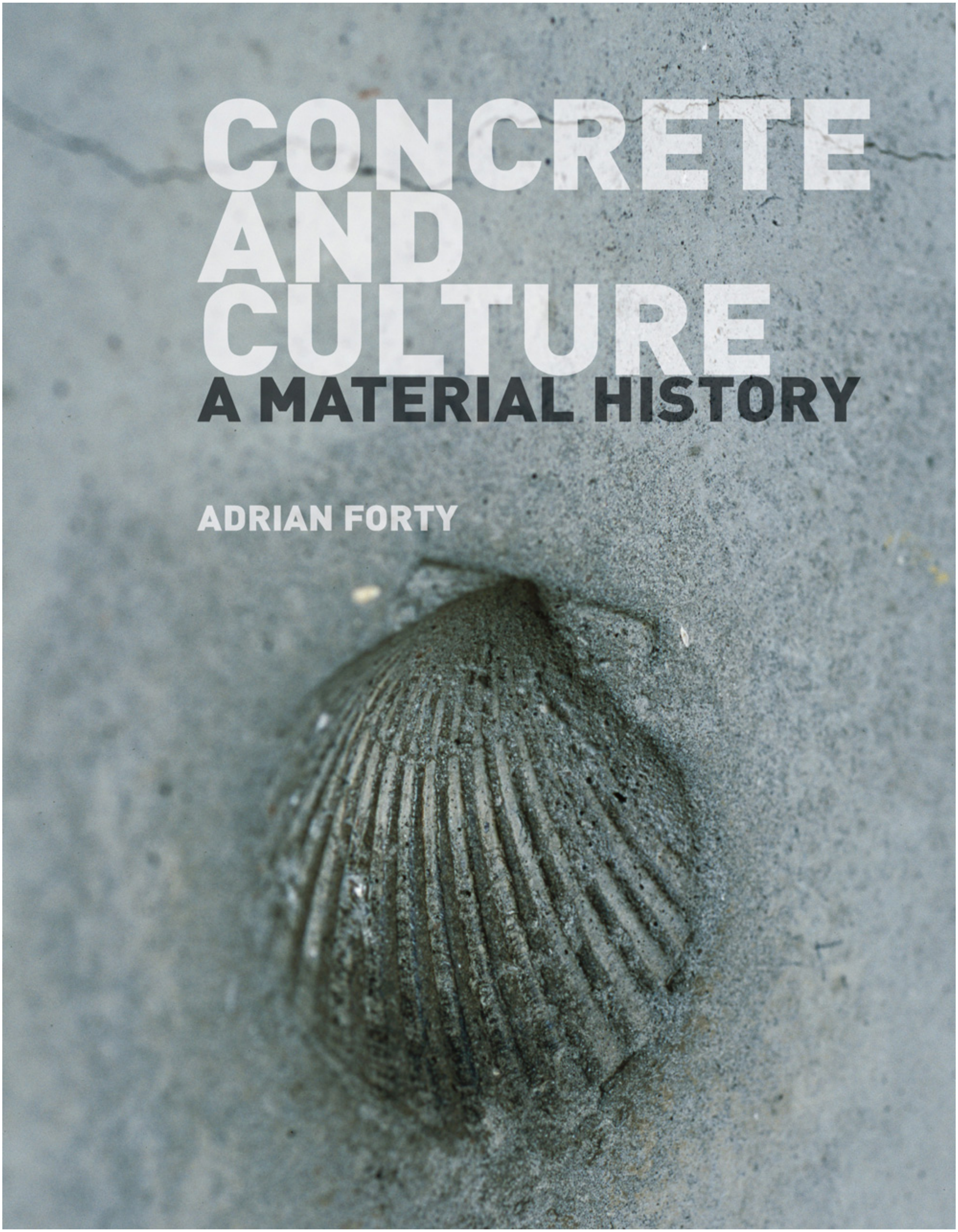

CONCRETE AND CULTURE

A MATERIAL HISTORY

ADRIAN FORTY

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INTRODUCTION

I STARTED thinking about concrete in the latter stages of writing a previous book, *Words and Buildings*, which was about how people talk about architecture. Compared to the fugitive, ephemeral world of language, it seemed a relief to turn to something that had substance, where there were physical objects to see and touch. The novelist Graham Greene used to distinguish between his serious works of fiction and those which he called ‘entertainments’: this book was to be an ‘entertainment’, giving me reason to travel widely, and justifying a visit more or less anywhere. What I did not anticipate were the intellectual difficulties I was letting myself in for – although possibly at some subliminal level they were what had attracted me all along. Like language, concrete is a universal medium, found in different forms all over the world, and the problems concrete presents to study are not unlike those of language. Just as with language, it is no good looking at any particular instance unless it can be related to the general condition of the medium: the difficulty, with concrete as with language, is to discover the rules for the general condition.

In so far as there are any accepted principles for concrete, they have generally been assumed to belong with its technical properties, and indeed the bulk of what has been written about concrete has come from engineers and chemists. Most histories of concrete begin with the Romans and their discovery of naturally occurring pozzolanic cements, and continue with the rediscovery of concrete in the nineteenth century and the subsequent invention of steel reinforcement. More interesting to me as a starting point is the description by Sir Thomas More in his *Utopia*, first published in 1516, of the houses of the Utopians:

> all the homes are of handsome appearance with three stories. The exposed faces of the walls are made of stone or cement or brick, rubble being used as filling for the empty space between the walls. The roofs are flat and covered with a kind of cement which is cheap but so well mixed that it is impervious to fire and superior to lead in defying the damage caused by storms.[1]

More had imagined, long in advance of its invention, a perfect, cement-based building material that would transform people’s lives. Not only does More’s description mark the beginning of a long-standing association between concrete and utopian movements of all kinds, but it makes clear that concrete has a metaphysics as well as a physics, an existence in the mind parallel to its existence in the world. It is the place this medium occupies in our heads that interests me more than its technical properties, and that this book tries to give some account of.

At the period that I became interested in concrete, I was spending a good deal of time in northern Italy and went to see a large number of post-war buildings, many of them built of concrete. A high proportion of these buildings used concrete in ways that can only be described as ‘decorative’, in that there was no particular structural reason for many of the features, and they did not correspond to how, according to the architectural orthodoxies that I was familiar with, concrete was supposed to be used. I had read Peter Collins’s *Concrete* of 1959, for many years the only substantial book about the modern architectural use of concrete, and Collins had nothing whatsoever to say about these Italian buildings, or about their non-conformist applications of the medium. That there seemed to be such a large body of work lying off the edge of the map seemed good reason to look further.

Surely there could be a history of concrete that did more than simply repeat the doctrines of architects, most of which in any case, when examined closely, turned out to be full of contradictions? Collins's book, published 50 years ago, although informative about the early years of concrete, was not a good model, since it was so determined to promote as an orthodoxy the very particular approach to concrete of one individual architect, Auguste Perret, whose Parisian apartment building at 25 bis rue Franklin, completed in 1904, is often regarded as a prophetic work for architecture in concrete. There were few exemplars for the sort of enquiry that I had in mind, whether about concrete, or any other building material. Richard Weston's *Materials, Form and Architecture* (2003), an admirable study of architectural ideas about materials, concentrates exclusively on the architectural perspective, and treats concrete as only one among other building materials. Recent surveys of brick and of corrugated iron are certainly global in their scope, but are essentially gazetteers of notable examples.[2] Two exceptions, closer to what I was looking for, and specifically about concrete, are the German author Kathrin Bonacker's *Beton: ein Baustoff wird Schlagwort* (1996) and the French historian Cyrille Simonnet's *Le Béton* (2005), the latter published well after I was into the project. Both have been valuable to me. Many of Simonnet's ideas coincided with my own, and reading him did much to make my own thoughts clearer; his book, of which I have made extensive use, has made my own a lot better than it would otherwise have been. At the same time, the work of two other francophone historians, Gwenaël Delhumeau on the Hennebique archive, and the Canadian Réjean Legault on architectural attitudes towards concrete in France in the early twentieth century, have both been exceptionally useful. But I never wanted to write a book just about architects, nor one limited to only one section of the world – part of the interest of concrete is that it is so ubiquitous and, for the most part, so innocent of architecture. Architects and engineers do not have a monopoly over concrete. My wish was to think about concrete in all the diversity of its applications, not just those controlled by architects and engineers, but to deal with its presence everywhere, whether in the work of self-builders, sculptors, writers, politicians, entrepreneurs, photographers or film-makers. For this foolhardy undertaking, there were no precedents.

Concrete is often regarded as a dumb or stupid material, more associated with death than life. Figures of speech in many languages take advantage of this. In German, 'Beton-Fraktion' is used to mean an intransigently stubborn political group; 'Beton-Kopf', literally 'concrete head', a reactionary political opponent.[3] In Sweden, Hjalmar Mehr, the powerful Social Democrat leader of Stockholm's city government responsible for the drastic redevelopment of the inner city in the 1950s and '60s, was referred to as 'betonsosse', a 'concrete socialist'.[4] In French, the street slang 'laisse béton', an inversion of 'laisse tomber', means 'drop dead'. In Kate Grenville's novel *The Idea of Perfection*, the boringness of the main character is communicated through his being a concrete engineer: '*Concrete!*', people would exclaim at parties, 'and their eyes would start to flicker past his shoulder, looking for someone better to talk to'.[5] In a book of improbable literary titles, we find *Highlights in the History of Concrete*, which draws a smile in a way that Highlights in the History of Oil, of Coal, of Steel or Glass would not.[6] And often, when I told people that I was writing a book about concrete, they would raise an eyebrow as if to say, 'you can't be serious'.

These and many other negative associations interest me. A side of concrete has always been repellent. 'There is an undoubted prejudice against the look and even the feel of Portland cement', wrote the English journal *The Builder* in 1876, and things have not changed much since, despite there being a lot more of it about.[7] An element of revulsion seems to be a permanent, structural feature of the material. Much of what has been written about concrete has tried either to ignore this, or to convince people that their feelings are mistaken. It is not my purpose to try to explain away the negativity that concrete attracts, nor to persuade people that what they find ugly is really beautiful. This is not an apology for concrete, meant to win people over to it. The many attempts, mostly originating from the cement and concrete industries, to put a better face on concrete strike me as misguided and pointless. There is more sense, I believe, in accepting the dislike people have for concrete for what it is, and in finding room for that repugnance within whatever account of concrete we are able to give.

This is not a history of a material in a way that a 'history' is normally understood – the reader wanting that should turn to one of the various existing historical studies.[8] I find it more productive to think of concrete as a medium than as a material, and the book is an attempt to make sense of a medium that has a history, without itself being a history of the medium. As a medium, through which all sorts of ideas, some of them architectural, have been communicated, concrete has been resistant to understanding largely on account of its tendency to slip between most category distinctions. 'What then should be the Aesthetic of concrete?', asked the American architect Frank Lloyd Wright in 1927,

> Is it Stone? Yes and No.
> Is it Plaster? Yes and No.
> Is it Brick or Tile? Yes and No.
> Is it Cast Iron? Yes and No.
> Poor Concrete! Still looking for its own at the hands of Man.[9]

And Wright went on to call it a 'mongrel' material, hardly the most complimentary description. The refusal of concrete to stay securely within any one class is one of its recurrent features. From many of the usual category distinctions through which we make sense of our lives – liquid/solid, smooth/rough, natural/artificial, ancient/modern, base/spirit – concrete manages to escape, slipping back and forth between categories. It is this resistance to classification that is, I suggest, part of the cause of the repellence that people feel for concrete; the book is organized around some of the polarities through which our cosmology is arranged, and looks at concrete in terms of the part it has played within these. To say that concrete has a tendency to 'double', to be two opposite things at once, is not a particularly original observation. Many other commentators on concrete have noticed the same thing, though they have often been at a loss to know what to do with the insight. The applications of concrete I most enjoy, and which strike me as most satisfying, are those where there is a knowing recognition by the creator of the slipperiness of concrete – of, as Wright recognized, its reluctance to stay firmly within one or another conventional scheme of classification.

The book has turned out to be more about architects and architecture than I would have liked. Yet there is a good reason for this, in that architects have paid more attention to the interpretation of concrete as a medium of culture than any other occupation. It is also in part because of my own disciplinary affiliation as an architectural historian, which makes me more familiar with architecture and architectural discourse than I am with some of the other fields touched by concrete. True to the articles of the discipline to which I was introduced by Reyner Banham, I have tried to avoid writing about works that I have not seen. Yet this strict attention to the observation of the physical need not limit us to the earthbound world of pure matter that the medium's French name, *béton*, might lead us to suppose is the extent of its existence (*béton*, like *bitumen*, comes from the Old French *betum*, a mass of rubbish in the ground). On the contrary, cursory inspection of even the most debased lump of concrete rapidly takes us into a fugacious world of beliefs and counter-beliefs, hopes and fears, longings and loathings.

ONE

MUD

AND

MODERNITY

On the one side science, order, progress, internationalism, aeroplanes, steel, concrete, hygiene: on the other side war, nationalism, religion, monarchy, peasants, Greek professors, poets, horses.

George Orwell, 'Wells, Hitler and the World State' (1941)[1]

The FerroConcrete Style has developed with telegraph and railroad, with motion picture and radio; it is a child of the age that created the League of Nations, and witnessed transoceanic flights.

Francis S. Onderdonk, *The FerroConcrete Style* (1928)[2]

After all, concrete was City par excellence, the definite sign of a step forward in life.

Patrick Chamoiseau, *Texaco* (1992)[3]

CONCRETE is *modern*. This is not just to say that now it is here, when before it wasn't, but that it is one of the agents through which our experience of modernity is mediated. Concrete tells us what it means to be modern. It is not just that the lives of people in the twentieth century were transformed by, amongst other things, concrete – as they undeniably were – but that how they saw those changes was, in part, the outcome of the way they were represented in concrete. Like the internal combustion engine, antibiotics, genetically modified crops and digital technology, concrete realized the prospect of transforming nature, and of transforming ourselves and our relationships with each other. In the state of poverty in which most of the world's population lives, concrete offers the possibility of hurricane-and earthquake-proof dwellings: like for the occupants of Patrick Chamoiseau's Martinique shanty town in his novel *Texaco*, it is a step up in life, a start on the road to progress. In the realm of building materials, these emancipatory possibilities could never have become attached to a traditional material like, say, wood, whatever other aura it may have. And while the social and physical transformations offered by concrete, as by many other twentieth-century innovations, promised to benefit mankind, each has also destroyed old ways of doing things, old craft skills, older forms of social relations, and has as a result always aroused some resistance. Concrete is no stranger to this ambivalence, and the objections and hostility that attach to it are no less a part of its modernity than all the many benefits it has brought.

The working out of these feelings, and their accommodation into consciousness, is a large part of what this book is about. Every one of the features of concrete picked out here is, in a sense, an attribute of its modernity. To talk about concrete means talking about modernity – and all the ambivalence that such a discussion brings with it. Reactions to concrete are reactions to modernity, and on that account should not be understood as direct affects of concrete, but have to be associated with the whole field of events and processes that constitute modern existence. In other words, to look for the causes of the nausea concrete has induced in the material itself is to look in the wrong place, for concrete is but one symptom of our discomfort with modernity and everything that comes with it.

Nevertheless, the fact that concrete has fitted so well into the 'modern' has its own interest, and we must ask why. This is not as self-evident as may first appear, for concrete's image as a progressive medium is not entirely borne out by its own history. Although George Orwell in the essay quoted at the beginning of this chapter placed concrete on the side of modernity, it can as easily sit on the opposite, alongside war, religion, peasants and professors of Greek. As we shall see, as well as being an 'advanced' technology, concrete also has a telluric backwardness, and its story is in part a playing out of the tension between its progressiveness and its residual primitivism – a conflict that is characteristic of many things with claims to modernity. Not that the backwardness of concrete has ever stood in the way of its adoption as a paradigmatic symbol of modernity. Whenever and wherever urgent modernization has been called for, concrete has been pressed into service: when the Turkish Prime Minister, Adnan Menderes, embarked on a programme of road building for Istanbul in the 1950s, so that, as he stated, 'the traffic shall flow like water', it was information about the concrete from which the roads were built, its thickness, its quantity, that filled the associated propaganda.[4] Nevertheless, there are many not-so-modern features of concrete – such as its reliance upon craft skills – that are always at risk of exposing it as less than the progressive medium it is always said to be. This tension, between a product of scientific technology, whose use lies in the application of a set of theoretically derived principles, and something rooted in the most basic manual craft practices, is never far away.

If concrete came to be, and still continues to be, regarded as a 'modern' material, this is a by no means natural or automatic association. The history of the early years of the development of concrete is in part the account of the winning of this reputation, a reputation that was far from guaranteed or good for all time. Concrete is always at risk of slipping back into its craft and earthbound origins, and only the constant vigilance of the cement and concrete industry preserves its soubriquet of 'progressive' through an aura of constant new developments and new inventions. Were this aura to vanish, concrete would lose much of its claim to be modern, and lapse back into the stock of 'traditional' – for which read 'static' – building processes.

Let us look then at the sequence of events through which concrete's modernity was brought into being. There are two aspects to consider here: first, the initial stages of the development of reinforced concrete, and second, the process by which concrete became aligned with 'modern architecture', the specific architectural representation of modernity.

The early development of reinforced concrete in the nineteenth century was not attached to a particular time or place; rather it was invented several times, in slightly different ways and in different places. Similar discoveries occurred over the same period in France, England and the United States, each without much apparent knowledge of or regard for the others.

However, there is one consistent pattern to the invention of reinforced concrete that sets it apart from that other great innovation in nineteenth-century building, metallic construction. With iron, and then steel, the technical development and subsequent practical application was always carried out by a single group of people, initially iron founders, and then firms of engineer-contractors, or, in the U.S., steel fabricators.[5] The development first of all of concrete, and then of reinforced concrete, however, was dispersed from the start across a variety of different groups – chemists and engineers who developed cements, industrialists whose prime interest was in the commercial exploitation of cement production, and ordinary builders who by trial and error on the building site developed the practical application of the material, and subsequently the technique of reinforcing it with steel. In so far as concrete came out of the speculative research of industrial chemists, it was a 'modern' material; likewise, in so far as it developed through the impetus of entrepreneurs to market cement, it was 'modern'; but in so far as it was a product of messy hit-or-miss experiments of tradesmen and contractors on the building site, it was wholly non-modern. Distinctive to the development of concrete is that it lay not in one single set of practices, but in the combination of several wholly different practices.[6]

To give a little more detail to the alternately 'modern' and 'un-modern' character of concrete in its early stages of development, the first historian of architectural concrete, Peter Collins, argued that the origins of concrete lay in the practical experiments of various enterprising artisans in late eighteenth-and early nineteenth-century France aimed at improving upon traditional *pisé*, or rammed earth, construction. At the same time, though, as these distinctly trial-and-error experiments, an engineer in the École Nationale des Ponts et Chaussées, Louis-Joseph Vicat, was undertaking methodical laboratory analyses of lime mortars and cements, and his research, published in 1818, provided the techniques for the evaluation of cement that were essential to its subsequent development. Vicat's understanding of the chemistry of cement, according to the more recent history by Cyrille Simonnet, shifted the control of 'firmness' – one of the Roman author Vitruvius' three legs of architecture – from what went on in the act of building to the management of the supply process. As Simonnet puts it, 'it was soon to be no longer the know-how of masons to which one looked for authority, but to the accounting and analytical skills of the entrepreneur'.[7] Scientific understanding of the chemistry of cement, a modern form of expert knowledge, was to displace the rule-of-thumb judgement of the tradesman.

England dominated cement manufacture in the early nineteenth century, but French production increased in the latter half of the century, and by the end of the century was concentrated in 29 factories, producing between them 1.14 million tons of cement. In Germany cement production developed rapidly, and along much more scientific lines – it was Germany that first established industrial norms for cement, a factor that was important in the rapid subsequent development of reinforced concrete in that country.[8] The dominance of cement production by entrepreneurs, whose interest in the marketing of the material led to their involvement in the development of concrete construction, may account for another distinctly 'modern' procedure, which was the tendency to patent every recipe and process for the production and application of cement. Patents were not customary within the largely craft-based building industry, and the introduction of this practice was a symptom of the entry of commercially minded and competition-conscious entrepreneurs into the industry.[9]

But despite the 'modern' features of the cement industry, and of its regulation, the actual work of constructing in concrete remained almost entirely in the hands of small firms using traditional skills. This pattern was not at all like iron and steel construction, where employees of the steel firms would assemble on site the components previously fabricated by the same firms.[10] It was out of the relatively small-scale, craft-based operation of concrete construction that the next significant development, steel reinforcement, emerged. The story here was marked by an almost total absence of theory, and was conducted by inserting pieces of iron and steel into the concrete and hoping for the best. Architects and engineers showed no interest in these developments at all, remaining largely aloof and indifferent to them long after they had become accepted within the building world: it was entirely through these artisanal experiments, and not at all from any professional input, that the benefits of steel reinforcement were discovered.[11] Whether reinforced concrete was discovered by Joseph Lambot in France, William Wilkinson in England or by another Frenchman, Joseph Monier, a garden designer who started using wire mesh to strengthen his flower pots, does not particularly matter.[12] The significant fact is that they all, as well as others involved in similar experiments over the same period, were primarily builders and contractors, whose expertise lay in what happened on the site, and not in any scientific or theoretical knowledge. It was only in 1887 that Matthias Koenen, a German engineer connected to the firm of Wayss & Freytag who had bought the German rights to Monier's patent, showed how to calculate the reinforcement, and for the first time gave a scientific basis for the positioning of the steel bars: Koenen's book *Das System Monier* was in effect the first manual of reinforced concrete construction, though it only appeared after twenty years of on-site experiments by builders and contractors. Up to this point, therefore, the development of reinforced concrete had been an entirely un-modern project, the result of many independent initiatives by small contractors, each working on a trial-and-error basis, without following any particular scientific or theoretical principles.

In the last decade of the nineteenth century, reinforced concrete became concentrated into the hands of the owners of a small number of proprietary systems: a client, or an architect, wanting to construct a concrete building would go to one of these firms, who would undertake to design, and in some cases to build, the required building according to their own patent system. In the absence of any codes or standards for reinforced concrete, which did not start to appear until 1904, going to one of the proprietary systems gave a building owner some guarantee of the reliability of the process. The Monier system, licensed to Wayss & Freytag, dominated the German and Austrian markets. Outside Germany, the best-known and most successful system was that of François Hennebique. Hennebique, a Belgian contractor, had set up in business in 1867, and in 1879 started experimenting with reinforced concrete. In 1892, alarmed by an American development of which he had heard, he took out a patent for his process, and at the same time gave up contracting and concentrated his business solely upon the design of reinforced concrete structures, the construction of which was carried out by licensed concessionaries, first of all in France and then ultimately all over the world. This separation between design and construction enabled Hennebique to carry out an enormous number of projects – in 1898 he had 714 projects on his books, and by 1905 was estimated to control one-fifth of the world market in reinforced concrete construction – without himself needing either the capital or the human resources to execute them.[13] The heart of Hennebique's business was the *bureau d'études*, the engineering drawing office that translated into reinforced concrete the designs or requests for buildings that had been submitted to the firm. Hennebique operated his own *bureau d'études* in Paris, where he had moved his centre of operations in 1892, while licensed agents also managed their own *bureaux* elsewhere. The structural design and licensing operations of the firm were backed up by a formidable publicity machine that promoted Hennebique's system and the work of his agents and concessionary contractors.[14]

Hennebique's insistence that he was not a contractor – 'Hennebique n'est pas entrepreneur' it stated on the firm's business card – and the elaborate publicity apparatus – a monthly magazine, *Le Béton Armé*, exhibitions, banquets for the concessionaries and so on – have caused recent commentators to see Hennebique as a prototypical modern enterprise founded upon technical expertise and publicity rather than the actual fabrication of buildings. What Hennebique produced were not buildings, but images of buildings, whether production drawings or photographs of completed buildings for public circulation.[15] However, if his firm was in this respect 'modern', Hennebique himself, the self-made, uneducated contractor, whose system had been arrived at by trial and error, retained a residual suspicion of engineers trained at the École Centrale and the École Nationale des Ponts et Chaussées; always afraid that they were out to destroy his monopoly, he told his concessionaries in 1899: 'I have a holy hatred of that useless hotch-potch, science. The factors in our formula . . . add up to plain cooking, all of whose elements are easy to understand.'[16]

If the development of reinforced concrete was a combination of the modern with the not-so-modern, we come now to the question of how this process came to be adopted as a prime symbol of the body of theory, practices and representations that made up 'modern architecture'. By the mid-1920s, at least in France, reinforced concrete had become synonymous with the new architecture. As Marcel Magne, the author of the architectural section of the official report on the 1925 Paris Exhibition of Decorative Arts wrote, 'the *material*, or if one prefers, the *raiment* of modern architecture is without doubt reinforced concrete'.[17] Although by 1925 concrete was wholly identified with modern architecture, this had been far from a foregone conclusion fifteen years earlier. Compared to steel, in many ways a much better qualified candidate to carry the message of modernity, it is not a little surprising that reinforced concrete, with its ambiguously modern and un-modern symptoms, should have taken on this role. Steel, lightweight, wholly reliant upon specialists from outside the traditional building trades, had many advantages in the modernity stakes over reinforced concrete – heavy, reliant upon carpenters to make the formwork, and with a need for much unskilled labour to realize it. It is worth pointing out that when Walter Benjamin, the great German critic of modernity, elaborated his 'Arcades' project in the late 1920s, it was the iron and steel of nineteenth-century construction that held his attention, because of its capacity to represent the 'subconscious'; reinforced concrete, which he linked with Art Nouveau, he seems to have regarded as less characteristically modern, presumably on account of the concealment of its innards.[18]

While around 1910 a few far-sighted people had anticipated that reinforced concrete would lead to a new architecture, there was singularly little evidence that this might happen any time soon. Even Charles Rabut, who taught reinforced concrete at the École Nationale des Ponts et Chaussées and was as committed to its future as anyone, was cautious: 'The flexibility of reinforced concrete . . . must give birth to a new architecture, which will be characterized by its extreme fantasy; the birth of this new architecture will take time and a few men of some calibre.'[19] Yet still in 1914, signs of the imminence of such a revolution were scanty: a few stark industrial structures in Europe and the U.S., and some domestic and commercial buildings largely indistinguishable from buildings made from traditional materials. It called for considerable imagination to see how this new construction process might come to signify the 'modern'. And in the architectural world there was just as strong a body of opinion that saw concrete as an essentially traditional process whose origins lay in clay and mud construction. In England in 1913, W. R. Lethaby, one of the most forward-thinking architects of his day, who had himself built with concrete, described it as 'a continuous aggregation like clay or paste', making 'crude primitive things', and saw concrete as connected to mankind's earliest constructions.[20]

An early and often cited incident in the convergence between re inforced concrete and modern architecture was the publication in the 1913 edition of the yearbook of the Deutscher Werkbund of a supplement containing fourteen illustrations of American grain elevators and factories. Assembled by the German architect Walter Gropius, these images were to be recirculated repeatedly in Europe over the next fifteen years, most notably in the pages of Le Corbusier and Amédée Ozenfant's Parisian magazine *L'Esprit Nouveau* and in the illustrations in Le Corbusier's manifesto of modern architecture, *Vers une architecture*.[21] What is at once curious about the selection of these pictures is that if Gropius needed to illustrate some works in reinforced concrete, why did he not choose from the products of Wayss & Freytag in Germany, or Hennebique in France, which could have provided him with abundant easily accessible examples? Apart from their great size, what really seems to have appealed to Gropius and the others who reproduced the pictures was their exoticism – they came from America, and originated (or so they thought) from outside the privileged circles of professional architecture – they represented, as Reyner Banham suggested, a kind of modern 'noble-savagery'.[22]

Gropius's pictures of American silos and factories certainly fuelled the imaginations of the avant-garde. In Italy the architectural manifesto of the Futurist group proclaimed that 'Futurist architecture is the architecture of calculation, of audacity and simplicity; the architecture of reinforced concrete, of iron, of glass, of pasteboard, of textile fibre, and of all those substitutes for wood, stone, and brick which make possible maximum elasticity and lightness.'[23] If the appeal of the substance lay in its synthetic anti-naturalism, realizing what such a Futurist architecture might look like was achieved in the astonishing drawings for an imaginary *Città Nuova* produced in 1914 by Antonio Sant'Elia. The power of these images, reproduced in post-First World War Paris, certainly encouraged the association of concrete and modernity, and gave some substance to the often-made claim that reinforced concrete was a 'revolutionary' material.[24]

Still to be explained, though, is what caused the – as it turned out, temporary – displacement of steel as the material of modernity. Although in the U.S. steel always retained the image of modernity, in France the picture was different. Some credit for this must go to Hennebique, who had waged a continuous war against steel and steel producers. The pages of his magazine, *Le Béton Armé,* were full of aggressive denunciations of steel and of the nefarious practices of steel producers. His starting point was the superiority of reinforced concrete over steel in terms of fire resistance (the company slogan was 'Plus d'incendies désastreux' – 'no more disastrous fires'); illustrations in the magazine showed the twisted frames of fire-damaged steel buildings, as well as catastrophic collapses of steel bridges and structures. How far Hennebique can be said to have been responsible for turning the younger generation of architects away from steel is hard to say, but his anti-steel propaganda was certainly not lost on them.

Finally, as a last episode in the turning of concrete into a 'modern' material, there is the story of Auguste Perret (1874–1954), the outstanding French pioneer of architecture in reinforced concrete who, finding himself caught up in the move to brand concrete as 'modern', carefully distanced himself from the enthusiasms of the younger members of the Paris avant-garde.[25] Perret's case is interesting, for while he had already established himself before the First World War as a 'master' of design in reinforced concrete, his stance in the 1920s was one of subtle resistance to attempts by the avant-garde to adopt him as a figurehead. Critics have always found Perret's work puzzling on account of the apparent contradiction between the newness of his chosen material and the classicism of his forms. However, this contradiction diminishes, and maybe disappears altogether, if one accepts that the 'modernity' of reinforced concrete was not inherent to it, but rather a construction placed upon it – and one not shared by Perret. He himself showed no particular interest in the 'modernity' of reinforced concrete, and was much more concerned with making concrete acceptable as a material for monumental architecture. Perret's own sparse statements do not reveal much about his intentions, and we are forced to rely on the critics who wrote about his works, two of whom, Paul Jamot and Marie Dormoy, seem to have been sufficiently close to him to represent his ideas fairly accurately. The picture is complicated by the fact that in some of Perret's buildings the concrete was exposed, while in others it was not: this inconsistency led to a certain amount of adjustment in the accounts of his work during the 1920s. Before 1914 Perret's reputation rested, in particular, on three Parisian buildings.[26] 25 bis rue Franklin (1903–4) is an apartment building with a concrete frame and walls consisting of panels set within the frame, all clad in decorative ceramic tiles that preserve a visible distinction between the frame and infill elements; although the building is celebrated for the open expression of the frame, in reality the tiles conceal the frame's irregularities and suggest that it has a slightly different shape to that which in reality it takes. What mattered to Perret was that the frame should be apparent, though not necessarily represented literally. At the Garage in the rue de Ponthieu (1906–7), now demolished, the frame was exposed on the street front, though with a slight adjustment – the thickening of the beams at their ends caused by the concentration of reinforcement at this point was concealed by widening the beam along its entire length. The third building, the Théâtre des Champs-Élysées (1910–13), was the largest and most impressive. The original design by Henry Van de Velde was to have been built in steel, but when the owners decided to change the construction to reinforced concrete, they consulted the firm of A. & G. Perret (Perret and his brothers were also contractors), and Perret ended up taking over the design of the whole commission. Although the frame is concrete, no concrete is visible inside or out; columns, beams and soffits are plastered on the interior, while the exterior elevation, with a grand order and faced in stone, only suggests, but does not actually represent, the presence of a concrete frame within. Prior to 1920 there seems to have been little discussion about the 'modernity' of these buildings. Perret's first significant work after the First World War was the church of Notre-Dame-de-la-Consolation at Le Raincy (1922–3), to the east of Paris, built entirely of reinforced concrete and where for reasons of economy concrete was left exposed inside and out (pp. 84–5). In this remarkable work, the entire external wall is made up of coloured glass set in concrete *claustra*, while above, a billowing vault of concrete is supported on slender columns. The interior attracted much comment and wonder, and was variously interpreted both as ultra-modern and as a reworking of the French Gothic tradition.[27] Notre-Dame du Raincy was the first stage of development towards Perret's mature style, best represented in Paris by the Mobilier National and the Musée des Travaux Publics, strongly related to the French classical tradition, and in which everything is made of concrete, down to the sleeping lions at the entrance to the Mobilier National, and the concrete is everywhere exposed, bush hammered to reveal the aggregate.

Despite the approbation given to Perret by the younger generation of avant-garde architects, among them Le Corbusier who had worked in Perret's atelier in 1912, the regard was not reciprocal. Perret's criticisms of the work of the younger architects focused amongst other things on their use of reinforced concrete, where Perret thought that they were too intent on the plastic effects that could be obtained by using concrete, and insufficiently attentive to the properties of reinforced concrete itself. The 'modern architecture' of 1920s Paris was characterized by expansive surfaces, achieved by paint and render finishes applied to elements that could be built either in concrete or in conventional masonry, or, as was often the case, with both. Perret deplored this indifference towards the representation of the structure; as one of Perret's friends, Marcel Mayer, remarked, 'It is not enough to build *with* reinforced concrete to make *concrete architecture*.'[28] The more younger architects concealed their composite structures, the more Perret seems to have become determined to advertise the purity of his: after Notre-Dame du Raincy, not only was the structure of his buildings increasingly legible, but so too was their material made visible. Needless to say, Perret had himself not observed these principles in his own earlier buildings – 25 bis rue Franklin had been clad in decorative tiles, and the exterior of the Théâtre des Champs-Élysées had done no more than suggest the presence of a frame within – and accordingly Jamot and Dormoy changed the story of Perret's work, playing down these buildings and playing up the Garage rue de Ponthieu, which the two critics now described as the work where 'the original beauty of reinforced concrete first emerged', while Notre-Dame du Raincy, whose exposed concrete had initially been referred to as '*brut*' or '*nu*', implying incompletion, was now described as '*apparent*' or '*visible*'.[29]

Perret's concern was to establish concrete as 'noble', not as 'modern'. This led him to emphasize its similarity to stone, and increasingly to organize his architecture in terms of trabeation – columns and beams – a construction system originally derived from timber. Even the arches and vaults found in Perret's earlier work disappeared as he became increasingly determined to avoid his work being swept into 'modern architecture'. In the 1930s, however, the situation changed somewhat. The avant-garde in France abandoned reinforced concrete as the symbol of modernity and turned back to steel: Le Corbusier's principal buildings of the 1930s, the Maison Clarté in Geneva (1930) and the Swiss Pavilion at the Cité Universitaire in Paris (1932), were built with steel, and it was Beaudouin and Prouvé's lightweight, metallic Maison du Peuple at Clichy (1939) that was the iconic Parisian building of the 1930s. Perret carried on building in reinforced concrete, but no longer had to protect it against appropriation as modern. In the French context, concrete had ceased to be a 'modern' material, and so by the time Le Corbusier's concrete Unité d'Habitation at Marseilles started to be built in 1946 it had rather different connotations – though the many young architects from other countries who came to admire this building were unaware that this shift had taken place, and mistakenly assumed that what they were seeing was unequivocally 'modern'.

If concrete ceased in France to be the exclusive raiment of modernity in the early 1930s, this was not the case elsewhere, where its associations with modernity, while they may have developed more slowly, turned out more enduring. However, the designation of concrete as 'modern' was always fragile, always open to question and constantly in need of refreshment. Concrete's inherent backwardness, its earthbound origins in the peasant process of *pisé*, is never far away, and always ready to reclaim it back from the engineers and technicians. While concrete has the appearance of an advanced technology, based upon theoretical understanding of stresses and the chemistry of cements, knowledge held by trained experts, reinforced concrete is also at the same time a simple process that can be, and in many parts of the world is, executed by people with no theoretical knowledge whatsoever. One man with a cement mixer and a wheelbarrow can produce passably modern structures: as Hennebique remarked, 'reinforced concrete is the art of doing large things with small means'.[30] It is the ease with which concrete lends itself to self-building that makes it hard to sustain the notion that we are dealing with an 'advanced' material: what we have instead is a crude building process that has given many people with only the most limited skills the power to build sound and durable structures – but whether this qualifies its being called 'modern' is doubtful. Most of the concrete used in the world is expended – in a manner that can hardly be called 'new' or modern – upon the most mundane and basic building enterprises. All around the Mediterranean, across Latin America and in shanty towns throughout the world, there are simple, framed structures built out of reinforced concrete, whose relationship to modernity, if we are to understand that as a distinctive form of industrial organization and of labour relations, is decidedly questionable. In a sense Le Corbusier's 'Domino' system, a simple column and slab system that he tried, but failed, to patent in 1915, is everywhere. But when the openings are filled in with hollow bricks or blockwork, these structures become part of the vernacular: buildings that are to all appearances traditional dream of a modern past embedded within their 'primitive' frame. The near-permanent state of incompletion of many of these buildings only adds to their Arcadian quality: in many parts of the world, where building loans and mortgages are not available, construction only progresses as fast as the owner's disposable income allows, prolonging construction over years or even decades. This, and the fact that concrete post-and-slab construction lends itself to partial occupation of an incomplete structure, enhances the archaism of the process. And in parts of the world where regulations exempt unfinished buildings from property taxes, incompletion becomes a permanent state. Projecting reinforcement bars on the rooflines of otherwise seemingly finished buildings, so common in Latin America and the eastern Mediterranean, are like the triglyphs of classical architecture, skeuomorphs of the ends of wooden beams, relics of the supposedly timber origins of Graeco-Roman architecture; but the projecting reinforcement bars are symbols not of the past, but of a future, of a future that may never arrive. 'Castles of hope' they are known as in Mexico.

Since early in the twentieth century Western architects have been fascinated by these vernacular uses of concrete, building practices unreliant on the professionally educated architect or engineer, while employing exactly the same technical means – a fulfilment of the architect's dream of the 'primitive'. The architect Bernard Rudofsky (1910–1987), later in life best known for his exhibition and book

Architecture without Architects (1965), studied a variety of vernacular architectures during his time as a student in Vienna. An extended stay on the island of Thera in Greece in 1929 led to his 1931 doctoral thesis on 'The Primitive Concrete Construction of the Greek Cyclades'.[31] Rudofsky's fascination with the Mediterranean vernacular coincided with similar interests in 1930s Italy, where he lived between 1932 and 1938 before moving to Brazil. In Naples Rudofsky collaborated with the architect Luigi Cosenza, and together they and the art historian Roberto Pane researched the rural vernacular of Southern Italy. The Neapolitan group's interests ran in parallel with those of the Milanese architectural circle around Giuseppe Pagano, the editor of *Casabella*, and Guarniero Daniel, who together organized the exhibition of *Architettura rurale italiana* at the 1936 Milan Triennale. Both groups saw the vernacular not as opposed to the avant-garde, with which they were broadly in sympathy, but rather as a way of framing a new syntax free from academicism.[32] The same attitude was also present in Mario Ridolfi's *Manuale dell'Architetto* prepared in 1938, a handbook that codified the vernacular for the benefit of architects and builders. Not published until 1946, it became much used in the period of Italian reconstruction; while more recent editions have dropped the explicitly artisanal aspects of the original, what we see in this whole episode is the recuperation by a metropolitan elite of anonymous building that was at once 'primitive' (in its dependence upon the uneducated *architetto contadino*) and at the same time 'modern' (in its use of material), for the purposes of developing a new architecture.[33] As the French critic Jean Badovici wrote in 1926, 'Cement imposes a return to elemental truths'[34] – it offered a way to rid architecture of its cultural obesity: Rudofsky, Cosenza, Pagano and Ridolfi took this literally, and in the vernacular of the Mediterranean discovered, as they saw it, a basis for the renewal of architecture.

The relative ease of working with cement and concrete, and the absence of a need for specialists, has meant that concrete has always appealed to 'outsiders' and made possible the realization of their personal visions, whether working on their own, or employing the labour of their disciples. The outstanding and probably original such case was Ferdinand Cheval, the *facteur* or postman of Hauterives in the Département of the Drôme in France. In 1879, struck by the beauty of the natural stones he found on his rounds, he started work on an extraordinary monument to human civilization, the Palais Idéal, which occupied him until 1912 and for which his only financial outlay was on the 3,500 barrels of cement that he bought.[35] Simon Rodia, who created the Watts Towers in Los Angeles between 1921 and 1945, was another self-builder whose monument relied upon steel reinforcement and cement. Neither of these were technically using reinforced concrete, but a more recent and even more eccentric work, the English surrealist Edward James's 'garden of Eden' at Las Pozas in Mexico, with its 36 concrete follies, built between 1949 and 1984, does use reinforced concrete. For the cement and concrete industry, these 'outsider' works have always been vaguely embarrassing – the obsession of an individual, and demonstrating no technical innovations, their 'primitiveness' has always seemed potentially damaging to the 'progressive' image that the industry wants to promote.

When it comes to self-building, not of follies but of buildings with a purpose, concrete again has always appealed to alternative movements everywhere. When in 1921–2 Rudolf Schindler built the Kings Road studio house for himself, his wife, and Clyde and Mrs Chase in Los Angeles, his choice of concrete was decidedly eccentric, for as Reyner Banham observed, 'Concrete, the symbolic proof of modernity in Europe, was an odd-ball or underground material in Southern California.'[36] The tilt-slabs from which this remarkable house (Banham thought it was the single best work of modern architecture done anywhere by anybody up to Le Corbusier's Villa Savoye in 1930) was constructed were cast flat on the ground, then tilted upright, with a small gap between them that was glazed. Although not self-built, this was a cheap, low-skill operation, and the resulting effect, with its outdoor rooms, is not far (as was Schindler's intention) from the tents in which the Schindlers and the Chases had camped in the Californian desert.

Concrete's application in these and many other alternative and 'outsider' projects draws attention to concrete's double history in the twentieth century – its technically sophisticated developments in shells, prestressing, extended spans, but at the same time its crudeness, its atavism, a quality that for some has provided a means of reconnecting with architecture's supposedly primitive origins in mud. This double aspect of concrete, modern and backward, emerges especially in the *making* of reinforced concrete. While some of the components of concrete – steel, cement – are industrially produced, the way in which they are brought together, with sand and aggregates and water, to make concrete, is not itself an industrial process. However many men in immaculate white overalls attend the mixing and laying of concrete, that itself remains a manual, craft-based operation, dependent on human muscle. The fabrication of the shuttering, the fixing of the steel, the mixing, pouring and vibrating of the concrete, and the care needed in the removal of the shuttering are each manual processes reliant on skill and judgement if the results are to be of any quality. Concrete's shame is that it is so dependent upon labour and upon such a variety of trades, to an extent far greater than its principal rival, steel. While prefabrication eliminates some of this dep endency upon craft labour, and it was for this reason that prefabrication was heavily promoted in both Western countries and the Soviet Union in the 1950s and '60s, the high labour content of reinforced concrete is never entirely eliminated. The absolute and decisive effect of formwork upon exposed concrete means that it is how this is built that largely determines the appearance of the result: as the Swiss architect Andrea Deplazes puts it, a building's character depends upon the quality of the formwork, so that 'It tends towards either the archaic or the abstract'.[37] He contrasts the sedimentary rock-like effect of Rudolf Olgiati's Alleman House with the ceramic fragility of Tadao Ando's works.

What are the implications – for architecture, and for culture in general – of the dual nature of reinforced concrete as both 'modern' and 'un-modern'? For architecture, the pattern that we see is of an alternation between the use of concrete to represent either the 'modern' or, less often, the non-modern. What is uncommon is to find the modernity and un-modernity of concrete represented simultaneously: a seemingly contradictory and distinctly more difficult operation, though these are often the works that turn out to be the most rewarding.

The modernity of reinforced concrete has been represented architecturally in various ways, of which the original and most common has been *monolithism*. Compared to all previous methods of construction, where the procedure was the assembly of parts, reinforced concrete produced buildings in which there were no 'parts'. Walls, floors, columns and beams formed one continuous structure, dissolving the traditional distinction between load and support: as one turn-of-the-century engineer remarked, in reinforced concrete 'walls are just up-ended floors'.[38] Unlike iron and steel construction, which operated on the principle of assemblage, each component fulfilling a distinct structural purpose to create a geometric equilibrium, with reinforced concrete, every element became part of the web of forces distributed throughout the structure. The earliest architectural expressions of monolithism in reinforced concrete were in Germany, where before 1914 a number of large public buildings had been built with an exposed internal concrete structure: the outstanding example is the Centennial Hall of 1913 in Breslau (now Wrocław, Poland), but there were a number of other market halls that appear to have been almost as striking. Monolithism also led to the principle that one material should serve for every part of the building – according to Auguste Perret, 'A construction is only reinforced concrete when all its elements could only have been executed in concrete, and when all other materials have been banished, that is to say where concrete is rationally used and without being clothed in any other material whatsoever.'[39] For Perret, as we have seen, this principle became a point of honour.

While monolithism may have been reinforced concrete's most distinctive structural property, it does not invariably identify concrete with the modern – or at least not with those versions of the modern associated with speed, dynamism and energy. Rudolf Steiner's Goetheanum, at Dornach, near Basel, unquestionably monolithic, was not 'modern' in any Futurist sense. More attractive to architects wanting to draw attention to the dynamism of modern life by means of concrete was the use of the cantilever. From the early 1920s, cantilevers fly out everywhere, enhancing the horizontality of buildings that was already associated with modern architecture. By hiding the means of support, cantilevers showed that the traditional relationship between load and support had been dissolved, and that buildings were no longer tied to the idea that the transfer of forces should be legible. By the 1940s the fashion for cantilevers started to be superseded by the interwar inventions in concrete, thin shell structures and prestressing. After 1945 large shells, sometimes eccentrically shaped and spanning large volumes, became the distinctive sign of the modern, especially when combined with the long slender beams made possible by prestressing. We see this in the factory at Brynmawr in south Wales designed by Architects Co-Partnership in 1948; and most spectacularly in the series of shell structures designed by Eero Saarinen in the United States, the Kresge Auditorium at MIT (1952–6), and finally the TWA Terminal at JFK Airport (1956–62).

Meanwhile, non-modern properties of concrete have most obviously emerged in terms of weight, mass and evidence of *facture*, the working of the material. Steiner's Goetheanum, massive and monolithic, was as much un-modern as modern. The French architect Tony Garnier, in the years before the First World War, produced the drawings for an imaginary ideal city, the *Cité Industrielle,* a contrast to Sant'Elia's *Cittá Nuova* in that the social programme was far more developed and utopian, but the architecture, though entirely of concrete, was less obviously progressive. The houses were to have had thick walls, flat roofs and regular window openings, and in their weight and solidity had more in common with the Mediterranean vernacular than with the Futurist city. By the 1950s Le Corbusier, who had previously regarded reinforced concrete as a synthetic and 'modern' material, had started to see concrete as a 'material of the same rank as stone, wood or terra cotta', evident in works like the Marseilles Unité d'Habitation and the manifestly 'south and peasant' Maisons Jaoul.[40] More recently, there has been a developing interest in the more 'primitive' uses of concrete, where its weight, density and mass were an alternative to the gravity-defying qualities of modernist architecture, and with the paper-thin surface effects of post-modernism. A good example of this exploitation of the backwardness of concrete is in the work of the Swiss architect Peter Märkli. The particularly massive concrete construction of his pair of houses at Trübbach (1982), a reaction against post-modernism, was, he remarked, 'a primitive way to start the profession'; and at La Congiunta at Giornico (1992), his rural gallery for the sculptor Hans Josephsohn, the extreme roughness of the construction recalls some crudely built artisanal structure, recuperated from the agricultural vernacular.[41]

When, however, it comes to representing the modern and the un-modern simultaneously, which, I am suggesting, comes closest to the 'reality' of concrete, the examples are fewer and far between. Le Corbusier's Unité d'Habitation at Marseilles, built between 1946 and 1952, might be seen in these terms (p. 252). As a project this was thoroughly modern, a built fragment of Le Corbusier's ideal city, the *Ville Radieuse*, with an entirely novel arrangement of duplex apartments and a variety of social amenities. Le Corbusier had planned to build the Unité in steel, by then, as we have seen, the more 'modern' material in France, but post-war shortages caused his engineer, Vladimir Bodiansky, at the last moment to change the construction to reinforced concrete. Le Corbusier and Bodiansky turned this to their advantage. It has been pointed out that the use of concrete in the Unité was relatively backward and did not make use of recent developments in the material: there was, for example, no prestressing, which Le Corbusier was later to employ on the monastery at La Tourette. Also the design of the building exaggerates its heaviness – the pilotis are unnecessarily massive and do not, as they seem, carry the main load of the building, which is actually carried by the two longitudinal beams above them. The result was, as Le Corbusier described it, 'a play between crudity and finesse, between the dull and the intense, between precision and accident' – or, in other words, between properties of the modern and the non-modern. These qualities were lost in his later Carpenter Center at Harvard, of which he allegedly complained it was 'too finely finished'.[42]

But it is in the work of Le Corbusier's Japanese followers that the duality of modern/non-modern was taken furthest. Although, as we shall see in chapter Four, a building like Kenzo Tange's Kagawa Prefecture building at Takamatsu (1955–8) also belongs to a discussion about 'national' concretes, there is a connection to a pre-modern past through its manifest structural redundancy: there are too many beams, and more joists than strictly necessary. Likewise, the jubilant excess of Tange's Gymnasium at Takamatsu (1965) set it apart from the restraint and asceticism characteristic of most Western models of 'advanced' modernism.

