenous people of Papua New Guinea.

The concept of affordances includes both positive and negative versions however and this is where it starts to have real meaning for the discipline of architectural technology. The observation that adding extra heating capacity to an existing building in temperate climates can have unseen consequences is not new; there is now a deep understanding of the relationships between insulation, heating sources and losses, moisture control and condensation, etc., that was not there initially. A project systematically designed with a deliberate assessment of positive and negative affordances might have foreseen some of these issues and prevented the problems.

A proposition here theorises that architectural technologists are partway there in that they are usually very aware of the complete range of affordances from traditional solutions but remain fearful of new technologies. Adopting this systematic approach may help to mitigate some of the barriers to innovation sometimes found in the risk-averse world of technical design in architecture.

Carrying on with the theme of innovation, another very interesting variation on design thinking comes from the realms of industrial design. Understanding the nature of innovation is core to this concept and, in particular, the relationship with design. *The Concise Oxford Dictionary* suggests that to innovate is to 'make changes in'. This is not much help in itself but as the derivation is from the Latin *novo*, for new or *novare*, make new, we can take a meaning that suggests something like 'changes that are new'. This definition can be interpreted as having two components, the idea (new) and the action (changes).

While it would be agreeable to suggest that innovation is truly democratic and open to all who wish to make changes, the reality is that it is an action that responds to a perceived need; something that by definition needs changing and understanding that need in depth is part of the process. The generation of original ideas therefore is very much linked to a defined problem and is dependent on the knowledge and imagination of the conceiver. 'For instance the background, knowledge and experience of the individual will impact on his or her ability to imaginatively consider a given topic. In order to see the shape of a horse in the clouds one must be equipped with the knowledge of what a horse actually looks like' (Wylant, 2002).

In architectural technology terms, this can be related to the individual designer's skill palette, which is in itself a product of education, experience and desire to accumulate inspiration and motivation from many different sources. This palette can also be depicted as subject-specific skills such as experience of design and detailing particular building elements and the ability to adapt to new situations such as detailing of a particular element where no experience exists (Wienand, 2007). Where the industrial design process takes this further is in the idea of organised ideation, commonly referred to as brainstorming. This means not just having a meeting to discuss a particular problem but organising that meeting specifically to generate new ideas. The constitution is therefore very important with members potentially invited not just because of their inherent knowledge but maybe for their ability to turn things upside down – maverick thinkers who can offer some valuable insights. Therefore the process is important, the people are paramount and so is the organisation to ensure that a solution is possible. 'The wild, nonsensical idea may eventually be discarded but open-minded consideration of the wild idea can lead to a potentially useful idea' (Wylant, 2002). Although the idea of a wild uncontrolled ideas fest is not totally alien to architectural technology, it is certainly not part of the mainstream process.

In an earlier section it was argued that in terms of an eventual solution, ideas taken from the pages of a standard text differ little from those generated from first principles; however, there may be limited understanding of standard solutions with a much deeper understanding possible with new design solutions arrived at via a process of careful consideration and planning. It can also be argued that design solutions are often much easier to arrive at through a detailed understanding of the problem at hand; in fact, the deeper the understanding, the more evident the solution. The definition of the problem at hand is central to understanding and clarity helps to dismiss unrelated issues and to assign degrees of importance to others (Wienand, 2007).

As with the systematic approach of affordances above, an approach that masters the outputs of apparent but controlled chaos could help to mitigate some of the fears of innovation that can stifle good design. In the risk-averse world of technical design in architecture, design theory in architectural technology is still in its infancy but there is a good deal of interesting and relevant precedents from which to learn.

Conclusion

It has become clear that a theoretical approach to architectural technology provides a framework that holds together all of the various strands that make up the discipline. It provides an historic underpinning of the profession, a rationale for the academic discipline and a possible methodology for taking the profession forward as an organised, specialist technical design discipline, striving systematically for innovation and in full control of risk factors.

Speaking in 1950, possibly the greatest 'technical architect' of all time, Mies van der Rohe (1950) proposed that 'Architecture depends on its time' and that technology and architecture being closely related 'will grow together, that some day the one will be an expression of the other' (cited in Braham and Hale, 2007). It can now be argued that many buildings of the 21st century bear testament to his aspirations, but we cannot possibly suggest that we have a system in place that allows all buildings to achieve this aspiration; in fact it could also be argued that the architecture of the Middle Ages achieved this far more effectively. Essentially he described a system that values in equal measure the aesthetic and technical inputs; what is now fundamentally different is the complexity of the developing architecture. To master this complexity we need a professional approach to building creation that is inclusive, organised and multidisciplinary; indeed the term omnidisciplinary has been used by George Hazelrigg, a mechanical engineer, to describe the position where 'any and all disciplines may be involved in the solution to a particular design problem' (cited by Maier, 2008).

A very interesting new sphere of work has emerged around *evidence based design* that, when juxtaposed on the earlier observation of Del Favero (2011) that different professions see the same things very differently, provides a platform to adopt a genuinely 'omnidisciplinary' methodology to technical design in architecture. Where evidence based design merely suggests that design decisions should have a basis in factual proven knowledge as opposed to intuition solely, the argument can be made that architectural technologists have always taken this approach without necessarily being cognisant of the fact. The onus is therefore on the architectural technology profession to make this correlation more evident and this book is a major step forward in that process. Following a related theme, Brandt *et al*. (2010) argue that the architectural profession by comparison is too reliant on intuitive design and 'must be able to rely on evidence to anticipate the effects of our work'. In providing some intriguing case studies they also point to three primary areas of 'evidence': experiential such as modelling and simulation, social science and the physical and natural sciences. They also point out that while the physical and natural sciences are often viewed as similar in their difference to the social sciences, they do in fact represent two very distinct sources of evidence for building designers, physical sciences being vital to understanding how structures perform whereas natural sciences are more about how we as organisms react to buildings. The challenge for both professions and all those allied to the production of buildings is to make meaningful connections that encourage the dialogue and compel the desire to seek out and find the necessary 'evidence'.

We have now considered architectural technology historically in terms of alternative theories, also viewed it through theories of technology and in particular also by means of complementary design theories. What has emerged is that architectural technology in its many expressions, be they historical, physical or metaphysical, needs a theoretical basis primarily in order to establish and document its existence. In addition, it could also do with a distinguishing approach to design theory that reinforces its position as the primary technical design authority in the modern construction industry, a professional standing that is not without historic significance.

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