Partly inspired by Japanese examples, Western architects were also by the early 1960s starting to go back on concrete's modernity and showing signs of wanting to regress to a more primitive treatment. The American architect Paul Rudolph complained that U.S. concrete contractors took too much pride in precision, giving their work a 'thin metallic-like quality'; instead, he said, 'Concrete is mud. I work with concrete not against it. I like mud.'[43] Rudolph's first exposed concrete building, the Temple Street Parking Garage in New Haven (1958–63), was an explicit turn away from the smooth precast concrete work of his previous buildings. But the conjunction of the modern and the pre-modern is perhaps most obvious in the work of Rudolph's contemporary, Louis Kahn. Kahn's architecture, as is well known, makes general reference to ancient Roman buildings, and he liked particularly the way that over time Roman structures had had successive uses inserted into them. Kahn's buildings, while thoroughly modern in his attention to the structural systems and finish of the concrete, are ancient in the way that the structure seems to exist as something independent of the uses to which it has been put. This is particularly evident at the Salk Institute at San Diego, California. While it may be said that this has nothing to do with concrete, for the same effect could be achieved with, say, brick, the monolithicity of concrete adds to the seeming permanence of the basic structure, compared to the transience of the internal occupations.

Concrete offers something unique to architects, in that while founded in 'scientific' knowledge and experiment – most especially in the development of cements – it still offers opportunities for experimentation to anyone. Just as the original invention of reinforced concrete came from trial and error on the building site, even today it does not always need the resources of a scientific laboratory to come up with novel and original results. One of Carlo Scarpa's former assistants who worked on the Brion tomb at Altivole told me how they had wanted to make the gate out of concrete, but realized that if they did so, it would be too heavy to move. Then, one evening, sitting outside a bar together after work, they noticed the granules of a light porous material in the plant pots around the bar, and hit upon the idea of using these as an aggregate. Gigon Guyer's experiments with copper and iron additives to concrete are likewise simple applications that do not necessarily need a PhD in chemistry. In architecture, most innovations in materials consist of taking a material from a field not normally associated with building – Cor-Ten steel from shipbuilding, the rubber sheeting of wetsuits – and applying it to building. But with concrete, though, there still remains the opportunity for the architect to be his or her own alchemist, and to create an entirely new substance. Primitive this may be, but in this quality lies part of concrete's appeal.

Turning now to the question of culture in general, what are the implications here of concrete's dual history as modern and non-modern? Concrete is an example of a technology where innovation matters a lot less than use. A history of reinforced concrete based on the technical inventions would not tell one much – steel reinforcement, shell technology, prestressing, glass fibre reinforcement – the list would be brief: what matters is not where, when or how these inventions happened, but the use that has been made of them. In *The Shock of the Old*, David Edgerton argues that it is not always the most advanced technologies that have had the greatest social effects: that pharmacological wonder, the contraceptive pill, has been of less consequence than its predecessor, the technologically unsophisticated condom; more bicycles have been produced in the world since the late 1960s than motor cars.[44] In global terms, reinforced concrete is one of the ‘new technologies of poverty’ – in overall quantity consumed, its use by self-builders in poor countries probably exceeds all other applications. In the shanty towns of the world, its use is characterized by ingenuity rather than innovation: new or even relatively old developments in concrete technology are irrelevant, what matters is the way small amounts of reinforced concrete are made to go a long way. Even trained engineers are surprised by the economy of means employed in the construction of *favelas* in Rio de Janeiro. Everywhere in Latin America, making concrete is integrated into domestic life: in São Paulo, *mutirões*, self-build cooperatives, produce a significant part of low-income housing. The labour force mainly consists of women, who make precast concrete components during the week, and the components are assembled into buildings at the weekends, when more people are available.[45] Reinforced concrete lends itself to this kind of low-skill work, and in this context, making reinforced concrete is hardly ‘modern’ in the sense of an advanced technology or industrial process. Seen in these terms, to classify reinforced concrete as either modern or non-modern is not particularly appropriate. As one of the ‘new technologies of poverty’, it belongs to neither category.

Similar arguments might be made of other ‘new’ technologies such as, for example, plastics, whose use for water distribution and storage in poor countries was never imagined by their inventors and far exceeds in human value the uses of plastics within Western countries. But the difference between plastics and reinforced concrete is that people make reinforced concrete themselves.

Seen from the developed world, part of what makes reinforced concrete disagreeable is precisely its poverty, its association with the slums of Mumbai or Mexico City. However, what the discussion of concrete’s global use draws attention to is the inappropriateness of the classification of concrete as either ‘modern’ or ‘non-modern’. It is not just that concrete refuses to stay securely within either the one or the other category, flitting between them, but that it fails to conform to a classificatory system through which we habitually make sense of the world; this is without question one of the causes for the distaste with which it is often viewed within the developed world. Concrete’s floppiness threatens our faith in our own belief systems, but more than that, the way in which concrete is used in poor countries makes the designation of concrete as either ‘modern’ or ‘non-modern’ inapposite. The classificatory scheme that Orwell outlined is simply irrelevant. This leads one to ask why so many people, for so much of the twentieth century, have persisted in believing in it, and why so much effort – by architects, engineers, concrete suppliers and contractors – went into maintaining it and representing it. Were we to discard Orwell’s classification, and were concrete to lose its talismanic properties as the raiment of modernity, not to retreat to some atavistic, aggressively un-modern state but simply to become ‘stuff’, another substance, then a large part of the discourse around concrete that so preoccupied twentieth-century architects would simply evaporate. That this has not happened can only be attributed to the energy the cement and concrete industry has put into promoting the modernity of concrete, and to the complaisance with which the Western architectural profession accepted the ‘modern’ as a precept for architecture in the twentieth century, with the consequential need to find adequate means for its representation. The question for the future is whether concrete could ever become detached from ‘modernity’.

TWO

NATURAL

OR

UNNATURAL

CONCRETE is not natural – but that is not to say it is ‘unnatural’. Its being not natural is both its virtue and its failing. Its virtue in that, as a synthetic material, and especially when reinforced with steel, it can achieve things that would be impossible with any naturally occurring material. It has the capacity to resist nature (gravity, the sea, weather) and so gives us power over nature to a greater degree than most other materials. Its failing, though, is in its perceived lack of qualities found in so-called ‘natural’ materials, while it is often seen as cutting people off from nature, or obliterating nature. ‘To concrete over’ is to erase all trace of nature. Beneficial though the capacity to hold back nature has been, it has detracted as much from concrete’s reputation as it has added to it.

Like all simple classifications, the designation of concrete as non-natural, or artificial, is more complex than at first appears. Although cement, the active ingredient of concrete that adheres aggregates and steel together, is a synthetic product made by heating chalk and clay together at high temperature, there are naturally occurring cements, the best known of which, pozzolano, was familiar to and used by the Romans. While the process of concrete production, mixing cement with sand, gravel and water, is normally carried out by human labour, it has also occurred geologically. Deposits of naturally occurring concrete are found in many parts of the world – like Point Lobos in California – and the resultant compound has been widely quarried and worked as a building material.[1]

Notwithstanding the geological evidence, the general view is that concrete is not a natural material, and in a sense this must be right, because of the reliance upon human labour to make it. The concrete of modern buildings and infrastructure does not exist prior to the arrival of the constituent ingredients, cement, sand, aggregate, steel, at one place – a building site, or a casting factory – and it is only at the moment when human labour combines them together that they become concrete. In this respect, concrete can be more accurately described as a *process* than as a *material*.[2] If this makes it non-natural, then we might want to reconsider our customary description of other building materials, like stone, timber or brick, as 'natural'. Each of these rely upon the application of human labour to become a construction material: rock lying in the ground is not building stone until it has been quarried and hewn, any more than a tree growing on a hillside is timber until it has been cut down, seasoned and sawn to usable dimensions. Even 'natural' materials rely upon human labour to acquire value as building materials. The difference between these and concrete is only a matter of when and where the application of labour takes place: with 'natural' materials, a considerable amount of their value lies in their preparation before they arrive at the site, whereas with concrete most of the work occurs at the place where the concrete is to be formed. The 'hard-won' element of natural materials is what has often made them more valued than concrete, whose coming into being is, as we shall see, often regarded as 'too easy'. If we follow the line of argument that all materials are the outcome of processes involving human labour, then it is clear that if concrete is 'unnatural', then so too are most of the other materials out of which buildings are made. It is not that certain materials are artificial and others natural, but that *all*, to the extent that they rely upon human artifice, are non-natural.

Nonetheless, the view that concrete is somehow different from other materials does not go away. We see evidence of this in the very considerable amount of effort that ever since its invention in the mid-nineteenth century has been put into 'naturalizing' this novel product, generally by making it look like either stone or wood. While some of the nineteenth-century attempts may look ridiculous to modern eyes, they are no less absurd than the widespread use in more recent times of board-marked concrete, leaving the imprint of wooden formwork on the surface of the finished concrete: all are ways of connecting to the natural world a substance perceived as 'unnatural'. When in many Western countries a reaction against exposed concrete set in at the start of the 1970s, threatening the livelihood of cement and concrete producers, many responded by rebranding their product as 'artificial stone', hoping this association with a 'natural' material would exonerate the substance. Not that this was new, for ever since the early applications of concrete in the nineteenth century concrete constructors had tended to resort to the practices and formal language associated with existing traditional materials in order to 'represent' the new product. Indeed, how else was one to 'show' concrete but by making it like stone? Although at the beginning of the twentieth century, some constructors started to explore alternatives, many distinguished and respected designers of reinforced concrete structures persisted in thinking of their material as a kind of stone. Auguste Perret maintained that 'concrete is the stone that we make, much more beautiful and more noble than natural stone', or 'rejuvenated stone': in other words, like stone, only better.[3] Perret went to great lengths to select aggregates that had great richness of colouration when they were exposed, and employed skilled stonemasons' techniques to finish his concrete, so emphasizing its stone-like quality. Although he regarded concrete as superior to stone because it was monolithic and without joints, Perret never abandoned the reference to stone.

Amongst reinforced concrete constructors at the beginning of the twentieth century, the more usual analogy for concrete was with iron and steel construction. Metal construction was the technical innovation that had directly preceded reinforced concrete and, initially at least, reinforced concrete was thought of simply as a form of steel construction in which the steel was encased in concrete.[4] This had a certain logic to it, for much of the early attraction of reinforced concrete lay in its being a fireproof method of construction, a superior alternative to steel and iron, whose unprotected members were prone to buckling and cracking if exposed to great heat. One of the questions for reinforced concrete construction was how to represent on the exterior the presence of the steel within.[5] While none of the early twentieth-century attempts at this were particularly successful, it is worth drawing attention to the representation of reinforced concrete as metal in a much more recent building, Richard Rogers Partnership's Lloyd's building in London (1978–86), where the concrete columns and bracing girders are formed and detailed as if they were cast metal. In this case, what is being replicated is not a 'natural' material, but rather a form of construction that is visually more comprehensible than concrete. Unlike reinforced concrete, where the mode of the transmission of the forces within the substance is not externally apparent, with steel construction the position and dimension of the members roughly corresponds to the forces that they carry. As the engineer Peter Rice, who worked on the structure of the Lloyd's building, wrote, 'Our aim was to exploit the natural qualities of concrete while trying to achieve the visual articulation and legibility normally associated with steel'.[6] Leaving aside what Rice meant by 'the natural qualities of concrete', the strategy of designing concrete as if it were metal, because metal gives a more realistic representation of the internal forces, can also be said to have been a way of naturalizing concrete, even if the material simulated is not itself 'natural'.

Efforts to 'naturalize' concrete are endless – to give it the smoothness of polished marble, the density of limestone, the laminar quality of wood, every one of these ways of finishing concrete are attempts at representing the otherwise formless and inarticulate results of the process as 'natural'. What all of them confirm is that concrete permanently awaits deliverance from the category of the 'unnatural'.

Concrete and Stone

Architects used to be advised not to place stone and concrete where they could be seen together. For instance, the Danish architect Steen Eiler Rasmussen in his popular and widely read book on architectural aesthetics *Experiencing Architecture* (1959) observed that 'In Denmark today sidewalks are often paved with several rows of concrete slabs separated by rows of granite cobblestones . . . the combination gives a singularly inharmonious surface. Granite and concrete do not mix well; you can almost feel how unpleasant it is right through the soles of your shoes.' Further on, he warns against the 'fatal' effect of combining cast cement with brick or stone, and against placing concrete structures next to 'real' buildings.[7] Rasmussen thought that the juxtaposition of stone and concrete only drew attention to the poverty of concrete, and devalued the nobility of stone.

Needless to say, like all prohibitions, this one was asking to be broken – and starting in post-war Italy architects did so, shamelessly. In Figini & Pollini's Madonna dei Poveri (1952–4) in Milan, the perforated triforium screen wall is made of alternating courses of stone and concrete (p. 186). This is the only stone in this otherwise raw building. The concrete courses are continuous, but the stone blocks are spaced so that there are gaps that allow light into the nave. It is not at first sight clear which material is doing the most work – concrete has partially displaced stone, and provides structural continuity, while the stone carries the compression load and serves an iconographical function. Italian architects took pleasure in this kind of confusion in the hierarchy of materials, leaving it impossible to say which, stone or concrete, was superior. Carlo Scarpa, in the Casa Ottolenghi, a private house near Bardolino on the shore of Lake Garda, alternated concrete and stone drums in the cyclopean columns outside and inside the house. Here concrete mocks stone: no longer able to claim its historic role as the more noble material, Scarpa renounced all judgement as to which is better, either structurally or symbolically. In the reconstruction of Terni in the 1950s, many of the new buildings designed by Ridolfi & Frankl for the city mixed stone and concrete. Their formula was very simple – a concrete frame, often very roughly finished, was left exposed and filled (or sometimes clad) with carefully chosen other materials, always including some terracotta or ceramic elements. This system bore some relation to the vernacular of this part of Umbria, where stone walling frequently contains courses of brick or tile.

Stone–concrete combinations became a regular feature of advanced architecture in the 1960s and ’70s, and of the hundreds of exponents one of the best known was the American architect Louis Kahn, whose employment of this conceit was almost certainly inspired by Italian practice. At the Salk Institute, the research laboratory on the coast at San Diego in California, Kahn inverted the more customary relationship of these materials – the paving is travertine, while the vertical surfaces of the buildings, where conventionally one would expect to find the noble material, are exposed concrete. According to Kahn,

> Travertine and concrete belong beautifully together because concrete must be taken for whatever irregularities or accidents in the pouring reveal themselves. Travertine is very much like concrete – its character is such that they look like the same material. That makes the whole building again monolithic and it doesn’t separate things.[8]

Kahn made use of a similar combination on the staircase at the Mellon Center for British Art at Yale: travertine on the treads and landings, concrete for the walls of the stair drum. A British example where stone and concrete are combined is the Sir Thomas White Building at St John’s College, Oxford, designed by Arup Associates, completed in 1976: the dominant feature of this building is the precast concrete frame, while the rooms inserted into the grid have walls of Oxford stone. Although Philip Dowson, the architect responsible, claimed that Kahn was one of his inspirations, the combination of materials, delicately chamfered details and multiple layers of the building’s surface have as much in common with Italian practice of the 1950s.[9] Here, as in many other cases, stone was mixed with concrete on the face of the building for reasons of decorum, out of respect for older neighbouring buildings.

A more shameless disregard for the nobility of stone occurs where stone is made to imitate concrete. Although concrete imitates other materials, especially stone, all the time, it is exceedingly unusual for other materials to imitate concrete. Yet this does happen, and again, the earliest instances are in Italy. At the Borsa Valori in Turin, discussed further in chapter Three, designed by Gabetti & Isola, the entrance vestibule is lined with a grey material, in fact *pietra serena*, but from the way the surface is dressed, the dimensions of the blocks and the manner in which they are set, it looks like concrete blockwork, and only after very close examination did I realize that it is not.

The conceits of juxtaposing stone and concrete, or dissembling stone to appear as concrete, rely upon a pre-existing category distinction between natural and synthetic being in place. The force of the conceit comes from confounding a conventional distinction between natural and non-natural; and the results, as these architects almost certainly intended, leave us asking what this distinction amounts to.

Imperfection

If we turn from the visual appearance of concrete, and think about it more in terms of its performance, the ambiguity of concrete’s position between ‘natural’ and ‘non-natural’ becomes more apparent. As a material, reinforced concrete is not dissociable from the works made from it – one cannot take a piece of reinforced concrete, a ‘sample’, to show what the structure will be made of, for reinforced concrete only happens when the work is cast and the network of forces between steel and concrete becomes ‘live’. It is only through use, through the works made from reinforced concrete, that reinforced concrete exists. This situation is quite unlike that of naturally occurring materials, where blocks of stone, timber joists and so on, exist in their complete state prior to construction and are compositionally unchanged as a result of the process of construction. We can see and touch a piece of timber prior to its being cut and worked, but this we cannot do with reinforced concrete. As Roland Barthes wrote of plastic, a synthetic material similarly lacking in a 'raw' state, it 'is wholly swallowed up in the fact of being used'; there is no pleasure to be had from the material as such, for it only exists to satisfy a previously defined use.[10] This feature, which, as we shall see, has had a number of implications for concrete, would confirm that it belongs unambiguously to the class of synthetic, artificial, non-natural materials and processes. Yet concrete does not fully conform to the expectations of synthetic materials in that it lacks their *perfectibility*. The aesthetic raison d'être of synthetic materials lies in their capacity to achieve the seamlessness of finish, and uniformity and homogeneity of texture that naturally occurring materials lack. While variations in texture or grain may be part of the attraction of naturally occurring materials, part of their charm, the value of artificial materials lies in the fact that they are free of faults and blemishes, and are totally consistent. In this, though, concrete singularly fails to deliver. The difficulty of achieving perfection of finish has frustrated many architects and engineers, but it has also been turned into a source of delight, as Kahn recognized. The French architect Paul Andreu remarks, 'if concrete was perfect, it would be less good'.[11] Amongst synthetic products, concrete is an oddity, as defects in it are inescapable, indeed essential – for the steel in reinforced concrete to work, the concrete *has* to crack, however microscopically. This is a material whose success rests upon an imperfection. At a more straightforward, operational level – and this is to what Andreu refers – it is hard to achieve concrete without some imperfections. While these imperfections have sometimes been held responsible for concrete's unpopularity, they do not really seem to be the source of the problem. More it is that concrete, a non-natural, industrially derived product, does not conform to the expectations that we have of synthetic products. Were we to succeed in making concrete wholly perfect, it would, Andreu says, 'have no interest, it would resemble plastic'. So we are faced with a process that while non-natural in its incapacity to exist apart from the uses to which it is put, is on the other hand much more like a natural material in its failure to be perfect. It is this contradiction, rather than the imperfections themselves, that seems the more likely cause of concrete's distastefulness.

Weathering

Concrete does not age and weather like 'natural' materials. A concrete structure can look old and dilapidated even before it is finished, or sometimes as fresh 50 years later as the day the formwork was struck. The unpredictable behaviour of concrete over time is one of the main causes for its being perceived as 'unnatural' – and indeed for its bad name generally. Fairly representative are the historical geographer David Lowenthal's comments, 'Some substances age less well than others. Concrete becomes more ugly every passing year, looking greasy if smooth, squalid if rough', accompanied by a picture of a disused cement works with the caption 'Unpleasing decay'.[12] Concrete's erratic behaviour over time has not only put people off the material, but it also disturbs some of the architectural profession's conventional articles of belief. Cyrille Simonnet writes: 'Concrete presents an unexpected difficulty with regard to our traditional aesthetic categories: it does not *go to ruin*.'[13] Simonnet is alluding to the long-standing view in French architectural circles that, as Auguste Perret put it, 'architecture is what makes beautiful ruins'[14]: but ruined concrete, while quite possibly sublime, is not beautiful, and so risks letting architecture down. Behind all this there lies an expectation that architecture should behave like organic things – that what begins as nature should return to nature – an expectation concrete is unlikely to fulfil. The best a concrete structure can hope for is to become hardcore for a motorway.

The convention is that natural materials improve through age and use. The Japanese writer Junichiro Tanizaki described how 'wood, as it darkens and the grain grows more subtle with the years, acquires an inexplicable power to calm and soothe'.[15] From such sentiments, and Ruskin's influential ideas about time and ageing in 'The Lamp of Memory', David Leatherbarrow and Mohsen Mostafavi developed the argument that buildings are incomplete until weathering 'completes' them – what man begins is finished by nature.[16] But most synthetic materials do not behave like this – they look good for a while, then they just deteriorate. There are some exceptions – like Cor-Ten steel, overenthusiastically described by one American architect 'as like wine or leather, it ages well; it is like pearls on your mistress's skin that assumes a beautiful patina'. But, he regretted, 'This is not true of concrete', which develops stains, streaks, mould growths, and eventually starts to spall.[17] Concrete's tendency to lose its sparkle, often disconcertingly quickly, was a handicap from the start. The stains that disfigured the concrete church at Le Vésinet, built in 1864 by François Coignet, put French architects off concrete for 40 years.[18] Almost a century later, the Royal Institute of British Architects committee convened to advise on materials in reconstruction after the Second World War warned that 'The natural grey of Portland cement is cold and depressing, and time and weather, which give mellowness to brick and stone, make untreated concrete more and more dirty, dark, and untidy and rapidly lower its initially low power of reflecting light.'[19] Yet despite these and numerous other warnings, and the evidence of existing older concrete structures, architects in the post-war era were disinclined to believe that the same fate would befall their own buildings. As the Finnish architect Pekka Pitkänen, looking back on his career, said in 2003,

> In the 1960s we regarded concrete as a nearly everlasting material which had to remain clearly in sight. It required no covering with any 'false' surface layer. The grey concrete was rich with nuances. It fascinated us. A real problem with the concrete of the 60s was that it has not resisted humidity and frost in the long run as durably as we believed.[20]

In the 1930s Le Corbusier had started to abandon the smooth white finish of his earlier buildings, realizing the difficulties of maintaining their pristine quality, and used rougher finishes in his small pre-war houses, but the full-blown *béton brut* of the 1950s proved ineffective at hiding the effects of weather. One of the early icons of the heavy concrete style, the Istituto Marchiondi at Baggio, Milan, completed in 1959, was already disfigured within two years; *Architectural Design* commented: 'it has weathered very badly, and now that the exposed concrete is stained and streaked, to the visitor, it seems very harsh'.[21] A decade later, the exposed concrete of the Brunswick Centre in London was badly stained even before the building was finished. Theo Crosby commented breezily, 'There are the usual stains and streaks, the usual lack of drip mouldings which might throw the water clear of the vulnerable splayed surfaces, but again that is almost an essential element of the new architecture'; concrete's deficiencies with regard to the effects of time seemed unavoidable.[22]

Already by the late 1950s many architects had become worried about the disagreeable ageing of concrete, and were increasingly taking the view that if they were to use the medium, they must find ways to control its weathering. The search for a time-and weather-resistant concrete took two distinct paths and absorbed an astonishingly large amount of architects' time and attention in the early and mid-1960s. One strategy was to develop the use of precast concrete, which allowed for greater control over the composition of the material, and made possible denser, less porous and more perfect surfaces that would be less prone to staining. This approach coincided with (and provided a further justification for) the desire in most developed countries to move building production off the building site and into the factory. The other approach was to concentrate upon the design of buildings and of their details – the sorts of things Crosby had identified as lacking in the Brunswick Centre – so as to make them more resistant to the effects of weather. This approach led to all sorts of results, some affecting the entire overall form of buildings. A few examples will give an idea of the enormous diversity and ingenuity of these experiments.

The ‘corduroy’ effect of the exposed concrete developed by the American architect Paul Rudolph, where the concrete was cast with vertical ribs that were roughened by hammering away the surface to expose the aggregate, was in part a response to the weathering of concrete. Rudolph’s first exposed concrete building, the Temple Street Parking Garage at New Haven, had a smooth finish, but with pronounced raised marks left by the joints between the boards of the formwork. Aware of the shortcomings of exposed concrete, in his next building, the Art and Architecture School at Yale (1958–64), Rudolph adopted a different approach, which he later explained as follows:

> The notion of the concrete and how it should be handled derives from how concrete weathers. My notion was that if you got to the inner guts of the concrete, the aggregate and its color, and ex posed that, and then made channels for the staining to occur, that it would weather much better.[23]

Vertical ribs were also used on the much larger Place Bonaventure in Montreal (1964–8), where the severity of the climate put exposed concrete to the test; here the outside walls were made of precast panels, the ribs were not hammered away except on some of the lower portions, and open joints between the panels allowed rainwater to drain away behind the panels. A case of more delicate precast facing panels was an office building in London, in Arundel Street, by the Aldwych, where three types of panel were used, one a smooth-faced shallow pyramid for the spandrels on the upper floors, the second flat with diagonal grooves, and the third with vertical grooves. Their purpose was, as the *Financial Times* correspondent put it, to ‘turn the weather to good account by breaking up the rainwater and allowing some surfaces to be washed and others to remain sheltered’.[24] Other experiments with diagonally grooved surfaces of this kind to control the flow of rainwater include the large Ballymun housing scheme in Dublin, designed by James Cubitt & Partners, and James Stirling’s Student Residences at the University of St Andrews, Scotland (1964–8). A more radical approach was adopted by the architect John Partridge, of Howell Killick Partridge & Amis. His concern was, as he put it, to ‘aim defensively at ensuring that the effects [of weathering] are negligible and insufficiently damaging to the general design’. Identifying traditional ‘hole-in-the-wall’ window openings as inevitable causes of staining where water runs off the sills, Partridge devised an entirely different form of ‘hooded’ window to prevent that from happening. By this means, and a number of intricate details to contain the flow of water over the surface, Partridge, in buildings he designed for two Oxford colleges, St Anne’s and St Anthony’s, tried to ensure that concrete would not succumb to the weather. Yet for all the ingenuity of his efforts to prevent its disfigurement, and to take the building out of time, he admitted wistfully that ‘weathering is still a bit of a gamble’.[25]

These experiments to limit the contingent effects of time and weather came to an abrupt end around 1970 when exposed concrete fell from grace. When it made a comeback in the 1990s, part of its attraction to the architects who started to use it again was precisely that it *did* stain, *was* subject to unpredictable effects of weather, that it *was* a gamble. As Jacques Herzog, of the Swiss architectural practice Herzog & de Meuron, one of the pioneers of the revival of exposed concrete, explained: ‘we are interested in the mosses and lichens that grow on the surfaces of stones . . . The pencil of nature (that is what Fox Talbot called photography) would also become the pencil of architecture.’[26] The hazards of weathering ceased to be regarded as a defect, and now became a positive asset to the architect. In buildings like the studio for Rémy Zaugg, or the Rudin house at Leymen (1996–7), outside Basel, the architects made no attempt to control the flow of water, allowing it to take its own route down the surface of the building. The house at Leymen has no gutters, so water just runs down the exposed concrete of the outside walls: one, clearly intentional, result of this is that the building’s appearance is always changing according to whether the surface is wet or dry. The pencil of nature leaves its mark. Another similar, slightly more controlled, way of inducing weathering was adopted by another Swiss architectural practice, Gigon Guyer, who in their extension to the Oskar Reinhart Museum at Winterthur (1997–8) added copper to the concrete, so that it has developed irregular green streaks where the surface is frequently wetted. At the signal box at Zurich

(1996–9), a monolithic concrete block, Gigon Guyer added iron oxide so that the building has acquired a rust-like patina over time. A comparable experiment in 'enhanced' or 'accelerated' weathering is Sarah Wigglesworth Architects's building at Stock Orchard Street in North London (1996–2000), described in more detail in chapter Nine, where the side of the building that abuts the main railway line is faced with bags filled with sand, cement and lime; as the fabric of the bags rotted away, the concrete inside was exposed, the hollows and recesses attracting dirt, and the exposed surfaces cracking and crumbling.

These recent experiments set out to make concrete behave, if not like nature, at least in accord with it; they are distinct from earlier approaches where it was assumed that the quality of concrete to be brought out was its capacity to resist, or to overcome nature. These experiments are all relatively small-scale, and at present it seems unlikely that we shall see any large intentionally dirt-attracting exposed concrete structures appearing in our cities: too easily mistaken for a 1960s concrete megastructure.

What, we might ask, are the expectations for a building to behave 'naturally' over time? The traditional attitude towards weathering seems to rest on a supposition that buildings are like humans, who as they get older show their age in their outward appearance. People's skin wrinkles, becomes visually more complex and interesting, their physiognomy shows what they have been through – not for nothing did Rembrandt choose to paint old rather than young flesh, and sometimes makes explicit analogy between the aged hands and face of the sitter and the decaying stone of a wall. Concrete, however, does not conform to this pattern of ageing: the surface of concrete is not a reliable indicator of its internal condition. Reinforced concrete deteriorates from within, as water penetration sets off alkali-silica reactions, causing carbonation and corrosion of the steel, all of which is invisible until the decay reaches an advanced state, when spalling occurs and pieces fall off the surface. A lot of remedial work in concrete repair goes into diagnosing what is happening beneath the surface, to determine whether chemical changes are occurring; the appearance of the surface is no guide to its internal condition. Unlike traditional materials, where decay starts on the outside and works its way inwards, concrete decay starts inside and works its way outwards. This process, disconcertingly like cancer if one must draw a biological analogy, does not correspond to the ageing of 'natural' materials. What discomfort at the erratic ageing of concrete draws attention to is not its 'unnaturalness', but rather our over-attachment to the appearance of human skin as the aesthetic criteria by which we judge materials.[27] While recent experiments with concrete have been largely concerned with the unfreezing of time, recognizing and accommodating its contingency into architecture, they take place against the context of an unthinking assumption about the normality of the separation of the natural from the non-natural. If concrete offends, it is not so much for being 'unnatural', but rather because it threatens the convention of the division between nature and the non-natural.

Reworking Nature

It is not only concrete that is affected by nature, but ‘nature’ is changed by concrete. John Boorman’s film *Point Blank* (1967), set in San Francisco and Los Angeles, follows the single-minded determination of Walker, played by Lee Marvin, to recover his share of a robbery after he has been crossed by his wife and his accomplice, Reese. Walker tracks down and then disposes of first of all Reese, but then every level above him in the underworld organization with which almost every character in the film seems to be associated. There is a lot of concrete in the film; many of Walker’s encounters with other people occur on, in or under pieces of infrastructure – freeways, bridges, water courses – and the blankness of these settings seems to replicate Walker’s own hardness and indestructibility. So impassive and inscrutable is Walker that we start to wonder whether he is indeed alive at all, or whether the whole thing is not some point-of-death hallucination. The most dramatic and extended of these encounters in a landscape of concrete takes place on the Los Angeles River. After he has disposed of Reese, Walker pursues Carter, Reese’s superior in the organization. Carter agrees to pay Walker his $93,000 and sends a henchman off with it in a parcel to a rendezvous on the Los Angeles River. Correctly suspecting a trap, Walker forces Carter to come with him, and at gunpoint makes him go down to the riverbed to collect the package, whereupon the sniper whom Carter has placed on one of the bridges shoots and kills Carter, mistaking him for Walker. Walker walks down to the bottom of the riverbed, rips open the parcel, finds that it contains not dollar bills but only blank pieces of paper, and watches impassively as they scatter and float away down the river.

In this and similar scenes set against concrete, men are tested, and sometimes destroyed. The concrete landscape of Los Angeles takes the place of the desert, where in Westerns, as in Judaeo-Christian mythology, men are pushed to their limits and, through thirst or hunger, disclose their inner nature. But whereas in the Western, or in the biblical origins of desert-testing symbolism, the desert is apart from the city and by that definition a 'natural' place, in *Point Blank* the *mise en scène* is a denatured nature, located within the city. The Los Angeles River, the setting for the climactic scene, is a colossal work of hydrological reconstruction, executed over 30 years by the U.S. Army Corps of Engineers, the largest project of its kind undertaken in the U.S.[28] Earlier in the twentieth century, the river had been liable to flood, causing devastation in its lower reaches before entering the sea at Long Beach. In 1930 F. J. Olmsted Jr and Harland Bartholomew had proposed the creation of a floodplain to absorb the floodwaters by public appropriation of 100,000 acres of land that would also have provided a recreational area within Los Angeles; but opposition from the owners of the land, who wished to develop it for building, caused the plan to be abandoned, and instead, in 1938, work was begun to contain the river within a concrete channel – one section of which appears in *Point Blank*. Some have viewed the Los Angeles River project as a dispossession of nature: moving water is channelled and controlled, and all sign of organic matter has been erased in order to satisfy the desire to profit from the development potential of the land. However, as *Point Blank* suggests, while it is certainly true that one kind of nature has been displaced, another has also been created. Let us, following others who have written about this phenomenon, call this new nature 'urban nature' – here, as so often, created through the agency of concrete.[29]

To film-makers and writers, nature reworked in concrete has been rich material. Like Boorman, Stanley Kubrick saw the opportunities of the concrete landscapes of Thamesmead in southeast London as a setting for the violence of *A Clockwork Orange* (1971). And in literature, a story like J. G. Ballard's 'The Terminal Beach' (1964), where the concrete installations of an abandoned military research base become the surrogate of nature, relies upon the atmosphere created by this background. But this alteration to the nature–culture relationship is everywhere – in common speech it is the 'concrete jungle', no less.

Most revealing of these realignments of nature are moments of resistance to the process. In Western societies the most common points of tension have been around large-scale hydrology projects of land drainage, irrigation and fresh water supply, and road building. We have already seen one case of hydrology reworking nature with the Los Angeles River, but it has particularly been the need to supply cities with water that has forced recognition that the boundary between 'city' and 'nature', so heavily invested in Western culture, is a less secure category distinction than had been supposed. As cities grow, they need more and more water, and that water has to come from somewhere outside the city, in some cases hundreds of miles distant. Turning on a tap in Paris instantly connects one to chalk springs in Champagne: one of the more successful, if less well known, of Baron Haussmann's projects for the modernization of Paris was the creation of a water supply from the springs feeding the Vanne river, 80 miles to the southwest.[30] Its construction produced some impressive engineering – and one stretch, the two-mile-long aqueduct crossing the valley of the Yonne, completed in 1873, was built in concrete. This, probably the earliest major infrastructural project to use the new material, was executed by the concrete entrepreneur François Coignet, an industrial chemist whose experiments with the production of cement led him, in the search for commercial applications for his new product, to become a pioneer concrete contractor.[31] The massive structure, made from compacted concrete and without reinforcement – for it predates the invention of steel reinforcement – was exposed, and not faced with another material; although Coignet considered facing necessary for his urban projects, economy here dictated otherwise, and it seems to have aroused no criticism at the time.

Nevertheless, in later water engineering projects, the intrusion of the city into the countryside has been a far more sensitive issue, raising questions about the status of 'nature' as something external to the city, and pre-existing human society. The Marathon Dam, built in the late 1920s to create a water supply for Athens, with American loans and by an American civil engineering firm, was, as Maria Kaika has shown, 'sold' to the Greeks on the basis of its connections with Greek antiquity. At the base of the dam stood a replica of an ancient temple, 'The Treasure of the Athenians'; the original marked the victory of the Athenians over the Persian 'barbarians' in 490 BC, and the replica celebrated the victory of civilization over wilderness. The concrete dam itself was faced with Pentelian marble – the same as was used for the Parthenon – so as to merge the construction into both the historical and the physical landscape of the locality.[32] The Hoover Dam in Colorado was the first of the great hydraulic projects whose modernity was explicitly and visibly celebrated; here, exposed concrete was justified on the grounds that it stood in such a remote spot (p. 275). Elsewhere, though, and especially where water supply projects were politically contentious, the tendency was to conceal the 'unnatural' construction of the dam with natural materials.[33]

Road building, especially of freeways, motorways, *autostrade* and *autobahnen*, connecting cities across the countryside, is another incursion of the urban into 'nature'. Although *in* the countryside, they are not *of* the countryside; they are urban arteries that are alien to nature, but which nonetheless allow travellers to experience nature. The German autobahn programme, commenced by the National Socialists in 1933, demonstrates the dilemmas arising from this relationship particularly well.[34] The autobahns were intended for recreational driving – the assumption was that freight would be carried by rail, so the only traffic on them would be cars. The experience of the countryside offered by the roads was an important priority, since National Socialist ideology, with its antagonism to cities and longing for nature, was looking for ways to reconnect the German people with the land, the soil. Driving on an autobahn would not only allow the urban dweller to enjoy the German landscape, but more particularly the chance to experience it in a wholly novel manner, unfamiliar even to the railway traveller. The routes for the autobahns were not necessarily the shortest, or the most practical in terms of gradients, but were chosen to offer the best scenery: as one of the autobahn engineers, Walter Ostwald, explained, 'We must build not the shortest, but rather the most noble connection between two points!'[35] The Munich–Salzburg autobahn, instead of following the line of the valley, was taken over the foothills of the Alps, so as to afford a varied and changing landscape. According to a story consistent with the *Wandervögel* origins of many of those responsible for the autobahns, the route was chosen by Fritz Todt, the Inspector General of the *Reichsautobahn*, following a hike in the mountains 'with a few engineer and skiing friends'. Todt wrote: 'No other route offered the possibility of composing the landscape experience with such variety and intensification as here.'[36] The road climbs the Irschenberg, and when it arrives at the crest presents a spectacular distant view of the Alps – yet the gradient necessary to achieve this effect slows the traffic down, and still now causes frequent traffic jams. But while the routes were chosen to offer the best scenery, and curved so as to enhance the views from a moving vehicle, the physical structures of the autobahns, built out of concrete, were an invasion of the technical into the natural scene that was being revealed. A considerable amount of attention went into planting and design so as to minimize the impact upon the landscape, yet at the same time the engineers did not want the engineering achievements of the construction to be entirely hidden and left unappreciated, for it was also part of National Socialist ideology to overcome the contradiction between nature and technology. The bridges and viaducts, the most visible feature of the roads, were therefore treated as important symbols of the successful resolution of the nature–technology relationship. The most critical points of all were where one autobahn crossed over another; normally the engineering of the roadway was beneath the motorist and so invisible, but at intersections the motorist, while travelling along one road, was able to appreciate the engineering skill that had made possible their own transit. Hence particular attention was given to the appearance of these intersection bridges. Where bridges crossed the autobahns in open countryside, the policy enunciated by Paul Bonatz, the architect who acted as artistic adviser to the road construction agency and designed many of the bridges, was to make the bridges as transparent as possible, minimizing their mass, to preserve 'as much as possible the clear view for the user' and not obstruct the view of the landscape beyond;[37] they therefore avoided tunnel-like bridges with solid abutments that would block the view and favoured concrete, and later the newly developed prestressed concrete, as the means to the most slender construction. (Steel was discounted because of connotations of engineering rationality, its overly American character and insufficient monumentality – and in any case, after 1936 when the re-armament programme began, was unavailable in sufficient quantity for civil engineering.) The earlier bridges were built in exposed concrete, but in order to avoid the 'monotonous and expressionless' surface of concrete, and to connect with the landscape of the region, they were generally built using local aggregates and the cement skin removed by the stonemasonry technique of bush hammering, allowing the concrete 'to gain its material character' as the natural colour of the aggregate was revealed.[38] However, the use of exposed concrete for the structures of the autobahn came into conflict with one of the other propaganda claims of the autobahns, that they provided the opportunity for the re-employment of traditional trades, especially stonemasons, who had suffered during the Depression; for this reason, and on account of increasing sensitivity about making the structures harmonize with the landscape, most of the bridges built after 1936–7 were either faced with natural stone or built entirely of stone. A further possible reason for this was that, especially once re-armament began in 1936, there was a chronic skills and labour shortage for autobahn construction, and it may have been found too difficult to achieve exposed concrete work of satisfactory quality, and easier to face it in masonry. The masonry facing of the concrete structures also followed the practice of the American parkways, whose bridges had likewise been faced in stone to preserve the motorist's illusion that while driving along the parkway they were 'in nature'; although the scale of the German autobahns far exceeded the American parkways, Todt studied their example closely and had all the relevant American publications on parkways translated into German for the benefit of his engineers.[39]

Throughout the propaganda for the autobahns, there was repeated reference to the idea that technology had awoken the landscape and revealed it to the German people. Yet while technology had realized a new nature, it could not be allowed to overpower nature. A booklet about the autobahns published in 1941 writes:

> With their broad clear band of supple lines, the autobahns add a new feature, a creation of the age of technology, to the natural forms and cultural landmarks of Germany. Following their own laws, the autobahns impose upon the accustomed scene of forests, fields and plains without however destroying the character of the setting. Like towns, villages, roads, canals, railways, they represent the human will making its mark upon the countryside; however, they engage even more fully with nature because their routes are chosen to avoid human concentrations. They do not stand out brutally from the landscape, like some unrelated and purely technical project; on the contrary, the work of an artist, they are closely adjusted to it. In the mountains, the concrete piers of the autobahn bridges are clad in natural stone, quarried from the locality, so as to adapt each bridge to its surroundings. Thus the very best has been done to make the new technology fit organically into the landscape.[40]

Contained in this passage are references to the reconciliation of nature and technology that were so central to German engineering under National Socialism. Whereas American practice was seen as guided purely by efficiency, the aim of German engineering was to create 'culture' and to realize human potential. As Alwin Seifert, the principal landscape designer of the autobahns, said at the opening of the first autobahn section in 1935, 'To conceive of motor and motor roadway as ends in themselves, that is just barely civilization; to use them as means for a deeper experience and new insight, that alone is culture.'[41] On the autobahns, concrete was the medium that made possible the realization of the German landscape, and of the German *Volk*, changing each in the process into something new. It is in this context that we need to understand the dilemma facing the designers of the autobahns and their associated structures, like the petrol stations and restaurants, as to whether the concrete of which they were built should be visible or concealed. If concrete represented 'culture', then its relationship to 'nature' had to be evident; yet at the same time, if too visible it risked appearing as an unacceptable intrusion into nature or compromising the creation of a 'new' nature.

The ambivalence towards concrete and nature present in the German autobahns and the great hydrological projects draws attention to the difficulty we have in characterizing 'nature'. The traditional view is that nature is that from which man is absent, the place on earth before man arrived, and from which he emerged. Nature, it is supposed, has a power of its own, a power that man lacks and on account of which man is dependent upon nature, forced to draw upon its resources. Within this cosmology, the city, a construct of man, stands against nature. These ideas about nature, which mostly go back to the eighteenth century, have been under attack for some time, principally by Marx, who argued that man created 'nature' in order to satisfy his own needs. Nevertheless, the older notions of nature have had an extraordinary persistence, and nowhere more so than in modern political notions of ecology, where the existence of a benign, original nature with healing powers stands against the 'selfish' exploitations of mankind. Concrete is thoroughly caught up in the confusion and contradictions that constitute our ideas about nature. On the one hand, an artificial product, plundered from nature, it resists nature and produces environments from which nature is excluded, that are 'denatured'. On the other hand, what it makes possible, and allows to emerge, are analogues of nature, places and situations that fulfil many of the roles traditionally filled by nature within human consciousness, yet without the presence of organic matter.

Nowhere does the confusion over concrete's 'unnaturalness' emerge more clearly than in the lack of agreement over concrete's environmental consequences.

Sustainability

> Concrete is an issue for me; it's not really a sustainable building material.[42] Martin Willey, President of the Royal Town Planning Institute, 2009

> Concrete is . . . environmentally sustainable, with green credentials that outperform both steel and timber.[43] Concrete Centre website, 2009

In the late 1980s, discussions about the relationship between nature and concrete shifted to concrete's effects upon the earth's natural resources and the planetary ecosystem, effects whose enormity made previous aesthetic concerns look trivial. Concrete absorbs a significant quantity of global resources: it is the most widely used material on earth apart from water, with over two-and-a-half tons produced each year for every man woman and child on the planet.[44] Concrete production is estimated to consume annually eight billion tons of raw materials, mainly sand and aggregate, but also limestone, the main ingredient of cement.[45] The evidence of this is visible everywhere, in the scars left by the extraction processes, gravel pits, chalk quarries and entire mountains removed to feed the insatiable demand for cement. Since these materials are so plentiful, and are not themselves likely to run out, concrete had not figured in earlier alarms about the depletion of natural resources in the mid-1970s, when warnings about the 'limits to growth' were first heard.

However, the growing realization during the 1980s that the greatest threat facing human occupation of the planet was not the using-up of reserves of energy and materials but global warming caused by CO_2 emissions shifted attention onto concrete. Concrete, and more specifically cement production, was a significant and readily identifiable source of carbon in the atmosphere. Cement, which constitutes around 13 per cent by weight of normal concrete, generates exceptionally large amounts of CO_2: the production of one ton of Portland cement produces around one ton of CO_2 – though, as we shall see, there are ways in which this can be reduced through the addition of non-cementitious additives, and the claim made by the association of the world's eighteen largest cement firms for the extraordinarily low figure of 670 kg of CO_2 emitted per ton of cement must be based upon assumptions of a high use of such additives.[46] Cement production involves baking limestone and clay at 1450°c to produce glass-like pieces called clinker that are then ground to a powder. The carbon emissions are generated in two ways: as a chemical reaction when the limestone is burned, and from the fuel used to fire the kilns and extract and transport the materials. Around 50 per cent of the carbon emissions are the result of the chemical reaction; around 40 per cent by the burning of fuel to fire the kilns, and about 10 per cent from fuel to extract and transport the raw materials. The CO_2 produced by the chemical reaction is unavoidable, and there is nothing that can alter this, but there is scope to reduce the CO_2 generated by burning fuel through the use of more efficient kilns, or by using as fuel waste products like used tyres that would otherwise go into landfill, and so offsetting the carbon emissions. Whatever the result, though, it seems impossible to reduce the CO_2 from the production of Portland cement below 900 kg per ton, so the total emissions from cement production are enormous – estimates range between 5 and 10 per cent of all world CO_2 emissions. (This vast discrepancy depends upon the source and is characteristic of the imprecision of many of the 'facts' about the sustainability of concrete; part of the reason lies in uncertainty about the annual global production of cement, estimates for which range between 1.5 and 2.5 billion tons.)[47]

Cement producers from developed countries claim that on account of their own greater fuel efficiency, '80 per cent of emissions in the cement sector come from developing regions' – principally China, which now produces half the world's cement.[48] This claim is not entirely convincing, however, since apparently North America has some of the least fuel-efficient kilns, while the most fuel-efficient kilns are said to be in less developed countries: India, the world's second largest cement producer, is reported to have the most efficient cement plants in the world. That China carries such a large share of the CO_2 production deriving from cement seems indisputable though, and fits with current figures for overall CO_2 emissions from China, which in 2009 produced 24 per cent of the world's CO_2, just above the United States, responsible for 22 per cent. China's response to this figure was that since China's industry largely manufactures goods for export, responsibility for the carbon emissions should be borne by the consumers, not the producers of those goods (6 per cent of China's emissions are linked to exports to Europe, 9 per cent to exports to the U.S.).[49] Since the infrastructure to make the goods is in large part made of concrete (think of the quantity of concrete in the Three Gorges Dam), it might be argued that some of China's cement-derived CO_2 emissions could similarly be charged to Western nations.

In this game of passing around blame for CO_2 emissions, what is inescapable is that on the global scale the production of concrete produces a disturbingly high proportion of all CO_2 – at the lowest estimate 5 per cent of the total, compared to the 4 per cent generated by that well-known reprobate, air transport. In the face of this reality, and the extraordinary, insatiable demand for cement – current consumption is estimated to double by 2042[50] – there is good reason to be anxious about the effects of concrete upon the environment. At this point the argument moves on to the possibility of making concrete with less cement, or none at all. For some time it has been known that by adding certain compounds to cement, the cement content of high strength concrete can be reduced. The most effective additives are fly ash, the residue captured by filters in the flues of coal-burning power stations, and ground glass blast furnace slag (GGBFS), a waste product of steel production. It is possible to replace as much as 80 per cent of the cement in concrete with fly ash and GGBFS and still retain the concrete's strength. There is, however, a disadvantage in that unlike cement, which generates heat that accelerates setting when water is added, these additives do not, and therefore it takes much longer for concrete made with them to attain full strength, which slows down construction. In practice it has been found that a 60 per cent substitution of cement, which reduces the total embodied CO_2 by half, produces satisfactory results. Persistence Works, an exposed concrete arts studio building in Sheffield, designed by Feilden Clegg Bradley, finished in 2003, was built using 60 per cent GGBFS and 40 per cent Portland cement in the concrete.[51]

A more radical solution to reducing the embodied CO_2 of concrete is to do without Portland cement altogether, either by using non-cementitious binding agents, which act like cement but are not themselves cement, or by reverting to traditional materials and processes – lime, rammed earth, mud bricks. In the progressive approach, various alternatives to Portland cement have been developed, but as none have so far satisfied the necessary testing and validation processes, their use seems to be limited to non-structural applications like paving stones, drainage pipes and sea defences. The first of these cement substitutes are the geopolymers developed by Jean Davidovits's Geopolymer Institute of Saint-Quentin in France: these are silicon-aluminium compounds, synthesized at much lower temperatures than Portland cement, and therefore producing about one third of the CO_2 of Portland cement. With characteristic modesty, Davidovits states: 'There is no other existing and proven technology in the world today which offers such hope for saving the world's atmosphere.'[52] A comparable product, Eco-cement, developed by John Harrison of Hobart, Tasmania, is based on magnesium carbonate, which again is produced at a much lower kiln temperature, 650°c. This product is also claimed to *absorb* carbon; for although this happens to a limited extent over time with all cements (and indeed is a major cause of the deterioration of reinforced concrete), it is said to happen more rapidly with magnesium carbonate cement. A third cement substitute is made from the heavy residue left in the process of refining oil. This has traditionally been disposed of by mixing it with lighter oil and burning it, but a process developed by Shell and the Technical University of Delft developed a binding agent from this waste product, 'c-fix', from which so-called 'carbon concrete' can be made.[53] Since none of these products have been licensed for structural use, their impact on the market for Portland cement has, so far, been negligible.

The argument for older materials and processes that predate Portland cement is that while they cannot substitute for Portland cement's structural applications in reinforced concrete, there are nevertheless a great many occasions on which Portland cement is used unnecessarily, simply because it is convenient. Lime, which has a lot less embodied CO_2 than cement, when mixed with aggregates, is of sufficient strength for many applications, like foundations. A new development (though it is in effect simply an industrialized version of a pre-modern building technology) is to mix lime with a vegetable aggregate, chopped hemp, to produce a lightweight, non-structural product, 'hemp concrete', with good sound-absorbing properties and high thermal inertia, good for internal walls and for non-structural external walls, with suitable weather protection. The product has been developed and used in Britain and France. An example of its use is the distribution depot built in 2006 for Adnams Brewery outside Southwold in Suffolk, where the external walls are made of 'hemcrete' blocks, with a brick facing for protection at the lower level. Hemp concrete's great advantage is that by using hemp, a fast-growing crop, it is possible to capture carbon from the atmosphere and so, by sequestering CO_2, to build structures that have a *negative* CO_2 emission: one ton of harvested hemp will have absorbed two tons of CO_2 while it was growing, and hemp concrete passes this gain on to the building. The Adnams distribution depot generated a carbon *credit* of 80 tons of CO_2, compared to approximately 450 tons of embodied CO_2 emissions that a building of this size would normally have created.[54]

When we come to the older techniques of rammed earth and mud brick, we are dealing with very basic technologies that have been in use for thousands of years with, in many cases, long-lasting and satisfactory results. The argument here is that the inexorable advance of cement into every kind of construction in every part of the world has displaced, possibly unnecessarily, these older processes which consume virtually no energy at all in their production, and which can be made extremely efficient in terms of their energy use in occupation. In many parts of the world, mud bricks have been used, and continue to be used, to produce perfectly satisfactory buildings of up to two storeys – it is estimated that there are more mud-brick or rammed-earth buildings in the world than there are stone or timber. Yet increasingly, as the cement industry has become established in developing countries, in its search for new markets it has entered the field of low-tech domestic building. Two factors favour cement. The first is that its performance is predictable, it is manufactured according to established norms, whereas mud and rammed earth lack any constructional standards, making their behaviour unpredictable. As soon as a third party enters into the construction process – a contractor, an architect, an engineer – their obligation to take responsibility for the project and to avoid liability for any failure always inclines them towards the tested and validated materials and processes, and away from the unpredictable and non-certifiable. Particularly in earthquake-prone regions, there are good grounds for anxieties about mud-brick construction, for it is notoriously susceptible to earthquake damage, often with fatal consequences. Secondly, the desire to be 'modern' puts traditional processes at a disadvantage. As Paul Oliver has written, 'in all parts of the world where mud is employed there is a fascination for steel, concrete and glass on a Western model', and twenty-five years ago he suggested that one remedy for this might be to invest earth building in the West with glamour, so that it too might become a model for emulation in the developing world.[55] Nor should we forget to ask to whose advantage such a transformation might work: as the geographer David Harvey reminds us, 'all debate about ecoscarcity, natural limits, overpopulation, and sustainability is a debate about the preservation of a particular social order rather than a debate about nature *per se*'.[56] Discouraging people in developing countries from building their houses out of concrete might save some CO_2 emissions, but is the purpose of doing so simply so that Westerners can continue to enjoy their accustomed way of life? The Brazilian architect Lina Bo Bardi was scathing about the international aid agencies' enthusiasm for promoting earth and raw brick construction in underdeveloped countries, '*mud* for the third world, and concrete and steel for those above the equator': it was simply a way to exclude them from the 'club'.[57] Even a small reduction in the West's carbon emissions, which might have as much or greater consequence for the planet as any change in building practices in the developing world, could not easily be achieved without significant political and social changes.

So far, we have been looking at the CO_2 consequences arising from the production of structures, buildings and of the materials that go into them, or so-called 'embodied CO_2'. Advocates of concrete argue that while concrete has a higher embodied CO_2 than other building materials, when it comes to the use of buildings over time, concrete has the potential to reduce CO_2 emissions. This argument applies only to buildings that consume energy, and not to civil engineering structures like bridges. Because the energy consumed over the lifetime of a building in heating, cooling and lighting far exceeds the energy expended in its construction, even small savings in the energy use of a building are of far greater long-term consequence than large savings in the construction stage. (The UK Concrete Centre estimates over the 'typical' 60-year life of a building, about 10 per cent of its CO_2 emissions are attributable to construction, and about 90 per cent to heating, cooling and lighting.) Concrete has high thermal mass, or in other words it is good at storing heat, and this property can be used to help to maintain an even temperature inside buildings, so reducing, or altogether doing away with, the need for air conditioning and heating. This puts concrete at an advantage over other building materials. In warm climates, or during the summer in temperate climates, exposed concrete surfaces inside a building absorb heat, and then at night, if cool outside air is passed over them, they cool down again, ready to absorb heat again the next day. In winter the process is reversed, as concrete absorbs heat during the day from solar gain, human occupation, electrical equipment and heating, and then during the night, as the building cools, releases this heat, so that less energy is needed to warm the building up again the following morning. This process of evening out daytime and night temperatures is most effective in temperate climates, and in buildings like offices and schools where the peak internal temperatures correspond to the maximum occupancy. To take advantage of the thermal mass of concrete, the surface has to be exposed, with the greatest effect coming from the exposure of the soffits; exposed vertical surfaces give some benefit, and floors the least. There needs also to be a means of allowing cool air to pass over the surfaces at night in the summer to cool the concrete. Experiments done with house construction in the UK by Arup Research and Development show that houses built with masonry or concrete will overheat less than more lightweight timber-frame constructions: a house built with brick and block cavity walls, although it has 1.25 tons more embodied CO_2 than a house built with timber frame construction, was estimated to emit 15 tons less CO_2 in heating and cooling over a 60-year period, from 2001 to 2061.[58] This appears to be one of very few pieces of research to assess the relationship between embodied and lifetime energy costs associated with concrete – and its argument rests upon an estimate of sharply rising summertime temperatures in the twenty-first century: in other words, the sustainability benefits of concrete do not exist at present, but will only accrue in future, if temperatures rise at the rate estimated. In the absence of any further reliable information about the relationship between embodied and lifetime energy costs of buildings, we can only say that the case for the 'sustainability' of concrete awaits further evidence before any conclusions can be reached.

The final controversy over concrete's sustainability is over what happens at the end. The early pioneers of concrete thought they had found an 'everlasting' material; in this they were to be sadly disappointed, for the internal chemical changes to concrete caused by alkali-silica reactions and carbonation mean that it is not as stable a substance as they had supposed. Although it may last for a very long time, it does undergo changes, and according to the precise combination of ingredients, and local atmospheric conditions, may lose its strength or otherwise deteriorate over time. Amongst concrete experts, the view is that *all* concrete structures will sooner or later need radical repair if they are to continue to be useful – and concrete repair, especially when it calls for the re-alkalination of the material, is a difficult and costly process.[59] But even if the substance were itself everlasting, the products made from it are not, and like all structures fall victim to obsolescence, which usually ends with demolition. What happens to buildings when they are demolished? Construction debris and demolition waste is estimated to contribute between 25 and 50 per cent of all municipal solid waste in Europe, or between a half and one ton of waste per person per year.[60] Where does this waste go? In the UK, in 1999–2000, around 65 per cent of construction waste ended up either in or on the land.[61] Concrete waste, because it is the least easily recycled, probably makes up a large part of this figure. Structures made of steel, brick or timber can be dismantled and the materials reused, but the monolithic nature of reinforced concrete makes it, by definition, impossible to disassemble. Only by attacking it with explosives or mechanical weaponry, and then breaking it up into pieces, can it be removed. The steel reinforcement can be salvaged and recycled, while the remaining matter can be ground down into small pieces and reused as aggregate; however, this is a messy, noxious and expensive process, and while the theory is fine, in practice the market for recycled concrete aggregate is limited. Its chemistry will be uncertain, depending upon the ingredients originally used, and likelihood that the supply of recycled aggregate will have come from different sources means that it is not a reliably consistent material, and is only good for low-grade uses like motorway foundations. (In some European countries there are requirements that all concrete foundations contain a percentage of recycled aggregate to divert it from ending up as landfill.) So while the advocates of concrete are correct in saying that reinforced concrete *can* be totally recycled, the reality is that far from all waste concrete is recycled. For this reason, those contemplating demolition of a concrete building are encouraged to look at the alternatives – but although it is increasingly common to see older concrete buildings stripped back to the frame and serving as the structure for a new building, there are limits to this: a redundant shopping centre cannot be turned into residential accommodation, nor a multi-storey car park into offices (the floor-to-ceiling heights are too low). So concrete buildings still end up being demolished, and although in theory all their waste could be recycled, in reality only a proportion of it is returned to use.

In short, the relationship of concrete to nature thrown up by concerns over the environment is entirely inconclusive. While it is clear, as the cement and concrete industry argues, that concrete *could* be as sustainable as other building materials if not more so, given improvements in cement production, attention to the choice of cements, care in the design of buildings to promote long-term energy savings, and accountability for demolished concrete structures, the facts of the case are that we are still far from achieving that position. The claims for concrete's sustainability, while perfectly credible, belong in the future rather than in the present.

The discussion of sustainability can leave no doubt about the physical changes to nature brought about by concrete, even if their extent is inconclusive. No less significant though are the changes that concrete has made to what we perceive as 'natural'. Any encounter with a piece of concrete, anywhere in the world, at once launches us into a dialogue about what 'nature' is, and exposes all the uncertainty and confusion that surrounds that term. Without concrete, 'nature' would indeed be impoverished.

THREE

A MEDIUM

WITHOUT

A HISTORY

The unhistorical and the historical are necessary in equal measure for the health of an individual, of a people and of a culture.

Friedrich Nietzsche (1874)[1]

IS CONCRETE a historical medium – or is absence of history part of its appeal? For much of the twentieth century professionals and non-professionals alike have struggled to make sense of concrete. The technical development of the medium and its extraordinarily rapid take-up by the construction industry outran the capacity to think about it: people had to accommodate something that had not been there before into their mental universe. A lag between the invention and creative exploitation of a medium and its cultural assimilation is not unusual – with both cinema and television, critical thinking about their social and artistic implications developed well after the first rush of creative output – but in the case of concrete, the process has been even more prolonged. For a medium developed in the mid-to late nineteenth century, people were still in the late twentieth century working out what to think about it. A significant amount of this mental effort went into deciding where, if anywhere at all, concrete belongs in relation to history. Within the field of architecture, there is one intellectual tradition that sees concrete as having made it possible for architecture to fulfil its destiny, to achieve things that people in previous times had dreamed of, but had lacked the means to realize. According to an alternative line of thought, though, concrete's newness detached it from all past traditions, set it outside history, and offered architecture the means to break free from the burden of its past. What follows are some reflections on these two apparently irreconcilable points of view and their consequences.

The Historicity of Concrete

In France, at the time when concrete came on the scene, the dominant and most persuasive architectural theory was the body of principles known as structural rationalism. For architects, therefore, the problem was to accommodate concrete into structural rationalist doctrine, according to which architecture was an ever-developing structural art. While concrete looked as if it should conform well to the doctrine, it at the same time called into question some of its principles and was, ultimately, its undoing. One of the axioms of structural rationalism was, in the words of Eugène-Emmanuel Viollet-le-Duc, its principal theorist, that 'a change of materials must bring about a change of forms.'[2] The problem concrete presented to architects who subscribed to the doctrine was what the appropriate form for the new material should be. A second axiom was that no material should imitate the forms of any other, a prohibition Viollet-le-Duc shared with other major nineteenth-century architectural thinkers, John Ruskin, and the German architect and writer Gottfried Semper. As important in German-speaking countries as Viollet was in France, Semper laid great emphasis upon the independence of each material. In his first published article he wrote: 'Let the material speak for itself . . . Brick should appear as brick, wood as wood, iron as iron, each according to its own statical laws.'[3] Amongst German-speaking architects Semper's ideas were widely taken up, and so, for example, we find at the end of the nineteenth century the Viennese architect and critic Adolf Loos repeating the same argument in his 1898 essay 'The Principle of Cladding': 'Every material possesses its own language of forms, and none may lay claim for itself to the forms of another material.'[4] As even the most superficial history of concrete shows, not only has it been an indiscriminate borrower of the forms of other materials, but there has been a striking lack of agreement as to what its proper form should be.

Structural rationalism and Semper's theory of architecture were *historical* doctrines, that is to say they were based upon the examination of past architectures, from which they made prescriptions as to how architecture should evolve in the future. The ten volumes of Viollet-le-Duc's *Dictionnaire raisonné de l'architecture française* and the 900-odd pages of Semper's *Der Stil* are almost entirely taken up with discussion of historically remote architecture and craft: Gothic in Viollet's case, Assyrian, Egyptian and Greek in Semper's. Architecture, as Viollet saw it, was a progressive structural art whose aim was the comprehensive representation of the structural system in the outward appearance of the building, accompanied by the optimum economy of means – a definition to which Gothic architecture corresponded more closely than any form of architecture built until his own time. Structural rationalism encouraged architects to think historically, that is to say not only to look at past architecture for principles, but also to measure their own work against that of the past, and to judge their success by how far they had advanced upon the past.

Although Viollet himself did not write about concrete – it was little used by architects during his lifetime – his followers quickly saw reinforced concrete's potential continuity with Gothic, and its relevance to structural rationalist theory. The first built work to explore these possibilities was the much discussed Parisian church of Saint-Jean-de-Montmartre (1897–1904), designed by Anatole de Baudot, where ribs of *ciment armé* took the place of the stone ribs of Gothic architecture.[5] The apparent correspondence of Gothic and concrete was a commonplace in French circles in the early 1900s. The young Le Corbusier, while working in Auguste Perret's atelier, in 1908 bought Viollet-le-Duc's *Dictionnaire raisonné* and in the section on flying buttresses noted the analogy between Gothic and reinforced concrete:

> It too is a monolith, a cage of iron wires, where the steel bars of the concrete take the place of the mortar of the roman rubble-work in resisting the vertical forces and oblique thrusts. *Now*, Aug. Perret told me, hold to the carcase, and you will hold true to Art.[6]

And when Perret's church of Notre-Dame du Raincy was completed in 1924, it was nicknamed 'La Sainte-Chapelle du Béton Armé' and seen as the culmination of a process begun by the master builders of the Middle Ages.[7] Of Perret's competition design in 1926 for the enormous church of Sainte-Jeanne d'Arc planned for Paris, Paul Jamot wrote: 'this edifice would fulfil the dreams of the Gothic builders who, due to the weakness of stone, were not able to erect as many nor as high towers on their cathedrals as they had planned'; and he added, 'Thanks to reinforced concrete and to the changes it brings about, Auguste Perret – bridging five or six centuries – achieves the ideal of the Middle Ages.'[8] This idea, that reinforced concrete was the logical continuation of Gothic, circulated widely. The American engineer Francis Onderdonk took it up, but subtly shifted it, so that rather than seeing concrete as the fulfilment of Gothic, he argued it was its successor, 'a new type of Gothic', in which the pointed arch would be replaced by the parabolic arch.[9]

But as well as being a successor to the Gothic, reinforced concrete was also seen as offering a continuity of the classical tradition, an interpretation especially promoted by the English historian Peter Collins. Writing in 1953, Collins declared, 'A new trabeated stone construction, which was the dream of French classical architects, is now within our grasp, so that perhaps a fresh consideration of basic classical principles may help us to develop reinforced concrete design along its proper lines.'[10] Collins interpreted Perret's work as the refinement of classical principles. Even Notre-Dame du Raincy, Collins argued, was not so much Gothic as classical, on account of having more columns than were structurally necessary, and of its symmetry.[11]

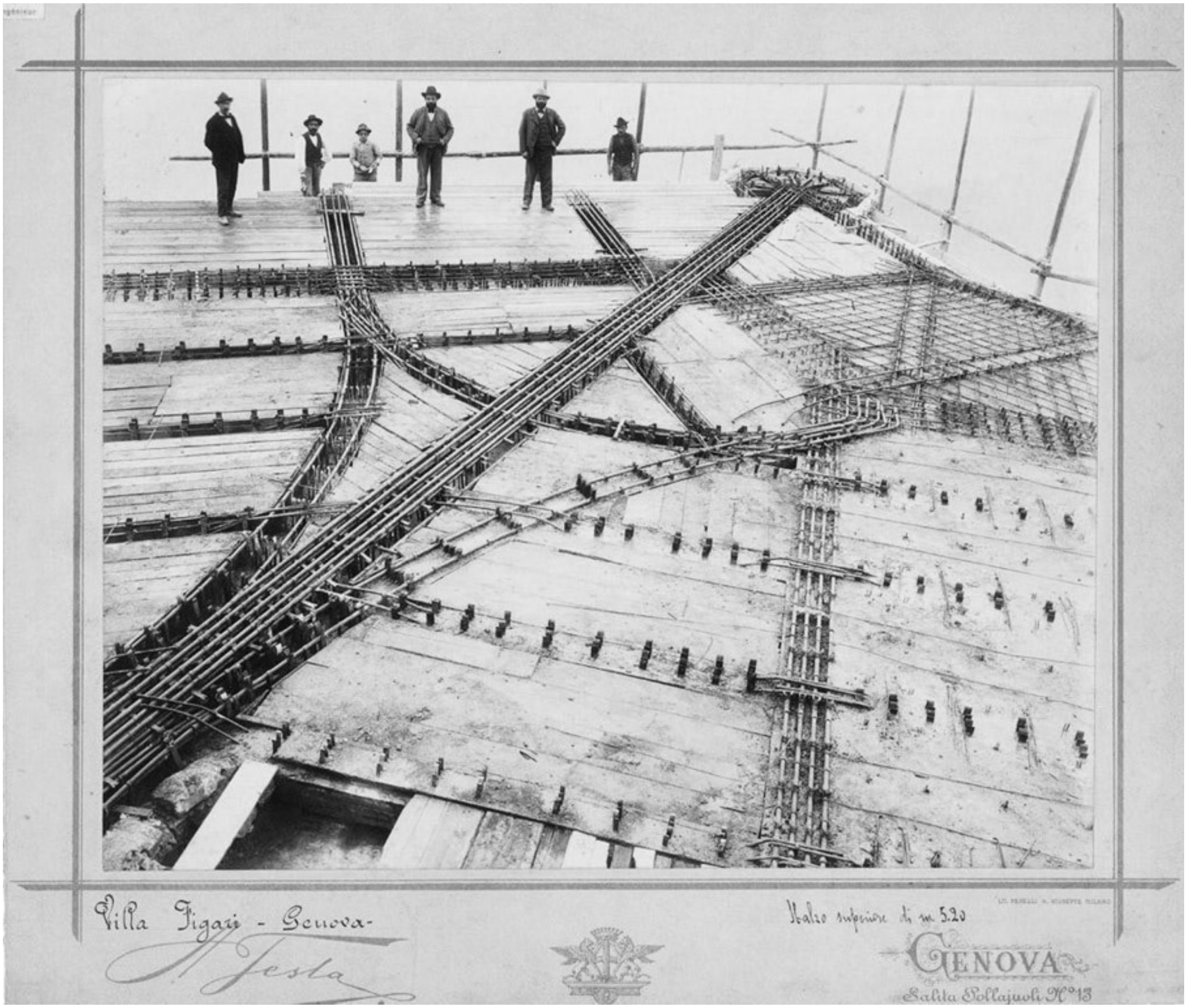
Other critics have seen reinforced concrete as realizing alternative historical traditions. The Greek architect P. A. Michelis, writing in the 1950s, saw reinforced concrete as in succession to late Roman and Byzantine architecture, distinguished by domes and mosaic revetments.[12] This interpretation fitted with Michelis's argument that hyperbolic paraboloid forms and shell concrete domes, whose thickness was proportionately thinner than the shell of an egg, had transferred the emphasis of architecture to the surface: the curved internal surfaces of Byzantine architecture were now more amply expressed on the exterior of the new concrete shell structures. And yet another interpretation came from the Italian critic Gillo Dorfles, who, writing in the mid-1950s, argued that reinforced concrete represented the fulfilment of Baroque architecture:

> The shock of massive constructions, the uneven projection and re-entry of forms, facades breaking away from the floors, the grafting of plastic elements one upon another, are the embryo of those constructive possibilities that two or three centuries later would be realized with the advent of steel and reinforced concrete.[13]

The ultimate interpretation of the historicity of concrete comes with the argument that its advent marked the end of architecture. Writing in 1935, the English critic Adrian Stokes argued that the Western tradition of architecture and sculpture had always rested upon carving; but reinforced concrete, which replaced stone, is not a carved but a moulded material, whose synthetic procedure deprives it of all opportunity for the deposit of fantasy. Stokes wrote,

> today stone architecture is dying. The creations of Le Corbusier and others show that building will no longer serve as the mother art of stone, no longer as the source at which carving or spatial conception renews its strength. Architecture in that sense of the word, indeed in the most fundamental sense of the word, will cease to exist.[14]

Ironically it was Stokes's anti-modern argument that came closest to acknowledging the absolute novelty of reinforced concrete. Each of the interpretations that connected reinforced concrete to one historical tradition or another partly compromised its modernity and the claims that thanks to concrete, the world was witnessing the birth of a new architecture.



An Unhistorical Medium

By the 1950s, architects seem to have become less inclined to see reinforced concrete as a historical medium, and more likely to take the view that, as Michelis put it, ‘the morphology of the architecture of reinforced concrete is partial and incomplete, if not still impossible to fix’.[15] A new-found belief in the absence of a clear historical trajectory brought architects much closer to the position that concrete contractors and engineers had held all along: that reinforced concrete marked an absolute break with all previous systems of construction, and lacked any connection to history. Writing in 1901 in Hennebique’s house magazine, *Le Béton Armé*, the French architect Edouard Arnaud claimed, ‘reinforced concrete is more than a material, it is a totally new construction process which permits the realization of all kinds of forms, the solution of all constructional problems’. Presciently, he added, it ‘can appear under all kinds of costume. It is too general to have a proper physiognomy.’[16]

Arnaud was giving a point of view reiterated over and over again by Hennebique and by other concrete producers and engineers over the succeeding century. From its origins, the cement and concrete industry showed little interest in past developments: it was not the purpose of Hennebique's magazine *Le Béton Armé*, nor of the British *Kahncrete Engineering*, nor any of the other equivalent trade publications to promote the historicity of concrete, but rather to show how it might be used in the present and in the future. On the few occasions when reference was made to older concrete buildings in their publications, it was usually to point out how little affected they had been by the process of ageing and decay that they would have suffered if built in any other material – in other words to advertise their eternal newness. *Kahncrete Engineering* in 1932 illustrated a 1905 reinforced concrete building, the former Clays Printing Works (still extant) in Paris Garden, Southwark, London, remarking that it 'is as good today as when it was constructed'.[17] Consistently, the emphasis in all the material originating from the cement and concrete industry is upon the 'present possibilities' and 'future potential' of concrete, phrases repeated monotonously. Over and over again we are told that concrete is a material full of possibilities, whose full potential is yet to be realized. This was being said in the early 1900s, and it was being said in the 1960s, and it is still being said today. Characteristic are the words of the American architect Albert Kahn who, with family connections to the industry, stated in 1924 that 'the development of concrete, both structural and artistic, will exceed any present expectations.' Two years on, another contributor to the same journal described it as 'capable of unlimited development'. Forty years later, in 1966, the American journal *Progressive Architecture* in a similar vein remarked, 'the potential of exposed concrete is untapped'.[18] The denial of history is total: it is not that concrete is simply new, it is so new that it has not yet happened; it belongs only in future time.

For a material that has now been around for a century and a half, such exclusive attention to its future is decidedly odd. Concrete may be 'modern', but it is not 'new'. One of its more curious features is how very discontinuous have been the developments in concrete construction. From trabeated structures to parabolic vaults, shell constructions and awe-inspiringly long prestressed spans, each successive technique is developed only so far, and then abruptly abandoned, and we set off in pursuit of some wholly new development. Rather than a gradual refinement of each process and its assimilation into the repertoire of construction, what we are presented with is a field littered with truncated techniques. Each new generation seems to have approached concrete as if they were starting from scratch with a material only just discovered. This reluctance to treat concrete as a gradually evolving practice is particularly evident in how few built works of architecture ever make reference to concrete's own history. Rare exceptions are details like the mushroom-head columns of London's Queen Elizabeth Hall (1965–8), a deferential gesture to Sir Owen Williams, the British concrete pioneer who introduced this feature into Britain. Lina Bo Bardi's cultural and sports complex SESC Pompeia (1977–86) in São Paulo was a celebration of concrete in more ways than one, but the oozing joints of the symbolic chimney were a conscious reference to the same feature in Louis Barragán's Satellite City Towers in Mexico City, and thereby to the Latin Americanness of concrete.[19] For the most part, though, the question of how to represent concrete's history has not been considered worth bothering about, which is not a little surprising given architectural culture's heavily historical orientation and customary pleasure in knowing references or explicit negations. The general silence and routine avoidance of references to past techniques and processes indicate just what a peculiar medium concrete is in relation to temporality and our perceptions of the relation between past, present and future.

Quite clearly concrete *does* have a history, yet while occasionally architects have been conscious of the paradoxical nature of concrete as a medium that is both historical and yet seemingly without a history, they have generally been at a loss to know how to communicate this insight in their buildings. Auguste Perret once remarked that 'Construction in concrete is amongst the oldest of all building methods, and at the same time it is one of the most modern',[20] and although this does not entirely convey the full sense of the paradox, he had some sense that concrete was both in history, and yet out of it. Nietzsche's insight that consciousness of the historical *and* of the unhistorical are necessary for the health of a culture rarely seems to have reached the practice of reinforced concrete.

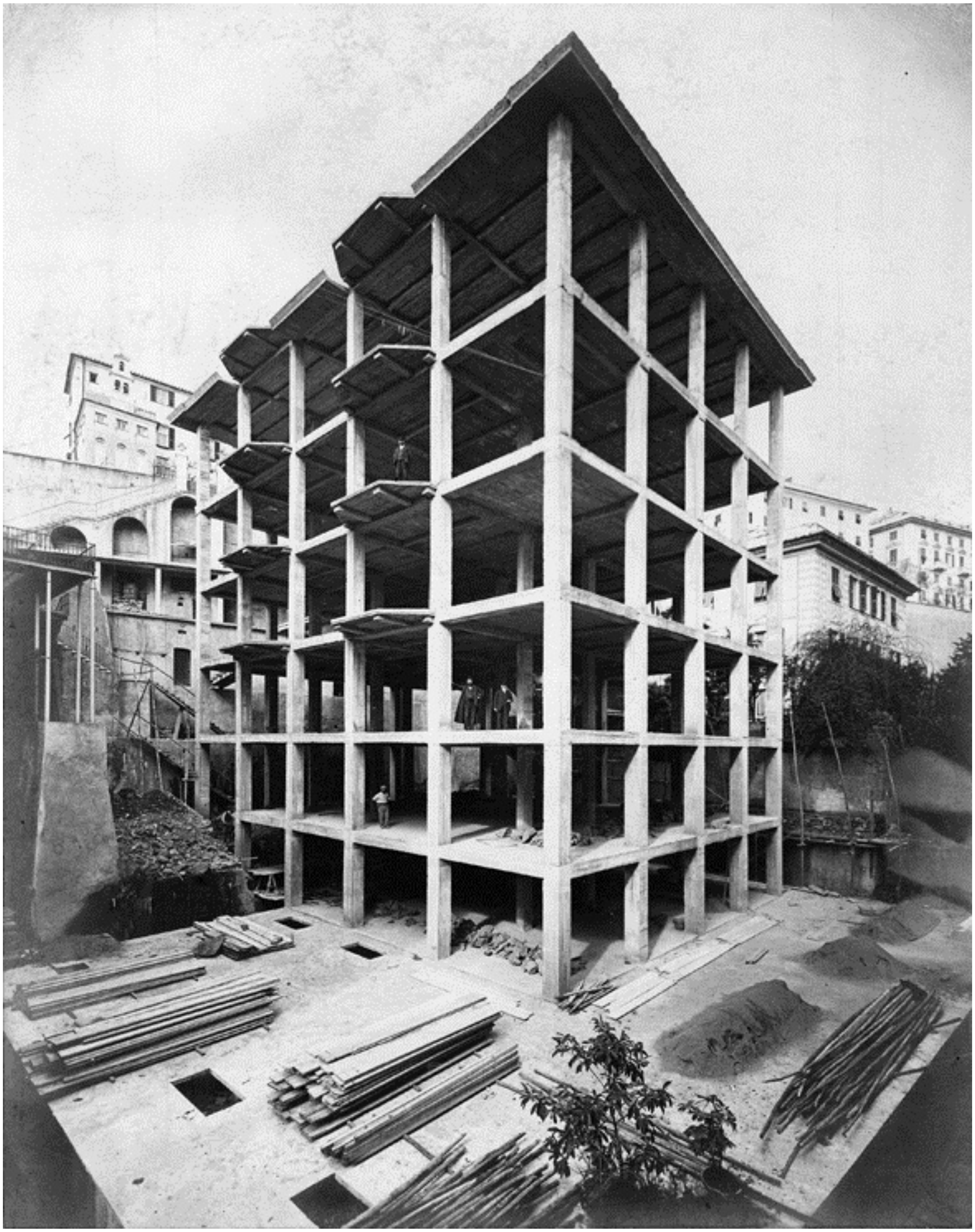
Mixing Past and Present: Postwar Italy

A significant exception to the general embargo on reflection upon concrete's history occurred in post-war Italy, where the fact that concrete had a past as well as a future was, uniquely, taken seriously. Italian architects' engagement with historical issues came about through the peculiar circumstances that they found themselves in after the war: having to distance themselves from fascism, yet not wanting to reject the architectural modernism that had been promoted and flourished under fascism. But they needed also to reach back over time, to modern architecture before fascism, to show that the fascist period had only been an episode within the wider history of modern architecture, and that there were other traditions of modernism, uncontaminated by fascism, that could be drawn upon. The general strategy of the Italians, articulated in the late 1940s and early 1950s, to a large extent by Ernesto Rogers through the pages of the magazine *Casabella-Continuità*, of which he was editor, was to situate pre-war modernism as a historical phenomenon, and rather than proposing an absolute rupture with the fascist era, to emphasize multiple continuities with the past. Seen in these terms, concrete could be at once a historical material and yet of the present. If we look at some northern Italian buildings from the 1950s and early 1960s, we can see how this idea was explored.

2–4 Corso Francia in Turin was designed by BBPR (of which Ernesto Rogers was a partner) and finished in 1959, just after the same practice's more famous Torre Velasca in Milan. The building has shops at street level, offices in the mezzanine above and then apartments at the upper levels. The externally expressed grid of the frame, with the interstices filled by brick, follows a model set by Ridolfi and Frankl with the widely praised housing blocks on the Viale Etiopia in Rome, built between 1950 and 1954: the Viale Etiopia blocks, with their exposed frame, cut-off corners and infill walls in another material, established a formula that became ubiquitous for apartment buildings all over northern Italy in the latter half of the twentieth century, though rarely executed with such grace and delicacy.[21] But 2–4 Corso Francia (as possibly the Viale Etiopia too) is also indebted to Perret, about whom Rogers had written a short and generally enthusiastic book in 1955 – though the many differences it has from Perret's buildings make it clear that Rogers's criticisms of what he saw as the mannered, formulaic character of Perret's late work at Le Havre had been absorbed into the practice.[22] The creation of a void at the corner is the very opposite of Perret's usual practice of giving emphasis to corners by thickening up the structure at that point. Highly uncharacteristic of Perret are the columns that break at second-storey mezzanine level and change direction to carry the jettied upper floors, tapering as they do so; Perret would never have countenanced an angled column, but on the other hand these columns and their tapered shape owe something to another tradition of concrete, the work of the Italian master of reinforced concrete, Pier-Luigi Nervi. The choice of brick infill for the walls of the apartments is not characteristic of Perret, but is an acknowledgement of Turin's traditional building material; unlike Perret, too, is the studied irregularity of the fenestration of the apartments. On the other hand, when we look at the surfaces of the concrete, BBPR were clearly following Perret. There are three different surface treatments, each corresponding to a different priority in the structure. The grid of the upper-level frame is bush hammered, and this is continued down into the ribs that merge into the upper part of the ground storey columns; the roughness of the surface has caused it to hold dirt, making it appear darker than the smooth surface of the lower part of the columns, the second finish. The third finish is the board-marked concrete of the soffit of the portico. Although this differentiation of the finishes for the different parts of the structure is consistent with Perret, what does not come from Perret is the partial cladding of the columns at pavement level in thin sheets of stone. The cladding is arranged so that an area of concrete is left exposed at eye level on the sides of the columns, so that you are left in no doubt as to the true nature of the structural material. Presumably the veneering of the columns was to humanize the space of the portico, and to make the shops more attractive to tenants; whatever the reason, BBPR chose a stone whose tone and roughened surface were sufficiently like concrete to lead the averagely inobservant observer to assume that they were precast concrete. What we see here is a building that deferred to some of concrete's various histories, but incorporated them into the time and place of its construction.

Also in Turin, the Borsa Valori, constructed slightly earlier between 1952 and 1956 to designs by Gabetti & Isola, has a more complex set of historical connections.[23] Like Rogers, Roberto Gabetti was interested in Perret as an outsider who did not belong to the orthodox account of modern architecture, which in their view over-privileged the work of just a few masters. But Gabetti was also attracted to other 'minor' architects and stylistic tendencies that had, so it seemed, faded away and never become part of the mainstream – the most notable of these interests was in Art Nouveau, or Stile Liberty, which gave rise to the notoriety of the practice's Bottega d'Erasmo in Turin. Most unusually for an architect at this period, Gabetti researched and wrote a history of the early development of reinforced concrete, figuring Coignet, Hennebique and Cottancin, and this research caused him to reflect on how his own work might incorporate the work of these and other pioneers into a critical and historical architectural practice. The Borsa, a somewhat over-scholarly reflection on this question, is one of those buildings that displays just too many ideas. I have already discussed in chapter Two the disconcerting use of stone in the entrance vestibule to represent concrete block, merely one of the collage of motifs present in this building.

From the front, the Borsa has a white box-like upper level rendered in white stucco, on which are traced fine lines suggestive of masonry. The upper level is supported on exposed concrete legs that rise up out of a rough stone plinth. This is a marriage of two architectural traditions: the machine-age geometrical precision of the upper level and its supporting columns refers to the monolithic concrete construction of the rationalist movement of the 1920s and '30s, the Italian version of mainstream international modernism, while the stone plinth would appear to recall the rustication of the American nineteenth-century architect H. H. Richardson, one of the pioneers of the Chicago School, another of those architectural traditions apparently superseded by international modernism. When one turns the corner, though, the upper, rationalist level abruptly ends, turning out to be no more than just a fascia, and gives way to the rhythmic angular roofline as if this more decorative, ornamental line, reminiscent of Art Nouveau, were the building's real motif. At least three architectural traditions are represented on the exterior. But the biggest surprise of the Borsa is the interior of the exchange hall, which is a large volume covered by a roof made up of slender branching ribs, from the ends of which is carried a shallow ribbed dome; the effect of this web of ribs and paper-thin panels is reminiscent of Anatole de Baudot's Saint-Jean-de-Montmartre in Paris, a correspondence that was almost certainly intentional since Baudot was another of Gabetti's forgotten 'minor' characters, and he considered the church to be the first work to have shown that reinforced concrete could be treated architectonically.[24] This elaborate montage of historical references to concrete was Gabetti's way of demonstrating an active continuity between past and present.



The Spine Bianche (1954–7) in the suburbs of Matera, in the Basilicata region of southern Italy, is a mixed-use building with apartments and shops, designed by the Milanese architect Giancarlo De Carlo.[25] For all its apparent modesty and anonymity, it gained unlikely notoriety as one of the buildings that, together with the Torre Velasca, precipitated the row that led to the break up of CIAM at the 1959 Otterlo congress. At first sight it belongs to everyday building practice, but it also contains some knowing references to architectural culture: it has a Perret-like exposed concrete frame, but on the rear elevation it is 'deviant' in that the intervals between the columns at the lower level are irregular, and missing altogether at the corners, while some of the first-and second-floor columns are placed over intervals below. The haunching of the beams at the column heads on the lower level (though not above) is a feature that refers to the by then long-expired Hennebique patents.

By far the most extreme of the attempts to fuse the historical and the unhistorical, and in many respects the culmination of this tendency in post-war Italian architecture, was the Chiesa dell'Autostrada (1960–64) outside Florence, designed by Giovanni Michelucci and built as a memorial to those who died in the construction of the Autostrada del Sole. The outside is remarkable enough, and anticipates Gehry by 40 years, but it is the inside that is most extraordinary. This is a place where any idea of concrete construction as being a *rational* affair is completely exploded. Columns, struts and bracing are all crowded together in an utterly chaotic way: it is an affront to the elegant clarity of Nervi's engineering, and indeed to Michelucci's own pre-war rationalist architecture, and to his previous post-war Perret-influenced churches.[26] But the Chiesa dell'Autostrada is also post-Ronchamp, and Michelucci lets us know this: the taut shell of the roof at Ronchamp here becomes a sagging tent, barely held in shape by a few bits of inadequate-looking concrete bracing. Critics saw in the result parallels not only with Le Corbusier, but with Gaudí, with German Expressionism, Finsterlin and Steiner's Goetheanum, and with Scharoun's Berlin Philharmonie. There is a complete confusion of almost every known tradition of working concrete: it is neither a frame nor a shell, and with structural members that seem arbitrarily dimensioned it manages not only to mix together different traditions but also to question the value of the engineering principles that up to then had dominated concrete architecture. As Luigi Figini, architect of the church of Santa Maria delle Povere in Milan, observantly remarked, the church was a 'warning against pure technology', against acceptance of the authority of engineering. Nor did Michelucci attempt to defend its faults; on the contrary, they were essential to it – as he acknowledged in his reply to Figini, 'the defects of this building are many and great; but in truth, I do not know how I could have avoided them.'[27]

All these Italian buildings were composite structures: they mixed concrete with other materials, with brick, or with stone in a way that was still, elsewhere, regarded as heretical. But not only were they composite in the sense of mixing materials, they also mixed histories, a no less heretical and altogether more noteworthy achievement. Whereas most practitioners of concrete have stuck rigorously to one tradition of construction only – whether monolithic, trabeated, arch or shell – and would not countenance their combination, what we see here is a willingness to make structures that are *historically* hybrid. Out of concrete's discontinuous history of truncated developments these Italian architects created a synthesis that attempted to make the history of the material meaningful, and to realize that combination of the historical and the unhistorical that Nietzsche claimed was so necessary.

For architects, making sense of concrete meant making sense of it historically. However, the whole direction of the engineer-dominated culture of concrete was that concrete was an unhistorical material, and this presented the greatest obstacle to fitting concrete into the historical schema. In general, the problem was just too difficult, and few outside post-war Italy considered it worth making the effort, and resigned themselves instead to using it as a modern, unhistorical material.

FOUR

THE GEOPOLITICS OF CONCRETE

IN JACQUES TATI'S 1967 film *Playtime*, set in a fictive Paris, an American tourist stops as she leaves a travel agency to look at a poster advertising London. It shows a picture of a large modern multi-storey building, with a double-decker London bus in the foreground. And then, as she goes outside, the camera pauses to show us the identical building across the street. Later, back in the travel agency, she sees more posters for other travel destinations – the U.S., Hawaii, Mexico, Stockholm – each one illustrating a view of the same building, which, we discover, also appears in every other advertisement in the office. Tati, whose film is in large part about the disorientations produced by modern architecture, was ahead of his time in the way he made fun of its flattening of space and erasure of local differences; and concrete's contribution to this effect has been one of its less-liked features. Concrete is everywhere, and makes everywhere the same – or does it? This is the paradox that we shall investigate here.

Cement is now a global commodity, like oil, traded worldwide. The German cement company Heidelberg, one of the four large cement producers that between them account for a quarter of the world's cement production, operates a fleet of over 900 ships to move cement around the world to take advantage of local spikes in price.[1] The trade relies upon the absolute uniformity and consistency of a bag of ordinary Portland cement, wherever in the world one buys it. But while cement is a standard product, concrete's other ingredients – labour, steel and aggregates – vary from place to place, opening the possibility that it might have distinctive regional qualities. Occasionally this has been exploited for cultural or political reasons: Fritz Todt, the Inspector General for German Roads in the 1930s, went out of his way to emphasize how the use of crushed limestone aggregate from the lower Alps would harmonize autobahn bridges and other structures with the landscape in that part of Germany and make them seem to have sprung from the soil. This and similar attempts to give concrete regional character through the choice of aggregates, however, never seem to have been particularly effective at convincing people that it is truly a local medium; for the most part, it keeps its global aura, and this indeed has long been part of its value.[2]

Recognition of concrete's universal properties occurred early in the history of its development. The French entrepreneur François Coignet, who developed cement production and contracting from his chemicals business in the 1850s, foresaw that concrete would have a revolutionary effect on building construction by lifting the previous geographical limitations on the use of materials: no longer constrained by the need to find a local supply of stone, nor fuel to burn bricks, nor by the availability of a skilled labour force, concrete made durable and stable construction possible anywhere. 'Whatever can be done in Paris,' wrote Coignet in 1861, 'the same can be done in every land.'[3]

Following the First World War, the universality of reinforced concrete became entangled with architectural aesthetics and the pursuit of an 'international style'. The universal nature of reinforced concrete was taken as a justification for promoting a uniform style of architecture for all countries and all regions, while the worldwide diffusion of reinforced concrete construction was taken as proof of the legitimacy of the uniform style. Needless to say, this 'international style' was a creation of Western countries, and its circulation throughout the world was as much to do with the dominance of the West in the twentieth century as with the supposed universality and placelessness of any particular medium or process. The residual consequences of the creation of a universal style of architecture are still with us at the beginning of the twenty-first century, and concrete, implicated from the start, remains part of the problem.

A confusion between the universality of concrete as a medium and the universalism of architectural style began in France in the 1920s. Reporting on the 1925 Paris Exposition des Arts Décoratifs (where Le Corbusier had displayed his Pavilion de l'Esprit Nouveau), the critic Marcel Magne wrote: 'Reinforced concrete is a conglomerate of materials found in all countries, and it can satisfy, economically the requirements of so many different programmes that its use will become universal. Can it be said that this means of construction will give birth to a universal style?'[4] Magne's rhetorical question rapidly turned into a self-justifying fact, so, for example, the architect Robert Mallet-Stevens remarked in the following year, 'In Los Angeles one builds the same as in Amsterdam, in Tokyo as in Paris. The needs are the same, the customs are the same, the materials, thanks to reinforced concrete, are the same.'[5] By the time that Sigfried Giedion wrote his book *Building in France* in 1928, concrete had for him become proof of the dissolution of distinctions between national and international that he believed were transforming architecture.[6] And in the American engineer Francis Onderdonk's book of 1928, the view that reinforced concrete was a generic material was normalized: 'Gothic flourished thruout [sic] Europe but the new style will develop thruout the whole world; for reinforced concrete is now already used on every continent – in Bombay as well as in Stockholm, in the Argentine as well as in Russia.'[7] However, Onderdonk went on to add, 'Climatic differences and historic backgrounds will prevent monotony', thereby opening a chink in the apparently seamless universality of reinforced concrete – it might not, after all, be quite the same everywhere.

When in the 1950s and '60s people started looking for arguments against the international style of modern architecture, the interpretation of concrete started to change and the possibility of regional or national differences began to be given more weight. We started to hear about 'Swiss concrete', 'Indian concrete' and 'Japanese concrete'. But we should no more be taken in by these authentic-sounding categories than by the 'universal concrete' of the 1920s; just as that served to sustain an argument about the international unity of architectural style, so these new 'national concretes' serve to do the opposite. Faced with any piece of concrete, does it at once join us to a universe of all other concrete things or is it, alternatively, a local occurrence, attaching us to the particular place it happens to occupy? Or might it not do both at once? As with the argument that says a place is a place in so far as it is both global *and* local, maybe what makes a piece of concrete *concrete* is its connection to both – and what becomes anomalous are attempts to fit it within an intermediate and artificial category of the 'national'.[8] The difficulty of these questions only makes us realize how fluid are the geopolitics of concrete.

The Nationality of Concrete

A starting point is to ask to whom concrete belongs. Absurd though this question might seem, given the generic nature and worldwide availability of reinforced concrete, it is not quite as ridiculous as it sounds, for certain nations have put much effort into asserting ownership of concrete – or sometimes, alternatively, into disowning it. The country that has without doubt been the most aggressively proprietorial is France, and while there is some justice to the claim, for it was in France that many of the inventions and discoveries to do with concrete and its reinforcement occurred, nevertheless some of the same discoveries were made simultaneously elsewhere, and a few of the most crucial steps did not take place in France at all. Lambot's iron-reinforced cement boat, exhibited in 1849, occupies a mythic status in French histories of reinforced concrete, while the developments of Monier, Cottancin and Hennebique, prominent in the well-rehearsed genealogy of the medium, certainly give France a pre-eminence in the early application of reinforced concrete. However, there are alternative ancestries, and so, for example, if one takes the case of the English cement manufacturer James Pulham, who in the 1840s diversified into concrete and artificial stone garden rockeries, ferneries and other structures (his products survive in the gardens of Buckingham Palace), then a rather different history of the material might emerge in which decorative properties count for more than the structural properties that dominate in the French accounts of the medium.[9] The reality is, as Cyrille Simonnet says, that concrete was invented many times, in many different places. Notwithstanding this, France has repeatedly claimed both cement and concrete as its own. The French critic Paul Jamot wrote in 1926, 'A Frenchman invented it [reinforced concrete] eighty years ago, it is French engineers who developed its first applications'. A couple of years later another French critic, Myron Malkiel-Jirmounsky, claimed that, while the new style of architecture was universal, reinforced concrete was a French invention and that it was the French that had first demonstrated its plastic and modern possibilities.[10] Subsequent French claims to the title became increasingly nationalistic, and in the 1938 film by Jean Epstein, *Les Bâtisseurs*, concrete is presented as the new national material of France.[11] In 1949 the French cement and concrete industry held a congress marking the centenary of reinforced concrete, an event which of course confirmed the primacy of Lambot's boat. The accompanying publication, *Cent ans de béton armé*, makes some far-reaching claims for the French proprietorship of reinforced concrete, and the final image in the book shows reinforced concrete as 'the radiation of French thought and creativity across the world'. The volume concentrated exclusively on French inventions and achievements, with no mention whatsoever of German or American developments. Claudius Petit, the Minister of Reconstruction, set the nationalistic tone in his address to the congress: 'This material was born on French soil, it is right that it is feted on French soil'.[12]

The notable omission from the French centenary celebrations was any mention of the German contribution, for it was German engineers who had first developed mathematical methods for the structural analysis of reinforced concrete, making it possible for the medium to progress beyond the trial-and-error methods of Monier, Hennebique and the other early concrete contractors. The first manuals for the calculation of reinforced concrete were German (Wayss and Koenen's *Das System Monier* of 1887 and Emil Mörsch's *Der Betoneisenbau* of 1902), and it was these that, by putting knowledge of concrete design into the public realm, made possible the worldwide diffusion of concrete, ultimately empowering any engineer in any country to design reinforced concrete structures. In 1902 the Austrian engineer Fritz von Emperger started a monthly magazine for engineers, *Beton und Eisen*, followed by a series of handbooks on concrete construction, originally projected at twelve volumes but which eventually by 1939 ran to twenty volumes. Emperger's publications were scientific, objective and much more international in outlook than the propagandist and commercially orientated French publications of the same period, and Simonnet suggests that part of Emperger's purpose in producing the magazine and the handbooks was to assert German authority over reinforced concrete.[13]

Also absent from the French *Cent ans de béton armé* was any reference to shell structures, which had been pioneered and perfected by the Germans in the interwar years. Only in the late 1950s did the French start to make use of shell structures, though by this time shells had become sufficiently international for them no longer to be identified with Germany, or any other nation. Earlier in the century, rivalry between France and Germany had largely revolved around two aspects of reinforced concrete: size and finish, in both of which Germany held the initial advantage. Prior to the First World War, Germany produced the largest buildings: France had nothing to equal the size of the 1913 Breslau Centennial Hall, which was for a long time ignored in French publications (p. 146). Only after Freyssinet's airship hangars were completed at Orly in 1923 was there anything comparable in France, and these works featured prominently in subsequent French accounts of concrete. German architects' and engineers' other initial advantage was in the finishing of concrete. Exposed concrete was being used for prestige buildings in Germany from the early 1900s, and German firms had perfected techniques for finishing concrete to make it resemble stone.[14] And in situations where structural concrete could not be cast sufficiently well to provide a good finish, German architects became skilled at simulating the appearance of monolithic cast concrete, as in the interior of the entrance hall of Fritz Schumacher's Hamburg art school. German architecture acquired a reputation for these stone-like concrete surface effects, which were looked down upon in France with some disdain, although the French later emulated them. The Perret brothers' Théâtre des Champs-Élysées, although the concrete was not exposed, was regarded on its completion in 1913 as tainted by German influences on account of its lack of surface ornament.[15] Likewise in Italy, one of the first public buildings with an exposed concrete interior, Piacentini's Cinema Corso, on a historically sensitive site in Rome, was heavily criticized when it was completed in 1918 for the association of bare concrete with Germany, with which Italy was then at war, causing the building to be denounced as unpatriotic, even 'defeatist'.[16] A French engineer, Léon Petit, writing in 1923, dismissed as 'pure absurdity' the German fixation with finishing bare concrete so as to make it stone-like: 'Bush-hammering and simulated spall-hammering, false joints, dyes to imitate red sandstone, or attacking the surfaces with hydrochloric acid to give the appearance of granite: we do not want any of these camouflages, which, it hardly needs to be said, are most of all met with beyond the Rhine.'[17] Whether or not his characterization was accurate, the purpose was to disparage the simulated stone treatments for which German concrete work was reputed.

In the early 1920s a rather different geographical alignment of concrete started to emerge, in which the U.S. was identified as the nation of steel, and Europe the land of concrete. This often-repeated half-truth lasted for half a century: to quote a critic writing in 1967, 'European engineers have had as marked a preference for reinforced concrete, as Americans for skeleton steel structures.'[18] Interestingly, the allegations of American prejudice against reinforced concrete never extended to Canada, where it was more readily accepted, partly, it is said, on account of its proportionately larger number of immigrant European architects and engineers, who took their skills and their preferences with them.[19] The supposition that concrete was not an American material rested primarily on the fact that most skyscrapers, at least in New York and Chicago, were steel-framed. However, reinforced concrete was certainly not absent from the U.S., and indeed Americans had played an important part in its early development and initially been ahead of the French. Ernest Ransome had invented a successful system for building factories in the 1880s, and exploited it not only in California but also in the Midwest and on the East Coast. Reyner Banham, whose account of Ransome's achievements corrects the French bias in most previous histories of concrete, notes that by around 1895 the main technical developments in steel construction were over, and that in U.S. engineering circles in the decade after 1900 all attention was on reinforced concrete as the exciting new material.[20] Even in tall building construction, not all skyscrapers were steel, and for a short period, in 1901–2, the highest office building in the world was concrete, the sixteen-storey Ingalls Building in Cincinnati constructed with the Ransome system.[21] Writing in 1928, W. A. Starrett, chairman of the construction firm that had built (in steel) many of the New York skyscrapers, acknowledged the contribution of concrete to skyscraper construction: according to him, there were more than 350 reinforced concrete buildings over ten storeys in the U.S., the tallest of them a 21-storey office building in Dayton, Ohio. But for Starrett, while steel was a wholly American material, concrete was only partially so and he generously conceded a half share of it to the Europeans.[22] In 1903 the Kahn brothers of Detroit, Albert, Julius and Moritz, drawing upon German expertise, had developed their own extremely successful system of reinforced concrete, promoted by the Trussed Concrete Construction Company, or Truscon. As well as providing the buildings for Henry Ford's car plant and for Packard, the Kahn brothers' influence extended far beyond America. In interwar Britain, it was the Kahn system, marketed under the name 'Kahncrete', that dominated concrete construction for commercial buildings.[23] Even from the European perspective, prior to the First World War, and after it too, American concrete was important. The first book in any language on the aesthetics of reinforced concrete, Emil von

Mecenseffy's *Die künstlerische Gestaltung der Eisenbeton bauten* of 1909 (published in Emperger's series of handbooks), included more illustrations of American buildings than those of any other country apart from Germany.

Crucial to the American reluctance to lay claim to reinforced concrete were misgivings as to whether it could truly be considered an 'industrial' material. America's national myth was that the country's industrial strength had come about through the way it had overcome its shortage of skilled craft labour by developing methods for the mass production of components that could then be assembled by unskilled labour; any process that did not conform to this model was regarded with suspicion. Reinforced concrete, which required a lot of craft labour for the fabrication of formwork, did not correspond to the American industrial principle, whereas steel construction, with factory-produced components assembled on site, fitted it perfectly. Even Albert Kahn, who might have been expected to stand up for America's title to reinforced concrete, seems to have been willing to accede it to the Europeans for this reason: as he put it, 'with labor costs much lower and careful workmanship more general than here, it was only natural that they [Europeans] should produce results quite impossible in this country.'[24] Even into the 1960s, the view persisted that concrete was not an American material, because of its reliance upon craft labour. An American architect, Walter Seligman, expressed his doubts as follows: 'The basis of any discussion about concrete is the dichotomy of the nature of material and the idea of American technology. Even at best, with the ultimate in control, it remains a *tour de force* to make concrete fit the idea of industrialization.'[25]

Unsurprisingly, European architects and engineers willingly colluded in the fallacy that concrete was not an American material. We have already seen how German National Socialist ideology identified steel with America, while concrete provided a more *völkisch* alternative. In France, we find Rob Mallet-Stevens writing in 1925 in the special issue on Frank Lloyd Wright of the Dutch journal *Wendingen* that 'The Americans resisted this mode of construction for a long time, and iron reigned supreme in their art of building.'[26] This was hardly ignorance, more a wilful disregard of the facts, though it was not, at that time, of any great consequence. The geographical allocation of concrete to Europe and of steel to the U.S. only really started to matter after the end of the Second World War, when American influence in European affairs became a serious political and cultural issue. The choice between one material or another ceased to be just a question of taste, or economics, but became instead a sign of either acceptance of or resistance to American cultural dominance. In post-war Europe, distinctions between steel and concrete always implied a stance towards the United States. Such is the subtext of, for example, this passage from the Italian architect Gio Ponti's *In Praise of Architecture*, published in 1957:

> Many years ago, being Italian, I thought, 'the architecture of reinforced concrete, however new, is nevertheless architecture; it is made by architects. The architecture of steel is architecture only if it is made of space as well as steel. Steel that is only structure and skeleton is not yet architecture; or at least it has yet to receive anything from architects. It is something made by other men, men of a different race, a race of smiths, of metallurgical, industrial men. Architects still work with water; they model on the spot; they are sculptors who work through others. This different race does not work on the spot; it works with fire instead of water and does not model but forges. Afterwards it builds up a gigantic mechanism; it works with bolts and wrenches, with welds, with hammers that do not chisel but pound. The architecture of steel does not exist yet, at least among us Italians.'

And he continued,

> I cannot definitely classify as architecture a structure made entirely of steel if I mean by architecture a work of art dedicated to something, an expression of beauty, and not just a technological achievement with no other purpose but that achievement.[27]

In the circumstances of post-war Europe, Ponti's preference for concrete over steel cannot but be read as an assertion of the superiority of European over American culture.

For their part, when American architects started in the late 1950s and 1960s to become interested in concrete, it was to Europe that they turned as the ground upon which to experiment. Gordon Bunshaft of SOM had always hankered after concrete: 'We knew we could do all sorts of things with concrete', Bunshaft later recollected, 'but we needed education'. The American architect's first works in concrete were built in Europe, the Istanbul Hilton (1951–5) and the Banque Lambert in Brussels (1959–65); with a few significant exceptions, particularly the work of Eero Saarinen, it was not until the latter part of the 1960s that reinforced concrete started to form part of the regular constructional repertory of American architecture.[28]

Two iconic works of post-war European architecture each in different ways show how reinforced concrete formed part of a transatlantic dialogue. The first of these, in Gio Ponti's home city of Milan, is the Torre Velasca, which was a building central in more ways than one to post-war architectural culture.[29] So bitter was the row it provoked among the delegates at the 1959 meeting of CIAM that CIAM never met again, but the building was also significant within the history of European relations with America. The Torre Velasca was the result of an abnormally long period of gestation, from 1950 to 1958, during which time there were significant changes in the client, the context of the building, and to the design itself. Originally projected as part of a new American-funded central business district in an area of Milan that had been partly destroyed by bombing during the war, its design should be seen in relation to the struggle against communist influence for ideological and political control of the country. The architects, BBPR, prepared two alternative schemes, low-rise and high-rise; the clients chose the skyscraper (of which there were initially two versions, one a folded slab, the other a square tower) presumably on the grounds that it was more 'American'. It was the square tower that was taken forward, and BBPR'S initial design for it, though similar in profile to the final building, was to have been built in steel, aligning it to the accepted tradition of the American skyscraper. In the mid-1950s the American backers withdrew and the site passed into Italian ownership, at which point the construction material was changed from steel to concrete. The engineer also changed, and a new engineer, Arturo Danusso, a concrete enthusiast from Milan, was appointed. Whatever the exact reasons for the change from steel to concrete construction, it signified a distancing from America, where skyscrapers were still being built in steel (the first post-war American reinforced concrete skyscrapers, Saarinen's CBS building and Yamasaki's World Trade Center, were not finished until a decade later). The change in construction material also coincided with the development over the same period by Ernesto Rogers, one of the partners of BBPR and also editor of the architectural journal *Casabella*, of ideas about the relationship of architecture to tradition, *ambiente*, and vernacular language. In Europe at this date a skyscraper of any sort was a novelty, and the obvious and indeed only model was American; the Torre Velasca's eccentric form, with its reference to Lombardic fortresses and its visibly reinforced concrete construction, constituted an explicit rejection of the American norm. Compared to the Sarom building and Gio Ponti's Pirelli Tower, Milan's two other skyscrapers finished a few years later (though their design period overlapped with the construction of the Torre Velasca), the Torre Velasca was unmistakably European. Although the two later towers were also built in reinforced concrete, the material was not visible, and their curtain-wall construction and sleek profile put them within the American skyscraper tradition. The Torre Velasca, on the other hand, with its all too apparent reinforced concrete frame, its surface of marble-cement render, anachronistically hand-finished with skilled artisanal labour, and its distinctive precast panels with their special ceramic composition of marble chippings, bore no relation to any American building of the time. Yet when in the following decade American skyscrapers started to be built in concrete, and to become more formally adventurous with buildings like the John Hancock Tower and the Sears Tower in Chicago, it was the historical architecture of Italy that their architects would invoke to justify their departure from the curtain-walled standard, just as BBPR had done in Milan. The maligned Torre Velasca, though not itself cited as a source, had shown the possibilities for an alternative model of skyscraper design that was to emerge in succeeding decades.

Another equally famous work where reinforced concrete denoted Europeanness is the Economist Building in London, designed by Alison & Peter Smithson and completed in 1964. The Smithsons were appointed as the architects of the scheme in 1959 and, no doubt mindful of the excoriation of BBPR that they had witnessed at the Otterlo meeting of CIAM the same year, were at pains to avoid anything as openly confrontational as the Torre Velasca. The Economist is a more subtle hybrid of American and European construction techniques, in which neither tradition dominates. Most of the previous high-rise office buildings in London – the Shell Centre, the Vickers Building, the buildings on London Wall, New Zealand House, Castrol House – had been steel-framed: the UK was exceptionally slow in adopting reinforced concrete construction post-war for large buildings, despite the economic advantages of doing so, and British cities during the 1950s were described as resembling 'forests of structural steel'.[30] At that date the only London architect experimenting with reinforced concrete for office buildings was Richard Seifert. The Smithsons' choice of reinforced concrete for a building that was in so many respects a diminutive version of a New York office tower is striking, and has to be seen in the context of their own ambivalence towards the Americanization of British architecture.[31]

While the Economist Building owed much to American office design – it had a central service core, a relatively new development not found in many British office designs of the time, air conditioning, also a novelty, and an overall reticence characteristic of Mies van der Rohe's American buildings – in other ways it departed from the U.S. model. The most notable deviation was the chamfering of the corners in order to improve the penetration of daylight into the back of the plot, a feature that would never have been countenanced in an American speculative office building on account of the loss of premium rentable floor area. The slope of the ground is taken advantage of to create an ambiguity as to whether the tower is at street level or whether, in the customary American manner, it sits upon a raised podium. The treatment of the structure is similarly hybrid. The building could perfectly well have been made with a steel frame, and had the Smithsons wanted a more obvious identification with American building, they might have wished people to believe that it was steel. But although they had previously built an American-style, Mies van der Rohe-inspired, steel-frame building, Hunstanton School, the Smithsons had gone off steel by the late 1950s, and indeed had turned against American architecture in general; in an article in 1958, Peter Smithson deprecatingly referred to recent American work as 'the buildings of metal working peasants which by purist standards are not architecture at all'.[32] According to Peter Smithson, the Economist Building was originally 'designed to be made in concrete, but not rough concrete, engineering-looking concrete . . . but then . . . probably they [the clients] began to have doubts about concrete in St James's Street'.[33] The result was that the Economist and its related buildings are reinforced concrete, but clad in Portland stone, the sober and specifically English business attire of most public buildings in London – but the Smithsons subverted this by choosing not the normal close-grained Portland stone, but roach-bed Portland stone from the upper layer of the stone beds, normally at that date rejected for building purposes but rich in fossils and deeply fissured, giving an altogether more luxuriant feel, not unlike Travertine marble. Rather than continue the stone cladding all the way down the columns to the plaza, the dressing stopped a couple of inches short of the plaza, revealing the bare concrete of the frame beneath (or at least it did until 1990, when as part of the building's refurbishment the exposed section of concrete was covered by render). This ever-so-demure lifting of the skirt to reveal a glimpse of ankle, the 'Brechtian trick' as Peter Smithson called it, was a further, somewhat contrived, allusion to the differences between American and European building – like, but definitely not alike.

While concrete became part of a transatlantic dialogue in the post-war era, competition between the European nations for the rights to concrete returned temporarily in the 1950s and '60s with the rise of prefabricated systems. This episode is described in more detail in chapter Five, and is discussed here only for the sake of its geopolitical connotations. The precasting of concrete components for assembly into complete buildings had from the 1870s been one of the most common, and reliable, applications of concrete, on account of the control over the production process that it made possible. Although rejected by some on the grounds that it compromised the principle of monolithicity, which many have regarded as the fundamental feature of concrete construction, prefabrication always had its supporters. Various systems of prefabrication were developed in England, France and the U.S. in the late nineteenth century, though none became widespread. The First World War and its aftermath boosted interest in prefabrication due to the prospect it offered of reducing the need for skilled on-site building craftsmen at a time when there was both scarcity of skilled labour and a high demand for house building. Most of the systems developed were variants of the concrete block, a component of a size that could easily be handled by one man, but there were a few experiments with larger components.[34] A well-known one was in Frankfurt in the late 1920s, where the city's extensive social housing programme justified the research and investment necessary to make large wall panels in a factory. Although short-lived, ending with the post-1929 slump, which made redundant any process whose rationale was the saving of labour, the experiment did draw attention to one of the preconditions for the successful development of a system of large-scale prefabrication – the assurance of a substantial and steady demand over a long period of time to justify investment in the plant to make the components and guarantee continuous operation at full capacity.

After the Second World War a depleted housing stock and shortages of skilled labour replicated the conditions following the First World War, though on an altogether larger scale, while all over Europe the involvement of the state as both client and financier for new housing provided the ideal conditions for resuming the experiments with prefabrication. Although all countries went in for prefabrication, the one that led the way in developing systems of precast concrete prefabrication was, for a combination of reasons, France. Already before the war, France had developed a composite steel and concrete system, the Mopin system, that was used quite widely and exported under licence to other countries including the UK.[35] During the war German military engineers had employed French contractors to build the Atlantic Wall and numerous other concrete military installations all over France, introducing under duress even small building firms to relatively advanced techniques of concrete construction, expertise that they were later able to draw upon. After the war the decisive factor favouring prefabrication was the centralization of building construction within a single ministry, the Ministry of Urban Reconstruction, with control over urban planning, expenditure on housing and research into construction. This unusual concentration of functions created the optimum conditions for large-scale investment in prefabrication, as the state could guarantee demand for its products. The first post-war patent for a large panel system was taken out by Raymond Camus in 1949, following which a contract from the French government to build 4,000 apartments on one site close to Paris enabled him to set up his first plant at Montesson. Camus had previously worked for Citroën, and his ideas about the production of building components were in large part based upon his experience of automobile manufacture. In terms of business organization, the innovation brought about by Camus, and the other contractors who followed his lead, was that for the first time house building, previously the province of small to medium-sized building firms, now became a market dominated by very large firms, whose rationale for entering the market lay in their ability to capitalize the prefabrication plants, and whose continued presence in the sector relied upon an endless succession of new sites and housing schemes to receive the products of their factories. This, in short, is the story of the *grands ensembles*, the large multi-storey social housing blocks that grace the outskirts of every town in France. Camus, Balencey, Coignet and the other French systems gave France in the 1950s and '60s pre-eminence in European concrete prefabrication. By 1962 Camus had twelve prefabrication plants in production across Europe and, as we shall see in chapter Five, seen his methods taken up in the

USSR. Although other Western European countries, notably Denmark and Sweden, also developed precast concrete panel systems, none had construction firms of the size and capitalization of the French, nor ready access to such a large guaranteed market, backed by the French state.[36]

The French vaunted their achievements with precast concrete prefabrication in the 1950s and ’60s, and even long after the *grands ensembles* had fallen into disfavour, at least one French historian took a mordant pride in France’s unique gift to the world.[37] While the large international trade in building systems gave a superficial impression of their universality – and indeed only an expert eye could discriminate between a Swedish, Danish, French, Belgian or English system – nonetheless there was some fierce patriotism among the sponsoring firms. One system, the Bison Wall Frame, promoted by the British firm Concrete Ltd, supplied more dwellings than any other in Britain: it was a British-developed system, a fact of which the firm was careful that its potential customers should not remain in ignorance. ‘It is British throughout and subject to no overseas licence’, announced the Bison publicity booklet.[38]

In the early 1970s precast concrete prefabrication systems all but disappeared in Western Europe, making their nationality irrelevant. At the same time, as cultural tensions between Europe and the U.S. lessened, the distinction between concrete and steel ceased to be a defining difference between the two continents, especially as concrete construction became more widespread in the U.S. In the last two decades the economic centre of gravity has shifted towards Southeast Asia and, increasingly, towards China, introducing a new and entirely different contender for ownership of concrete, displacing any questions of French or German, European or American ownership. Those earlier disputes now look trivial – and irrelevant. The pressing question today is whether concrete belongs to the ‘developed’ world or to the ‘developing’ world. An early sign of this shift was when, in the 1950s, some of the architects in the BBPR office working on the design of the Torre Velasca travelled to São Paulo in Brazil to learn about the behaviour of tall concrete buildings under wind load.[39] At that time there were no concrete structures of the height projected for the Torre Velasca in either Europe or North America. Only Brazil, outside the core of developed Western countries, had buildings of equivalent height and the expertise to construct them. Already by the 1950s concrete know-how was passing away from the Western nations; fifty years later, the balance had entirely shifted. By the beginning of the new millennium, consumption of concrete in the ‘developing world’ far exceeded that in the ‘first world’, giving the nations of the former a title to the ownership of concrete. China now produces more than half the world’s cement; and China’s output is almost ten times that of the second largest producer, India.[40] China’s per capita consumption of cement between 1973 and 2004 rose from 25 to 430 kg, whereas U.S. consumption over the same period remained constant at around 350 kg per head. A good deal of this cement has gone into civil engineering projects, the largest of which is the Three Gorges Dam, the biggest civil engineering project in the world, consuming 26.43 million cubic metres of concrete, and twice the volume of the world’s next-largest dam, the Itaifu project in Brazil. The experience of constructing the Three Gorges Dam has given Chinese engineers and construction teams a level of expertise in design and management of very large concrete projects that they are now in a position to export to the rest of the world. The world’s tallest habitable buildings – the Shanghai World Financial Center, Taipei 101, Petronas Twin Towers – are all built of reinforced concrete and are all in Southeast Asia. The centre of gravity of concrete has shifted away from the West, which no longer dominates construction and, decreasingly, expertise. In the ‘developed world’, concrete has tended to become a bespoke material, treated with sometimes almost decadent affectation; in the ‘developing world’, it is the generic medium of construction, a means to an end – modernization – used with unselfconscious abandon. For the foreseeable future, if concrete can be said to belong anywhere, it is not to the First World, where it originated, but to the poorer and later-developing parts of the world. Few, if any, other technologies have made the transition from West to East, from North to South, quite so completely as concrete.

National Concretes

As long as the market for reinforced concrete was dominated by proprietary systems – Hennebique in France, Wayss & Freytag in Germany, Truscon in the U.S. – the most obvious difference between one work of concrete and another was in the system employed, rather than their putative nationality: a Hennebique building in Turin had more in common with a Hennebique building in São Paulo than with a Wayss & Freytag building in Turin. With the decline of the systems in the interwar years, concrete ceased to be identified by brand, an effect that both liberated concrete constructors but also, as we shall see, led to a greater tendency towards national differentiation, as countries introduced individual codes for concrete construction to guarantee the safety of buildings. France established a code in 1906, Germany followed in 1907, and although there was an attempt in 1908 to create an international standard for reinforced concrete construction, this was never accepted and regulation remained a national affair, with each country setting its own rules. While this was in some respects a retrograde step, it contributed to the formation of national identities in reinforced concrete. Different regulatory regimes, different constructional cultures and differences in local labour markets have all contributed to variations in ways of doing concrete: for example, in the 1930s Germany, Switzerland and Spain each developed their own distinctive styles of thin concrete vaults.[41] Some countries, though, have acquired a reputation for something more profound, an entire national inflection of concrete, of which two of the best-known instances are Brazil and Japan.

Brazil

Brazil's emergence on the international architectural scene in the 1940s was closely connected to the employment of concrete. As Philip Goodwin, the curator of the Museum of Modern Art's exhibition *Brazil Builds* of 1943, which put Brazilian architecture on the map, wrote in the accompanying book, 'Modern Architecture in Brazil has always relied on reinforced concrete.'[42] While an identification with concrete is not unique to Brazil but is true of all Latin American countries, the Brazilian case has its own particularity.

The arrival of cement in Brazil in the early twentieth century put the country, as it does all 'backward' countries, on the road to development and gave the architects and engineers who used it the opportunity to produce works that were in every respect equal to or even superior to those produced in the developed world. The fact that a high proportion of those architects and engineers were themselves immigrants from Europe meant that they were both familiar with reinforced concrete and expected to be able to produce with it works that would stand comparison with those in the countries from which they had come. Yet while concrete was 'a step up in the world' for Brazil, it also placed Brazilian architects and designers within a system of values that originated in and was largely regulated from the West. Thus concrete both gave them a freedom and deprived them of freedom. This conundrum – that the acquisition by a country outside the Western core of developed countries of a means to speak on equal terms with those countries carries with it the obligation to do so on the terms set by those countries – is a problem familiar throughout the underdeveloped world. It is the way in which the Brazilians approached the problem that is worth examining.

Until 1926, when the first cement plant was established in Brazil, all cement was imported, making it a relatively scarce and expensive material used mostly under the supervision of European-born or trained engineers on works carried out by licensees of European or North American patents. Even until after the Second World War local production of cement was small, and most of the cement used in Brazil was imported. The preference for concrete over steel construction can be explained by the fact that Brazil had no steel mills capable of producing rolled steel until after the Second World War; all constructional steel had to be imported and cost more to import than did cement. In the 1950s import substitution policies encouraged overseas suppliers of the cement consumed in Brazil to set up plants there, and within a relatively short time almost all the cement used in Brazil was produced domestically. 'It should be noted', wrote a 1965 survey of the Brazilian economy, 'that Brazil is exceptionally well equipped to produce cement on a large scale.' By 1959 Brazil was producing 3.7 million tons of cement and importing a mere 29,000 tons, or less than 1 per cent of domestic production. By 1966 production had increased to 6 million tons, and then over the next ten years, the Brazilian economy's great boom, output more than trebled to 19.1 million tons in 1976.[43] It is little surprise that this extraordinary increase in cement production had an effect upon Brazilian architecture.

Brazil, it is often said, created 'the first *national* style of modern architecture',[44] a development first commented upon at the 1939 New York World's Fair, where the Brazilian pavilion designed by Lucio Costa and Oscar Niemeyer was specifically intended to represent the 'Brazilian spirit'. Full recognition of the Brazilian identity of the country's new architecture came four years later with the Museum of Modern Art's exhibition and accompanying book, *Brazil Builds*. A feature of the Brazilian creation of a national version of modernism is that its recognition relied upon critics in other countries, of which by far the most important was the United States. The story of how the New York exhibition *Brazil Builds* made Brazilian architecture known to the rest of the world, and to Brazilians themselves, has often been told.[45] But there is a particular point to be made about this episode: to a large extent the 'Brazilianness' of Brazilian architecture was discovered by the Americans and came about through American command over the diffusion of news and information to publicize this worldwide. One might say that the 'Brazilianness' of Brazilian modern architecture was in effect an American creation that served American political purposes at that particular moment in the Second World War. However original the Brazilian architects might have been, however effective they may have been in inflecting the global language of architecture with a Brazilian accent, ultimately the success of this project relied upon how it was represented to the rest of the world. The extraordinarily widespread reception of *Brazil Builds* ensured that the Brazilians invariably found the terms in which they built controlled by rules set elsewhere. And in so far as Brazilian modernism was an architecture of concrete, as it was said to be, the Brazilian use of concrete could never be more than a dialect, shall we say, of a language regulated by authorities located in the First World. From a Brazilian point of view, the identification of 'Brazil' through the medium of concrete was not necessarily a benefit, for it immediately drew Brazil into a global discourse in which it was, unavoidably, the weaker party, the object rather than the subject.

There are three distinct phases in the Brazilian appropriation of concrete. The first was to build in concrete what in other countries would have been built in another material. This was the strategy for which Brazil was best known in the late 1920s and early 1930s. A good example is the Martinelli building in São Paulo of 1929, which looks like a North American skyscraper but rather than being built of steel, in the customary American manner, was built of concrete. Whatever technical achievement it represented, in cultural terms it is a piece of mimicry and could hardly be regarded as an original application of concrete.

The second phase was initiated by architects from Rio de Janeiro, the so-called Carioca school, of whom Oscar Niemeyer, whose reputation eclipses that of all other Brazilian architects in the twentieth century, is the best known. Its origins are usually dated to the visit of Le Corbusier to Brazil in 1936, and his collaboration in the design of the Ministry of Education building in Rio de Janeiro. As the Carioca school developed, its prime feature became the use of thin, curvy sheets of concrete and an avoidance of orthogonal shapes. Apart from Niemeyer, the best-known exponents of it were Jorge Machado Moreira and Affonso Reidy. Joaquim Cardozo, Niemeyer's engineer, in 1955 summed up what he saw as the main features of the Carioca school: 'It is clearly a tendency towards wide surfaces made into true concrete *sheets*. I say *sheets* because they form thin layers that suggest an intimate lightness that greatly resemble envelopes of hot-air balloons and dirigibles.'[46] With works like Niemeyer's church of São Francisco at Pampulha, Belo Horizonte, the pedestrian bridge over the road to Reidy's Museum of Con temporary Art, or the school at Pedregulho, you can see what Cardozo meant. The startling slenderness of Brazilian concrete work was made possible by the Brazilian concrete construction codes, which permitted about half the amount of concrete cover over the reinforcement to that required in the U.S.; this generosity persisted until 1979, when a change in the codes increased the required amount of concrete by about 20 per cent, contributing to a heavier style of construction.[47]

When some of the European architectural avant-garde visited Brazil in 1953, they were surprisingly critical of what they saw of the Carioca school. Although Le Corbusier was its acknowledged godfather, several of the visitors condemned it for what they regarded as its deviant tendencies. Nikolaus Pevsner commented on the 'subversive character' of the Pampulha buildings, and the Swiss designer Max Bill was particularly critical. In an article published in the *Architectural Review*, Bill talked of its 'barbarism', calling it 'jungle growth in the worst sense', and he criticized the architects for having fallen into an inappropriate urge for self-expression. Nor was the usually more sanguine Ernesto Rogers, writing in the same issue of the *Architectural Review*, much more generous, commenting of Niemeyer, 'I cannot overlook the many and often unforgivable faults in the work of this capricious artist', and referring to the 'architectural monstrosities' of his followers.[48]

These remarks stung the Brazilians and illustrated the way in which the Western world, having exported modern architecture to the periphery, would then proceed to try to regulate its application there. It exemplified too the difficulties for architects and engineers outside the developed world of using concrete, and the difficulty of escaping from the rules of taste set by the Western countries that had first developed the medium. Smarting from the criticisms of Bill and Rogers, a group of younger Brazilian architects in São Paulo determined to develop an architecture, and ways of using concrete, that would escape dependency upon Western judgement and values, and be immune to the authority of foreigners. The so-called Paulista school represented the third phase in the use of concrete.

One building in particular demonstrates the development of this alternative discourse of concrete. The Faculty of Architecture and Urbanism (FAU) at the University of São Paulo was designed by Vilanova Artigas, started in 1962, and finished in 1969. It is a work whose significance extends far beyond its immediate purpose as a school of architecture. A massive block of concrete sits upon twelve spindly little legs. There are enormous cantilevers at the corners, the cantilevers exaggerating the weight of the mass above, relative to the delicacy of the legs supporting it. I know of no better demonstration of Ruskin's principle of 'superimposition', of 'heavy on light', than this, where we see a dead weight carried upon visibly active supports. If we look at the piers, seen face-on to the facade, they are a continuation of the surface of the block above, formed into inverted triangles, whose apex would just touch the ground were they not truncated by having merged into a slender pyramid, whose tip just reaches to the bottom edge of the concrete box above. Seen from face on, the piers look reasonably substantial, though their attenuation in the middle – the very opposite of the entasis of the classical column – diminishes their bulk. But when the piers are seen from the side, their shape changes into elongated pyramids rising from the ground, diminishing to a needlepoint where they touch the mass of the concrete box above. These piers, which are wholly 'active' in the Ruskinian sense of the word, are the result of some fairly ingenious engineering: Artigas and his engineer went to a great deal of trouble to create the effect of so much being carried on so little.

What I find remarkable about this building is the contrast between, on the one hand, the extreme elegance and sophistication of the engineering of the structure, and on the other hand the crudeness of the execution, for the concrete work itself appears rough and impoverished, the product of 'backwardness'. This is a rare conjunction, for generally speaking architects and engineers have tended to take the view that technically advanced works should be executed skilfully – it is as if the technical excellence of a work risks being compromised if there is a visible lack of skill in the execution. While there are plenty of works where the roughness of the execution is visibly apparent – one may think of Le

Corbusier's *béton brut* works of the 1950s, the first Unité d'Habitation at Marseilles, or the monastery of La Tourette – these works were not distinguished by *technical* virtuosity. It is relatively unusual to find a work that, like FAU, is simultaneously primitive and at the same time technologically sophisticated. In the Latin American context, this conjunction provides a very distinct and unusual commentary on the three connected themes of Latin America, concrete and modernity. The building is certainly knowing about the global discourse of concrete – for example the device of twisting the axis of a pier through 90 degrees had already been done by the Italian engineer Pier Luigi Nervi – but at the same time it responds to the specific condition of Latin American economies. Equally, the building shows a familiarity with the already established 'Carioca' style: what appears at first sight to be a large concrete block sitting on legs turns out, when one examines it from the corner, to be a wafer-thin sheet of concrete enclosing something – an open volume – within, so it does, in a sense, conform to what Cardozo had identified as the 'Brazilian style' of thin sheets of concrete. Where it differs, though, from the Carioca school's concrete sheets is in being first of all demonstratively flat, and second, exceedingly raw. As I have already said, what we see in this building is an odd combination of sophisticated technical expertise with, on the other hand, great crudeness in execution. While we might see this combination as being for purely aesthetic effect, it has been suggested that we can also see it as an attempt to absorb the backwardness of Brazilian labour and lack of industrial productive capacity.[49] The combination of the primitive and the sophisticated that we see here can be differentiated from the European 'Brutalism' with which it has sometimes been compared. Rather what we see here is a building that makes use of the one material that Latin America has in abundance, unskilled labour, and by combining it with Latin America's other resource, human inventiveness, suggests a strategy for the endemic Latin American economic crisis. If the synthesis is awkward, it must be in some sense an expression of the futility of *any* solution to the problems of Latin America, to the impasse of development. Instead of achieving development by importing capital, processes and techniques from 'First World' countries, the strategy represented here acknowledges the backwardness of the Brazilian economy and exploits its limitations. While the results might be more gradual, and in the short run achieve less rapid growth, this approach was thought by some economists at the time more likely to lead to social integration than the alternative approach to development that relied upon foreign investment to set up advanced manufacturing industries.

The interpretation of FAU as 'an attempt to absorb the technological deficiencies of Brazilian building techniques' is confirmed by what we know of the intentions of Artigas.[50] Artigas had been trained as an engineer and took pleasure in technological innovation: his Londrina bus station (1950) was reputed to be the first concrete shell structure to be built in the whole of the Americas, North or South. At the same time Artigas was a communist and opposed to United States involvement in Latin America. He was also a strong critic of the Carioca style promoted by *Brazil Builds* precisely because this version of Brazilian architecture had been 'made' by the Americans; likewise he was critical of the influence exercised by Le Corbusier upon the Carioca school, because of the dependent status in which it cast Brazilian architecture.[51] Artigas's alternative works with the acknowledged 'facts' of Brazilian building – concrete, abundant unskilled labour, lack of productive capital – and used these to develop a version of 'Brazilianness' that was less dependent upon a First World model, but at the same time redolent of the heroic futility of all attempts to modernize the Brazilian economy.

Similarities between São Paulo architecture and European Brutalist works caused some critics to refer to the Paulista school as 'Brutalist'. Unsurprisingly, Artigas himself rejected, possibly a little too emphatically, association with a style that had been defined by European critics. As he put it, 'The ideological content of European brutalism is something other. It brings with it a cargo of irrationalism', where architectonic form, despite its appearance of technical determinism, was in fact arrived at through arbitrary or accidental aesthetic choices.[52] The gist of the objection seems to have been that from the standpoint of Brazil, European Brutalism was an expression of melancholy, the work of a civilization that had all but destroyed itself in the Second World War, and whose use of technology was always now tainted by knowledge of its own capacity for self-destructiveness. In this respect, European 'Brutalism' was a conceit: although European countries had had in the immediate post-war period to deal with material shortages, these had never been more than short-term, and provided no justification for prolonging the aesthetic 'austerity' of Brutalism into the late 1950s and 1960s. For Brazil, these conditions did not apply – not only had Brazil not been destroyed in the recent war, but neither had it enjoyed a state of advanced development previously. Far from having to deal with the ruination of an advanced economy, the problem for Brazil was to achieve an even half-advanced level of economic development to start with; seen in this context, the use of raw concrete finishes was not, as the historian Hugo Segawa puts it, 'a technological "front", but the most advanced technology that Brazilian architects had'.[53]

Artigas's FAU was not only a statement about the social relations of production in Brazil, but also implied resistance to the global discourse of concrete. Building in concrete, as Brazilians had to do, encouraged critics inside Brazil and out to compare their work to concrete architecture in other parts of the world – it is the 'natural' effect of concrete to unite all nations, and put each in a relation to the other. Any attempt by an individual country to develop a separate identity always predicates an 'other' on which such a difference is based – and in the politics of economic development, this 'other' will always turn out to be the 'developed' world. Brazilian architecture, working in the transcultural medium of concrete, was drawn into a global discourse that cast it in dependency to the more developed world. Each of the three phases of mid-twentieth century Brazilian architecture reveal the peculiar difficulties faced by architects in a country on the periphery when they aspire to represent aspects of that country's identity through the medium of concrete; although the Brazilians' chances of success were limited, the results nonetheless had originality. If there is such a thing as 'Brazilian concrete', it emerged from the presence of a global discourse about concrete and out of an attempt to escape the restrictions of that discourse.

Japan

In a work by Tadao Ando – let us take the Rokko apartments in Kobe, or the Church of Light in Osaka – there are certain distinctively Japanese features, some of which attach to the concrete. Compared to the Brazilian examples, Ando's works are massive and heavy, and there seems to be a redundancy of material in the members. The beam that crosses the columns at the top of the Rokko apartments is the same dimension as the columns that support it, when there is, structurally, no need for it to be as thick; everywhere in Ando's buildings there seems to be more concrete than is necessary. The finish is superfine, exceedingly even and smooth, with few air bubbles in it – again, a total contrast with the Brazilian concrete. There are no chamfered corners, which would have much simplified the casting process, and instead the arrises are exceedingly sharp and have come clean from the mould with no damage and no sign of any remedial work on them. All these effects are the result of much care and diligence in the making of the work: the smoothness of the concrete is achieved partly by very careful preparation of the moulds, and partly by repeated hammering of the moulds with wooden mallets while the concrete was being poured, so as to stimulate the flow of the concrete and release air bubbles. After the moulds are removed, the surfaces are polished and treated with a glaze. The sharp corners are achieved by placing newspaper in the joints of the moulds to draw moisture out and increase the density of cement at that point. These and other features give Ando's concrete a reputation for being both perfectionist and 'Japanese'. But at the same time, Ando is an international architect whose work has been built in many countries. Is an Ando building in Fort Worth, Texas, still 'Japanese concrete', or is it 'American'? Ando's work, as the historian Ken Oshima notes, 'illustrates the dialectical international/regional nature of concrete'.[54]

This dialectic has been present in Japan since the introduction of both reinforced concrete and of ‘architecture’ into the country. Within Japan, ‘architecture’ was an alien practice – prior to the opening of relations with the West in the second half of the nineteenth century there were neither specialist designers independent from building craftsmen, nor a discourse of design. When ‘architecture’ and ‘architects’ first appeared in Japan, both the practice and the styles of building that they adopted were modelled entirely upon Western example – initially British, but by the 1920s increasingly American and German. However, within a culture as wary of all things foreign as Japan, there was considerable resistance to this adoption of Western practices. The particular focus for this resistance was earthquakes, whose severity and regularity seemed to single out Japan as different from Western countries, and provided a reason for not borrowing their way of building.[55] The Great Nobi Earthquake of 1891, the most violent in modern times until 2011, and its consequences, convinced many that Japan must develop its own science of construction. The study of seismology and the development of anti-seismic building techniques became an early reason for Japanese engineers to distance themselves from Western practice, and in particular to become interested in reinforced concrete. When concrete was introduced into Japan in the early 1900s, it was sanctioned by the architectural academy almost immediately on account of its anti-seismic value, whereas in Europe and the U.S. at that date it was still almost exclusively the province of engineers and contractors, and looked upon with suspicion or disdain by the architectural establishment. From the moment of its arrival in Japan, concrete was recognized as an *architectural* medium with anti-seismic properties, and immediately became central to the practice of architecture in Japan. The influence of one particular architect-engineer, Rikki Sano, who had been trained by the first seismologists, contributed to the transformation of the Japanese architectural profession into an ‘anti-earthquake regime’. Earth quakes, and reinforced concrete as a solution to them, provided Japanese architects with an escape from the artistic and cultural dominance of the West, to which they had initially fallen victim, and rendered irrelevant the sorts of artistic concerns with which European-trained architects preoccupied themselves. Sano later wrote in his autobiography, ‘I believed that whether a building was good looking or not and what colour it was were only women’s things and men should not talk about them’. And because of the priority given to anti-seismic construction in Japan, Sano was able to say that ‘Japanese architects are essentially different from European and American architects’.[56]

Although Hennebique had made claims for the earthquake-proof potential of reinforced concrete following the Messina earthquake of 1908, the firm had nothing substantial to offer in the way of anti-seismic expertise or experience[57]; the Japanese had to work this out for themselves, so endowing the science with a Japanese imprimatur. At the same time, reinforced concrete came to be seen as central to a nexus of problems from which Japan suffered: earthquakes, fires, housing shortages, overcrowded cities. The relative shortage of steel in Japan, as in Brazil, made concrete the preferred medium for their solution.

The superiority of reinforced concrete over all other materials in terms of earthquake resistance was demonstrated in the Tokyo earthquake of 1923, in which the largely concrete buildings of the recently constructed office quarter of Marunouchi survived with little damage, while older European-style masonry buildings were severely affected. Frank Lloyd Wright made much of the fact that his Imperial Hotel, built of reinforced concrete, had been unharmed, but the Japanese architectural community was far less impressed by this than they were by the fate of another American-designed and American-built structure nearby, the Maru-Biru office building for the Mitsubishi Corporation. Steel-framed, it was damaged while still under construction by a smaller earthquake in 1922; the Japanese owners sought the advice of a Japanese engineer, who recommended reinforcing the steel frame with concrete, but although this was done, the building was again damaged in the earthquake the following year. Among Japanese architects and engineers, the Maru-Biru became known as the American building that had failed; foreign knowledge and expertise had been humbled, while Japanese reinforced concrete construction and anti-seismic expertise had been vindicated. Following the earthquake, new building regulations drawn up by Sano and his colleagues virtually banned stone and brick for large buildings in favour of reinforced concrete, which they anticipated would become the building material of the future. In no other country in the world, not even France, was reinforced concrete so strongly sanctioned by the authorities.

The damage caused by the 1923 earthquake was nothing compared to the devastation caused to Japanese cities by the United States Army Air Forces in 1944–5. It was above all the conventional bombing of Tokyo and other cities, rather than the atomic bombs dropped on Hiroshima and Nagasaki, that caused the greatest destruction. One young architect, Kunio Maekawa, was so appalled by the ease with which Japanese cities had been destroyed that he resolved that the Japanese must in future build more solidly and more permanently.[58] Concrete, already established from the 1920s as the prime medium of Japanese construction on account of its earthquake resistant properties, was further justified by the wartime revelation of just how fragile and combustible Japanese cities were.

For Maekawa and his peers, two of whom, Sakakura and Yoshizaki, had like Maekawa worked in Le Corbusier's office in Paris before the Second World War, the ambition was first of all to be modern, and secondly Japanese. What part did reinforced concrete play in realizing their aims, and how far did what they built inflect reinforced concrete as 'Japanese'?

Here we have to take account of the fact that when European modernists had first discovered Japanese traditional architecture what had appealed to them were its proto-modern qualities, its purity, the fluidity of inside and outside space, its careful use of materials. Bruno Taut, who arrived in Japan in 1933, had been transfixed by the lightweight, sparse Katsura Imperial Villa, a space made up of screens.[59] As Reyner Banham remarked of Walter Gropius's visit to Katsura, in an exceptionally perceptive essay about post-war Japanese architecture, 'rarely has an explorer gone into another country so determined to find what he so transparently hoped to find'.[60] For Gropius and other modernist architects of his generation, Japan seemed to offer Western architecture a way to save itself from its own follies, and they had certain expectations as to how Japanese architecture should develop. That it did not go in the direction they had anticipated was, Banham argued, because the resemblance between Japanese traditional building and twentieth-century modern architecture was entirely coincidental, and that Japanese architecture 'had sources and destinations that had almost nothing to do with Western architecture'.

Yet the expectation that Japanese architecture should follow a particular course put Japanese architects, especially those who had studied or worked in the West, under an obligation that they were most reluctant to follow. Something of this tension is evident from the book on the Katsura Villa to which Gropius wrote the preface, and Kenzo Tange, a former assistant of Maekawa, the main text. Tange's interpretation of Katsura is almost the opposite of Gropius's. Far from seeing it as delicate, refined and in the spirit of international modernism, Tange saw in it features of the early Jomon culture of Japan, Dionysian, atavistic and vigorous.[61] These features, which were to erupt in Tange's own architecture, were not, contrary to what Banham suggested, entirely unrelated to the West, for according to Arata Isozaki, the early post-war, American-approved Japanese style of international modernism that used curtain walls and slender elements became increasingly disliked during the 1950s as resentment grew against the conditions of the post-war settlement and the San Francisco Treaty of 1951 that had marked the formal end of hostilities. The *japonisme* of this style became associated with American influence in Japanese affairs and, according to Isozaki, the interest in Jomon culture as an alternative approach was 'not irrelevant' to the anti-U.S. movement in Japan.[62]

Earthquakes, wartime bombing and Jomon culture all predisposed Japanese architects and engineers towards reinforced concrete, and towards a heaviness of construction in its use. But there is one other factor to be taken into account, often referred to in Japan, and that is concrete's symbolic relation to wood. Unlike in Europe or North America, wood was the noble material of building in Japan, stone being used only for civil engineering and fortifications. All buildings of high status, religious and secular, were historically built from wood. Moreover, and again unlike Europe, where wood, when it was used, was employed sparingly and in slender sections, in Japan it was used abundantly and excessively without regard for economy. In Japan, as in Europe, with the entry of concrete into the repertory of building materials, it was regarded as a substitute for whatever stood at the top of the hierarchy of materials – masonry in Europe, wood in Japan. As one Japanese architect said to me, 'In Italy, they use concrete as if it were stone'; in Japan, though, it was used as if it were wood, with all the honorific associations that that carries in Japan. Reyner Banham argued that, familiar with the massive timber construction of temples, Japanese eyes saw nothing strange or illogical in gross and colossal columns joined to indecently slender elements, long flat beams spanning wide spaces, and exaggerated cantilevers all executed in concrete, any more than they would have done when confronted by the presence of these same features in traditional buildings in wood. Untroubled by structural rationalist prejudices, by the expectation that the maximum effect should be obtained with the least material, Japanese architects were not discomforted by redundancy or excess. At a time when the rest of the world was taken up with the possibilities of lightness offered by concrete, and especially shell structures – so that, as one commentator put it, the objective was 'strength through form rather than strength through mass'[63] – the Japanese went resolutely in the opposite direction, towards weight and solidity. The massive piled-up block structure of Kurashiki City Hall (now Art Gallery) looks strange compared to slender Western structures of the same date, but is not so odd when the Nara Treasure House is your point of reference for what constitutes a monumental architecture.

If massiveness and excess are two of the features that characterize the Japanese use of concrete, another is extreme refinement of finish. This too bears some relation to wood, in particular to the continuing strength of the carpentry tradition in Japan. In a culture where building meant, and to some extent still does mean, carpentry, it is this particular craft that set both the standards and expectations for the standard of finish of concrete. Although Japanese architects had been inspired by Le Corbusier's use of board-marked concrete, *béton brut*, in France and at Chandigarh in India, Japanese architects did not set out to emulate the roughness of finish of his works. Kenzo Tange's first major work, the Hiroshima Peace Memorial Museum, completed in 1955, was, like Chandigarh, a major national monument executed in concrete with the evidence of the formwork left exposed – a previously unthinkable violation of the rules of architectural propriety. However, where Chandigarh is rough, Hiroshima is refined, finished in the most beautifully executed board-marked concrete; though made of concrete, the Hiroshima Museum is a timber building at heart, and the evidence of this is, or at least was, betrayed on the surface, in the craftsmanship that went into making the formwork. I say 'was' because when the original finish deteriorated, it was treated with the sprayed textured synthetic coating known as 'bontile', universally used in Japan to protect decaying concrete, and after this too started to break down, the entire surface was removed and recast in new timber forms; the upper storey, originally also exposed concrete, has now been clad in marble. What we see now is not the building's original surface.[64]

The Kagawa Prefecture at Takamatsu (1958) is another work of Tange's where concrete takes on the character of wood. This is a building in which every detail and aspect is fully resolved, and everything fits together in a remarkable synthesis. In the office building, which is to the rear of the complex, the careful relationship of beams, columns and balconies is related to the temples of Nara; the exposed beams are multiplied in excess of structural necessity as if they were wood, and the junction of the balcony balustrades is a timber detail. The columns at ground level are again board-marked concrete, cut away at the foot, suggesting that the columns have been clad in timber: the effect is entirely different to the superficially similar detail at the Economist Building, where it implied an interior truth – here any 'truth' is in the super-addition, rather than what lies within. Amongst Japanese architects, Tange is sometimes referred to as an 'architect of surface', an all-too-literal description for the Takamatsu Prefecture.

An association between wood and concrete was certainly part of post-war Japanese architectural culture. Writing in 1958, the architectural commentator Yoshioka Yasuguro stated that 'the Japanese feeling for the texture of concrete is certainly the result of long experience with materials such as tile, pottery and wood'. And, he continued,

> It is doubtful that concrete is handled with such pains anywhere except in Japan. The idea of an exposed concrete surface seems to fit in with Japanese ideas of decor. One detects a certain kinship with the practice of using gnarled tree trunks and resinous pine slabs in Japanese-style interiors.[65]

The wood-like character of Japanese concrete is still much appreciated in Japan. A curator – not an architect – at the Kurashiki Museum, where the interior is richly finished in board-marked concrete, told me how much he liked the wood surface of the concrete, he felt comfortable with it. It makes concrete seem familiar within the Japanese context. Unlike Western architects who have, since the 1950s, become accustomed to combining concrete with brick or stone, Japanese architects seem to avoid this juxtaposition. Instead, the more usual accompaniments for concrete are wood, bamboo, tatami mats, fabric – all Asian materials – and Japanese opinion is that these go better with concrete than brick or stone. Japanese concrete's relationship with wood is also apparent in its fabrication. The refinement of finish is the result of much care in the making of the formwork, and when this is timber, architects are able to draw upon a continuing Japanese carpentry tradition whose standards of workmanship are higher than those found in other developed countries; the existence of many skilled carpenters in Japan makes it possible to obtain carpentry of a quality inconceivable, or prohibitively expensive, elsewhere. This, it is said, has contributed to the standard of Japanese concrete work, especially in the 1950s and '60s, and is a reason why Japan never developed much interest in precast concrete, as it was always relatively easy to have on-site formwork fabricated even when the shapes were difficult to make. Today, the work of the current 'masters' of Japanese concrete, Tadao Ando, Fumihiko Maki and Toyo Ito, is mostly cast in steel forms, and wooden formwork is reserved for more specialized work, where Japanese architects can be confident of using complex shapes in the knowledge that the formwork can still be successfully fabricated in wood. The irregular curve of the roof of the Crematorium at Kakamiga hara, designed by Toyo Ito and completed in 2006, was only feasible with wooden forms, for every section of the formwork has a different profile. The forms were works of art in themselves, and only possible through the availability of skilled craftsmen capable of fabricating them. As far as the medium itself is concerned, the Japanese concrete industry pioneered the development of self-compacting concrete, which flows more easily than normal concrete through the use of additives and gives a more reliably smooth and even finish. In Japan the technical aspects of concrete production have been perfected to a degree that leaves architects and designers free to concentrate on other issues.

Against the near-perfect standard of concrete attainable in Japan, one might ask where that leaves two other qualities that have figured large in Japanese culture: the virtues of incompleteness (as in Metabolist architecture) and of imperfection (as in Japanese gardens and pottery). Whereas Western architects have been inclined to make a virtue of the imperfect and the accidental in concrete, Japanese architects appear to have been much less interested in exploiting these aspects of the medium. Zaha Hadid recently said: 'I like architecture to have some raw, vital, earthy quality. You don't need to make concrete perfectly smooth or paint or polish it' – an implied criticism of Ando's work.[66] But Japanese architects do not seem to have been attracted by the unpredictability of concrete. Ando feigns a certain indifference as to the results of his concrete – the bulges in the steel formwork of some of his early houses gave a quilted effect under certain light conditions, but this was not intentional, and he went to great lengths to avoid this happening again in his later work; at the Church of Light in Osaka, I was told that he had been unconcerned about the blowholes in the concrete, but again his determination to avoid these on later buildings suggests otherwise. I know of only two examples of cultivated imperfection in Japanese concrete: one a small house in Tokyo, Takamitsu Azuma's Tower House of 1966, where reasons of economy obliged the architect to abandon any attempt at refinement of the interior finish; the other a commercial building in Tokyo completed in 1987, Azabu Edge, where the fractured, scored edges of the concrete, as if it were already under demolition, appear to have been a deliberate and explicit criticism of the perfectionism of Japanese concrete. The colossal Kyoto Conference Hall, completed in 1966, with its exquisite bush-hammered surface, exposing evenly graded granite aggregate and a concrete whose deep rich grey was achieved by mixing ink (think of the quantity and the task) with the cement, represents, or so it was described to me, 'the peak of Japanese concrete', against which anything else would be judged.

Is then 'Japanese concrete' an objective fact? Or is it imaginary, something dreamed up by Westerners and Japanese alike in order to preserve a mystique of the Orient? These are not exclusive options, it is not a matter of just one or the other – both may be possible. The circumstances of 'Japanese' or any other national concrete can be seen in terms of discussions since the 1980s about the annihilation of space. As speed of communication increases, compressing spatial distance, so, the argument goes, places become more alike out of the need to compete with each other for capital and investment. Capital, rootless, nevertheless needs locality in order to generate economic activity and growth, though as soon as another more advantageous location appears, it will move elsewhere. Lower labour costs and more relaxed regulatory regimes are what capital looks for in the first instance, but other factors are the image of a city or country, and its attractiveness to the wealthy and powerful as a place to live. David Harvey, who first developed this argument, describes the central paradox: 'the less important the spatial barriers, the greater the sensitivity of capital to the variations of place within space, and the greater the incentive for places to be differentiated in ways attractive to capital'.[67] In terms of the built environment, European cities customarily differentiate themselves through 'heritage', but Harvey also suggested that post-modern architecture should be seen as part of the same process, and particularly in places that have little or no heritage to draw upon, new building has undoubtedly been important in creating an image that might both attract capital in the first place, and keep it there in the long term. It has become an economic necessity for places to manufacture difference, whether or not it has any objective basis. Concrete is part of this process, and indeed what better way of evoking difference could there be than to be able to point to distinctive 'national' characters in this otherwise global medium. Notwithstanding the extraordinarily monotonous and homogeneous character of most Japanese cities, Japan has been relatively successful in achieving an identity for itself through its creative industries, fashion, design, cinema, comic books – and architecture. The promotion of concrete as 'Japanese' has to be seen, whatever its actual features, as a symptom of the need to make differences out of the most minor variations between one place and another. Much the same argument would apply to Brazilian, Swiss, Mexican or any other seemingly national style of concrete.

The geopolitics of concrete are beyond the control of any one nation, and certainly beyond that of any one cement producer – despite their size and reach – but instead form part of the process of exchange and transfer that characterized all cultural practices in the twentieth century, and which look likely to continue into the present century.

FIVE

POLITICS

CONCRETE is political in many senses, but it has been particularly identified with the politics of the left, an alignment traceable from the beginning of the twentieth century. An early incident in this long-running association was the Centennial Hall, completed in 1913 in Breslau (now Wrocław in Poland, but then in Germany), as part of the celebrations to mark the centenary of the Prussian king Friedrich Wilhelm III's call to his subjects to oppose Napoleon. This vast circular hall, designed to hold an audience of ten thousand and at the time of its completion the widest uninterrupted interior space in the world, has been an icon in the histories of modern architecture and of reinforced concrete, but until recently its political connotations have been overlooked, although they were clear enough at the time.[1] Despite the patriotic and Imperialistic nature of the celebrations, the Kaiser, when he attended the anniversary event in August 1913, refused to enter the hall, where a choir of schoolchildren was waiting to sing to him. What he objected to were the pacifist and democratic undertones of the occasion, organized by the Social Democrat and Liberal municipality of Breslau. The city, and its architect Max Berg, had built the hall to draw together crowds of all classes in mass spectacles that would, it was hoped, reunite them into an 'organic' social community. This progressive political programme was well understood, not only by the Kaiser – and it was recognized that what had made it possible was reinforced concrete. As the critic Robert Breuer wrote in a review of the building five months before the Kaiser's visit, 'ferroconcrete and democracy belong together'.[2]

Breuer described the interior of the hall as like 'being inside the rib-cage of a prehistoric beast', an experience about which he was distinctly ambivalent. 'The courageousness of the construction confuses, and the feeling is between anxiety and enthusiasm'; and in an interior where all the structural elements were inclined or curved, he commented on 'the lack of calmness in the enclosed space, where all vertical surfaces are transparent . . . The impression is stimulating, but not satisfying.' But Breuer was not in doubt of the political significance of this constructional tour de force: the concrete hall was 'the sign of the people's victory on their way to power'.

The sense that reinforced concrete offered a means to draw people closer together, and by so doing enhance their collective social consciousness, was further endorsed following the October Revolution in 1917 in Russia. Not only were many of the new buildings of the regime built in concrete, but the synthetic nature of reinforced concrete made it a symbol for Lenin's view of the 'indissoluble unity' of the proletariat, formed through the process of revolution. In Fyodor Gladkov's classic socialist realist novel *Cement* (1925), set in a cement plant during and after the civil war in Russia, the significance of cement is that, like socialism, it creates a bond between a mass of loose particles. As the hero, Gleb Chumalov puts it, 'We produce cement. Cement is a firm bond. Cement is us, comrades – the working class.'[3]

In Western Europe in the interwar years, concrete was routinely associated with radical politics, and left-wing municipalities went out of their way to exploit the medium. Concrete 'manifesto' buildings from this period include the Town Hall (1931–4) of the working-class Paris suburb of Boulogne-Billancourt;

designed by the architect Tony Garnier (whose earlier *Cité Industrielle* projected an ideal city in concrete), this was a building in which, in the words of the formerly communist but by then socialist mayor, André Morizet, 'sumptuousness was sacrificed for practicality'.[4] Also in the outskirts of Paris was the concrete Karl Marx School of 1932–3 in the communist-controlled municipality of Villejuif, designed by André Lurçat. In England, the socialist London Borough of Finsbury's Finsbury Health Centre (1935–8), designed by the Russian émigré architect Berthold Lubetkin, was conceived as a miniature 'social condenser' where dramatic use of concrete advertised Finsbury's radicalism against the national government's lack of a social programme.[5] Everywhere, concrete was associated with left-leaning politics. The English art historian Anthony Blunt, later exposed as a Soviet spy, went to Spain with the poet Louis MacNeice in the 1930s and returned to Britain expecting a socialist revolution. MacNeice wrote later,

> If Spain goes communist, Anthony said, France is bound to follow, and then Britain, and then there'll be jam for all. Which incidentally will mean new blood in the arts – in every parish a Diego Rivera. And easel painting will at last admit it is dead and all the town halls will bloom with murals and bas-reliefs in concrete. For concrete is the new medium, concrete is vital.[6]

It was, however, in the post-war era that reinforced concrete attained political maturity, when it became a formidable weapon in the arsenal of the Cold War. Although usually associated in the Cold War context with bunkers, missile silos, hardened aircraft hangars, fallout shelters and miscellaneous military installations, these applications all placed concrete in an essentially passive role, there to absorb blasts and to protect people and equipment against radiation.[7] It was within the ideological strategies of the Cold War that concrete took on a more active role. Architectural politics in the Cold War era has been usually seen in terms of 'showpiece' projects, like the Stalinallee in East Berlin, to which the response of the West was the Hansaviertel, an informally arranged group of international style housing blocks designed by a variety of Western architects.[8] But ideological conflict was not confined to these relatively isolated propaganda schemes, but was more broadly present in the field of ordinary building production, where each side, communist East and capitalist West, tried to outperform the other. It was in this struggle that concrete came into its own, and in which the East was the immediate victor – though the price it paid was its own ultimate collapse, and at a cost that will be borne for many years to come by all the former Soviet-controlled states.

Concrete in the USSR and Eastern Europe

Throughout Europe in 1945 there were severe housing shortages, the result of wartime destruction and the cessation of new building for six years. The worst affected country of all was the Soviet Union, where even before 1939 housing had been in short supply and the sharing of apartments between families commonplace. In the urgency of demand for new housing, all countries faced similar conditions, in particular the needs for speed, and to not hamper economic recovery by diverting skilled labour away from other industries and into building production. The solution was widely seen to be prefabrication, for which reinforced concrete was generally the preferred medium. All countries developed reinforced concrete prefabricated systems – though none exploited them as fully as the Soviet Union. The *Plattenbauten* apartment blocks made of reinforced concrete panels became symbols of the Soviet Union and of its dominance throughout Eastern Europe. Just how this happened is worth describing.

The moment when the Soviet Union first set its course to make concrete panels the exclusive mode of construction occurred on 7 December 1954, when Nikita Khrushchev, first secretary of the Communist Party Central Committee, delivered a speech to the All-Union Conference of Builders, Architects and Workers in the Building Materials Industry.[9] It cannot be overemphasized just what a remarkable event this speech was. Entitled 'On Wide-Scale Introduction of Industrial Methods, Improving the Quality and Reducing the Cost of Construction', it must have lasted the best part of two hours, and was almost entirely about construction in concrete. On no other occasion, before or since, has a head of state delivered such a lengthy and well-informed address about concrete. Not only did the speech reaffirm the traditional importance of concrete within Soviet ideology, but it occurred at a moment of great political significance. Stalin had died in March 1953, and in the subsequent manoeuvring, Khrushchev emerged as the dominant figure, though it was not until early in 1956 that he was to give his famous speech denouncing the cult of personality that decisively marked the end of Stalinism and the beginning of the 'thaw'. Just over a year previously, when he spoke to the audience of builders and architects, Khrushchev chose building construction as the ground upon which to make his first public criticism of Stalin's policies, and the speech therefore marked a momentous turning point within Soviet politics.

Before looking at the speech itself, we should describe some of the features of building production in the USSR in the early 1950s.[10] Following the war, some new apartment buildings had been built with precast concrete panels: in some cases the panels had been used throughout, in others, they were combined with a steel frame. Stalinist orthodoxy required all buildings to be neoclassical in style, with appropriate decoration. For the apartments in precast concrete, decorative details were cast integrally with the panels, and pilasters were used to hide the joints between them. These details caused complications in the construction – they were easily damaged, and skilled labour was needed to make good the damage. Architects and engineers had come to the conclusion that if they were to take advantage of prefabrication, they must renounce classical design, though this was not, of course, a step that they were free to take on their own. The view of architects, to quote an article in a professional journal, published shortly after Khrushchev's speech, was that 'it is essential to design smooth panels, without profiles, and to construct prefabricated buildings in large panels with exposed joints' – the very features that were to become the hallmark of Soviet construction.[11] Russian architects were well aware that by the mid-1950s Western European countries had made significant advances in the technology of reinforced concrete panel construction, but Soviet isolationism and automatic vitiation of all things Western as bourgeois prevented them from sharing in these new developments.

It was in these circumstances that a young architect, Georgei Gradov, in February 1954 wrote a long letter, of more than a hundred pages, to Nikita Khrushchev setting out all the shortcomings of Soviet construction. Khrushchev, who had had earlier experience of construction as the director of works on the Moscow underground system in the 1930s, saw the political potential of Gradov's bold letter, and decided to call a conference of architects and builders at the close of which, advised by Gradov, he would make a speech. Although Khrushchev's speech is well known and often referred to by historians on account of the criticisms he made within it of socialist realism in architecture – 'The modern apartment house must not be transformed . . . into a replica of a church or a museum' – in fact these remarks amounted to no more than a minor and relatively insignificant part of the whole address; and in any case neither then nor later did Khrushchev ever renounce socialist realism as such, merely its excesses.[12] The bulk of the speech was about concrete, and its place in building production.

There were five stages to Khrushchev's argument. The first was that anything and everything that could be made out of concrete should be made out of concrete: railway sleepers, telegraph poles, the frames of factories and so on: 'Comrades, we must resolutely put a stop to the extravagant expenditure of metal. Only what is essential should be built of metal. Everything in building which can be replaced by concrete or reinforced concrete should be replaced (*Applause*).'[13] This principle led, ultimately, to some doctrinaire absurdities: in the Baltic states, for example, where timber is abundant, every telegraph and electricity pole was nonetheless made of concrete. Brick too was condemned as a labour-intensive and inefficient material: 'Is it not better, instead of bricks, to make concrete wall blocks two, three, five tons in weight for use with existing hoists? Building with blocks produces high labour productivity and a high output.'[14]

The second theme concerned the advantages of prefabrication over in-situ concrete work. In-situ work 'inevitably leads to filth on the construction area, the use of all kinds and designs of shuttering, to the overexpenditure of iron, to the loss of cement, to the loss of inert materials and concrete'.[15] In-situ concrete construction is wasteful, but worst of all, it is reliant upon handicraft methods and therefore 'backward' modes of construction.

Having established the advantages of prefabrication over work *in situ*, the next question to consider was what kind of prefabrication should be adopted: large blocks or heavy panels? Khrushchev came out in favour of panel construction, which he says uses 20 to 25 per cent less labour. And it was not only precast wall panels that Khrushchev wanted to see introduced, but systems with precast floor sections – 'By the broad use of panels for floors and ceilings we shall evict from construction projects the "handicrafters" who use poured concrete',[16] reiterating his attack on craft methods of construction. And he goes on,

> At the present time stairways and landings are being delivered to many construction projects from reinforced concrete factories with poorly finished surfaces. Therefore at the construction projects they are forced, in installing the stairway assemblies and landings, to finish them on the spot. The same thing happens in numerous cases with wall, floor and ceiling panels. This is incorrect. All work in the finishing of reinforced concrete parts must be carried out fully at factories. Stairways must be delivered with finished upper and under surfaces . . . Pieces must arrive at the construction project in complete form, completely ready for installation. Otherwise what advantage shall we receive from prefabrication if we prepared a prefabricated part at the factory, install it on the eighth floor, and then have to consider how to get to it in order to clean or polish its surface?[17]

From this argument, there followed the entire realignment of the Soviet construction industry to the production of large panels.

Having established the advantages of heavy panel construction, Khrushchev turned to his fourth theme, the need for standardized designs:

> Why are there 38 standardized designs for schools in use at the present time? Is this expedient? Apparently it has come about because many officials have a spendthrift attitude towards building. We must select a limited number of standardized designs for apartment houses, schools, hospitals, buildings for kindergartens and nurseries, stores and other buildings and installations and carry out mass building only according to these designs for only five years.

As he went on to explain,

> Standardized designs will make it possible to organize the factory manufacture of structural parts and sections and abandon conventional construction for the assembling of buildings, carrying out this work in short periods of time.

Evidently anticipating that there would be opposition, he continued:

> To introduce standardized designs we must be determined and persistent, for we may meet resistance in this matter. Evidently there are some people who need a good explanation of the necessity for standardized designs.
>
> The use of standardized designs in building will have a tremendous effect on economizing, speeding up and improving construction work. Of this there is no doubt. (*Stormy applause*).[18]

The standardization of design was the easiest aspect of the new policy to introduce, and a decree of 2 August 1955 legislated a single set of designs. Although it was some time before one system was arrived at, and even then there were always variants of it, the slogan ‘A single system of construction for the whole country’ held good.

The fifth theme of the speech concerned the significance of precast panel construction in relation to building labour. Not only would panel construction bring an end to handicraft labour – as we shall see in chapter Eight, an objective in many countries though rarely attained in practice – but also, more importantly in the Soviet context, it would abolish unskilled labour, and make everyone a ‘technician’.

> A collective farmer arrives at the construction site without any skills, qualifications, and he is put down, as is well known, as an unskilled worker. And so he works as an odd-job man; his output is low, he has no special trade and his earnings are not great. He begins to look around, and then a comrade comes up to him and says: ‘Look here, give up this work and go into a factory. There you will have a trade within six months, you will receive a rating and perhaps even a place to live.’ He looks around and is off; after six months at the factory he has learned a trade and is earning twice or three times as much as at the construction site. Is that not true? (*Shouts of ‘Yes, quite right!’*) . . . If every builder were helped to master some trade well and helped to become a skilled worker who could use machinery proficiently, he would then love his work and say with pride: ‘I am a builder!’[19]

Khrushchev’s speech provides one answer to the question of why it was concrete, not steel or glass, that was *the* medium of the Cold War. What Khrushchev did, most emphatically, was to draw attention to the way concrete prefabrication was expected – and this was just as true in the West as in the East – to solve two problems at once: to increase the supply of housing, and to overcome the skills shortage. At the time of Khrushchev’s speech, only a fraction of the housing being produced in Russian cities was being built by precast panel concrete construction. Russian building labour was badly paid and operated at low levels of skill. It was estimated that in 1956, 40 per cent of all building workers were women, and the majority of building workers in the cities were new immigrants from country regions.

At Khrushchev’s initiative, contacts with the West were established, experts were sent to Britain and France and other European countries to study precast systems. The closest relationship was established with France, where the Russians were most interested in the Camus system (see chapter Four), a variant of which was adopted in the USSR. A decree of 1957 established building cooperatives, called DSK, to manufacture the standardized components; the first of these was set up in Leningrad in 1959; by 1967, there were 300, and by 1982, 482 DSK in the USSR with a combined output of 58.4 million square metres of housing per year. In 1965, 25 per cent of all new housing was large panel construction, by 1977, 50 per cent, and by 1988, 90 per cent of new housing in the Moscow region was built with large panels manufactured by the DSK.[20] The initial standard design was a five-storey apartment block type, nicknamed *krushcheby* (a play on *trushchoby*, the Russian word for slum), built with large panels, and without lifts; in the early 1960s it was realized that apartments built with this system were relatively expensive, and that savings made by the absence of lifts did not justify the costs incurred in the production and transport of the panels.[21] Exactly as in the West, the decision was taken to build higher, to nine or sixteen storeys, to achieve a higher return on the capital cost of the plants. However, the panel construction system of the five-storey *krushcheby* could not be adapted to build higher, and a new system had to be designed in its place. In the 1960s the Soviet Union generously donated to its South American allies, Chile and Cuba, plants for the manufacture of its by-then obsolete five-storey type, creating a further diaspora of the Soviet concrete dwelling.[22] The new standard type for sixteen-storey blocks remained in production even after the end of the Soviet era: the DSK-1 plant in Moscow was still producing 1.2 million square metres of housing per year in 2000.[23] While making use of a product that had, initially, been designed in the West, the Soviet Union developed production of its notoriously inflexible system on a scale that exceeded even the imagination of anyone in the West, producing identical buildings, from Vladivostok to the Elbe, under the control of one organization, which at its height employed some thirteen million people.[24]

Khrushchev's drive to industrialize housing production took place against the background of the USSR's declared aim to catch up with and, by 1966, overtake the U.S. in all aspects of material existence. In this, as in the desire to abolish craft labour and turn all workers into technicians, the attachment to concrete was ideological. On the other hand, as Khrushchev made clear in his speech, the reasons for adopting concrete over other modes of construction were also economic. Comparing the labour involved in building two Moscow schools, a brick school required 7,360 worker days, while a school built with concrete panel construction required only 1,780 worker days, or 24 per cent of the labour of the brick building.

The average daily output of a worker on the brick building was 268 roubles, that of a worker on the concrete building was 1,432 roubles, 5.4 times as much: 'That, comrades, is where lie our reserves for growth in the productivity of labour and increase in wages.'[25] Concrete panel systems would release the reserve, trapped in unskilled labour, for growth in productivity, creating a surplus that would, in the Soviet Union, be diverted into armaments and defence, whose voracious share of Soviet GDP was to be the cause of the ultimate downfall of the USSR.[26]

Concrete in Western Europe

While no country in the West became as dedicated to concrete as the USSR, nor developed the means to produce it on the scale of the USSR, Western European countries employed concrete for much the same reasons. Khrushchev's justifications for precast concrete panel systems – to speed up the supply of new building, the elimination of specialist trades, and the utilization of unskilled labour – were all familiar arguments in the West. However, the political circumstances of the Western European countries were rather different, and the political inflections of concrete took on a different aspect. The central problem for all Western European democracies in the post-war era was to establish and maintain a stable consensus between capital and labour. The strategy everywhere was the creation of a welfare state, guaranteeing all citizens access to certain minimum standards of healthcare, education, housing provision, old age pensions and unemployment benefit, that would, in the words of the British politician Aneurin Bevan, provide for them 'from the cradle to the grave'. However, not even in those countries that adopted the most progressive tax regimes and achieved the greatest redistribution of wealth was there any pretence that social and economic inequalities would entirely disappear. Instead, consensual support for the system relied upon a constantly rising standard of living, a sense of living in a world that was undergoing continuous change, and a certainty that whatever the present, the future would be better. As T. H. Marshall, the ideologue of the British welfare state, wrote in 1950, 'what matters to the citizen is the structure of legitimate expectations'. Yet this system led to an ever-accelerating inflationary cycle, for the more that the state was able to offer, the more that people would be led to expect, committing the state to ever-greater expenditure. 'As the standard of the service rises', wrote Marshall, 'as it inevitably must in a progressive society – the obligations automatically get heavier. The target is perpetually moving forward, and the State may never be able to quite get within range of it.'[27] The hope of politicians seems to have been to short-circuit this endless process by providing sudden, wide-scale evidence of social transformation. As Harold Watkinson, the Minister of Transport who initiated Britain's motorway building programme, put it in a remark that was more than just a metaphor, 'somehow we had to make a lot of bricks without straw – and quickly'.[28] Prefabrication in concrete rescued the social democracies from their political predicament, for it offered the prospect of building houses, hospitals, schools and roads fast, and with unskilled labour.

Rarely was there any pretence that concrete and prefabrication would make construction any cheaper: in all Western European countries there were sufficient reserves of skilled tradesmen to make traditional construction always more economic, but what these methods could not offer was speed. Speed, and the prospect of being able to offer a dramatic leap in the standard of provision, was what made prefabricated concrete attractive. As Cleeve Barr, in charge of the British state agency for promoting system building in housing, emphasized, what prefabricated concrete construction offered was a better, though not a cheaper, product: 'standardisation can give greater space for very little extra money'.[29] For politicians, the anxiety was that they would find themselves unable to meet the challenge of constantly rising expectations. Playing on this fear, Michael Shanks, Economic Advisor to the 1964 Labour Government, warned that the construction industry was simply not producing housing of a sufficiently rapidly rising standard: 'if existing productivity trends in the various countries were to continue, by the early 1970s the average Briton would find himself worse off than almost all his continental cousins, and on a roughly comparable level with the average Russian, Venezuelan or Israeli'.[30] It was this alarming spectacle, that the standards of housing would fall to the level of Russia, that drove the British and other Western European governments to adopt precast concrete panel construction systems, even though they were well aware that no savings in costs would follow. In this respect, a block of flats built with, for example, the 'Bison' concrete Wall Frame system, widely used in Britain in the 1950s and 1960s, could be thought of as a strategic weapon in the Cold War. Unfortunately for British hopes, the weapon exploded almost immediately after take-off, when early in the morning of 16 May 1968 a gas explosion on the eighteenth floor of Ronan Point, a point block in Canning Town, London, built with the Larsen Nielsen system, caused the collapse of the corner of the building, killing four people and injuring seventeen others.[31] More than any other single episode, the collapse of Ronan Point disabused British people of expectations that concrete might change the *quality* of life for the better. Whatever confidence there had earlier been in concrete prefabrication evaporated, and the use of prefabricated systems went into rapid decline thereafter.

In the communist East, normally regarded as the home of ideology, one might have expected the preference for concrete as a building material to have been primarily *ideological*, while in the West, driven by market forces, one would expect the use of concrete to have been economically driven. But the situation turns out to have been quite the reverse. In the Soviet bloc, it was the *economic* incentive, to create surpluses to fund the armaments programme, that was primarily responsible for the widespread use of concrete, while in the West the incentives were above all ideological, the need for social democratic governments to maintain their electoral advantage by keeping the scenery moving, even if life stood still. In Western Europe, precast concrete systems only lasted as long as the state was prepared to subsidize them; when the subsidies were removed, contractors stopped using them, and reverted to more traditional techniques of construction. The state had subsidized concrete construction because it helped create the illusion that the landscape of daily life was undergoing accelerated change, without draining skilled labour from manufacturing industry, the source of actual economic growth. Within the mixed economies of post-war Western Europe, concrete construction was above all *ideological*. Such was the investment in the image carried by concrete prefabrication that at one of the Greater London Council's largest, and last, housing developments, Thamesmead (which was to provide the setting for Stanley Kubrick's 1971 film *A Clockwork Orange*), traditionally built blocks were made to look as if they had been system built. The development had been designed to be constructed with a prefabricated concrete panel system – the Balency system – but it proved impractical to use this for some of the three-storey blocks that were part of the scheme; rather than rationalize the designs to suit the system, instead these units were cast *in situ*, and specially made non-structural panels were applied to match the panels used elsewhere on the scheme, making it appear that these blocks too were system-built.[32] Not even in the Soviet Union could a more absurdly doctrinaire use of concrete have occurred.

Post-1989

Since the collapse of the Soviet Union, a major problem facing both East and West has been the 'decommissioning' of housing built with concrete panel systems. What is usually presented as a problem of 'regeneration' is not simply a matter of maintenance and of upgrading these now ageing dinosaurs, but of decontaminating them of their Cold War associations – communism for those in the East, the welfare state for those in the West. The process started rather earlier in the West and took place through a double strategy – of offering tenants the opportunity to buy their apartments, or, in blocks where no one wanted or was able to afford to buy the apartments, demolition. These demolitions, often carried out with explosives – 'blow-downs' – became regular public spectacles and were a useful device for marking the end of a period of history that politicians wished people to think had come to a close. But the problems of the West in dealing with its stock of concrete buildings were as nothing compared to Eastern Europe and the former Soviet Union, where the number of precast panel system buildings was far greater, and their proportion of the total building stock far higher.

In many parts of Eastern Europe and of the Soviet Union, the physical problem of the concrete *Plattenbauten* has been compounded by depopulation. With the closure of state-run industries, people have moved away and apartments fallen empty, increasing the burden of upkeep on those who remain. In eastern Germany, where this has been especially a problem, demolition has been one answer, but there have also been some more creative solutions, either partial demolition of *Plattenbauten* and then renovation of the remainder by the addition of balconies and other improvements, as has been done in the Berlin suburb of Marzahn, or more radically by dismantling the *Plattenbauten* and then reusing the panels to build new, two-or three-storey houses, as has been done in Cottbus, and by the architect Hervé Biele in the Berlin suburb of Mehrow.[33]

Associated with the 'decommissioning' of the *Plattenbauten* is the inducement of a new attitude towards them as 'unfinished'. The architect Frank Zimmermann, responsible for the Cottbus reconstructions, explained, 'System-built houses are very ordinary dwellings that have just been occupied too early, in the finishing phase so to speak. They just have to be finished with solid workmanship, show that the materials used are good quality and then these houses will be perfect.'[34] Similar ideas are found in Western Europe: the French architects Lacaton & Vassal have specialized in the alteration of former social housing blocks built with concrete panel systems by expanding them outwards to increase the habitable area within each apartment. In all these cases, what we see is an effort to show that concrete panel systems are not fixed for all time within their origins as either communist or welfare state products, but that these represent only one stage, the preliminary one, of their existence, and that their 'completion' effects their transfer into another political realm.

The option to 'complete' these supposedly unfinished buildings, however, is only available to richer countries. In the majority of Eastern Europe and the Soviet Union, the scale of the problem of decaying, poorly insulated, progressively abandoned cities of concrete is beyond such tactics. The millions of dwellings built in the 40-year period between 1950 and 1990 with broadly similar systems will all deteriorate over a similar period, some of them sooner rather than later. For many East European and Asian states, these buildings are a burden beyond their means and, because of the nature of their construction, beyond the means of those who live in them. In 2000 one World Health Organization official foresaw that the condition of the buildings could threaten political stability in those regions.[35] Far from being an agent of social unity, concrete may yet provoke a revolution.

SIX

HEAVEN

AND

EARTH

‘Concrete – God’s gift to religion.’[1]

Bishop of Brentwood

CONCRETE is a base material. Its dense mass lends it to the resistance of forces, whether natural or man-made. Good for foundations, sea defences, fortifications, nuclear shields, anywhere that monolithic inertness is called for, this quality puts it low down in the hierarchy of materials. At the same time, though, concrete has from its earliest days appealed to church builders, and indeed some of its most spectacular and creative applications have been for religious architecture. Paradoxically, this base medium finds itself employed for the most numinous of purposes. Whether intentionally or not, concrete’s spiritual iconography has always been inflected by its less honourable applications – though the dynamic of this relationship is not constant and has changed over time.

Although when first developed in the early nineteenth century concrete was regarded as a low-grade substance suitable for foundations and retaining walls, it was the mission of entrepreneurs like François Coignet in France, or W. H. Lascelles and James Pulham in Britain, to redeem it – and church building, the most prestigious branch of architecture, presented the best of opportunities to lift the medium out of its base associations. Churches are amongst the earliest of concrete buildings, some of which, like François-Martin Lebrun’s of 1835 at Corbarieu in Tarn-et-Garonne, William Ranger’s of 1835–6 at Westley in Suffolk, or Boileau and Coignet’s at Le Vésinet (1855), are still standing. In Britain alone, a surprisingly large number of nineteenth-and early twentieth-century churches were built in whole or in part of mass concrete, sometimes with some rudimentary reinforcement, and by 1910 even more traditionally minded architects were using concrete for churches.[2] The choice of material was almost never made for symbolic reasons: a rare exception is the church at Northfleet, Gravesend, where the architect, Giles Gilbert Scott, justified the use of concrete on the grounds that the area had a historic association with the material, for it was near the site of William Aspdin’s cement works and many abandoned chalk pits remain to this day.[3] While the usual motive for using concrete seems generally to have been economy, there is no doubt that the promoters of concrete saw it as a way of overcoming prejudices against the use of the material for above-ground work – a prejudice for which in Britain the influential army engineer Charles Pasley, author of the first English manual on concrete, has been held responsible.[4] Similarly, it was most likely for reasons of prestige rather than profit that the commercially minded François Hennebique undertook so many churches: 185 in all, from Mexico to Armenia.[5] We know little of what churchmen thought about the new material, though the resemblance of concrete to stone, the traditional church-building material, possibly made it seem less of a threat to the essentially conservative world of the church than other available new materials. Even so, despite the widespread use of the medium, until the 1920s no architect or constructor embarked on a mission equivalent to William Butterfield’s to give sanctity to brick. Concrete generally remained hidden, and when it was exposed, as for example in the upper parts of Westminster Cathedral, it was by default, the intention to cover it with a more noble material frustrated by lack of funds.

As an essentially passive medium, capable of absorbing enormous forces, concrete’s defensive properties were recognized early on, and among its other early applications were sea defences and harbour works. French engineers used it successfully for the construction of a breakwater at the port of Algiers in the 1830s, and in the 1840s for a new mole at Marseilles.[6] From maritime defences it was but a short step to military defences, where the monolithic properties provided exceptionally good protection against explosive blasts. By the latter half of the nineteenth century, concrete was being widely used for military fortifications: the first large-scale defensive use of concrete in Britain was at Newhaven, where 20,000 cubic metres went into the fort built in 1865. How far these associations with civil and military engineering affected perceptions of concrete before 1914 is hard to say, but there is no doubt that the experience of the First World War permanently changed people's view of the medium. The French forts at Verdun and Belfort incorporated vast quantities of concrete, and in the largely static campaigns of the war it came into its own as a prime medium of protection, the Germans making particularly extensive use of it on the Western Front.[7] From 1918 onwards, the connection between concrete and warfare was inescapable – and not to concrete's advantage. As the English architect Charles Reilly remarked of the largely concrete environment of the Empire Exhibition at Wembley in 1924, 'Naked concrete seen near at hand always reminds me of the war and its effects . . . I admit it has character and strength, but to my mind it suggests that the British Empire is very far down the scale of civilization.' And, pointedly, he asked, 'Has the war really made us cave men again?'[8] Concrete had slipped even further down the scale of values.

Concrete Churches in France and Germany, 1919–39

After the end of the First World War, concrete became a significant, and visible, medium for church building in both France and Germany. Before looking at these, there hangs over the whole discussion of concrete and religious architecture in the twentieth century the question of whether concrete's popularity for church building has simply been because it has become part of the conventional repertory of building materials – and therefore of no particular significance – or whether, to borrow a term from nineteenth-century ecclesiology, concrete has 'sacramentality', liturgical or iconographical properties that give it an advantage over other materials when it comes to building churches. And, should it have this quality, we might go on to ask, to what extent might it derive from concrete's base associations? These are not easy questions to answer, not least on account of the reluctance of churchmen in the twentieth century to be drawn into discussions that might in any way seem to place the fabric of church building before the communion of souls. The Bishop of Brentwood's possibly apocryphal remark, quoted at the beginning of this chapter, is uncharacteristic. Twentieth-century theology, at least in Western Europe, has been marked by a tendency to emphasize the church as an institution whose features are social and spiritual, rather than lying in the material substance of buildings. The reticence of churchmen towards concrete's possible theological significance means that we have to resort to the evidence of the buildings themselves, and to the statements of architects. And architects, when they have talked about the virtues of concrete for religious building, have generally done so from an architectural, rather than a theological point of view. For example, writing in 1934 the French architect Georges-Henri Pingusson argued that concrete was a noble material suited to church building, but on the essentially architectural grounds of its monolithism, that the entire construction could be from a single material; of its sacramentality, he made no mention.[9]

The first church anywhere entirely made of reinforced concrete is generally said to be Anatole de Baudot's Saint-Jean-de-Montmartre (1897–1904), built with the Cottancin system (p. 78). Although this church generated great interest in architectural circles, on account of its contribution to the discussions about structural rationalism, its ecclesiastical impact seems to have been slight, and no rush of reinforced concrete churches followed it. Only after the First World War did concrete become a regular medium for the construction of churches, of which the most celebrated example was Auguste Perret's Notre-Dame du Raincy (pp. 84–5). Although Perret designed a number of other churches in exposed reinforced concrete, his motivation for exploiting the medium was primarily architectural; there is no evidence that he was particularly interested in the theological aspects of church architecture, and from a liturgical point of view, his designs were relatively traditional.[10] Often linked to Notre-Dame du Raincy, but in fact very different from it, is the almost contemporary and much larger Antoniuskirche in Basel, designed by Klaus Moser and built between 1925 and 1927, also entirely finished in exposed concrete. Unlike Perret's churches, which are free-standing objects, and without their classical tendencies, the Antoniuskirche combines a north-facing street facade with a liturgically correct west door, and also a south door, both reached from the street through a monumental archway: the free arrangement of the elements – tower, archway, north wall – make this particularly effective as part of the architecture of the street. Its engagement with its urban surroundings was to make it an important precedent for, especially, Italian post-war church architecture. Although structurally less inventive than Perret's church, the exposed concrete plays a larger part in the architectural effect: not only is there more of it relative to the volume of the building, but it is used in a more explicitly plastic way, with a combination of coffering, smooth, blank surfaces and window tracery.

For a more explicit convergence between religion and modern architecture, we must turn to Germany. Here and in Austria also, reinforced concrete had been used before 1914 on an altogether more ambitious scale for church building. The outstanding examples are Theodor Fischer's Pauluskirche at Ulm, a very large church completed in 1910 and seating 2,000, where the requirement for an uninterrupted view of the altar and preacher resulted in a wide nave without aisles – more like a theatre – and a roof carried on concrete beams; and in Vienna, Josef Plečnik's Church of the Holy Spirit, completed in 1913, was built of reinforced concrete, much of it, especially in the crypt, exposed, and on the exterior bush hammered. However, to appreciate the potential connection between concrete and religion in Germany, we must look first at what was happening in secular building in pre-First World War Germany, where there was much more interest than elsewhere in the socio-political connotations of architectural innovation. German engineers had pioneered the development of large open interiors spanned with reinforced concrete arches for market halls and railway stations, both building types where the absence of internal supports was an advantage: outstanding pre-1914 examples were the market halls at Munich and Breslau, and the station concourses at Leipzig and Karlsruhe. Of the buildings constructed with this technique the largest in pre-war Germany was the 1913 Centennial Hall in Breslau (now Wrocław, Poland), already encountered in chapter Five. The Centennial Hall made possible the congregation of unprecedented numbers of people at a collective event, and the hall's central arrangement ensured that everyone enjoyed an equal experience of the mass entertainments specially devised for it by Max Reinhardt.[11]

It was to these kinds of buildings for mass spectacle that the German Catholic Church turned when it began its major programme of church building in the 1920s. Although a conservative institution, the Church took advantage of the techniques developed by Berg and Reinhardt to reanimate religion; in particular, the Church responded to ideas present in the loose alignment of artistic avant-gardism and social progressivism that went by the label of German Expressionism, within which art and architecture were seen as having a power to realize a consciousness of what it meant to be part of an urban, industrial society. Out of this convergence of reinforced concrete, the spectacle and the collective, Catholic church architects developed a programme for church architecture that was both liturgically and architecturally innovative.

In Germany, the catastrophic ending of the First World War, the revolution that followed and the setting up of a new republic generated a level of political debate and of social introspection not found in France. The Catholic Church's building activity was a part of this movement to stabilize society, and drew upon the belief of architects like Bruno Taut and Peter Behrens that art and architecture might serve as a means to this end. In theology, the key thinker was Romano Guardini, author of *The Spirit of the Liturgy*, published in 1918. Guardini's ideas were taken up by the two leading architects in the revival of church architecture, Dominikus Böhm and Rudolf Schwarz. The aim of the liturgical movement, of which Guardini was part, was to rethink all aspects of worship, including its location. There was much stress upon the conditions under which the first Christians had worshipped, at first using whatever spaces were available and safe – catacombs, caves, rooms in private houses – and then, when Christianity became officially recognized, taking over buildings – the basilica – that had previously served other, civil, purposes. The liturgical movement saw itself as stripping away a millennium and a half of accumulated tradition, in search of something that would purely and simply accommodate the needs of Christian worship; the emphasis was upon the dissolution of a hierarchy between clergy and congregation, so that religious observances might become a dialogue between the two, requirements which in architectural terms meant bringing nave and sanctuary close together, and ensuring that sight lines were not interrupted by structural elements. These conditions recommended the architecture of the pre-war collective spaces, and Böhm, in his church at Bischofsheim in Mainz, used parabolic arched vaults very similar to those at the Breslau market hall, and in the larger St Engelbert in Cologne took this further to create a centrally-planned circular nave, spanned by an arrangement of converging parabolic vaults: as Kathleen James-Chakraborty writes, the liturgical movement was

> using state-of-the-art concrete construction in a way which would enable a working-class congregation uneducated in the nuances of historical style or complicated iconography to be united by the empathetic experience of architecture and ritual.[12]

This effect was, she suggests, directly arrived at by drawing lessons from contemporary theatre.

Guardini's other architectural disciple, Rudolf Schwarz, between 1926 and his death in 1961 designed around 70 Catholic churches.[13] In 1938, at a period of little church building activity, Schwarz wrote the book *Von Bauen der Kirche*, later translated as *The Church Incarnate*, which sets out a philosophy not just of church building, but of building in general – for Schwarz saw church building as simply the purest and most complete expression of what it meant to build. As a contribution to the phenomenology of architecture, Schwarz's book is in many respects more interesting than the far better-known essay by Martin Heidegger, 'Building Dwelling Thinking'.

Although there is concrete in Schwarz's churches, it was generally combined with other materials – stone, brick, timber or steel. More significant was his rejection of the traditional forms and materials of church building, for, as Schwarz saw it, the technical means of building, and the meaning of architectural forms, had changed so much that they had become obsolete, and there was no going back to them.

> For us the wall is no longer heavy masonry but rather a taut membrane, we know the great tensile strength of steel and with it we have conquered the vault. For us the building materials are something different from what they were to the old masters. We know their inner structure, the positions of their atoms, the course of their inner tensions. And we build in the knowledge of all this – it is irrevocable. The old, heavy forms would turn into theatrical trappings in our hands and the people would see that they were an empty wrapping.[14]

Schwarz was thus an enthusiastic believer in the liberating power of new technology, and of the new architecture, towards which he was more open-minded than Dominikus Böhm. Schwarz's identification of modern architecture with religion was to be especially important in post-war Germany, where there was a widespread programme of new church building. The 1947 German 'Directives for the Building of a Church' absorbed, in somewhat diluted form, Schwarz's principles: 'The church edifice today is intended for the people of our times. Hence it must be fashioned in such a way that the people of our times may recognize and feel that it is addressed to them.'[15]

While the pre-war espousal of modern architecture by German church builders set a precedent that was followed throughout Europe in the post-war period, there was also a shift in the significance attached to the liturgy. The pre-war churches of Böhm and others had been concerned with the immersion of the individual into the collective, with the emphasis upon visible demonstration of a greater social unity: in the words of Guardini,

> The liturgy is not celebrated by the individual, but by the body of the faithful. This is not composed merely of the persons who may be present in the church; it is not the assembled congregation. On the contrary it reaches out beyond the bounds of space to embrace all the faithful on earth.[16]

A tendency to value the collective mass, visible or invisible, above the individual corresponds, as James-Chakraborty points out, to other anti-modern critiques, including fascism, and after the Second World War the Church became more circumspect about references to the collective spirit, and tended to place more emphasis upon the cellular strength of the individual congregation. The political significance of Böhm's architecture, as of his own changing political allegiances, has been much argued about, and while it could not be said that Böhm's concrete churches were complicit with Nazism, at the same time it cannot be denied that they encouraged the immersion of the individual in a larger collectivity in a way that ceased to be acceptable in post-war Europe. One of the tasks of architectural politics in post-war Europe was to detach 'modern architecture' from its association with the kinds of mass spectacle that the great reinforced concrete buildings, secular as well as religious, of the 1920s and '30s had made possible.

Post-1945

The Second World War, in the course of which unprecedented quantities of concrete were poured, permanently reconfigured concrete's base associations, aligning it with violence, destruction and death, and pushing it even further down the scale of values than it had ever been before. Far from putting people off concrete for churches, though, concrete became a more popular church-building medium than ever before: out of 130 churches in a recent survey of post-war churches, 60 are built of exposed concrete, while in many more it is present though concealed; even allowing for the bias of this particular selection towards German-speaking countries and the architecturally noteworthy, the pervasiveness of concrete is inescapable.[17]

As a medium of defence, the most spectacular use of concrete was in the construction of the Atlantic Wall, the line of coastal fortifications built by the Germans during the Second World War, reaching from Denmark to the Franco-Spanish border. According to Albert Speer, in charge of its construction in the latter stages, the creation of this line of forts, personnel bunkers and pillboxes consumed in their two years of construction 17.3 million cubic yards of concrete. Although as Speer later admitted, from the military point of view, 'All this expenditure and effort was sheer waste', the symbolic effect of the defences was considerable, especially on the post-war generation.[18] In his *Bunker Archaeology* (1975), a uniquely outstanding study of the signification of concrete, Paul Virilio noted the entirely obsolete function of the bunker in an age of fast-moving, mobile warfare, but recognized its symbolic power, 'a pseudo-tank made of concrete'.[19] Virilio commented on the 'naturalness' of the bunkers' forms, the contrast between the modernity of the bunkers and their atavism, and the impression that they were relics of a previous civilization, 'each casemate a little temple minus the cult'.[20] Virilio saw the bunkers as prosthetic objects, a form of protective clothing, their curved, aerostatic form and rounded corners 'prematurely worn and smoothed', serving a double purpose of protecting against blasts and the impact of projectiles, but also, by softening their silhouette and the shadows cast by them, of protecting them from sight. He also draws attention to the fact that the bunker's significance lay not in itself, but rather in a negative quality; it is a mirror that reflects what it protects from – in this case the firepower of the allies.[21] The abomination of the bunker, he proposes, lies not in itself but in what it opposes. This negative property has taken on an even greater significance in the post-war, nuclear age, when the source of danger, radiation, is invisible, and exists in large part in the imagination. In this respect, the nuclear fallout shelter gives form to fear, of the unseen, and the unknown.

The extensive use of concrete all across Europe during the Second World War for defensive fortifications and bombproof shelters, as Virilio says, altogether changed the meaning of concrete, overlaying its previous association with progress, with other properties, of aggression and of protection. The bunker, a pure concrete monolith, offers that most atavistic of human needs, shelter. In war zones, the safety of concrete makes it precious. The inhabitants of Beirut during the 1970s and '80s quickly learned to seek the shelter of concrete buildings at times of bombardment: as Virilio writes, 'Concrete offers life through its protection'.[22] Its double property as both aggressive and protective made concrete both a less, and a more, suitable material for church building than it had before been. The church of Ste Bernadette at Nevers (1966), on which Virilio collaborated with the architect Claude Parent, exploited this ambiguity: it is bunker-like, part memory of the cave in which St Bernadette had her vision, but also, in a nuclear age, part symbol of protection and salvation. Many other post-war religious buildings play on this dual quality of aggression and protection. The pilgrims' lodgings at Notre-Dame-du-Haut at Ronchamp are bunkers, with embrasures as windows, and the effect of the randomly set stones in the external concrete wall is as if it has been shelled by artillery. Le Corbusier's church at the monastery of La Tourette is a concrete casemate with ancillary bastions: it is hard not to look at the outer wall of the church and the bastions and think of a blockhouse. The architect's own descriptions of the light sources as 'cannons' and 'machine guns' emphasizes, as if they were needed, the military associations. The aggression of the exterior and the roughness of the surfaces apparently encouraged some of the monks to see the building as the ‘stigmata of suffering’, a rare instance of concrete being associated with religious iconography.[23] Inside the church, though, the atmosphere is of complete calm, of security and withdrawal from the world: with no more than a trickle of light coming through the illumination slits low down and from the narrow clerestory, you do not know whether you are above or below ground.

Church and City

Only a small minority of post-war churches are bunkers. In so far as post-war churches deployed concrete, there were two general areas of concern – the relationship of church and city, and ‘poverty’ – in which concrete had some part to play. The rapid suburban expansion of many European cities after the Second World War left large areas of population without access to religion, and in most countries the ecclesiastical authorities, already alarmed by the decline of belief, saw the building of new churches in the outer districts of cities as an urgent priority. The form that these new churches should take was widely discussed. In France, the journal *L’Art Sacré*, founded in 1935, debated this over many years, until it ceased publication in 1969: the journal discouraged the habitual references of church architecture – tower, richness of decor, monumentality, spectacle – in favour of poverty, modesty, banality and absence of conventional religious symbols. However, it was in Italy that the churches built responded most explicitly to the new urban context, and where there was most attention by architects and their patrons to the conception of the church not as an independent object, but as a part of the architecture of the city. Cardinal Giacomo Lercaro, who was an important figure in the post-war renaissance of Italian church architecture, and who commissioned an unusually large number of architecturally innovative churches, many of them concrete, in the diocese of Bologna in the late 1950s and early 1960s, drew attention to this in a speech in 1955.[24] Describing how the first Christians had adapted the civil basilica to religious purposes, Lercaro said, ‘Here was a building which, despite having its own specific function, was completely at home amid the civil buildings that surrounded it, and which, together with it, made up the city. Yet it was vibrant with an utterly new spirit.’[25] This, he believed, was the way new churches should connect to their urban settings. For Italian architects, this relationship between the city and the church was to be a major concern and was variously interpreted: an exemplary and much commented upon demonstration was Giancarlo de Carlo and Ludovico Quaroni’s Chiesa della Sacra Famiglia (1956–9) in a suburb of Genoa, incorporated into a public stair on a hillside. The many hundreds of concrete churches built in post-war Italy should be seen in terms of the intention to make the building meaningful within its social and urban context.

Some of the results are a surprise. The Tiburtino district of Rome, built in the early 1950s as social housing, borrowed its imagery from the villages of southern Italy, from where many of its residents came. The irregular massing of the blocks, the winding street pattern with no long vistas, the pitched roofs and the side-hung shutters were features of traditional settlements that led to description of the Tiburtino as ‘neo-realist’. The arrangement of two-storey dwellings, each with a small enclosed yard, made it seem designed for a community of artisan craftsmen who would ply their trades from these courts. Looming above this slightly romantic set of buildings there is a large concrete object whose purpose I could not identify when I first saw it, but which I assumed to be something to do with a utility, a water tower, or maybe an electricity substation. Only when close to did I realize that it is in fact a church. Built later, between 1965 and 1971, Sta Maria della Visitazione is the very opposite of its surroundings: against the vaguely nostalgic air of the painted stucco of the residential blocks, the church, with its inclined walls in exposed concrete, is everything but a replication of the traditional parish church of an Italian village. Clearly this church is intended as something very different, and to be exactly as it appears, a piece of urban infrastructure, a reservoir of spiritual energy servicing the inhabitants.

Or to take another example, in the undistinguished Milan suburb of Novegro there stands a large and roughly finished concrete box, hardly worthy of description as an architectural object, more like a container or distributor for some public utility. The particular resource that this container, the church of S. Alberto Magno, distributes is spiritual rather than material, but the language is the same. If this was one way of introducing religion into the suburbs, as the equivalent of highways, electricity substations and water distribution, the use of concrete made this connection exceedingly obvious. The inside of this building reveals its two architectural 'wonders': first of all the walls are punctured with tiny windows, imperceptible from the outside, filled with stained glass; and second, the roof is not supported by the outside walls, but is carried entirely on a long transverse beam running down the centre of the church, allowing a continuous band of glazing to run around the top edge of the wall. This was the kind of engineering feat that Michelucci, in the Chiesa dell'Autostrada, was so keen to avoid.

Another better-known, post-war Milan church is that of the Madonna dei Poveri in the suburb of Baggio, which I have already mentioned for its mixing of stone with concrete.[26] Standing in a district of mainly six-storey housing blocks, from the outside the church looks like a warehouse and lacks any of the signs by which a church is normally recognized. Internally the space is more familiar, basilica-like with a long high nave and low side aisles. A concrete grille lights the chancel, and some light filters in through the stone and concrete screen wall to the gallery. Below, the finishes are all concrete, and spanning the nave, below the chancel, are two massive castellated concrete beams, the openings in which suggest steel and introduce an element of engineering into the interior. The fusion of the industrial with the early Christian in this church was presumably intended to encourage the factory workers who lived in the area to identify with it, and to make a connection between the industrial setting of their everyday lives and their spiritual life. At the same time, the dedication of the church drew attention to another regular topic of discussion among architects and theologians in the post-war era, and that was the extent to which 'poverty' should form part of the language of church architecture.

Poverty and Kitsch

Poverty is not the same as economy. While cost is an often-given reason for choosing concrete as a medium for churches – Frank Lloyd Wright's Unity Temple in Chicago, Perret's Notre-Dame du Raincy and Le Corbusier's monastery at La Tourette were all built of exposed concrete to save money – we cannot assume that this is a general explanation for widespread use of concrete. Whether or not concrete actually is cheap, cheapness – whether real or apparent – is double-edged in relation to religious buildings. The principle of sacrifice dictates that in church building nothing but the best will do – but, and this was particularly the case in post-war Europe, there were strictures against profligate expenditure on church building: many cheaply built churches, it was said, would serve the purposes of religion better than a few magnificent ones.[27] In this context, cheapness became a virtue. But then also, there is the question of whether concrete is really 'cheap'. Although widely perceived as such, one has to ask, cheap in relation to what? To cut stone, maybe, but relative to the other viable twentieth-century alternatives, brick, steel or timber, not necessarily. Much depends on the standard of workmanship expected and on local labour costs relative to material costs; in general, the concrete work found in churches is anything but 'cheap'. Explanations of economy as the reason for the choice of concrete in church building as often as not point in the opposite direction.

The question of whether a church should manifest magnificence or poverty was hotly debated in European post-war Christian circles. The 1947 German 'Directives' had equivocated:

> It would be a mistake to arrange and decorate the interior of a church in such a way as to create the atmosphere of a comfortable and cosy bourgeois residence; and a mistake also to wish to imitate the

poverty of a proletarian dwelling.
The church interior should be neither bourgeois nor proletarian.[28]

A particularly outspoken critic of magnificence was the French theologian Abbé Paul Winninger, who argued that the primary need was to build churches quickly in the rapidly growing and godless suburbs, using the same systems of prefabrication as were being used for housing and schools. As Christ had lived and died in poverty, it was inappropriate, Winninger said, to build palatial images of celestial Jerusalem: 'The poorest chapel is a valid signifier of paradise'. The simple parish churches he favoured would not be ugly, for, as he said, 'Wood and cement are also noble, because they are sincere'.[29] If concrete was justified on grounds of expediency, it also, in the context of post-war reconstruction and industrialized building, fulfilled a liturgical significance in representing the Christian renunciation of worldly riches.

Schwarz too had argued against magnificence, on the grounds that all church building was, in religious terms, merely provisional:

> by ourselves, we can build no churches: that, God must do. But far beneath that exalted realm of true architecture lies that other area where houses rise as temporary structures which are little more than needy dug-outs or scanty shelters. Such emergency buildings are the only possible accomplishments of men before God, waiting rooms before his threshold . . . This is the honourable way to build churches: before God begins his work.[30]

Schwarz's almost Calvinist sentiments are a surprise coming from a Catholic, but in the post-war era the view that a church should be a place both of security, but also of austerity, while not a prescription for concrete, certainly favoured its use for church building. Sparseness coincided with the aesthetics of the new architecture, and modernist-aligned architects were inclined to be sympathetic towards the representation of poverty through the material medium of building. Le Corbusier wrote with approval of La Tourette's asceticism ('the interior displays a total poverty') and for some commentators, at least, this equated with sanctity: 'Never', wrote the journalist Alexandre Persitz of Le Corbusier's churches, 'has poverty of material appeared so sumptuous an expression of high spirituality'.[31] Georges-Henri Pingusson, another devotee of concrete, commented of his own design for a church in concrete: 'To be reproached for being poor and basic would please me – austerity does not signify deficiency.'[32] But people interpreted 'poverty' in different ways, and behind the opposition of base and spiritual, richness and poverty in concrete there glints yet another polarity, that of gender.

Within the French milieu, Pingusson's reference to austerity also implied a resistance to the sorts of popular religious art that were criticized by the *Art Sacré* movement. What *L'Art Sacré* condemned was the derivative, sensuous, uncomplicated art that filled Catholic churches – in other words, kitsch. In common with the long-standing derogatory tradition of connecting mass culture – romantic fiction, Hollywood slush – with women, *L'Art Sacré* denigrated popular Catholic art and architecture as feminine, and aimed to put in its place a more virile, masculine aesthetic.[33] Pingusson's comment about the virtues of austerity belongs within this polemic. The gendering of the case against 'false' art is particularly apparent in the remarks of an American theologian writing in the 1950s: 'The Christian has only contempt for pious frauds which are passed off as art, concrete used as if it were wood, steel used as if it were stone, false beams, simulated marble, imitation drapes . . . It is Christ seeming to be man, but not being man in reality.'[34] The Church lost power when it was too closely associated with woman, and part of the aim of the post-war church reforms, as well as to persuade more men to attend church, was to make religion more active, more engaged with the external world and less domestically orientated. This emphasis upon virility and manliness is present in the liturgical reforms, but can be seen also in the architecture of new churches. From Perret's Notre-Dame du Raincy onwards, most concrete churches conform to notions of the masculine, unornamented, visible structural system, naked finishes, and in some cases extreme roughness of finish, which, while they can be interpreted as symbolic of poverty, were also connected with the aspiration for a more virile Christianity. There are exceptions to this, though, for Le Corbusier went out of his way to code the church at Ronchamp as feminine. The rough, sprayed concrete finish of the walls he associated with women's skin, and there were other female connections related to its unconventional liturgical arrangement. Le Corbusier made it clear that the church was more about 'the psycho-physiology of the feelings' than religious requirements, in other words, it was intended to induce sensuality and emotion; Rudolf Schwarz thought it was 'trash' – in other words, it was too close to mass culture for him, too feminine.[35]

Giovanni Michelucci, architect of the Chiesa dell'Autostrada and of several other churches in northern Italy, had a rather different interpretation of 'poverty'. Michelucci had been disappointed by the response to the church he had built between 1946 and 1953 at Collina, near Pistoia, where partly for reasons of economy, and partly to evoke a 'primitive religiosity', he had replicated the crudeness of the houses of the local inhabitants.[36] The parishioners had disliked the result, and Michelucci abandoned this approach to the representation of poverty in his subsequent churches, concentrating instead on the process of construction itself. Michelucci believed that 'poverty is a moral condition of work', but that by giving crude materials 'moving testimony of life' they could give realization to 'our interior richness'.[37] This neo-Ruskinian belief in the redemptive power of work was amply demonstrated at the Chiesa dell'Autostrada (pp. 96, 99). Michelucci saw the building site as a metaphor for the human and spiritual community, a place where manual and brain workers came together and in their creative collaboration produced something that, while it might be made of poor materials, demonstrated the richness of humanity. At the Chiesa dell' Autostrada, chaotic, ugly and apparently provisional (these were Michelucci's stated desiderata for the new 'city of the poor'), the branching columns, every one a different shape and of constantly varying dimensions, were the most complicated things to build, requiring the highest degree of skill and patience. Michelucci apparently managed the site like that of a medieval cathedral, was present himself every day, and encouraged the craftsmen to take the initiative in resolving construction problems as they arose. Though the result was raw, it was certainly not 'poverty' in the sense of economy. The Chiesa dell'Autostrada was not a parish church, so lacked the continuous negotiation between architect, builder and parishioners that Michelucci believed necessary to achieve a religious building, but at the later church at Arzignano, near Vicenza, there was opportunity for such collaboration. Michelucci designed the church knowing that owing to the limited funds it would not be completed for many years (construction continued from 1967 until the deaths of both architect and priest in 1990), although the priest and parishioners wanted to have a fully functioning church up as quickly as possible. While not the only material with which this result could have been achieved, by building a reinforced concrete carcase it was possible to have the shell of a complete church operational from the start, though one that could be later embellished and developed over time.[38]

Richness in building can take many forms, and the particular form against which Michelucci reacted was technical sophistication. Taking their cue from the structural achievement of Gothic cathedrals, many churches and cathedrals in the modern era have relied upon engineering to achieve their effect: Niemeyer's cathedral in Brasilia, Candela's church of La Virgen Milagrosa in Mexico City and Alvar Aalto's churches are some of the famous ones, but there are many others less famous, like the church of S. Alberto Magno in Milan, whose effect relies upon structural ingenuity. A good example of a church that is pure engineering is the small Chiesa del Cuore Immacolata di Maria at Borgo Panigale in the outer suburbs of Bologna, built between 1955 and 1965 to designs by Giuseppe Vaccaro (who had previously designed a much-praised but more traditional church at Recoaro Terme); two very distinguished Italian engineers were involved, Pier Luigi Nervi and Sergio Musmeci. Completely circular, the roof is supported entirely by three slender tapering columns from which ribs spread out, and a continuous band of clerestory glazing separates the roof from the walls. At Trissino, north of Vicenza, the church of S. Pietro Apostolo, built between 1968 and 1971 under special papal favour to commemorate the Second Vatican

Council, is a magnified version of the Bologna church: still with only three columns, this church had a capacity of up to 5,000 people. Such a 'richness' of technique is precisely what revolted Michelucci, and what he resisted in the Chiesa dell'Autostrada – ironic in that what the church commemorated, the building of the autostrade, was itself one of the country's great engineering achievements.

As a coda to this discussion about 'poverty' as the antithesis of technical virtuosity, Le Corbusier's Notre-Dame-du-Haut at Ronchamp is ambiguously revealing. The most remarkable, most memorable feature of Ronchamp is the roof, whose shape is constantly in doubt, depending from where you see it. According to Le Corbusier, the idea for its form came from a crab shell; others have suggested an aeroplane wing. Both are equally plausible, but whichever, this is the building in Le Corbusier's career in which he is generally said to have broken decisively and completely with the straight line. The design, we are told, progressed from an initial sketch to models, from which definitive working drawings were then produced, using the technique of ruled surfaces to translate the curves into straight lines. The usual story that 'the free shapes captured in the imaginative technique were brought into being via the engineering technique' of ruled surfaces was questioned, though, by Robin Evans who showed that the ruled surfaces were there from the start, but kept out of sight so as not to weaken the apparent force of the imaginative impulse.

There is more evidence of engineering technique present in the development of the design for this building than in any of his pre-war 'machine age' works, but Le Corbusier concealed this, as if too much engineering might detract from the building's piety.[39]

There are signs that twentieth-century religion's love affair with concrete is waning. Of the recent pilgrimage church at S. Giovanni in Rotondo, near Foggia, whose enormous canopy roof is supported on stone arches, its architect, the distinguished modernist Renzo Piano, says, 'Stone makes it look more like a church. There is an instinctive memory of the church built of stone.'[40] Maybe recollections of the aggression and violence of wartime concrete are now too remote, at least in Western Europe, to any longer give concrete a spiritual charge.

SEVEN

MEMORY

OR

OBLIVION

NOWADAYS any middling-sized to large memorial is made of concrete. Think of Peter Eisenman's Holocaust memorial in Berlin: eleven acres of undulating charcoal grey concrete, made up of 2,751 concrete steles from 3 to 15 feet high. The Kennedy Memorial in Dallas, a 50-foot square, surrounded by 30-foot-high concrete walls. The 'Spomeniks', an extraordinary series of memorials to Second World War partisans, commissioned by Marshal Tito, in the former Yugoslavia. And there are too many other examples to count. Concrete has become the default material for memorials.

What is strange about this is that concrete has, at the same time, been so often regarded as the material of oblivion, erasing and obliterating memory, cutting people off from their past, from themselves, from each other. The French philosopher Gaston Bachelard complained that it was impossible to dream when surrounded by concrete: 'I do not dream when in Paris, in this geometric cube, in this cement cell, in this iron-shuttered bedroom so hostile to nocturnal matter.'[1] And another philosopher, Henri Lefebvre, objected to the way the concrete buildings of France's post-war new towns seemed impermeable to history: 'Here I cannot read the centuries, not time, nor the past, nor what is possible.'[2] Their lack of depth made the new suburbs unredeemably boring. All of this is neatly summed up by graffiti spotted on the concrete wall of a multi-storey car park in Marburg, Germany in 1992: *Beton ist Koma*.[3]

What is it then about concrete and memory? How can a material so generally regarded as amnesiac have at the same time become the medium of choice for the preservation of memories? A further twist to this paradox is added by the emergence in the 1960s of minimalist art, which called into question most of the previous conventions of sculpture. Wholly opposed to all forms of sculptural representation, and most of all to any mnemonic representation, minimalist artists were also fascinated by ready-made industrial materials and might therefore have been expected to be attracted to concrete – inert, industrial, anaesthetic – as an ideal medium. Curiously, though, minimal artists rarely used concrete, and when they did so it was generally in circumstances that were slightly exceptional, or in ways that were intended to question the concerns of minimalism. Finally, some of the concrete memorials of the post-war era bear an uncanny physical similarity to works of minimal art, despite their apparently opposite aesthetic intentions. In the case of the Berlin memorial the connection was actual, for Eisenman collaborated in the early stages of the design with the sculptor Richard Serra, but even without these personal connections, the visual resemblances are inescapable.

Unravelling this circular puzzle – concrete the material of oblivion, avoided by artists hostile to mnemonic representation, but chosen by those seeking to represent memory – might at least tell us something about the semantics of concrete, if not also about the modern representation of memory.

The twentieth century was obsessed with memory and, to commemorate the dead of its many and destructive wars, built more memorials than any previous era of history. At the same time, philosophy and psychology produced greater insight into the processes of memory than had been available to previous generations – and their general conclusions were to stress the aleatory nature of memory, its inaccessibility, its fragility against the forces of forgetfulness and repression, and to emphasize the utter futility of all attempts to perpetuate memory by making physical objects that might stand for it. In a word, the modern understanding of memory gave to it properties of mobility and fugitiveness that made all physical analogues inappropriate – and especially those made of concrete, whose inertness and indestructibility would seem to make them the very opposite of everything human memory was said to be.

If popular memorial building activity defied what philosophy and psychology had to say about memory, modernist artists and architects generally tended to be wary of memorials. Memorials occupy a strange position on the boundary between art and architecture, while satisfying the conditions of neither practice. Wholly symbolic, memorials lack the dimension of usefulness normally expected of architecture, while their generally singular message denies the opportunity for the diversity of individual responses that is normally valued as part of works of art. Their function as signifiers, commemorating specific people or events, puts them outside the boundaries of most modern art practice, which has generally tried to avoid such literal signification. More particularly, their role as repositories of memory places them in direct contravention of the general twentieth-century prohibition, in both art and architecture, on the mnemonic dimension of representation. Modernist aesthetics emphasized the immanence of the object as it presented itself directly to the senses, and was generally hostile to the association of ideas, to the view that aesthetic response occurred through the train of thoughts and images that objects might evoke. Objections to all forms of monument and monumentality were a common refrain in architectural discourse prior to 1939. After the Second World War it was in the fields of painting and sculpture where the strongest objections to memorializing activity were to be found: the influence of the American critic Clement Greenberg was such as to place an interdiction upon all work that operated other than by a direct relationship with the viewer in present time. Most artists and architects associated with modernism were suspicious of memorials, for with good reason they feared that they might become a graveyard for their artistic reputations.

Yet despite the reluctance of the more advanced artists and architects to become involved with making memorials and monuments, ever since the end of the First World War all over the world the landscape of towns and villages was being transformed by memorials commemorating the dead. Until 1939 the iconography was generally conservative and traditional, and although there could be inventiveness in the design of memorials, this inventiveness, with a few exceptions, owed nothing to the architectural avant-garde. Almost invariably these memorials were made of stone or bronze, the traditional materials of dignity and respect. While concrete may have been used for foundations and structure, they were almost always clad in another material; only in a very few rare cases was concrete ever exposed on the surface of memorials. Even memorials that might look as if they had been made out of concrete, or imply that they were made of concrete, turn out to have been made of or at least clad in stone. The war memorial at Como in Italy, built 1931–3 and designed by the rationalist architect Giuseppe Terragni, adapting a sketch by the Futurist architect Antonio Sant'Elia, was not, as one might have expected of a work with these origins, concrete, but was faced in stone. Presumably bare concrete would have been considered disrespectful to the memory of the dead, notwithstanding Sant'Elia's and Marinetti's enthusiasm for the material and their contempt for stone architecture.

The commemoration of the victims of the Second World War presented far greater problems than had been the case after 1918. Compared to the relatively static nature of the First World War – its deaths, principally of soldiers, relatively easily catalogued – the Second World War was mobile, its events unfolded all over the place, and furthermore the deaths of its mostly civilian casualties were often invisible, deliberately hidden by their perpetrators. As Theodor Adorno commented in his *Minima Moralia*, written during the closing stages of the war, one of the peculiarities of the Second World War was that while the general public had the impression, through the presence of cameramen and photographers in front-line units, of knowing more, of being more closely involved in the campaigns than had ever been the case in previous wars, it was on the other hand far harder to make sense of the strategy of the campaigns:

> The Second War is as totally divorced from experience as is a functioning of a machine from the movements of the body . . . Just as the war lacks continuity, history, an 'epic' element, but seems

> rather to start anew from the beginning in each phase, so it will leave behind no permanent, unconsciously preserved image in the memory.[4]

War left nothing that could be commemorated, or that had not been more amply recorded as surrogate experience on film.

At the same time, the atrocities of war and of fascism far exceeded those of any previous era, and this too made commemoration difficult if not impossible. Adorno pointed out that the greatest danger of all was to normalize events, to carry on as before as if nothing had happened. To repeat and continue the extensive memorial building after the First World War would simply have suggested just such a normality, a return to the status quo and, according to Adorno, have allowed fascism to continue elsewhere in other guises.

From the point of view of the avant-garde architect or designer, any post-war memorial ran the double risk of being both non-modern, not of its time, and of condoning the circumstances of the atrocity. While these strictures did not stop people from building memorials, their effect was to render most previous models of commemoration inappropriate, and to raise the level of difficulty in achieving a result that was neither banal nor complicit in the events remembered. Out of this there emerged some new and distinctly original solutions that turned out to have a lot more in common with the concerns of avant-garde art than the critical discourse surrounding modern art might have led one to expect.[5]

Within neither the discourses of commemoration nor of concrete has there been much attention to concrete as a medium of remembrance. A rare exception is a book produced for the Swiss Portland Cement Company entitled *Le Béton dans l'art contemporain*, in which we find the following statement: 'It is in the creation of monumental works that the use of concrete fully justifies itself.'[6] Now, this is a surprising remark: not in bridges, not in wide-span roofs, nor in any other structures that fulfil the ideal of achieving the most effect with the least – the customary measure of justification for a material – does concrete most fully justify itself, but in monuments, which notoriously display a serious redundancy of material. According to the author, Marcel Joray, concrete is especially suited to monumental works firstly because it is the only material affordable for their necessarily large size, and secondly because forms can be produced in it that would be impossible in stone or bronze.

But these explanations are not entirely convincing. Cost, with memorials, is irrelevant, or should be seen to be, since cheapness in a memorial is offensive to those it commemorates. Memorials, even more than churches, are structures on which, ostensibly at least, no expense should be seen to be spared – and it was for that reason that up until the Second World War granite or limestone were the almost invariable rule. If cost can be discounted as a sufficient justification for the choice of concrete as a material for memorials, so too can the argument about its structural possibilities. Solidity, mass and weight are the qualities most often displayed by memorials; if one were looking for examples of structural ingenuity, monuments are not generally where one would look. As a class, they must in structural terms be among the most conservative of structures, although this is not to discount the structural ambitions of certain individual memorials (nor those of many more proposals for memorials).

If neither economy nor structure account for the choice of concrete for memorials, what other explanations are there? It is in concrete's association with modernity that the most likely explanation seems to lie, for if the memorial was an inherently non-modern form, concrete offered it the aura of being modern. Concrete helped rescue the memorial from its archaic and obsolete status, and make it of the present.

Conversely, from the point of view of concrete, the memorial offers a rare opportunity for concrete to deal with the past. Against the myth of its persistent newness, memorials allow concrete to address not just the future, and the present (properties inescapable in any concrete memorial), but also historical events. Otherwise denied the opportunity to refer to history, the memorial is the one class of construction where concrete can deal with what convention forbids it to address, namely the past. Whatever service concrete may have offered to memory, memorials have benefited concrete by letting it reveal what normally remains repressed.

It is often supposed that the reason why so many memorials are made of concrete is because of its relative indestructibility, increasing the chances that what might otherwise be forgotten will be preserved for perpetuity: the larger and denser the block of concrete, the safer the memory will be. But this supposition rests on a misplaced power of objects to prolong human memory – it is not the physical decay of monuments that makes them so ineffective at preserving memory.[7] Nor can we assume that concrete has some inherent property of signification not found in other materials. This simply is not borne out by the historical evidence. If there is one thing that the discussion of the four memorials that follows makes clear, it is that no material, and least of all a modern synthetic material like concrete, has any absolute or immanent value. Three of the memorials were designed by architects, one of them by an artist, and in none of the cases was the choice of concrete a foregone decision, but had to do with the circumstances of their making.

Probably the earliest renowned concrete monument is the memorial to the *Märzgefallenen* in the cemetery at Weimar, designed by Walter Gropius, then director of the Bauhaus, at that time located in Weimar.[8] The memorial commemorated seven trades unionists who had died in March 1920 resisting the right-wing putsch led by Wolfgang Kapp to overthrow the Social Democratic government; Kapp was supported by one of the Freikorps, the paramilitary associations of ex-servicemen that figured large in the turbulent history of post-war Germany, and it was in a confrontation with these that the trades unionists had died. The Kapp putsch failed partly because the trades unions successfully organized a general strike in support of the government, and the event became an important episode in the Weimar Republic's short history because it demonstrated the effectiveness of organized working-class action in defending the new constitution against extremists; twelve years later, it was partly the failure of trades unions to organize in support of the constitutional government that led to Hitler being able to seize power in January 1933.

The initial design for the memorial was prepared by Gropius late in 1920; construction started in September 1921 and was completed by May 1922. It therefore predates the majority of the memorials commemorating the dead of the First World War, although the deaths it marks had occurred after the war, and it was clearly an important aspect of the project that it not be confused with a war memorial. As a political memorial to working-class martyrs, it was a type for which there was no model and no precedent. (The other well-known political memorial of the Weimar period, the Berlin monument to the Spartacist leaders Rosa Luxemburg and Karl Liebknecht, designed by Mies van der Rohe, was built later, in 1925–6). The memorial's explicit political significance and place in the martyrology of the Weimar Republic explains why it was destroyed (with explosives) by the Nazis in 1936, and then ten years later, in 1946, rebuilt by the Soviets. Its reconstruction in 1946, an almost precise reproduction of the original, executed with very nearly the same materials and by the same processes, must have been one of the very first acts of reconstruction carried out under the Soviet occupation. What we see today is the rebuilt memorial of 1946: it is a double memorial, a memorial to a memorial.

The large cemetery at Weimar, where the monument stands, is a Pantheon of German art and literature: it contains the tombs of, amongst others, Herder, Goethe, Schiller and Liszt. Although the Monument to the Märzgefallenen is some distance away from these, the design of the memorial, and the choice of the material for it was nonetheless a sensitive matter. The memorials to the great German writers were made of Carrara marble. Gropius's original design for the Märzgefallenen was to have been in limestone, a material traditionally used in Weimar for decorative elements of buildings, door and window surrounds, but not for tombs. Gropius's choice of limestone for the memorial was therefore almost as radical as the form – the jagged, crystalline flash; but although limestone was not used for funerary monuments, it was used for their bases, so the choice of this particular stone might have gone some way to making the highly unconventional form more acceptable. Stone was consistent with the principles of the Bauhaus manifesto, the collaboration of artists and craftsmen, for it would have used local artisan labour to execute a work of art. In the event, the memorial turned out to be very much a Bauhaus project: the work was supervised by Josef Hartwig, one of the Bauhaus masters, and some of the labour was provided by Bauhaus staff and students. By early 1921 it was clear that there would not be enough money to build the monument in limestone, so Gropius changed the design to a concrete structure clad in limestone. At the same time, the monument was made larger and given a more dynamic and unstable shape than would have been possible had it been made from blocks of limestone. This design too turned out too expensive and Gropius proposed changing the cladding stone to cheaper sandstone, but this produced only a very marginal saving in cost and finally the decision was taken to build it solely in concrete, in a yet further enlarged version.

Although concrete was chosen primarily for financial, rather than aesthetic or semantic reasons, it nonetheless coincided with the enthusiasm for new materials present in Bauhaus and avant-garde artistic circles in 1921. At the Bauhaus, Johannes Itten's foundation course encouraged experiment with materials to explore their properties, while German and Russian architectural critics were writing about how new materials should generate new forms. And indeed the shape of the memorial did change once it was decided to give it a concrete structure. However, the choice of concrete ran up against the local building code, which prohibited the use of concrete in cemeteries unless it was mixed with natural stone aggregates. Accordingly, when construction began in September 1921 the concrete was made using crushed limestone from nearby quarries, but some terrazzo was also added, thus combining a natural with a synthetic aggregate, a mix that may have appealed to Gropius because it neutralized the traditionalism of the stone aggregate with a more 'modern' addition.

The most skilled part of the production of the monument lay in the finishing of the concrete. The cement surface left from the casting process was removed with hammer and chisel to expose the stone aggregates beneath, and the edges finished, as in traditional stone masonry, with a 5-cm-wide tooled margin, leaving narrow ridges perpendicular to the edge. The result is remarkably delicate, showing that despite the coarseness of the material, manual skill could transform it into something refined.

This surface treatment of the concrete, pioneered in Germany and known as *Betonwerkstein*, stoneworked concrete, belonged to a continuing debate in German culture, lasting from 1910 to the end of the Third Reich, about the propriety of concrete. Even before the First World War *Betonwerkstein* was being promoted as the best finish for concrete. Josef Petry, the Chairman of the German Concrete Association, writing in 1913, had argued that working concrete in this manner was the way to answer objections to concrete as a low-value material. Petry had insisted that concrete should not be seen as a surrogate for stone, but as a material whose beauty lay in its artificiality, which was best revealed by this manual technique of finishing it. *Betonwerkstein* was used occasionally for other monuments in the 1920s, but acquired greater significance in the 1930s within National Socialist debates about material described in chapter Two.

At the time that the Märzgefallenen was built little was said about its being made of concrete. Even when it was blown up in 1936, the reason given was simply that it was 'ugly' – though clearly there was more to it than this, for the presence of a memorial commemorating martyrs of the Weimar Republic must have become, under National Socialism, a local embarrassment. Whether the fact it was made of concrete influenced the decision is not recorded.

Only after its destruction in 1936 did the concrete start to take on significance. When it was reconstructed in 1946, not only was there great care to reproduce the surface finish of the original (though without the addition of the crushed terrazzo to the aggregate), but commentators drew explicit attention to the material and to the way in which it symbolized socialism. The seamless, unbroken form is not personalized, they said, and shows no traces of individual, only collective effort. Furthermore, the material itself is the result of a chemical bond between the different components, producing a product that is stronger and harder than any of the individual elements – an analogy that, as we have seen, Gladkov had used to describe how, in a socialist society, individuals come together to form, with invisible bonds, a collective unity. Unlike stone, which is the result of a long process of sedimentation, concrete is formed the moment it sets, and this might be said to be analogous to the historical formation of the socialist republics, born instantaneously from the shock events of the moment, rather than like other regimes developed over long periods of time. Yet the Märzgefallenen only acquired these sorts of interpretations after 1946. In the 1920s the political reading of the memorial was more ambiguous: the critic Adolf Behne, a former colleague of Gropius's in the 1918 Arbeitsrat für Kunst, in 1925 described the monument as 'so nervously apolitical that, as a very general symbol of the uprising, it could just as well have been erected by the Kapp forces'.[9] And Gropius himself in 1948, though by then in America, and presumably in the McCarthy era anxious not to be identified with anything known to be communist, insisted that the memorial was designed not to commemorate working men but people of all classes who had died in the upheaval of the Kapp putsch.[10]

With the Märzgefallenen, all the evidence is that concrete did not initially signify at all; the material was chosen for economic, not symbolic reasons, and only later did political meanings become attached to it. This should warn us against assumptions about concrete having any positive, determinate meaning. In this particular case, it was only over time, and as circumstances changed, that concrete acquired a political, memory-bearing iconography.

The second memorial to consider is in Rome, at the Fosse Ardeatine, about two kilometres along the Appian Way, close to some of the Roman catacombs.[11] The memorial contains the graves of 335 Italians shot by the Germans on 24 March 1944, in reprisal for a partisan attack on an ss column in Rome that killed 33 Germans. Hitler himself ordered that ten Italians were to die within twenty-four hours for every dead German, and the local SS commander, Major Karl Hass, in his haste to carry out the order took the required number, plus an additional five, at random from those who were being held in prisons and police stations in Rome, although none of these were connected with the attack, nor were necessarily even partisans. The victims were taken to an abandoned pozzolana mine at the relatively remote Fosse Ardeatine, shot, and the caves dynamited to create a rockfall to conceal the bodies. Shortly after the German withdrawal from Rome on 4 June 1944, the site of the massacre was discovered and excavated. The bodies were put in coffins but left in the caves. In September 1944, while parts of Italy were still under fascist control, a competition was held for a memorial, and two designs were chosen. The two winning teams of architects were invited to collaborate to produce a final scheme, and it was this scheme, under the leadership of Mario Fiorentino and Giuseppe Perugini, that was built and inaugurated on 24 March 1949, exactly five years after the massacre.

From the start there was controversy about the memorial. The relatives of the victims wanted the bodies to be left in the caves; but the caves were unstable and lacked the monumental presence felt necessary to commemorate not just the victims but also the event for posterity. The solution was to create a covered mausoleum connected to the caves, and entered through them. The mausoleum consists of a shallow excavation, about 1.5 metres below ground level, containing the tombs of the 335 victims, covered by a single monolithic slab, 48.5 by 26.65 metres, and 3 metres high, supported at only six points. Beneath is a dark cavernous space about 2 metres high, compressed beneath the enormous, almost unsupported slab and lit by light coming through the narrow slit between it and the ground. The slit increases in height from 60 centimetres at the entrance side to 110 centimetres on the side away from the entrance, an optical correction to make the slit appear an equal size all the way around. The soffit of the slab, though it appears flat, in fact curves upwards by almost one metre so as to counteract the illusion of sagging downwards that such a large surface would give. The soffit is sprayed with a rough concrete finish giving it the same appearance as the pick-hammered exterior finish of the outside of the slab, and making it seem that the slab is indeed a solid monolith. Seen from outside, the mausoleum is a thick unbroken slab that seems to hover above the ground. Apparently solid, it is in fact hollow, a concrete box with internal beams and trusses. Its outside surface is a thick concrete render applied to the concrete walls, and finished by pick hammering to expose the Brescia *brecca* aggregate. What is therefore presented to the eye appears as a single stone, a stone so large and heavy as could never in reality have been quarried. In other words, concrete achieves what could never have been achieved with real stone; not only was no slab of this size possible in real stone, but also, if the concrete box had been clad in stone, there would have been joints, and these would have created questions about the means of support. Instead, here concrete goes beyond nature and improves on anything that could be achieved with natural materials. It is important to see concrete being used here not as a substitute for natural materials, but as Josef Petry had written in 1913, as a material whose beauty lay in its artificiality; but more than that, concrete here gives rise to emotions and sensations that could never be aroused by stone. At the Fosse Ardeatine, concrete is not a substitute for stone as a monumental material, it is superior to stone.

The Fosse Ardeatine is the first major architectural production of the immediate post-war years in Italy, with a genesis even before the war had ended. The massacre was widely regarded as marking the birth of republican consciousness: it is a founding event in the history of the post-war Italian Republic, and moreover, because it occurred in Rome, helped establish Rome as the place of the Republic's origin. (And the explicitly Roman features of the mausoleum, where as Tafuri puts it, 'geometry compromises with matter', helped emphasize Rome's claim in this regard.)[12] The memorial is loaded therefore with political significance, and indeed is still visited by parties of Italian schoolchildren learning their martyrology. Aldo Aymonino, writing in 1998, commented: 'The end result provided the newborn republic with one of the only two national monuments that the country has been able to produce over the last fifty years' (the other being, in Aymonino's view, the Autostrada del Sole).[13] And like the Autostrada, the Fosse Ardeatine is made of concrete.

The choice of concrete was, as already explained, partly for aesthetic reasons, but also had political connotations. First of all, it was a reaction to the 'imperial' imagery of the monuments of Mussolini's Italy: compared to their invariably classical references, the Fosse Ardeatine is modernist in its muteness and absence of iconographical symbols (though there is a socialist realist sculpture standing next to it, a feature that was deplored by critics then and since).[14] Instead, all the iconography is in the materials.

Second, in the context of Italy in the 1940s, concrete was not a 'cheap' or a surrogate material; as the material of reconstruction, then in short supply, to expend so much concrete on a memorial was, at this date, an act of sacrifice. And third, although Mussolini's memorials were invariably made of stone, Fascist Italy had been an enthusiastic and creative user of concrete. Import restrictions encouraged Italian engineers, most famously Pier Luigi Nervi, to produce some of the most innovative structures of the time, and even more than in Germany, concrete was the material that demonstrated the technological progressivism of the state. Another indication of how concrete was valued in fascist Italy is the curious 'shrine' in the Casa del Fascio at Como, completed in 1936: in the office of the party secretary, a section of a free-standing column was left as raw concrete, and encased with a glass cabinet in which various Fascist memorabilia was displayed. At the Casa del Fascio, the concrete skeleton was entirely covered by other materials, except in the inner sanctum, where it was exposed as if it were itself a religious relic.[15] If concrete in Italy was a fascist material, one of the tasks of post-war Italian architecture was to decontaminate concrete of its fascist connotations. In fact, the process had already begun before the war had ended, for as they retreated the Germans had blown up all the ingenious concrete lattice-structure aircraft hangars that Nervi had built for the Italian airforce in the late 1930s. This act of destruction, which Nervi always mentioned whenever he referred to the hangars after 1944, conveniently liberated concrete, allowing it to become the material of the new republic.[16]

The Fosse Ardeatine is the first of the post-1945 ‘empty-box’ memorials, a type that has recurred fairly regularly since, for example in the Yad Lebanim memorial in Tel Aviv (1963–4). The oppressive concrete slab hovering over a void has also been repeated, at for instance the Yad Vashem memorial in Jerusalem (1953) and the Resistance memorial at Udine in Italy (1959–69). But because big slabs and empty boxes have become familiar motifs of memorials, we should not assume that they, or concrete itself, are ‘natural’ signifiers of memory. At the Fosse Ardeatine, it was a very conscious and deliberate choice, concerned with producing an object that was free of the symbolism of the previous regime, and exploiting the material of reconstruction to create something that was more than could be achieved in any natural material. We cannot assume that the conditions that applied at the Fosse Ardeatine would also apply elsewhere, or that they could be relied on to evoke the same meanings. Nonetheless, the choice of material in both this case and the next contributed to the habituation of concrete as a material of memory.

The third memorial is in Paris, the Memorial to the Martyrs of Deportation. Situated at the eastern tip of the Île de la Cité, it was designed by Georges-Henri Pingusson, who was at work on it between 1953 and its completion in 1962. A hundred metres from Notre Dame, this is a historically sensitive site, on which construction of any kind would be contentious, let alone a memorial made out of concrete.[17]

Approached across an open garden, it is more or less invisible. Apart from a low wall with an inscription, there is nothing there until you go down the too-narrow stairway into a paved triangular court, open to the sky but otherwise entirely enclosed by 4-metre-high concrete walls, except for an opening covered with a metal grille through which one can see the moving water of the Seine. The transition is extraordinary. At ground level, you are at the centre of a panorama of the historic centre of Paris; go down into the memorial, and you are cut off from everything except the sky and the water, and only the two unpleasantly narrow and steep stairways allow for any escape. On the same side as the stairs, opposite the apex with the opening to the river, there is a narrow parting in a massive block of concrete, passing through which you feel in imminent danger of being crushed between the two sides; the opening leads to a crypt in which, through a metal grating, thousands of tiny lights dimly illuminate the walls of an endless corridor.

Of the four memorials discussed here, this is the only one that can be considered a success in memorial terms – and this is partly because it is an inversion of the conventional form of the monument. Not a protrusion, but a declivity; not an object, but a void – and when you are in the void, there is nothing there to look at apart from yourself, the sky, the water, and the unbroken surface of the concrete wall. Pingusson appears to have been the first of the designers we have looked at so far to have been aware of the fragility of memory and the general unsatisfactoriness of all attempts to transfer the evanescence of mental recollection into solid matter. (Pingusson’s own account of the memorial begins, ‘It is in the law of all living creatures, beings and things to one day disappear . . . everything will fade away, everything will pass, and to want anything to last is a great challenge . . .’.[18]) Apart from the crypt, there is no *sign* in this memorial; it is pure experience, there is nothing to be read, only the concrete itself.

Compared to the Märzgefallenen and the Fosse Ardeatine, at the Paris memorial the choice of concrete seems calculated from the start, part of a fully worked-out iconographic strategy. Once in the memorial, you are surrounded by concrete: the paving is stone, but the walls are pick-hammered concrete, of superfine quality, exposing a dense and rich mixture of aggregates. (The aggregates were chosen from all the mountainous regions of France, giving it, at least to the geologically minded, a national rather than localized symbolism; the difficulty of making sure that so many different aggregates were evenly distributed can scarcely be imagined.) Pingusson chose concrete, rejecting limestone, sandstone or granite as incapable of expressing the roughness and violence of the Holocaust: but the finish of the concrete is not crude or barbaric, reminiscent of military fortifications, in the manner of, say, Le Corbusier’s chapel at La Tourette. Instead the emphasis here is on the totally seamless, monolithic effect: Pingusson wanted it to appear that the memorial had been hewn out of a single rock. The concrete facing was poured simultaneously with the structural wall, so as to give an absolute bond between the two, without any evidence of joins. At the Fosse Ardeatine, the surface finish was applied after the structure of the slab was completed, and slight variations in the surface are visible as a result, diminishing the monolithic effect; in the Paris memorial, there is no trace whatsoever of joints between areas of concrete. It was the seamlessness of conrete that mattered most to Pingusson – though one may add that its other property is to defy nature. Exposed masonry surfaces always show signs of weathering and of time – but this concrete finish is entirely unblemished and seems impervious to the effects of age and weather. There had been an earlier French memorial in concrete, the Monument of the Trench of the Bayonets at Verdun, constructed in 1920, where concrete was used in preference to stone, so as, the architect said, 'to ensure durability' for a minimum of 500 years. A contemporary description explained, 'The Trench of the Bayonets will be everlastingly protected against the attacks of time or the cyclical pillage of the tourists. It will also be saved from the invasion of vegetable growths.'[19] In other words, the purpose of covering the site with concrete was to resist the effects of nature. Pingusson may have had something of the same intention at the Paris memorial, in which case his choice of finish was infinitely superior to that at the Trench of the Bayonets.

What we see at the Monument to the Martyrs of Deportation is concrete used precisely for the same reasons as it is generally despised – for its anti-natural properties, the fact that it does not succumb to the same processes of ageing and decay as other materials. Pingusson's memorial creates a kind of sensory deprivation, which forces the visitor to concentrate upon the sky and the present. The concrete surroundings do not invite any kind of historical reflections, or even on the passage of time; memory, if there can be such a thing, is of the moment, it cannot be captured or preserved, and this the permanent newness of the concrete seems to acknowledge. In other contexts, these effects are not generally welcome and concrete has often been condemned for inducing them. Here, though, they are a major component of the work's memorial function.

House, the cast made in 1993 by the English artist Rachel Whiteread of the inside of a London terraced house, was not a memorial in the same sense as any of the previous works, for it commemorated no one – not even the unfortunate Sydney Gale, the last occupant of the house of which *House* was the negative impression. Nevertheless, *House* and other works by Rachel Whiteread have often been referred to in terms of memory, while its being made of concrete raised expectations that it was some kind of memorial, even if to whom or of what was not clear. Its resemblance to a memorial also contributed to the hostility with which it was received in the part of East London where it stood; attacked verbally, and physically with graffiti, it seems to have been felt that whatever it might have been commemorating was not worth remembering. Variously described as a 'monstrosity' and an 'excrescence', in a district where there was already more than enough concrete, it seems that a concrete monument without any obvious referent was one concrete object too many. When *House* was demolished in 1994, as had been intended from the start, it was with relief – to the locals, and very probably to the artist, and to Artangel, who had commissioned it.[20]

While *House* has received a lot of attention as public art, to look at it in terms of concrete throws a slightly different light upon it. The choice of concrete as a medium was carefully made, and developed out of Whiteread's interest in casting as a process, apparent in her previous work *Ghost*, the interior of a room cast in plaster. Judging from the visual source material that Whiteread was collecting around this time, she was especially interested in concrete: there are pictures of dams, of unfinished houses in Greece and of miscellaneous concrete objects, like the concrete globe at Swanage in Dorset; and another work of hers, *Demolished,* consists of twelve prints of concrete tower blocks being demolished by explosives. While she had made some smaller works in concrete, *House* was the largest she had completed up to that time, whether in concrete or in any other medium.

For *House*, the interior of the building was cast around a steel armature, and the building itself then demolished. What was left therefore signifies an absence. This is true of all things made of concrete, though generally we are not expected to think about the mould once it has been discarded, nor to imagine what it might have been like. Amongst works in concrete, *House* was exceptional for drawing attention to the absent object from which the impression had been taken, and for making this the primary feature of the work. Features of the house that had been recesses, like fireplaces, became projections; elements that had been projections, like light switches and electrical sockets, became cavities. But then there were also some inexplicable features, such as the cast of a door on the second floor – where did this lead to? With the removal of the walls, 'I had suddenly realised what I had done', wrote Whiteread about her earlier work *Ghost*, 'I had made the viewer become the wall'.[21]

Although 'architectural' in scale and in form, Whiteread's *House* was produced within the conventions of sculpture rather than those of architecture. In twentieth-century sculpture, concrete had usually been a somewhat marginal material, used either as a surrogate for stone or as a more durable form of the sculptor's traditional medium of plaster. As was the case with the memorials we have already looked at, if sculptors chose concrete in preference to stone, it was generally because it made possible monolithic constructions, without joints, or because it was capable of more adventurous forms. What no one had done before was to make the casting process itself into the primary feature, as was to happen with Rachel Whiteread's *House.*

A reluctance to draw attention to the act of casting is not surprising, for within sculpture there has been a long-standing tradition of privileging carving over modelling techniques and, judged in these terms, poured concrete was always going to look inferior to stone.[22]

Many of the conventions of sculpture were turned on their head by the European and North American movement of the 1960s, usually called minimalism. When artists like Robert Morris, Richard Serra, Robert Smithson and Donald Judd set out to produce works that refused to be 'objects' in the way that sculptures had been up to that time, they adopted various strategies. One was to delegate the work of fabrication to others, so getting rid of the aura of the artist's touch; another was to adopt ready-made industrial materials in place of the stone, wood and bronze traditionally favoured by sculptors. A third was to present the work less as a finished thing than as evidence of a process of making. Concrete fitted all these characteristics rather well – industrial, without intrinsic value, reliant on tradesmen used to working to the instructions of others, with the process often all too much in evidence – and might have been expected to appeal to minimalist artists, but, curiously, did not. With a few exceptions, minimalist sculptors avoided concrete. These exceptions generally seem to have occurred either when some irony was intended, or in situations when concrete was used outside its normal register of references.

Bruce Nauman's *A Cast of the Space Under My Chair* (1965–8), a precedent for Whiteread's casts, looks like a piece of minimal sculpture: an inert, featureless concrete block, it would refuse all introjection by the viewer were it not for its title, which turns it into something absurdly specific and personal to the artist. Nauman's piece was evidently an ironic take on what his contemporaries were doing. Richard Serra's earliest works were process-based experiments using lead, latex or rubber, but in the early 1970s he started producing larger site-specific works in the open. One of the earliest of these was *Shift* (1970–72) in a field at King City, near Toronto: six concrete walls of varying lengths, rising from eight inches to five feet arranged in a formation that apparently followed the path of a walker moving across the site. But after *Shift*, Serra abandoned concrete in favour of steel (with two exceptions, *La Palmera* in Barcelona, and *Sea Level* at Zeewolde in the Netherlands), and said later that he found concrete too architectural. Serra's objection was that works of sculpture made out of concrete start to invite comparison with architecture: 'I did not want to start begging issues that seem irrelevant to sculpture'. Concrete, when the work is made *in situ,* presented no limit to the scale of the object, whereas with steel the processes of fabrication and of transport set a maximum size.[23]

A third American artist, Donald Judd, had also been making sculpture out of industrial materials – sheet metal, Perspex, plywood – since the 1960s. In 1978 Judd bought a ranch at Marfa in Texas, where he started to install his own works and those of a few other artists. In 1980 Judd conceived a large new work sited in the desert landscape, fifteen groups of 60 open boxes each of the same dimensions and around 2.5 metres high. At first Judd did not specify a material, though both adobe and concrete were considered. His main concern was for the objects to appear part of the desert landscape, and it seems that concrete was chosen as a more durable alternative to adobe, while retaining some of that material's primitive character. In other words, the choice of concrete was not on account of any industrial associations, but quite the opposite, its earthiness – although ironically it turned out that Judd was disappointed by the poor quality of the first boxes in the series, and called in a concrete expert to bring the workmanship up to a more 'industrial' standard.[24]

In all these works, the choice of concrete was for reasons that were in one way or another marginal to minimalism: concrete could not be said to have been a favoured material amongst minimalist artists. While Whiteread's *House* was not a minimalist work, it was nevertheless a reinterpretation of minimalism. Neither abstract nor representational, *House* was certainly made with a knowingness about minimalism, and the interest in minimalism in artistic circles in the early 1990s was such that it could hardly be viewed without minimalist concerns intruding.[25] However, anything to do with memory was anathema to minimal art, which made a virtue of not evoking memories, and of making sure that nothing got in the way of the immediacy of the encounter between spectator and object. Whiteread's casts, on the other hand, went out of their way to record traces of the previous object – patches of bare plaster, broken tiles, stains from the walls, leaving us in no doubt that we were looking at the absence of a particular house, and not at some generalized abstraction of a house. These traces, like everything else about Whiteread's work, betray an ambiguous relationship to minimal art: as evidence of the process of fabrication, and the contingency resulting from it, they are consistent with minimalism, but on the other hand in so far as they encourage speculation about the previous life of the house, they are anti-minimalist. Considered within the tradition of memorials, though, the work is also uncharacteristically specific – the aim of memorials being on the whole to cause reflection on the general, on noble causes, catastrophic losses, great sacrifices, but not upon the minutiae of everyday life. All that *House* did was to put what had once been private, the inside, onto the outside, making it public. This was hardly heroic stuff. On the other hand, the monumental scale of the work, as well as its being made of concrete, set up expectations that something big was being commemorated. There is a sense, often remarked on, that Whiteread's pieces seemed to be about death – an aspect both denied, but also confirmed by the artist.[26] As Molly Nesbit has written, 'She herself brushed death somewhere else in order to meet it and cast it. The precise location and composition of death remained mysterious. Somehow she got it outside.'[27] The aura of death hangs around *House*: even if it was not about death, it *ought* to have been.

Not long after *House* was demolished, an event which itself contradicted the expectations of permanency that has made concrete a preferred medium for memorials, Whiteread won a commission for a Memorial in Vienna to the Jewish victims of Nazism in Austria.[28] For this work, a true memorial, commemorating actual deaths, Whiteread followed a scheme similar to *House*, making a concrete cast of a book-lined room, of similar size and proportions as rooms around the Judenplatz in which the memorial stands. Concrete here was unambiguously identified with both death and recollection. In her subsequent public works, though, like *Water Tower* and *Monument*, Whiteread stopped using concrete and took to casting in clear resin. Abandoning concrete released her work from its earlier preoccupations with memory and death; resin makes the works less inclined to be seen as monuments or memorials.

Are we any closer to understanding how a medium, concrete, can at once be both a material of memory and of oblivion? Maybe not, but we can at least see how concrete was in certain circumstances turned into a mnemonic medium. And what is clear from the cases discussed here is that this happened not because concrete had any pre-existing memory-bearing properties, but purely for contingent reasons: for the opportunity it gave to make seamless objects, for its nature-suppressing qualities (ironically the very same reason for which it is so often despised), and for the political associations it has in certain circumstances conveyed. It has to be said that the large majority of concrete memorials betray a naïve optimism about the capacity of solid objects to preserve memory: all too often concrete has been used for, apparently, no better reason than that it offers the appearance of dense mass and indestructibility, as if an excess of these properties would be enough to guarantee the prolongation of human memory. Only the later generation of Holocaust memorials have been more circumspect and have taken to exploiting its oblivion-inducing properties, using it as a material into which memories sink, never to be recovered.

Finally, memorials do throw some light on concrete: above all that concrete *does* have an iconography, not something customarily acknowledged in the usual circles where concrete is discussed. For the most part, the problems concrete research has been concerned with are to make it stronger, to eliminate its imperfections, to make it smoother and finer. The attitude has been that concrete's shortcomings are technical: resolve these and it will lose its unpopularity. As a signifying material, it has been treated as neutral, its 'modernity' somehow giving it exemption from the systems of meaning attached to other materials. But the use of concrete in memorials exposes the fact that concrete is not immune to meaning, that it has an iconography – but unlike so-called 'traditional' materials, whose meaning used to be thought inherent and embedded in them, concrete's is entirely fluid and mutable, made by the circumstances of history. It resists the singular, simple meanings that the concrete industry would like it to have, and instead its iconography operates through paradoxes and contradictions. When the architect Louis Kahn said 'If you're dealing with concrete, you must know the order of nature, you must know the nature of concrete, what concrete really strives to do', what he omitted to mention was that whatever concrete strives to do, it almost invariably manages, at the same time, to achieve the opposite.[29]

EIGHT

CONCRETE

AND

LABOUR

Skill or No Skill?

To make things out of concrete has, since its nineteenth-century beginnings, customarily been seen as needing little or no skill. This has been both its gift and its defect. Its gift, in that it empowers people with no more than a rudimentary knowledge of construction to produce durable and salubrious structures on a scale that would otherwise be beyond their means. Its defect, though, in that the results are likely to be stigmatized as 'cheap'. Because, supposedly, anyone can do it, the work of making concrete carries little prestige; compared to things made out of materials whose workmanship relies upon crafts with long traditions and established patterns of training, concrete has for most of its history been looked down upon as inferior. Frequently the province of low-status immigrant labour – Italian in the U.S., Irish or West Indian in Britain, Algerian or Portuguese in France – concrete is low down in the hierarchy of building trades. But to say that concrete requires no skill is an oversimplification, as we shall see in the following account of some of the shifts that it has brought about in the labour of building.

Nineteenth-century discussions in the English journal *The Builder* reveal that from early on there was disagreement about the amount of skill concrete needed. There are reports of people building with unskilled labour: an Aberdeenshire landowner, Mr Lumsden, for example, sent his estate manager up to London to see how Joseph Tall's firm, the principal English concrete contractor of the time, went about building,

> and after a stay of a few days, he returned, and had been doing all Mr. Lumsden's building work since that period in concrete, employing ordinary labourers at about 17 shillings per week, and thus effecting a saving of from one third to one fourth the cost under the old method of building.[1]

But not everyone was satisfied that arrangements of this sort would produce satisfactory buildings; one dissenter wrote to *The Builder*, 'the advocacy of our concrete builders for unskilled labour must be wrong . . . Constant and qualified supervision is the necessity and a scarcity of skill the want.'[2] The reality was – and continues to be – that there is a distinction between high-quality and ordinary concrete work: as an editorial in *The Builder* recognized, 'The former is a work of art, scientifically prepared, in the almost strict observance of natural laws; the latter is the production to a certain extent of unskilled labour.'[3] In dealing with concrete, it is a mistake to treat it as all the same – there are degrees of excellence, and quality, just as much as in any other building trade, demands skill. The questions for concrete are where this skill comes from, who holds it, and how it is transmitted.

Part of the appeal of concrete lay in the prospect of cheapening construction through the opportunities it presented for 'deskilling' – for the substitution of less skilled and therefore cheaper labour in place of more highly paid skilled labour. There are good grounds for saying that the phenomenal success of concrete in advanced economies where wages are high has had as much to do with this aspect of concrete as with any constructional advantages. (The fact that rather different arguments apply in countries where labour costs are lower – and where concrete has been no less successful – should alert us to its variable conditions of existence in different parts of the world.) Concrete has done more than just change the economics of construction, it has affected the entire composition of the building industry, shifting the balance between skilled craft labour, unskilled labour and professional experts, to the advantage of the latter two groups and the disadvantage of the first.

When people talk, as they frequently have, about concrete being a 'revolutionary' material, the revolution has been as much human as structural.

To the early advocates of concrete, its appeal was that it offered an *alternative* to current methods of construction, and in the context of nineteenth-century Britain, this 'alternative' meant something more radical than simply the deskilling of the existing trades. Concrete offered a chance to bypass the traditional trades altogether, and to break their monopoly over construction, by making it possible to build without any need for them at all. Charles Drake, a contractor who had built up a concrete construction business, claimed in a lecture in 1874 that 'The work in building could be done almost entirely by unskilled labour. For that reason and because concrete offered an alternative method of construction he thought it ought, in these days of strikes and attempted restrictions of trade, to find favour with employers.'[4] In an industry where the skilled trades were strongly unionized and where there had been a number of significant strikes, concrete appeared to offer a means of weakening the power of unionized labour. In this respect, the attraction of concrete was not so much that it used unskilled labour, but more that it employed men from outside the unionized trades. As we shall see, although arguments about concrete were often presented in terms of 'skill', in practice what was frequently at issue was its potential value to employers as an alternative to traditional craft labour.

Many of the nineteenth-century pioneers of concrete were just as excited by the social possibilities of the medium as they were by its structural potentialities. The prospect of a sound method of construction that could be performed by people without any skill opened up all sorts of opportunities for social transformation, not just to the advantage of the employers and capital-owning classes, but to all social ranks. François Coignet, the French industrial chemist who diversified from cement production into concrete contracting in the 1850s, was also a Saint-Simonian socialist and believed that the means of production should not be concentrated only in the hands of the bourgeois, capital-owning class, but should be distributed as widely as possible across society. Concrete he foresaw as a means by which this might occur. Coignet, whose arguments in favour of concrete were distinctly messianic, believed that it would transform life in the countryside by making possible low-cost, dry, well-insulated dwellings, and providing dry, vermin-proof storage for grain and other produce; in the town, it would offer healthy, fireproof dwellings and improve health through its use for sewers and water pipes. Concrete, Coignet summed up, 'renders not only the greatest service to the art of building, but will increase the security, the well-being, the health and the morality of the population'.[5] Crucial to Coignet's vision was the way in which concrete would make any workman capable of high-quality construction. In an analogy between concrete and photography, Coignet wrote that the new process 'is to construction what printing is to writing, and tends like engraving, lithography and photography to the popularization of the art, putting it within reach of people of all fortunes'.[6] To better diffuse the emancipatory technique he suggested that 'regiments give instruction to soldiers, who, returning to their villages, would become initiators of this method that through its benefits to agriculture would give the soldier a means of performing an honourable and lucrative profession'.[7]

Another contemporary of Coignet's to see concrete's benefits to labour was the Englishman Andrew Peterson. Peterson, who had been a high court judge in Calcutta, retired in 1868 to the village of Sway in Hampshire, where he bought an estate. Not long after his return to England, Peterson discovered spiritualism, giving him an early place in the long line of visionaries, religious eccentrics, cranks and 'outsiders' to have been drawn to concrete – Rudolf Steiner, the Facteur Cheval, Henry Mercer's Moravian pottery works at Doylestown, Pennsylvania, Paolo Soleri's Arcosanti in Arizona, and many more.[8] Peterson built a commodious 40-room residence for himself, then many other buildings, houses for his employees, stables, pigsties and finally a tower, all in mass concrete, using the labour of local unemployed agricultural workers. 'The proprietor was his own architect throughout, and the whole work was performed under his personal superintendence by the unskilled labour supplied by the district', reported the spiritualist magazine *Medium and Daybreak*.[9] Everything was made of concrete: 'There is not a solid foot of stonework or brick to be seen anywhere. Ponds, aqueducts, gate-pillars, steps, garden walls, sheds – even the table on which the gardener pots his plants – are all of concrete.' Peterson believed that he had a duty to spend his surplus wealth on creating employment for others less fortunate, in such a way that they could improve their situation – and saw construction in concrete as a means of doing this. Peterson's principle, according to *Medium and Daybreak*, was 'to encourage local talent, and avoid the expensive blunders of professionalism. He has brought no skilled workmen from a distance, but given men in the locality an opportunity to distinguish themselves and better their position.' Peterson paid his labourers fourteen shillings a week, which was two shillings more than the current agricultural rate, annoying local farmers but benefiting the unemployed: it was reported that, 'As the results of his experiments, wages have been considerably raised in the district, while the poor rate has fallen in a gratifying manner.' By far the most remarkable of his works is the tower, begun in 1879 and completed in 1886, and which, at 218 feet, was then the tallest concrete structure in the world. The tower was built to Peterson's own methods and design – following guidance from the spirit of Sir Christopher Wren – using local labour, paid on piecework (two men received 10 shillings together for each 18-inch lift of the formwork, reckoned to be two days' work). Vague as to the tower's eventual purpose – Peterson had some idea of using it for spiritualist seances, and had his ashes buried beneath it after he died in 1906 – its actual *raison d'être* seems to have been to create work.[10]

For Peterson, as for Coignet, concrete offered a means of transforming the structure of employment by turning people without any previous experience of construction into builders. In the succeeding century and a half, millions of people all over the world have been empowered by concrete to become self-builders, from the favelas of Rio de Janeiro to dropouts in the Californian desert. Its value in putting an effective means of building within reach of the majority of the world's population may, ultimately, be considered its greatest gift.

To go back to concrete's effects upon the building industry, who did the work of making the earliest concrete buildings? We are frustratingly ignorant as to what kinds of people were employed, an ignorance that extends to the history of almost all the human aspects of fabricating concrete. The sketchy descriptions that follow reflect the scantiness of knowledge around this whole aspect of construction. When reinforced construction took off in the 1890s, it seems that the labour did not generally come from one of the existing building trades – masonry, plastering, bricklaying – but instead was a wholly new occupation, whose operatives were for the most part untrained in any of the established crafts. Nor was there a connection, as there had been in iron and steel construction, with the primary producers of the material: with iron and steel, the men who assembled and erected the components on the site were generally employees, or otherwise connected with, the foundries or steel mills that prepared the materials. In the case of concrete construction, the firms that produced the raw materials – cement and steel reinforcement – do not usually seem to have provided labour for construction. Such evidence as there is suggests that the workers employed on reinforcement fixing and pouring concrete were drawn neither from the existing established trades, nor from the primary producers of iron or steel. But where they came from it is hard to say, and as Simonnet remarks, 'their past is a jumble'. Almost all accounts of concrete construction around 1900 ignore the labour element: the first handbooks of concrete describe the work in terms of the various processes involved, often in great detail, but are inexplicit about the actual organization and conduct of the work on the site. Labour exists purely as an abstraction, acknowledged only through the names of the separate tasks. What backgrounds and experience the men shown in the photographs of Hennebique's construction sites had we know not.[11]

According to Hennebique's English agent, L. G. Mouchel, the requirements for becoming a concrete worker were not high. As he explained, the Hennebique system

> enables one to take any labourer of ordinary intelligence and to make of him an apt worker in a very few days – I was going to say hours. So when you read that one of the drawbacks of ferro concrete lies in the necessity of skilled labour, please do not believe a word of it. So far as the Hennebique system is concerned, it is not so; and surely I can speak with authority on the subject, since I had to form, myself, my own gangs of men when I introduced reinforced concrete into this country. It took me very little time to drill them in the practice of arranging the various parts of a work . . .[12]

But Mouchel's description was slightly disingenuous, for while the contractors who built Hennebique's buildings certainly made use of locally recruited unskilled labour, the Hennebique organization also retained highly experienced itinerant foremen whose job it was to educate the contractors in the practicalities of building in concrete, for without this knowledge the Hennebique system was just a meaningless set of instructions. For one early Hennebique project, a building in Nantes, Hennebique wrote to his local agent, 'I have just got ready for them [the contractors] some site managers who are going to give us a tip-top job'.[13] For the Hennebique buildings in Britain built by Mouchel, the French office provided French site managers and foremen to oversee the work and ensure that it was properly carried out: Hennebique's first project in Britain, Weaver's Mill in 1897 in Swansea, was built by a French contractor with French supervision, and for a group of five warehouses on the Manchester Ship Canal built in 1904–5, a site with 400 locally employed workers, the site manager and the carpentry and concreting foremen again were French, provided by Hennebique.[14] Even so, notwithstanding these measures, the quality of construction does not seem to have been especially high, and when Weaver's Mill was demolished in 1984 it was found that the concrete was fairly porous, poorly compacted and the aggregates unevenly graded, its strength only gained by an abnormally high cement content, which Hennebique had presumably specified as a precaution against poor workmanship.[15] Hennebique's and Mouchel's claim to be able to build with a largely unskilled labour force was a half-truth. The American architect Albert Kahn, admittedly not a disinterested witness given his family connection with the rival Trussed Concrete Steel Company system, later claimed that the Hennebique system 'was complicated . . . and with the excessive labour costs of our country, proved rather impractical here'.[16] At least by comparison with American concrete construction methods, Hennebique's process seems to have been relatively reliant upon skilled labour.

What, however, Hennebique's operational methods revealed was the extent to which it was possible, with concrete construction, to detach the skilled, mental work of building from the purely manual element. The opportunities that concrete provided for such a division of labour is what really distinguished concrete and made it uniquely different from all other construction processes in labour terms. No other means of construction allowed such a satisfactory separation of the mental from the manual elements of labour, a feature of concrete that has made possible the most ignominious chapter of its history, its association with forced labour, to which it has proved all too well suited. One of the earliest civil engineering works in concrete, the extension of the port of Algiers between 1833 and 1840 using 10-cubic-metre concrete blocks, was carried out by military convicts; German concrete defensive works on the Western Front in 1916–17 were built by Russian prisoners of war; in the Soviet Union, from the 1930s to the early 1950s, convict labour was extensively used in construction (30 per cent of building workers in 1935 were convicts), and much of the infrastructure of canals and highways created by Stalin was built with labour from the Gulags; the construction of German defences in concrete throughout Europe in the Second World War relied heavily upon forced labour; and at the end of the war, the Russians put German officers they had taken prisoner to work building the new concrete road between Tallinn in Estonia and Leningrad.[17]

If the use of forced labour demonstrates just how easily the purely manual element of concrete construction could be separated from the mental aspects of the work, the same applies under conditions of paid labour. Whereas in other constructional methods, the traditional trades retained control over much of the organization and quality assurance of the work, with concrete this was almost entirely removed from the site operative into the hands of site supervisors and engineers, a separation that continues to this day. There is little doubt that the relative cheapness of concrete construction over other constructional methods, at least in the early part of the twentieth century, was attributable to the higher proportion of unskilled labour found on sites where reinforced concrete was being used. When Moritz Kahn in 1917 estimated that a reinforced concrete frame factory cost 87 per cent of a factory built in fireproofed steel, a significant proportion of those savings must have come from the difference in the ratio of skilled to unskilled labour.[18]

Considered as a totality though, the work involved in making a concrete building involves just as much skill as does a building built by any other constructional method, and in that respect the question of skill or no skill is an irrelevance. The difference lies in the way that the skills are distributed between the various people employed in its construction. To a greater extent than with other processes of construction, the element of skill in concrete construction has been concentrated in a small group of specialists and experts, and detached from the bulk of manual labour. It was the opportunity that concrete provided for this division of labour that set it apart as unique amongst construction materials, and was the cause, as we shall see, of the fascination of the new discipline of scientific management with concrete in the early 1900s.

Concrete's reputation as low skill nonetheless stuck. In post-war Britain, complaints about the poor quality of concrete were common, and usually blamed on the low levels of skill of concrete workers. A pamphlet prepared by the London County Council Architects Department in 1962 stated that 'the quality of finish of exposed *in situ* concrete varies widely and often leaves very much to be desired'. The cause was attributed 'in part to the lowly status of the concretor in the hierarchy of the building trade, probably because it is a trade of comparatively recent origin, lacking the long craft traditions of the carpenter, bricklayer or plasterer' – though as we have seen it was exactly this lack of association with the craft trades that the pioneers of concrete had initially exploited.[19] The separateness of concrete work from other trades was confirmed by a 1966 survey, which showed that concretors and reinforcement fixers had little formal training and had usually been general labourers before entering their 'trades', if such they could be called.[20] In many countries, concretors occupy the bottom end of the hierarchy of the building trades, partly because it is dirty work, and in the building industry cleanliness generally signifies prestige.[21] While the cement and concrete industries like to show concrete operatives clad in spotless overalls and shiny hard hats, casting them as 'technicians', the reality, particularly in countries with strongly unionized building trades, was that there were always advantages to maintaining concrete work's unskilled status.

In the 1950s and '60s, the skill/no skill debate took on a particular architectural manifestation with the 'Brutalist' fashion for roughly finished concrete. While raw surfaces were meant to signify an engagement with the 'as-found' – the alleged lack of skill on the contemporary building site – the roughness of Brutalist architecture, as architects were well aware, generally required unusually high standards of workmanship. Design notes on rough board finished concrete drawn up in Britain in 1961 noted that 'The use of the word "rough" in a specification probably conjures up the wrong idea of what is necessary. The texture has to be rough, but the standard of shuttering and the concrete itself has to be of the highest – far removed from "rough" work.'[22] The construction between 1951 and 1955 of Le Corbusier's Maisons Jaoul in the Paris suburb of Neuilly-sur-Seine exemplified the contradictions of this architectural conceit. The intentionally messy brickwork was contracted to an experienced tradesman, the Sardinian Salvatore Bertocchi, with whom Le Corbusier had worked previously, and who fully understood Le Corbusier's desire for the '*mal foutu*'. The concrete work, however, was the responsibility of a general contractor, giving the architect no direct control over the workmen. On the first level the concrete was unacceptably bad; to compensate, on the next level the contractor made an effort to do better, only to be reproved by the site architect: 'you made an academic statement out of it by creating beautiful formwork compared with the others . . . Let me remind you that the architecture of this building is utterly simple: rough concrete, large bare walls of exposed brick etc.' The young James Stirling, visiting the houses in 1953, was wholly taken in and mistakenly believed them to be 'handmade with unskilled labour', using Algerian labourers equipped only 'with ladders, hammers and nails'.[23] If Brutalism was meant to be a way of preserving the myth of an unskilled labour force, it relied upon exceptionally high levels of craft skill.

The particular aspect of concrete where skill has never been in doubt is in the fabrication of the formwork. From concrete's nineteenth-century origins, formwork was the one stage of concrete production where it was impossible to dispense with skilled labour – and since this compromised the claims that concrete represented an 'alternative' mode of construction, advocates of concrete generally made no reference to this element of the work. Formwork carpentry represents a variable element in the cost of concrete construction, depending upon the complexity of the shapes and the standard of finish required: in America in the early 1900s it was reckoned that in any elaborate construction the costs of the formwork exceeded the costs of the concrete, and was generally the largest single item of expense on a concrete building.[24] This has, naturally, led to the development of systems to rationalize and simplify the fabrication of formwork, but in any work of quality it remains a significant expense. In terms of the building trades, formwork carpentry, generally a specialized branch of the carpentry trade, has occupied a significant proportion of carpenters: in Britain in the mid-1960s, it was estimated that 20 per cent of all carpenters and joiners were long-term specialist shuttering fabricators.[25] Formwork carpentry has been the Achilles heel of concrete's claim to need no skill.

Concrete and Scientific Management

Scientific management, when it discovered concrete, became enthralled by it. Originating in the U.S. in the 1880s with Frederick Taylor's studies of factory work, scientific management aimed to find the 'one best way' of performing every task, and by teaching this to the worker, to raise his or her output and the firm's profits. Of the leading figures in the scientific management movement, several had a history of involvement with concrete. Frank Gilbreth, the pioneer of motion studies, was initially a successful East Coast contractor, with a business that at one stage extended to Britain.[26] Among Gilbreth's contracts were a number of large buildings, including offices and power stations, built in concrete. Gilbreth's obsession with organization had already led him to prepare a set of standard operating instructions for his employees, published in 1907 as his *Field System*. This was followed in 1908 by *Concrete System*, which set out his procedures for building in concrete. At the same period Taylor had become interested in concrete, and his first published book (although he had previously published papers on factory work) was the *Treatise on Concrete,* co-written with a concrete engineer, Sanford Thompson, in 1905, six years before the appearance of what was to be his best-known work, *Principles of Scientific Management* (1911). When scientific management came to Europe, it was another concrete specialist, the engineer Pierre Couturaud, who introduced Taylorism into France.[27] Gilbreth's *Concrete System*, Taylor and Thompson's *Treatise on Concrete* and their subsequent *Concrete Costs* (1912) together set out in the most astonishing detail, unequalled before or since, every stage of the entire operation of constructing anything out of concrete. No one else has ever broken down so minutely each task involved in producing concrete, and measured the times taken to perform them. Taylor and Thompson's purpose was to produce a reliable means of calculating the costs of building in concrete, and in their first book these were presented in terms of quantities per day that could be expected of a workman, and of costs per cubic yard of concrete. Not satisfied with these approximations, in their second book, *Concrete Costs*, the analysis was far more thorough and they timed every movement of all processes on the site. The accompanying table, for handling cement, gives a good idea of the meticulousness of Taylor and Thompson's method; it is part of a larger table in which they broke down all the stages of mixing and moving concrete into 144 different operations, timing each one.

No	Item	Average men			Quick men
		net time min.	% delay	actual time min.	net times min.
56	†Cut string on cement bag	0.11			
57	†Move bag about 2 ft	0.08			
58	Dump bag of cement into hopper	0.12	50	0.20	0.09
59	Lift bag of cement to shoulder	0.30	50	0.45	0.21
60	Carry bag of cement 100 ft including return	1.18	30	1.53	0.83
61	Place bag of cement on pile	0.05	50	0.08	0.03

† Item not often used because done while mixing.

(From Taylor and Thompson, Table 62, 'Times of Unit Operations', Concrete Costs (1912), p. 421) In the table, 'net times apply for continuous work with no allowance for rest or other stops. Per cent delay includes rest, stops and delays which occur throughout the average day's work. Actual times include allowance for rest and delays.' The difference between 'Average Men' and 'Quick Men' they explained as follows: 'Average Men apply to the men and conditions of an ordinary contract job, Quick Men apply to men working fast under exceptionally good contract conditions but not to piece work.'[28]

There are hundreds of tables of this kind, as well as graphs for calculating intermediate values, covering every conceivable operation in working concrete. Besides distinguishing between 'average' and 'quick men' throughout, for every task involving wet concrete they give different times for two alternate mix ratios of concrete. Taylor and Thompson did not limit themselves to concreting operations, but also give times for the work of steel fixing and, more difficult, the construction of formwork. Gilbreth had largely avoided the question of formwork, simply acknowledging that it could represent the largest single component of cost; the uniqueness of each piece of formwork made it difficult to estimate except by a combination of guesswork and experience. For Taylor, though, this was not good enough, and he and Thompson gave times for the fabrication of formwork of columns, beams, walls and slabs of every possible size and dimension, as well as providing tables for such simple actions as moving different sizes of pieces of timber a given distance across the site.

From Taylor and Thompson's tables it was in theory possible to calculate the labour time, and therefore the cost, of any kind of concrete construction. They also gave values for the capital cost of plant and equipment on sites of different sizes, and for the costs of management. Previously, estimates in the building industry were made on the basis of past experience, but as no two jobs in construction are ever the same, this always involved some degree of guesswork. As Taylor explained,

> A far more accurate plan for estimating costs is the method adopted in this book of dividing each kind of work into a series of small elementary operations and of then timing and recording each of these 'unit times' and, finally, of adding together the proper series of unit times in figuring the cost of a new job. This method is new in the building trades, although it has been successfully practised for years in many large machine shops in engineering and manufacturing establishments in this country.[29]

As Taylor made clear, his purpose was to make building an industry like manufacturing, where all labour operations were visible to the management. In place of a craft-based industry in which how the work was done and the time spent doing it were determined by the individual trades, Taylor and Gilbreth wanted to take building in the same direction as the manufacturing industries had gone. The unique nature of every building project has always made it difficult for management to remove the element of self-determination and organization from the work of the trades, and for this reason, construction has never fully conformed to the norms that were being established in manufacturing industries. Taylor and Gilbreth wanted to change this, and by doing so hoped to make building as efficient as manufacturing industry had become.

Although they were not only interested in concrete – bricklaying was another trade that they studied – no other mode of construction received such thorough attention from scientific management as concrete. Because concrete was so new, with barely more than a decade's experience behind it, and it was still evolving, there were no accumulated traditions or working practices to stand in the way of their analysis. Furthermore, most of the site labour, with the exception of carpenters making the formwork, was unskilled – in the eastern U.S. largely Italian immigrants – and therefore more pliable, less likely to resist interference with their working practices. Concrete, therefore, from the point of view of scientific management, offered the most promising medium for the application of scientific principles to construction, and for turning it into a truly 'modern' industry. A French engineer, writing in 1918, insisted how, through the application of scientific management, 'the labour force of a site takes on all the appearances of the factory'.[30] Such was the fantasy, and one in which many architects indulged: as Le Corbusier put it in 1924, when at his most enthusiastically technocratic, 'Before reinforced concrete, all building trades were on site to build a house. After twenty years of reinforced concrete, we can dream of only one building trade on site: the *maçon*' (which in French also means 'concretor').[31] Although scientific management attracted considerable interest in the interwar years, in Europe as much as in the U.S. – Taylor and Thompson's first book appeared in a French translation in 1910, and *Concrete Costs* was translated into French in 1922 – there is little evidence that their methods ever had much effect on building construction. By the time that building started to be moved to the factory in the 1950s, with the advent of system building, scientific management had been largely discredited and replaced by the so-called 'Human Relations' school of management; significantly, the advantages of the shift to factory prefabrication of concrete that were stressed in the 1950s were not to do with opportunities for Taylorization, but rather with deskilling and the maintenance of a contented labour force.[32]

Absent from Taylor and Thompson's analysis of labour in building with concrete was any reference to its humanity. Apart from observing that 'the foreman of a gang of concrete mixers need not be of great intelligence' and that 'Italians make good men for mixing and transporting the concrete', they were entirely uninterested in the past experience, the affiliations or the expectations of the men who might carry out the work.[33] For Taylor and Thompson, labour was an abstraction, a unit of cost, absorbed imperceptibly into the finished product.[34] Concrete lent itself particularly well to this kind of analysis, for with concrete each individual workman's labour dissolves into the continuum of the whole, leaving no trace. Whereas in traditional building, signs of the craftsman's gesture remain, with concrete these disappear from sight; in this respect, concrete more closely resembled a manufacturing industry, in which lay part of its appeal to scientific management.

Experts

While concrete required less skill on the part of the workman than other methods of building, the corollary was the displacement of the expertise of construction on to others. In the redistribution of work effected by concrete, various new cadres of specialist emerged, the most important of which was the engineer. More than any other occupation, engineers have been the beneficiaries of concrete.

Engineers took control of two particular aspects of concrete, one concerned with what happened before the structure was built, its design, the other with the control of quality during construction. To take the preparatory stage first, reinforced concrete is unique among building materials in that it has a double existence as both a physical substance, but also as an entirely abstract body of mathematical and chemical formulae: more than with any other material, making a complex work of concrete relies upon the successful union between these two separate domains. For any building of substantial size to be realized in concrete, it has first to be 'translated' into the language of concrete. The work of translation was performed by engineers, whose competence lay in their knowledge of the formulae of reinforced concrete and their ability to calculate in advance the performance of any given structure. This particular expertise developed very rapidly in the 1890s and early 1900s, especially in France and Germany, as engineers studied the behaviour of reinforced concrete, established principles for its use and taught students how to apply this knowledge. The ways in which engineers fitted into the labour market varied between countries, and over time. Initially engineers were almost always employees, either of contractors or of the owners of proprietary systems. In France they were employed in *bureaux d'études*, where they prepared drawings and specifications for the works that their employers undertook to build. Although the *bureaux* had first developed with metal construction – Eiffel had a *bureau d'études* where the calculations for the steel supplied by his firm were done – they became more widespread with reinforced concrete, whose peculiarity was that so much of the intellectual labour was concentrated into the anticipatory stages of the work.[35] In the operation of the *bureau*, as in so many things concerning the organization of concrete construction, Hennebique was the innovator, and since he was not himself a contractor, but made his profit out of licensing others to build with his system, the core of the business was the *bureau*, which prepared the designs and specifications for the licensees to follow. The Hennebique *bureau d'études* grew rapidly. From a staff of seven in 1896, by 1905 there were 63 engineers, draughtsmen and typists employed in the *bureau*, occupying two floors at the firm's headquarters in Paris. By 1912 the number had risen to more than a hundred, and in 1913 there were 115, while spread across the offices of the firm's agents outside Paris and in other countries, there were altogether 530 engineers employed by the organization.[36] So jealously did Hennebique guard the expertise of his engineers that, apparently, their contracts of employment forbade them from working for any other concrete specialist within five years of leaving his firm.[37] Arrangements similar to the French system occurred in other countries: in the U.S. engineers were employed by concrete contractors in their own drawing offices, and in Britain the two most famous twentieth-century structural engineers, Owen Williams and Ove Arup, both started their careers as employees in, respectively, the offices of Truscon and of the Danish civil engineering contractor Christiani and Nielsen. Engineers and their employers were fond of saying 'materials alone do not constitute a system'. So integral was the presence of the engineer to the production of concrete that one American engineer was led to comment: 'A staff of experienced engineers is a most essential feature of a true system. The furnishing of reinforcing steel of correct types cannot constitute a system unless the design of the structure is complete in the hands of engineers experienced in the application of those particular types.'[38] According to this way of thinking, what defined reinforced concrete was not the material, but the presence of an engineer.

With the decline of the proprietary systems in the 1920s following the introduction of concrete codes and the expiry of the patents, their *bureaux d'études* and drawing offices ceased to be the only employers of concrete engineers, and other arrangements started to develop. In some cases architects employed engineers, as Auguste Perret did the engineer Louis Gellusseau, and this pattern later became common in the U.S. where architectural practices either employed or formed partnerships with engineers. A different pattern emerged in Britain, where engineers became independent consultants – the course followed by Owen Williams, Felix Samuely, Oscar Faber and Ove Arup.[39] Although generally thought to have had important consequences for the aesthetics of architecture, the existence of engineers as independent consultants changed nothing about the fundamental reorganization of labour that reinforced concrete had brought about: a new cadre of experts, lodged not on the building site, but removed from it, whose competence and skill lay in the anticipation of work that had yet to happen.

The other fraction of work of building in concrete that was appropriated by engineers was the control of quality on the site. Here the arrival of the site engineer, as an employee of the contractor, marked the entry of another category of expert into the building process, replacing a responsibility that with older methods of construction had lain partly with the tradesman, partly with the architect or the building owner's representative. Concrete work carries with it a series of routine tests: slump tests, which indicate the water content and mix ratio of liquid concrete, and strength tests, where samples of each batch of concrete are cured and subjected to strain and compression tests after a set length of time. In the U.S. these procedures to detect defective concrete were developed in the early 1900s, and from the start were carried out not by men from the building trades, but by college-trained engineers employed by the contractors. This new arrangement removed all judgement about the quality of materials from the site worker – a pure deskilling operation – and at the same time created a new occupation to carry out the quality control function. Amy Slaton, who describes this development in some detail, suggests that there may also have been an element of ethnic prejudice in it, since the concrete workers were largely immigrants, but the engineers white, native-born Americans. Attempts by the American bricklayers' unions to establish positions of authority in concrete work for their members failed, and they ended up conceding the field of concrete work entirely to unskilled, non-unionized labour, while the control of quality went to the new group of experts.[40]

The simplification of site labour to a series of repetitious tasks in the manner prescribed by Frederick Taylor and Sanford Thompson may have cheapened construction, but the introduction of a new cadre of experts to the contractors' payroll added a new cost. That the contractors were prepared to accept this cost was, at least initially, to do with the unfamiliarity of concrete, but in the long run was probably because of the contractors' concern to avoid mistakes in mixing and pouring concrete, conscious of the damage to their reputations if anything went wrong. The two classes of labour, one highly trained, the other entirely unskilled, corresponded to the double nature of concrete as substance and as concept, a dual existence reliant on constant ministration by a group of trained professionals.

Architects

Engineers it elevated, tradesmen it depressed, but what did concrete do for architects? Of all the occupations involved in building, architects are the group for whom there is most doubt whether concrete has enhanced, or weakened, their position. Early fears that reinforced concrete would bring about the extinction of architects have turned out to be unfounded, and they have survived, though whether despite, or because of, reinforced concrete depends upon one's point of view.

Initially in the second half of the nineteenth century, in Britain though not in France, architects embraced concrete enthusiastically. There was a flourishing business in concrete construction in Britain and several well-known architects experimented with it. At the same time though, they were wary of it, primarily on account of its aesthetic limitations. The architect George Edmund Street, presiding at a debate on work and wages in the building trades held at the Royal Institute of British Architects in 1878, commented that 'if they were to be restricted to concrete and compo, instead of masonry and brickwork, architects would almost have to give up'.[41] Street's concern was that concrete would restrict the expressive possibilities of architecture, but neither he nor anyone else at the time seems to have had any fears that concrete might entail a loss of part of their work to other occupations, or threaten their competence.

The situation changed abruptly in the 1890s, with the advent of reinforced concrete and the arrival of the proprietary systems protected by patents. Whereas mass concrete, whose structural and static properties were straightforward, presented no difficulties for the architect to design, reinforced concrete was another matter, and the expertise to use it was closely guarded by the entrepreneurs who had developed the techniques. Neither architects nor engineers had contributed to the development of reinforced concrete, and both occupations found themselves subservient to the entrepreneurs. Although, as we have seen, the owners of the systems employed engineers, the only way an independent engineer or architect could build in concrete was by going to one or other of the proprietary systems – or to devise a system of their own, a risky undertaking since the owners of the systems were exceedingly litigious and regularly went to law over potential infringements of their patents. The marginalization of architects and engineers was especially apparent in the increasingly valuable field of factories and industrial buildings, where several of the proprietary systems, notably Hennebique and Truscon, offered design and build services that circumvented the need for an independent architect or engineer.

One answer to the monopoly over reinforced concrete exercised by the owners of the proprietary systems was to establish national codes of concrete construction, which, as well as setting out universally available standards, made the owner of the system no longer the sole guarantor of the soundness of a concrete building, but shifted the responsibility onto the state or its representative authority. The first national concrete code appeared in Germany in 1904, followed by France in 1906. The initiative in France had come from the engineers of the various central state educational and administrative institutions, whose motive, though framed in scientific terms, was to gain the upper hand against the owners of the systems. Against the variety of empirical, trial-and-error approaches employed by firms like Hennebique, they wanted a general theory: Charles Rabut, professor at the École Nationale des Ponts et Chaussées and one of the members of the commission that drew up the code, presented the issue as an intellectual problem, 'I mean to tie all these innumerable systems to general principles, deduced from a single primary theory'.[42] When the code was published in 1906, it insisted that stresses must be calculated in advance, and not arrived at by empirical tests – an indictment of many of the proprietary systems, Hennebique's in particular: 'Calculations of resistance will be made according to scientific methods derived from experimental data, and not by empirical procedures.'[43] This was a victory for engineers.

In Britain the initiative for a code came from architects, for reasons that were explicitly economic and commercial. When Mouchel established himself as Hennebique's agent in Britain 1897, he was, until Truscon's arrival from the United States in 1905, the sole supplier of reinforced concrete buildings in Britain. Anyone intending to build in reinforced concrete had no choice but to go to Mouchel – or risk prosecution for infringing his patent. Furthermore, architects were in the unenviable position of carrying the legal liability for any building that they designed and which was built with Mouchel's reinforced concrete, although they had no means by which to verify the stability of the structure. Mouchel's monopoly, and the unsatisfactory legal position of architects using reinforced concrete, led a group of architects in 1906 to form a committee of the Royal Institute of British Architects to draw up an independent, unbiased working guide for reinforced concrete. There was a clear sense among these architects that reinforced concrete had put them at a disadvantage. The chairman of the RIBA committee was Sir Henry Tanner, who as chief architect at the Office of Works was the principal government architect; at a lecture in 1909, Tanner warned that unless architects took up reinforced concrete, they risked relegation to interior designers as the specialist concrete firms would assume control of all the structural and exterior elements of buildings. From an architect with Tanner's authority, this was a warning to be taken seriously. Although the Report of the RIBA committee published in 1907 had no legal status, it was said at the time that 'any one with this Report in his hands would be able to strike out confidently in the design of reinforced structures without having recourse to any particular patent system'. Another initiative, the foundation of the Concrete Institute in 1908, was, like the RIBA committee, a defensive response to the proprietary systems, although unlike the RIBA committee, this body also included representatives of the specialist firms as well as architects and engineers.[44]

The first architect to make a reputation through reinforced concrete was Auguste Perret. Perret's story has been told often and well, so needs no repeating, but there are features of his career worth drawing attention to.[45] Perret, although trained as an architect, was also, with his brothers, proprietor of a contracting business, and Auguste, who called himself 'architecte-constructeur', alternated between the two roles as it suited him. His association with the contracting business, however, disqualified him from official recognition as an architect, and there was always hostility towards him from the architectural establishment, although he was at the same time fêted by younger architects. Perret's first reinforced concrete work in Paris, the apartment building at 25 bis rue Franklin, was built in 1903–4 by Perret et Fils, the family firm, as general contractors, with the concrete structure subcontracted to a small specialist concrete firm, Latron et Vincent, who used a system of their own. Latron was an École Centrale trained engineer, and with his partner had previously worked for Edmond Coignet, the main rival proprietary system to Hennebique. The intimacy of the collaboration between Perret and Latron et Vincent (and maybe this is why Perret chose a small contractor, rather than one of the larger established firms) gave Perret the freedom to revise the design to take advantage of modifications to the structure: the result was that the concrete served the architecture, rather than vice versa, as was generally the case with buildings constructed with proprietary systems.[46]

Perret's next building in Paris, the garage at rue Ponthieu (1906–7), was the first in which the concrete frame was publicly exposed, and the first time that the Perret brothers' building firm undertook the design and execution of the concrete work themselves, a decision that the publication of the reinforced concrete code of 1906 most likely gave them the confidence to take. Thereafter, until 1930, when Auguste started to undertake public commissions that had to be put out to competitive tender, all of the Perrets' buildings were both designed and built by the one organization. In this respect the Perret brothers were not unlike other design and build firms, Truscon or Hennebique; the difference lay in the fact that what the Perrets offered was first of all an architectural service, to which the engineering was subordinate, whereas the reputation of the other firms lay in their ability to supply a proven, well-tried system that could be adapted to any particular need.

Architects' fears about the effect of specialist concrete firms on their occupation, although real enough at the time, did not materialize in the long term. The expiry of the patents of the concrete systems, and the introduction of national codes, brought reinforced concrete into the public realm, allowing anyone with the appropriate competence to use it. From this freedom, architects as much as engineers unquestionably benefited – as the success of the Perret brothers showed. Yet one cannot talk about the effects of concrete upon architects' relations with others without becoming entangled with architects' belief systems. An expectation that reinforced concrete would change architecture was summed up in 1928 by the Swiss critic and historian Sigfried Giedion: with concrete, he said, 'the architect, as a romantically sketching hero, became an embarrassment'.[47] Giedion, a propagandist for modern architecture, was voicing a view common among supporters of the 'new architecture', that architecture had become objective and was no longer an embodiment of emotion.[48]
But he was also suggesting that concrete would put the architect on a different footing in relation to the other occupations involved in building. Building in concrete made architects reliant upon others – engineers and concrete specialists – and placed them under a new, supposedly more rigorous, 'industrial' discipline; but if the need to collaborate with these other groups put architects into a state of dependency, at the same time it freed them to concentrate upon the eternal verities of architecture: mass, surface and plan for Le Corbusier; scale, proportion and harmony for Perret. To be a 'proper' architect, one who had fully engaged with the new conditions of building production, meant to build in concrete. The general view in interwar modernist circles was that concrete was good for architects, because it brought them into productive collaboration with other building professions.

Not everyone found it easy to understand why architects should have become so obsessed with concrete and to have regarded it as a virtuous material, superior to all others. The engineer Ove Arup, normally indulgent towards architects' enthusiasms, feigned astonishment at the way architects 'were prepared and indeed determined to design their buildings in reinforced concrete – a material that they knew next to nothing about – even if it meant using the concrete to do things that could be done better and more cheaply in another material'.[49] Yet, as Arup must have known, the reasons lay in architects' need to sustain their self-image as a 'modern' profession: concrete, although not the only building medium through which they might achieve this, was, for all the reasons we have described, exceptionally well suited to the requirement.

By the later 1950s certain architects seem to have tired of wanting their practice to be associated with a particular material. Sometime around 1960 Mies van der Rohe was asked by the Japanese architect Kenzo Tange what he thought of the differences between steel and concrete, and he replied that 'both are the same substantially'.[50] From an architect with a reputation for a close, not to say metaphysical, attention to the materials with which he built, and who had earlier eulogized 'the dashing weightlessness of new ferroconcrete structures', this was a very surprising remark and was not a point of view shared by Tange, nor by the majority of other architects of the time.[51] Most architecture of the 1950s and '60s was concerned with asserting the *difference* between steel and concrete, not their similarity. Mies van der Rohe's refusal to distinguish between them seems to have been made out of a sense that too much concentration upon material interfered with what really counted in architecture – space and clarity – and that an overly materialistic approach to architecture would only devalue the reputation of the architect, which should be founded upon a command of these higher truths.

However, the real threat posed by concrete to the occupation of the architect in the post-war period came not from the direction feared by Mies van der Rohe, but from the development of system building. When prefabricated systems, the majority of which relied upon precast concrete components, were first promoted in European countries in the 1950s, architects at first welcomed their development, because of the opportunities it gave them to develop the design of prototypes for components that would be produced on an industrial scale. Released from concerns with the detailed design for each individual situation, architects would have time to concentrate upon more strategic matters; as the Royal Institute of British Architects put it in their report on *The Industrialisation of Building* in 1965, 'Many forms of industrialisation enable the architect to give . . . [the client] a better service'.[52] What this generally enthusiastic attitude towards prefabrication overlooked was that once a system was in production, the architects' role was reduced to that of a technician, responsible for little more than setting out the arrangement of buildings on the site for the optimum deployment of the components.

From all over Europe there were anecdotes of the frustration and disappointment experienced by architects once prefabricated systems came into use.[53] Occasionally, there were covert acts of resistance, one of which occurred in the Parisian suburb of Créteil, where a young, not yet fully qualified architect called Paul Bossard found himself in 1959 responsible for the design of a housing estate called Les Bleuets. Unusually, rather than selecting an already developed system, Bossard designed his own system; even more unusually, he produced the technical specification and all the detail drawings of the system and of the scheme himself, instead of, as was and still is normal in France, leaving this to the contractor's *bureau d'études*. Bossard, moreover, undertook all the site work and supervision himself, again very unusual for a scheme like this. All the precast concrete sections were made on site, and were designed with abnormally large gaps between them – itself a criticism of system building where the mark of perfection was fine tolerances. The arrangement of the large pieces of shale in the concrete was left to the workmen on the site. The sections on the upper parts were precast, with the concrete poured around the stones; in sections at the bases of the buildings, the pieces of shale have been pushed into the still-wet concrete, so it oozes out around the edges. Bossard tells the story of how one day a labourer asked if he could have a go at making one of the sections. Bossard said 'ok, go on, but do it fast: you've got to do it in three minutes, you're doing a Picasso, not a Dürer.' The labourer stuffed the stones into the casting box and poured the concrete. When it was taken out, Bossard asked him what he thought of the result. 'Lousy', said the labourer. 'Well', said Bossard, 'it doesn't matter, we don't throw anything away.' So it was fixed in place, and Bossard again asked the labourer what he thought of it, and the labourer said it wasn't the same as the others. Bossard replied that none of the pieces were the same, and that if some were beautiful and some were ugly, well that was like the human race. For Bossard, Les Bleuets – uniquely subversive in Western Europe – was an attempt to escape the constraints that prefabricated concrete systems placed upon the architect, and at the same time to offer some compensation to the workmen for the alienation brought about by concrete prefabrication.[54]

Nowhere, however, were the consequences of system building for architects as serious as in the Soviet Union and its satellite countries, where the use of precast concrete panel construction became ubiquitous. Until the death of Stalin in 1953, architects had been a protected occupation, never subject to the purges that had affected most other professions; but as the Soviet building industry became, under Khrushchev, heavily industrialized, architects started to suffer, their role reduced to that of technicians. Forbidden to undertake 'individual' projects, obliged to use the approved standard systems everywhere, their function shrank to that of merely adapting the system to the particularities of the site. Even the title 'architect' started to disappear from use, replaced by 'project manager'. The Academy of Architecture was merged with that of Construction, the latter taking precedence, and finally the Academy of Construction and Architecture was dissolved in August 1963 and its educational and regulatory functions passed to the Ministry of Construction, Gosstroi. Similar things happened in other Warsaw Pact countries: in Poland, for example, where many architects found that there was no longer work for them as a result of prefabrication, they were slightly more fortunate in being able to go abroad to find employment. In the mid-1960s, there were said to be 200 Polish architects working in Paris on account of shortages of work in their own country.[55]

Whatever other vicissitudes may have affected the fortunes of architects since the demise of the concrete panel systems, concrete cannot be held responsible. As far as most architects today are concerned, the question of whether concrete is good or bad for their occupational status is irrelevant – though the notion is still widespread among architects that concrete is a 'virtuous' material, mastery of which offers more complete demonstration of their skill than any other medium. Overall, if we take a long-term view, aside from the two interludes of proprietary systems in the early twentieth century and of prefabrication in the 1950s and '60s, concrete has been good for architects.

NINE

CONCRETE

AND

PHOTOGRAPHY

CONCRETE photographs well, making it, as some of the illustrations of this book show, attractive to artists and photographers. Photography has done great service to concrete, but the relationship has not been all one-way: concrete has also benefited photography. The two modern processes, sharing closely parallel trajectories, both invented in the 1830s and both perfected in the late 1880s, have been of great mutual assistance to each other. The story of their interrelation has both theoretical and historical dimensions.

The Index

A concrete structure is very like a photograph. While this affinity does not explain why the two media have been so much use to each other, the correspondences are too strong to be ignored and allow us to see certain things about concrete, if not also about photography, more clearly. First of all, both are – or in the case of photography were, though no longer – the result of a negative–positive process. Just as a photograph was a positive image printed from a previously exposed negative, so a work in concrete is a positive form cast from a previously constructed negative mould.

This double process is fundamental to concrete: as is sometimes said, with concrete you have to build twice, first the formwork, and then the concrete. The fabrication of the formwork determines the finished result. And if the concrete is to be left fair-faced, the pattern or finish of the formwork at the moment the concrete was poured is permanently 'fixed' on the surface of the concrete. While in photography the reversal of light and dark makes it clear which of the two images is the negative, in the case of concrete, it is more ambiguous. Is the mould the negative, and the cast object the positive, or vice versa? Both alternatives are possible, and while it is more common to see the finished work as the positive, because that is what is left once the formwork has been dismantled and disappeared, one can think of the process the other way round. An American architect, Ralph Everett Harris, interviewed in 1966, recommended treating the formwork as a positive element and to 'view the finished product as a negative resultant'.[1] Such a reversal encourages us to see a concrete structure as the trace of a now lost object. The implications of this have been more exploited in the world of sculpture than that of architecture. Bruce Nauman's *A Cast of the Space Under My Chair* (1965–8) and Rachel Whiteread's *House* (1993) both drew attention to what was no longer there. While these works made the absence positive, the reversal is always present in any work in concrete, though we usually pay little attention to what is missing.

Like a photograph, a concrete structure is indexical – it carries within it direct evidence of the moment of its making. The photographic negative receives light from the person, object or view to which it was exposed, giving it a direct and indissoluble link to the original subject: such is the basis of a photograph's claim to truthfulness. Likewise a work in concrete carries the direct imprint of the material within which it was cast. The walls of Rudolph Schindler's Kings Road House in Los Angeles were cast flat on the ground before being tilted into place; the internal sides of the walls retain the impression of the texture and creases in the roofing felt that was used as a bed on which to pour the concrete. While constructors often go to great lengths to hide this connection between mould and cast matter, either by giving the mould as neutral and undefined a surface as possible, or by removing the surface finish from the face of the concrete after it has been cast, erasing thereby all traces of the mould, the indexical property of concrete has often been exploited. The imprint of a scallop shell, the badge of the pilgrim, in the door at Ronchamp is cast from a real shell – the motif is not, therefore, a *representation* of a shell. At the New Art Gallery at Walsall (see chapter Ten), the walls of the top-floor room were cast in moulds made of vertically placed Douglas fir boards, and the lower two metres of the wall lined with Douglas fir boards of identical width: index and indexical mark are placed together. The indexical aspect of concrete means that, unless it is subsequently treated, it carries the record of its own making; and while this is also true to a lesser extent of other constructional processes, especially stone carving, the connection in concrete is especially direct and literal.

Time

The indexical nature of photographs produces the often remarked upon effect that they 'freeze time'. The immobilization of time, its arrest, the fact that a photograph is always of a moment that once was but which can never be repeated, was regarded by Roland Barthes as the *noeme* of the photograph, its essence – the 'that-has-been' he called it.[2] For photography this has generally been regarded as an asset, valued because it gives the photograph its authenticity: someone was there to take the photograph, to record the moment, so the moment really happened. For concrete, so much truthfulness can be more of a burden than an asset, for every blemish and imperfection in construction is recorded for posterity. Both photography and concrete work have found ways to remedy the veracity that results from the freezing of time: in photography, retouching improves or changes what was seen by the camera at the moment of the film's exposure. In concrete, there are techniques such as 'bagging', applying a fine film of cement to the surface, to hide blotchiness and discolouration.[3] In both pre-digital photography and in concrete work, purists deplored these cosmetic finishing techniques. Le Corbusier famously insisted that the imperfections in the concrete of the Marseilles Unité d'Habitation be left untouched:

> The defects shout out at one from all parts of the structure . . . Exposed concrete shows the least incident of the shuttering, the joints of the planks, the fibres and knots of the wood, *etc.* But these are magnificent to look at, they are interesting to observe, to those who have a little imagination they add a certain richness.[4]

The similarity between concrete as it sets and photographic film as it is exposed makes concrete different to other building materials, and puts it at a disadvantage when it comes to the representation of time. We can return here to what was said earlier about the unhistorical nature of concrete, and about its failure to age in the same gradual and progressive way as other materials. As we have already seen, concrete buildings are condemned either to permanent newness or to instant decrepitude, rendering concrete ineffective at showing time.

Concrete is, we could say, *untimely matter*; it never speaks in more than one tense, generally the present, sometimes the future, almost never the past. Yet for time to be present in any work of art, there must be an awareness of different temporalities. In the novel, characteristically this is achieved by the present time of the narration and the past time of the story being told. In a photograph (and here concrete is not so like photography) there is always a tension between a future anticipated within the image, and our knowledge that that anticipation is now past: Barthes referred to the way 'each photograph always contains this imperious sign of my future death'.[5] And in architecture, while traditional materials can be used to create some of these temporal disjunctions, with concrete it is more difficult. Concrete does not easily make us aware of time, for it rarely deals with more than one temporality.

Can concrete be made to overcome this disability? Over the last half-century there have been occasional attempts to remedy concrete's untimeliness, not always well received. One such, BBPR's Torre

Velasca in Milan, a skyscraper topped by a jettied-out medieval Lombard fortress, was condemned by the historian Manfredo Tafuri as ‘impure’, ‘contaminated’ and ‘dirty’ on account of the way it mixed past and present time (pp. 111, 112).[6] A similar mixing occurred in the various treatments of the concrete from which it was made. While parts of the building, the wall infill panels, were precast with a special ceramic compound and have still now an even, pristine finish, the reinforced concrete structural frame was finished with a trowelled render upon which the marks of the tool are still visible, traces of the moment of its finishing: we have both eternal newness, and the presence of the moment in the past when the artisan gave a final sweep of his float across the surface. If this is ‘dirty time’, a little does no harm, for it is what allows us to recognize temporality.

Another, more recent, experiment is the house and office at Stock Orchard Street in North London (1996–2000), designed by Sarah Wigglesworth Architects. The site adjoins the mainline railway, and to insulate the office building from the noise of trains it is protected by a wall of sandbags containing a sand, cement and lime mix that was wetted after they were laid and allowed to set hard. In the years since the building was completed, sunlight has rotted away the fabric of the bags and the wall has emerged as concrete; for a time the marks of the bags were left imprinted on the surface, but rain and atmospheric conditions are now breaking down the surface and it is being eroded. We can see the concrete of the wall as not simply the result of an instant, a frozen moment, but also as something that is made slowly, revealing itself as an unpredictable and long drawn-out process. The architects write about it, ‘Most walls are detailed to shrug off the effects of time, but this is a wall that has been designed to allow time to pass through it, and thereby to modify it; an evolutionary architecture’.[7] It is an attempt to overcome the photograph-like arrested moment that is the usual fate of concrete, and to extend concrete’s vocabulary beyond the single tense to which it is normally restricted.

The office stands on piers and is cushioned by springs against the vibration of passing trains. The piers are gabions, filled with recycled crushed concrete. We are made aware of concrete as something that is not necessarily always bound to the present, but as a historical material, which had a previous life, maybe in a now-demolished tower block. The structural system used here is new, for a domestic-scale building, but the material is old, it comes with a history. The gabions suggest a double time – a past once filled with optimism but now discredited, and a present in which that past is not buried, but given a place.

These and some of the experiments described earlier in the book are attempts to remedy concrete’s untimeliness and show that rather than remaining restricted to the present tense, like the clumsy attempts of the novice learning a foreign language, concrete could progress to a richer vocabulary that includes some past tenses.

Colour / Monochrome

Concrete has in common with black-and-white photography that it is monochrome. This is not to say that concrete is without colour, but that it generally only has one colour, it is not *polychrome* – a feature that has often caused concrete to be seen as dreary and depressing. While the monochrome nature of concrete lends it to black-and-white photography, for it does not draw attention to the lack of colour within a black-and-white photograph, is there anything more to this particular resemblance between the two media?

In photography, there has been a good deal of discussion about the aesthetic differences between monochrome and colour. For a long time after the general introduction of colour photography, there was a resistance to colour as less authentic. Barthes wrote of ‘the original truth of the black and white photograph’ and saw colour in photographs invariably as a cosmetic ‘coating’.[8] While this and similar prejudices may be accounted for by a generational difference between those who grew up in an age when there was only black-and-white photography, compared to a younger generation who have been used to colour from birth, black-and-white nevertheless has continued to hold a certain attraction, especially to those photographers preoccupied with some kind of truthfulness of representation, like Bernd and Hilla Becher, or Gabriele Basilico. The philosopher Vilém Flusser had some useful things to say about this. Like many other commentators, Flusser was concerned with the difference between the world as seen in photographs, 'the photographic universe', and the world as it is experienced in reality. 'Black-and-white', he writes, 'does not exist in the world "out there", which is a pity. If they existed, the world could be analysed logically.' Black and white exist only as concepts, so 'Gray is the colour of theory'. And he continues, 'Black/white photographs display this fact; they are images of theories . . . Black/white photographs are the magic of theoretical thinking, and they transform the linearity of theoretical discourse into a surface.' Colour photographs on the other hand lack this theoretical directness, because each colour, say green, as it appears in a photograph has to be interpreted in relation to our experience of that colour, of all greens that we might have known: this produces for Flusser the paradoxical result that, because of the complex series of coding processes needed to view it, a colour photograph is more 'abstract' than a black-and-white image.[9] If we follow Flusser's argument that black and white in photographs makes them more conceptual, could we say that the monochrome nature of concrete makes it a more 'conceptual' medium? Even without going so far, it would appear that the monochrome of concrete, when photographed in the black and white to which it lends itself so well, may lead to its being seen as a more 'theoretical' medium than materials whose effect derives from their varied coloration.

Site Photography

In the historical relationship between photography and reinforced concrete, a dramatic convergence of the two media occurred in the 1890s, at the point when both had reached a state of technical development that made both generally serviceable: the dry plate process meant that outdoor photography was possible without the need for a darkroom on the spot to develop the image immediately, while the patents of 1892 made reinforced concrete a reasonably reliable construction process. In reinforced concrete's success, photography played an important, and in some people's opinion, indispensable role.

Concrete suffers from what Cyrille Simonnet has perceptively called 'a deficit of iconicity'. Whether regarded as a process, by which a gloopy liquid turns rigid, or as a system, in which forces are transferred through the combination of steel armature with cement and aggregates, concrete is hard to visualize. While the process of concrete's setting can be explained chemically, and the transfer of forces analysed mathematically, neither leaves us with any satisfactory image of the material. No formulae or diagram was adequate to convey all that was distinctive about reinforced concrete. Whereas in steel structures the components were more or less a diagram of the forces, the compound nature of reinforced concrete meant there was no correspondence between the outward appearance of the structure and the internal distribution of the stresses: the necessary invisibility of the steel reinforcement made the medium peculiarly resistant to visual comprehension. On its own, concrete was incapable of overcoming its lack of iconicity, and for the early promoters of reinforced concrete, needing to explain their process to a sceptical industry or incredulous public, this was a serious drawback, putting concrete at a disadvantage when it came to competition with steel: it was to compensate for this deficit that photog raphy was brought into service. In the early 1890s concrete producers anxious to promote the new product started to take advantage of photography to make up for the difficulty of visualizing the medium. As the historian

Gwenaël Delhumeau writes, 'The rise in the 1890s of the principal systems of reinforced concrete construction was completely bound up with the employment of photography.'[10]

Especially at a time when many different systems of reinforced concrete were competing, each trying to discredit the other, the definition of what constituted reinforced concrete was far from distinct, and this fuzziness only added to the difficulty of establishing a visual identity for the medium. In France, which led the field in the use of photography to promote concrete, photographs of concrete structures began appearing in the mid-1890s in the trade journal *Le Ciment*, sponsored by a consortium of cement producers, but the firm that exploited photography most extensively was Hennebique. Hennebique had started using photographs for publicity purposes from the late 1880s, primarily of building catastrophes: pictures of burned-out factories showed what could have been avoided by using reinforced concrete. However, it was only after the Hennebique patents were taken out in 1892, and the new pattern of operations established, with licensed agents and concessionaries, that photography became a serious part of the business. Hennebique made it a condition that the concessionaries who built using the firm's system photograph the buildings and supply the Hennebique headquarters in Paris with prints. As a result, the Hennebique office assembled a vast archive of photographs – around 7,000 still survive – of reinforced concrete buildings both under construction and completed from all over the world. These photographs were used by Hennebique in the company's magazine *Le Béton Armé*, started in 1898, in exhibitions, and loaned for use in publications not associated with the firm. This remarkable corpus of photographs has made possible an exceptionally thorough study of the commercial exploitation of photography in an early twentieth-century enterprise, an aspect of business in which Hennebique was something of a leader.[11]

Hennebique's firm had an unusually modern business model, licensing the system to agents and concessionary contractors, who did the building. The Hennebique company itself had only two core activities. One was the *bureau d'études*, the engineering drawing office that turned the designs submitted by agents into detailed working drawings for execution in reinforced concrete; the other was the publicity department, which promoted the system through a variety of means. It was in the second aspect of the business that photographs were indispensable, and there is little doubt that without photography Hennebique would not have been able to achieve such a large share of the market, nor operate on a worldwide scale. In his company's employment of photography, Hennebique grasped particularly clearly the true nature of the photograph – that is to say that a photograph is not a simple reproduction of an existing reality, as was generally supposed, but itself created a new reality. It was this new reality that Hennebique exploited, for the photographs of Hennebique buildings emphasized the homogeneous, monolithic nature of reinforced concrete structures in a manner that was not necessarily always apparent from the completed works. Viewpoint and framing, and above all the choice of the stage of construction when the photograph was taken, were all carefully orchestrated to reveal to best advantage the 'concrete' nature of the work; as one of the concessionaries said, 'one must choose the moment when the work is in just the right condition, and when it will be interesting to our clients'.[12]

Hennebique's use of photographs can be compared with that of his transatlantic contemporary, Frank Gilbreth, whom we have already encountered as a pioneer of scientific management. Gilbreth, an obsessive organizer, developed a set of rules for the smooth running of his company, and especially for the conduct of sites, and these rules were codified and set down in manuals for his employees.[13] Gilbreth supplied his site managers with cameras and required them, not professional photographers, to photograph the progress of work, recording the site on the same day each week. Gilbreth's reasons for insisting upon photographs were rather different from Hennebique's, for, as a contractor, he was primarily concerned with keeping in touch with what was happening on sites that might be hundreds of miles away from the head office. Advertising, which was Hennebique's primary motive for photography, was at the bottom of Gilbreth's list of reasons for using it, though he clearly foresaw the publicity value that photographs taken by his site managers might have. In the very comprehensive rules on site photography, almost a basic manual of photography in themselves, Gilbreth stipulated that 'In all cases we want to have the men taken while they are at work and not standing up, posing for a picture' and 'If possible keep all bystanders out of the picture'.[14] Compared to Hennebique's sites, Gilbreth's are full of activity, with emphasis on the different processes and equipment involved in making concrete, formwork, steel-fixing, aggregate crushing, mixing, apparatus for moving liquid concrete and other materials around the site, and so on, little of which appears in Hennebique's pictures. The relative neglect of construction processes from the pictures in Hennebique's archive underlines the very particular purposes for which Hennebique employed photography.

In practice, Hennebique's authority over concessionary contractors was a lot less secure than he would have liked, and the company files are full of disputes between the Hennebique business and the concessionaries, who unsurprisingly liked to take the credit for the works they built. Hennebique's publicity machine, especially the photographs, was a means for Hennebique of establishing his title to the work, even though it had been executed by another enterprise. The photograph, which created an extra-contractual bond between Hennebique and his concessionaries, concealed the divisions between the two – and in this respect, like all photographs, as well as revealing some things, they also obscured others. The photographs were valuable for both parties. The concessionaries always wanted more publicity, and the publication of photographs provided that outside their immediate circle. For Hennebique the photographs were, as he himself put it, 'unimpeachable documents' that put the reality of the works beyond doubt, verifying that they had actually been executed and were not merely projected schemes.[15] But above all, the photographs compensated for concrete's deficit of iconicity, providing evidence of armatures of steel bars and stirrups, everything that was swallowed up in the finished work and permanently lost to view. Hennebique realized that a photograph does more than simply represent the object photographed, but also creates a new reality of its own – a 'photographic universe' within which reinforced concrete, and the Hennebique system in particular, were superior to all other constructional methods – not a message necessarily apparent from the actual contemplation of the completed structures themselves.

Moving Concrete into 'Culture'

Hennebique's reliance upon photographs declined after the First World War and the firm adopted other means of publicity. However, in the 1910s, and increasingly in the 1920s, the photographs taken by Hennebique and the owners of other proprietary systems for the purpose of promoting their systems started to turn up in an entirely different context: art magazines and books on the aesthetics of architecture. Pictures of partially built factories, electricity power stations, airship hangars, dockside buildings, wine-storage tanks and so on that had originally been taken to demonstrate the superiority of reinforced concrete over other structural methods began to appear in architectural publications. Photographs that had previously circulated solely within the commercial world made a sudden, and surprising, leap into the world of culture. So accustomed have we become to seeing pictures of engineering structures within books about modern architecture that it is hard now to appreciate the shock of this transposition; Le Corbusier's and Sigfried Giedion's polemical use of them has normalized the practice. Reproduced in art books and magazines, these photographs furnished a new argument, not that reinforced concrete is better than other structural techniques, but that naked engineering structures, in their direct expression of need and purpose, provided an alternative to the sterile and dead forms of architectural convention. In this argument it was not the examples of concrete used for high-end, architectural works (where it was generally hidden) that interested the critics, but low-end industrial ones, devoid of ornament and any finesse.

A good example of the transposition of the image of concrete from one realm to another was an article in 1919 entitled 'L'architecture et les matériaux nouveaux' by Marcel Magne, a professor at the École des Arts et Métiers, in the French magazine *Art et Décoration*.[16] In a journal normally devoted to reporting the decorative arts, painting and sculpture, the reproduction of twelve photographs of reinforced concrete bridges, factories, steelworks and dockside structures, some still under construction, was a surprise, to say the least. Magne's argument was equally radical, that architecture had failed to come up with forms appropriate to contemporary needs, and that the most fertile sources of new forms lay in these engineering works, built wholly out of concrete. The publication of images of industrial structures outside a purely commercial or technical context had been anticipated by Gropius's illustrations of American factories and grain elevators in the Deutscher Werkbund yearbook of 1913, but Magne's article was different for two reasons: first of all that he took local, European examples, not 'exotic' American ones, and secondly, he was proposing that these objects, as depicted, had parity with 'art'.

Although the story of the appropriation of industrial structures by modern architecture is now well known, we should not lose sight of the fact that it was through photographs that the transaction took place: it was the images of structures, not the structures themselves, that sustained the argument. While the images that were starting to circulate within this wholly new context had not been taken for anything other than purely commercial reasons, as 'documents', they now started to become subject to the often-remarked upon effect of the camera, to find beauty in whatever it is turned upon.[17] Two illustrated books by a German engineer, Werner Lindner, exemplify the power of the photographic image to make concrete structures shed their ordinariness and become aesthetic objects. The first book, produced with the architect Georg Steinmetz in 1923, *Die Ingenieurbauten in ihrer guten Gestaltung*, illustrated pictures of coal bunkers, hangars, various kinds of silos from the archives of German construction firms, and juxtaposed them with examples of historical architecture to draw attention to their formal similarities. Lindner's second book, *Bauten der Technik: ihre Form und Wirkung: Werkanlagen* (1927), reproduced more of the same kind of images of factories and industrial plants, but organized into a typological classification similar to that later carried out by the photographers Bernd and Hilla Becher (who acknowledged their debt to Lindner). In both Lindner's books, photographs that originated with engineers and contractors were used for an altogether different purpose, to develop a cultural theme. The same thing happened in many other books and magazines published in the 1920s, in the pages of Le Corbusier and Ozenfant's *L'Esprit Nouveau* and in Sigfried Giedion's *Bauen in Frankreich* of 1927. In another of the books originating from the architectural world, Julius Vischer and Ludwig Hilberseimer's *Beton als Gestalter* (1928), many of the same images of coal bunkers, cooling towers and warehouses as had appeared in Lindner's book of the previous year were reproduced, though this time with an explicit connection between their form and that of recent works of the New Architecture. In all these publications, the aesthetic properties of concrete structures, enhanced by the camera, now superseded the original commercial purpose of the same images.

Photography succeeded in turning reinforced concrete into a medium of culture where earlier attempts by the concrete entrepreneurs to achieve the same result by promoting 'architectural' works in the medium had largely failed. Hennebique had built a house for himself at Bourg-la-Reine outside Paris, meant to show off the architectural value of reinforced concrete, but this and other equally elaborate confections attracted no architectural recognition. Most 'architectural' works in reinforced concrete prior to 1920 were insufficiently different from those executed in any other material to persuade anyone that reinforced concrete had any cultural value. Photography changed that and, partly through its capacity to make beautiful whatever it depicted, helped reinforced concrete to become a central part of modern architecture.

It was photographs of industrial buildings in reinforced concrete that had featured in the books and art magazines, and as architects started to replicate the sharp geometrical outlines and blank surfaces of the works illustrated in those photographs, it was again photography that gave authority and credibility to their work. Born out of the photographic representations of industrial buildings, the new architecture relied upon the photographic image to draw attention to the qualities it had borrowed from those industrial structures. As the English critic Philip Morton Shand noted, 'without modern photography modern architecture could never have been "put across"'.[18] If any confirmation were needed of the convergence between the aesthetics of photography and of architecture in the 1920s, we need look no further than Le Corbusier's famous definition of architecture as 'the masterly, correct and magnificent play of masses brought together in light' – which might just as well be a definition of photography.[19]

Photogénie, the process by which photography makes ordinary things beautiful, operates by decontaminating the scene represented from all the contingency and excess of reality that renders it uninteresting or unobservable. Photographers who specialized in architectural photography, and especially photography of the new architecture, like Dell & Wainwright in Britain, or Barsotti in Italy, learned how to take pictures that would emphasize the architects' intentions. From this point on, photography's main service to concrete was to enhance its aesthetic properties. The work of Lucien Hervé is a good example of this process in action. Hervé was a Hungarian-born but French-domiciled photojournalist who, after photographing the Unité d'Habitation in Marseilles, became Le Corbusier's chosen photographer and photographed all his subsequent post-war work. Hervé adopted some of the techniques of the New Photography – emphasis upon details rather than the whole, angled compositions with strong diagonals, strong contrast – to bring out the surface qualities and texture of the concrete on Le Corbusier's buildings: the pictures concentrate vision, so that one sees more in the frame of the photograph than one would see by looking at the same section of the building in life. *Photogénie* has become the stock-in-trade of the photography of concrete, and while this book, like all that reproduce photographs of concrete, is implicated in its effects and no less able to escape them than any other, I hope at the same time to loosen the grip with which every photograph of concrete seizes the viewer, compelling them to see beauty in it. Concrete, for reasons that we will look at when we consider what concrete has done for photography, photographs well, and even a photographer of less than average ability has no difficulty in giving any piece of concrete a sumptuousness far in excess of that provided by its actual presence. 'Photography has shed a spurious glamour on concrete and glass', wrote the English critic Michael Rothenstein in 1945 – an opinion with which one can only agree.[20]

Concrete and Photography-as-Art

For the anonymous commercial photographers who took the pictures of the structures built with the Hennebique system, the practice of photography was not an art. Their products were, as Atget famously said about his own work, simply 'documents'.[21] In the early decades of the twentieth century there existed, apart from the world of the commercial photographer, a separate, parallel domain of photography whose business was picture-making and whose primary reference was to painting, even if the exponents aimed to make work that was distinct from painting. In the 1920s there was a reaction against 'pictorialism' in photography and, originating in Germany, a move to distance photography from painting. One of the exponents of the so-called 'New Photography', Albert Renger-Patzsch, made clear the aims as follows:

Photography has its *own* technique and its *own* means. Trying to use these means to achieve painterly effects brings the photographer into conflict with the truthfulness and unequivocalness of his medium, his material, his technique. And whatever similarity to works of pictorial art can be attained is, at best, purely superficial.

The secret of a good photograph, which can possess artistic qualities just as a work of visual art can, resides in its realism. For rendering our impressions of nature, of plants, animals, the works of architects and sculptors, and the creations of engineers, photography offers us a most reliable tool. We still don't sufficiently appreciate the opportunity to capture the magic of material things. The structure of wood, stone and metal can be shown with a perfection beyond the means of painting. As photographers, we can express the concepts of height and depth with wonderful precision, and in the analysis and rendering of the fastest motion, photography is the undisputed master.[22]

What Renger-Patzsch was in effect calling for was a realignment of photography away from painting, and towards the approach and subject matter of commercial and industrial photographers – the world to which the photographers of Hennebique's industrial structures belonged. Its capacity 'to capture the magic of material things' lay, as he wrote elsewhere, in photography's basic elements: 'all shades of light from the brightest to the deepest shadow, line, plane and space'.[23] If the subject matter best suited to photography came from the industrial world, what it excelled in representing was surfaces with the fullest possible tonal range. Renger-Patzsch mentioned stone and metal, though not concrete, although concrete served equally well as a medium through which photography could display to advantage its ability to capture every tonal gradation. The photographers of Hennebique's structures had already demonstrated this: the photograph of a coke bunker at Saint-Vaast taken in 1898–9 with many shades of light falling across its prismatic surfaces and its sharp outline provides a perfect exemplar for the very same properties of the photograph that Renger-Patzsch wanted to draw attention to – although Renger-Patzsch would have composed the photograph differently, avoiding signs of contingency, the piles of materials and the figure of the workman.

As a surface that enabled photography to exploit its own specific qualities, its ability to represent every tonal variation from total black to extreme white, concrete was second only to human skin: and it was no coincidence that at much the same time the female nude became a subject for artistic photography, rather than pornography. Edward Weston's female nudes, considerably less erotic, as Susan Sontag says, than his photographs of fruit and vegetables, were pure experiments in the rendering of the slightest tonal variations. Concrete and human flesh, two ideal surfaces to demonstrate the medium of photography. Occasionally the two converge, as in the juxtaposition of a photograph by Hervé of the sprayed concrete finish of Ronchamp with a quotation from Le Corbusier's earlier book *When the Cathedrals were White*, 'I believe in the skin of things, as in that of women.'[24]

Although exponents of the New Photography, when they photographed structures fixated particularly on metal construction – as in Germaine Krull's *Métal* (1927), or the innumerable photographs of the zoomorphic outline of the Marseilles transporter bridge – they did also photograph concrete buildings. Renger-Patzsch carried out many architectural commissions, photographing examples of the new architecture in concrete, and when Walter Benjamin attacked the New Photography for beautifying the banal, it was images of concrete that stuck in his mind; the camera, he wrote, 'is now incapable of photographing a tenement or a rubbish-heap without transfiguring it. Not to mention a river dam or an electric cable factory, in front of these photography can only say, "How beautiful".'[25]

Whatever critics thought of the results, the New Photography freed photography from pictorialism, and in this the subject matter provided by new concrete structures had been of service. The anonymous photographers of factories, coal bunkers and dockside buildings had shown the opportunities concrete presented to demonstrate that photography was primarily concerned with light, shade, tone, surface and line. Subsequent photographers were to exploit these qualities even more extensively: more than three-quarters of the surface of the image in Ansel Adams's photograph of the Hoover Dam consists of bare concrete. A generation later, a more calculated use of the material appeared with the work of the German photographers Bernd and Hilla Becher. When they began photographing industrial structures in the 1960s, they did so initially for archaeological reasons, to preserve a record of mines, blast furnaces and the like that were about to disappear. The Bechers' approach was consciously based upon the New Photography, Renger-Patzsch in particular, but was also influenced by the original anonymous industrial photographers' images that Bernd Becher said he found lying about in the deserted offices of abandoned plants: he started to collect these, and then: 'I made up my mind to photograph the objects as precisely today as they were photographed back then – that is without any interpretation.' In time, the Bechers' project became less archaeological and more related to art, as they started to concentrate on the arrangement of the photographs into 'typologies' in grids of nine, twelve or fifteen images, though as they say, their work for a long time had had a borderline existence 'on the edge of art'.[26] Some of the structures that they photographed, particularly water towers and cooling towers, were concrete and while they never chose the structures to photograph because they were concrete, concrete served their photographic purposes well. Photographing only in black and white, on very slow film with fine grain and broad tonal range at long exposures, they were able to record minute variations of tone across the surfaces of the objects. Taking photographs only under hazy sun or overcast skies, they avoided strong shadows, and their technique allowed them to capture the maximum range of greys from the objects.

The Bechers' photographs initially hovered 'on the edge of art', but the subsequent expansion of photography-as-art, brought about in large part by their former students, has now put their work and that of their followers unambiguously within the world of art. Among the features of the new photography-as-art are that the subject of the photograph ceases simply to be what it is *of*, the objects photographed, but becomes photography itself, its own processes, and its relationship to other image-making practices. At the same time, as with all fields of art, conditions of viewing, of the relation between viewer and image, become an issue. Concrete has had a small but not insignificant part to play in these developments, well illustrated in the work of the Canadian artist Jeff Wall. Concrete is present in a surprisingly large number of Wall's photographs, and it is worth considering what it does there. Unlike the conventional photographic use of concrete as a light-reflective surface, which is how it operates in all the images we have looked at so far, in many of Wall's pictures concrete is a light-*absorbing* substance. In *Concrete Ball*, shot in a Vancouver park, concrete is – literally – central to the image: the shaded lower part of the concrete ball in the middle of the photograph is the darkest spot in the picture, a dark hole into which everything recedes. This is the very opposite of the way most photographers have used concrete, and it is a feature of many of his other photographs. In the almost identical pair of photographs, *An Octopus* and *Some Beans*, a reworking of Walker Evans's images of farm interiors, with their flat space and equal intensity of light and of focus over the entire surface of the image, the centre of each picture is a blank patch of concrete wall, laid bare through the removal of an area of panelling, or perhaps of a mirror. This colourless rectangle is, in a sense, *the* picture, around which everything else in the image is a frame. The monochrome of the grey patch, possibly a reference to Evans's black-and-white pictures, is the emptiest, least light-reflective part of the image, and also its true subject matter.

In Wall's night pictures, this relationship between light-reflective and light-absorbing surfaces is reversed, and the concrete walls that are the background to both *Cyclist* and *Night* are the most luminous areas of both images. This reversal, where what should be dark becomes light, has some relation to Wall's preoccupation in his black-and-white pictures with the nature of photographic processes. Wall has written about his fascination with wet and dry processes in photography, and to quote from his essay 'Photography and Liquid Intelligence':

Water plays an essential part in the making of photographs, but it has to be controlled exactly . . . So, for me, water – symbolically – represents an archaism in photography, one that is admitted into the process, but is also excluded, contained or channelled by its hydraulics. This archaism of water, of liquid chemicals, connects photography to the past, to time, in an important way. By calling water an 'archaism' here I mean that it embodies a memory-trace of very ancient production-processes – of washing, bleaching, dissolving and so on, which are connected to the origin of 'techné' – like the separation of ores in primitive mining, for example. In this sense, the echo of water in photography – a speculative image in which the apparatus can be thought of as not yet having emerged from the mineral and vegetable worlds – can help us understand the 'dry' part of photography differently.[27]

The concrete wall at the back of *Cyclist* shows abundant traces of the wet, gloopy process of pouring concrete – a once-wet object that has become dry; as such, it is surely an analogue for the wet processes of developing negatives and prints, which until the onset of digital photography were essential stages in the photographic process.

At the same time, the concrete wall is a *surface*. As Wall has pointed out, 'What you are experiencing in photographs, in the moment of seeing the thing depicted in the photograph, is the invisibility of the surface.' If it is a feature of photographs that – unlike painting – they have no surface, or make the surface invisible, Wall confesses that he is fascinated by surfaces. Indeed he has said, 'That is almost the only thing I am interested in – things like the quality of surface, of the grain, of the physical formal aspects of depiction.'[28] In *Cyclist,* the face of the concrete wall *is* the photographic image, both as an analogue of the photographic process and as a representation of the very thing that is missing from photographs, a surface. A work in concrete is very like a photograph: in *Cyclist,* it becomes photography itself.

TEN

A CONCRETE

RENAISSANCE

IN WESTERN EUROPE and North America – though not in the less developed world – concrete went out of favour in the early 1970s. Its fall from grace, a result of its association with modernity and of having been the construction material of the post-war boom, did not come entirely without warning. There had been premonitions from intellectuals well before that concrete's cultural effects were less than wholly benign. The Belgian Situationist Constant complained in 1959 about new urban developments as 'cemeteries of reinforced concrete'; Cartier-Bresson's photographs of urban peripheries, and the French philosopher Henri Lefebvre's famous essay 'Notes on The New Town' of 1960 both criticized concrete construction for its failure to signify in any but the most elementary way; and Jean-Luc Godard's film, *Deux ou trois choses que je sais d'elle* (1966), set in the new concrete suburbs of Paris, lamented the loss of all irregularities, any residue of irrationality in these new buildings, which seemed to threaten the capacity of cities to act any longer as an expressive medium.[1] When it came, the reaction against concrete was sudden, and catastrophic for the industries and individuals concerned; no one wanted to see exposed concrete any longer, firms went out of business, and much of the very considerable expertise in working concrete that had been built up in the 1950s and '60s was lost for good.

Since the early 1990s, in those parts of the world where concrete had earlier gone out of favour, there has been a renaissance in the use of exposed concrete. Concrete became fashionable again, and it is worth considering whether this revival might be seen as a continuation of the way concrete had been used previously, or whether it represented a new departure. Curiously, this is not a question much talked about, and for answers we have to turn to the works themselves. What they can tell us sheds a little more light on concrete's part in culture, and above all makes clear that there is nothing fixed nor predestined about this relationship.

The Neutral

The immediate architectural reason for the re-emergence of concrete in the early 1990s was as a reaction to post-modernism, to the way that architectural post-modernism had concentrated so heavily upon image and symbolism and treated works of architecture as representational, making them always stand for something that lay beyond the building itself. The objection was that so much symbolism left the works themselves empty, and as an alternative certain architects started looking at ways of making buildings where the work stood for nothing but itself, where 'thingliness' counted. This new approach, of which perhaps the best account is in the Finnish architect Juhani Pallasmaa's book *The Eyes of the Skin* (1996), was also accompanied by a turn in critical and historical writing about architecture: Kenneth Frampton's *Studies in Tectonic Culture* (1995) put forward the argument, by reference to the work of a dozen well-known twentieth-century architects, that 'architecture' lay in the way that architects approached the material facts of building. In these discussions, material assumed a new importance: whereas in post-modernism it had been quite acceptable for one material to simulate another, and for rich claddings to conceal banal structures, suddenly the question of what a building was made of, and how it was put together, began to matter, and in this context concrete started to look interesting again.

Characteristic of the new approach are the remarks of the Swiss architect Peter Zumthor:

> Wooden floors like light membranes, heavy stone masses, soft textiles, polished granite, pliable leather, raw steel, polished mahogany, crystalline glass, soft asphalt warmed by the sun . . . the architect's materials, our materials. We know them all. And yet we do not know them. In order to design, to invent architecture, we must learn to handle them with awareness. This is research.[2]

Younger architects, particularly those trained in the late 1960s and 1970s at the Eidgenössische Technische Hochschule (ETH) in Zurich, where the ideas of the nineteenth-century architect and theorist Gottfried Semper were influential, started to experiment with concrete. Because it lent itself to so many different surface treatments while at the same time being a structural material, it seemed a particularly rich medium. Architects like Zumthor, Valerio Olgiati, Peter Märkli and Herzog & de Meuron exploited concrete's sensuous and tactile properties, and its capacity to suggest that buildings were 'real', the outcome of an actual process of construction, and not mere signs.

The revaluation of materials, and of concrete, has encouraged people, when they look back to the architecture of the 1950s and '60s, to see it in the same terms and to assume that the same interest in sensuality and substance was present in those buildings. Yet whether all mid-century architects regarded concrete in this way is doubtful, and while there are certainly exceptions, many, on the contrary, seem to have been entirely indifferent to the sensuousness of concrete, and to have, on the contrary, been attracted to it as a 'neutral' medium, one that receded from attention and lacked presence. This interpretation contradicts the more recent, materialist view. The *anaesthetic* of concrete deserves closer attention.

The Chapel of the Holy Cross at Turku Cemetery, Finland, was designed by Pekka Pitkänen in 1967. The construction is exposed concrete inside and out, with parts of the exterior clad in precast panels. The architect says that in the 1960s, in common with many other architects, he 'regarded concrete as a nearly everlasting material, which had to remain clearly in sight'. The grey concrete interior was deliberately colourless, though there used to be slightly more colour than there is now. The ceiling was originally sprayed with blue asbestos which, because of its toxicity, has since been removed; apart from the blue of the ceiling the only colours in the interior were the blue, leather-bound Finnish Bible and hymn books; recently, however, the Church of Finland has introduced a new hymn book, which is not blue, so this element of colour too has been lost. The intention was that the grey concrete would allow other colours, including those of the congregation, to stand out. What the architect has described as the clumsiness of concrete is offset by the presence of finely finished noble materials, like the stainless steel cross. Underlying the use of concrete in this building is the attitude that, in the architect's words, 'concrete is a material without any absolute value as such'; Pitkänen talks of fair-faced concrete as 'insignificant', as 'hardly anything'.[3] Somewhat ambiguously – and the architect's comments draw attention to this – the concrete both recedes, making a background against which other things stand out, but also entirely dominates the building: you can hardly fail to notice the concrete, the building *is* concrete. If the concrete was meant to be invisible, it is unmissable.

The group of new cultural buildings built between 1961 and 1968 by the London County Council on the South Bank in London, the Queen Elizabeth Hall, Purcell Room and Hayward Gallery, are well known for their concrete. The board-marked finish was cast in shutters in which the meticulously prepared boards had a ⅛-inch variation in thickness, and there is hardly any repetition in the shutter forms.[4] Yet all this attention to detail is strangely at odds with the only declared architectural intention of the scheme, which was to make the individual buildings disappear, so as to be able to see 'the city as a single building'.[5] Conceived more as a landscape, the continuous concrete surface was a way to lose sight altogether of the buildings as individual objects, and instead to allow them to merge into a generic urban infrastructure. Both sensuous and neutral, the concrete of the South Bank is part of the scheme's particular achievement, to be at once effacingly insignificant and monstrously significant.

Like the South Bank, Habitat 67 in Montreal is one of the celebrated projects of the 1960s. It grew out of Moshe Safdie's student thesis project, a constructional system that became the basis for the ziggurat of 22 storeys of stacked apartments, though it was scaled down to twelve in the final scheme. Safdie was attached to the system, but indifferent about the material from which it was to be built. As he wrote afterwards, 'I had never decided what the material should be. It was just a cellular, three-dimensional modular housing system.'[6] The model presenting the scheme was imprecise about the structural details or the finish: what mattered was the concept and the form. Its being of concrete, though now its most insistent feature was, in a sense, of no importance at all.

In all these examples, we see architects preoccupied with the problem of how to make matter disappear so that other qualities would emerge – quite the opposite to the privileging of concrete's sensuous and tactile properties in the recent revival of concrete. For many mid-twentieth century architects, the quality of architecture lay not in the thing, but in the idea. The Italian architect Gio Ponti, for example, writing in 1957, explained, 'Architecture, after all, exists entirely in the design or in the model, being resolved before it is transferred to this or that material'.

> Architecture, a plastic and abstract fact, is colorless, or if you prefer, has no color. We can conceive of it in terms of color (or colors) and material (or materials), but if we want to consider it or judge it purely as architecture, in its architectural essence, in its architectural validity, we must consider it colorless.[7]

As a medium, concrete was thought to come closest to replicating the balsa or card of the models that many of the mid-century schemes began life as, with the expectation that it would prolong into the finished building the indistinctness of the model. The American architect Peter Eisenman, in his Houses I and II of 1967 and 1969, was quite explicit that it was this non-specific effect that he was after. 'Cardboard', wrote Eisenman, 'is used to question the nature of our perception of reality' and 'raises the question . . . is this a building or is it a model?'[8] But Eisenman did not build his houses out of exposed concrete: far from simulating cardboard, he knew that attempts to make concrete behave as if it were a colourless, recessive, non-substance invariably turned out to have the opposite result.

Architects of the 1960s and '70s who used concrete to escape from, or to transcend, matter did so under the supposition that concrete had become normalized as the medium of modernity: its ubiquitous presence for every kind of 'modern' purpose meant that when used for prestige projects it would not draw attention to itself and would simply merge into a universe of concrete modernity. Their choice betrays some parallels with writers' attempts to escape from the 'literary' and achieve a truly modern way of writing that was free from style. In his book *Writing Degree Zero* of 1953, the French critic Roland Barthes suggested that the solution to 'literature' was 'to create a colourless writing, freed from all bondage to a pre-ordained state of language'. Referring to the recent work of Camus and Robbe-Grillet, Barthes wrote:

> The new neutral writing takes its place in the midst of all those ejaculations and judgements [that make up conventional literary style], without becoming involved in any of them; it consists precisely in their absence . . . The aim here is to go beyond Literature by entrusting one's fate to a sort of basic speech, equally far from living languages and from literary language proper. This transparent form of speech . . . achieves a style of absence which is almost an ideal absence of style.[9]

Just as Barthes saw in writers like Camus an absence of style, within which the 'characters of language are abolished in favour of a neutral and inert state of form', so we might see some of the architects of the 1950s and '60s as having aspired towards a similarly neutral 'architecture degree zero'. Exposed concrete seems to have played a particularly important part in the pursuit of an absence of style – partly because of its approximation to the surfaces of models, partly because of the opportunity concrete gave to erase evidence of craft and workmanship from the face of the building – those details and traces of work that conventionally bestowed meaning in architecture. If this is what the architects who specified concrete hoped for, they were doomed to failure, for concrete has been one of the most meaning-attracting substances there is: meanings stick to it like flies to flypaper. Its very 'neutrality' makes it an Aladdin's cave of signification.

In a later series of lectures given in 1978 and recently published as *The Neutral*, Barthes went further in exploring the possibilities of 'the neutral' as an alternative critical category. The parallels with architecture are instructive. Barthes described the neutral as 'that which outwits the paradigm' – the 'paradigm' being the normal process for the production of meaning, in which one term, by its opposition to another, generates a meaning: 'light' means what it does through its opposition to 'heavy', 'weak' by the presence of 'strong'. Every concept exists through its opposition to another. Barthes' desire was to escape from the tyranny of this process – and indeed to escape altogether from signification and meaning. Barthes, the semiotician, dedicated to the discovery of meaning – and these are his own words – 'dreams of a world which would be *exempt from meaning* (as one is from military service)'.[10]

In *The Neutral*, Barthes identified 'figures' that escape the normal processes of signification and meaning and through which the neutral might, as he puts it, 'twinkle'. Most of these are related to literature, but some, like colour, apply to other fields. Barthes talks about colour in relation to fashion, where the primary signifying system is not one colour or another, but whether garments are specified as having a colour, or whether they are 'unmarked', that is to say 'colourless'. It is this state of the unmarked, the indistinct, that appeals to Barthes. The neutral, as Barthes says, 'implies a thought of the indistinct'.[11]

This is not so very far from those mid-century schemes, replicating the 'unmarked' qualities of the model in an attempt to prolong indistinctness. And if Barthes dreamed of approaching a world exempt from meaning through the neutral, then might not architects' efforts to make matter lose its substance have been a strategy to immunize architecture against meaning? As Peter Eisenman said of his House II (1969), the house 'aims . . . to be neutral with respect to its existing social meanings'.[12]

By no means all architects shared in the mid-century pursuit of the unmarked and the neutral, nor were interested in using concrete in this way. Among the exceptions was Paul Rudolph, whose distinctly sensuous use of concrete, much commented on at the time, was much closer to that of the architects of the post-1990 revival of concrete. Significantly, Rudolph avoided models in developing his designs because, he wrote, 'the model cannot readily indicate details or materials' and preferred his own style of highly worked pen-and-ink renderings that he thought better conveyed the substance of the building.[13]

In stratagems of the 'neutral' and the 'unmarked', concrete is no longer available as a medium. At least in the West, as long as concrete remains bound to modernity, with all the tensions that carries in its train, concrete cannot easily revert to invisibility. In the more successful instances of its recent use, it is given a presence, one that is fully knowing about, and engages with, ambivalence towards modernization.

Heroic, or Pliable

Mid-century architects and engineers often seemed to want their works to prove something about concrete, to show that concrete could do things that other materials could not. Today, as an architectural medium, concrete has ceased to be *heroic*: most recent works prove nothing about the medium. For most of the twentieth century, buildings made out of concrete celebrated the material's exceptional rigidity. When employed in post and beam type structures, concrete lent itself to the creation of unnaturally long spans, or of dangerously extended cantilevers, and it was a point of honour for a building to make the most of these: Frank Lloyd Wright's Falling Water (1935–48), or Lina Bo Bardi's Museu de Arte Moderna de São Paulo (1957– 68) with its astonishing span carried on only four supports. Used in curved forms, in vaults, like Kahn's Kimbell Art Museum at Fort Worth (1967–72), or in parabolic shells, like Reyna and Candela's Cosmic Ray Pavilion of 1952 in Mexico City or the Palais du CNIT (Centre National des Industries et des Techniques) of 1956–8 at La Défense, Paris, what was emphasized was the stiffness of the material, its *shell*-like nature. Boasts abounded of the thinness of the concrete, of the breadth of the space uninterrupted by supports and of the shallowness of the curvature of domes. Concrete was understood as an *exact* material, which resulted in precise structures. Every work appeared as an optimum solution, a determinate structural outcome, arrived at by mathematical calculation. It has to be said that this was always a front, as the experts themselves confessed. Even the leading engineers, Nervi, Maillart and Torroja, admitted that intuition counted for more than rational calculation; the French engineer Eugène Freyssinet recalled late in his life, 'When intuition contradicted the results of a calculation, I would have the calculation redone, and at the end of the day, it was always the calculation that was wrong.' As Cyrille Simonnet comments, 'There is for certain an arbitrariness in the most rigorous calculations for structures and rigid surfaces'.[14] Nonetheless, there was an expectation behind much concrete work of the middle decades of the century that the material was being pushed to its technical limits. That expectation has gone. Compared to the earlier taut and exact use of concrete, in some recent buildings we see the inverse, it becomes soft and flaccid, even if it is no less exacting a medium. Take for example Álvaro Siza's Portuguese Pavilion at the Lisbon Expo '98: the concrete roof covering the central space is a sagging canopy, hanging limply between the two side walls. This is not a roof that gives the impression of the *hardness* of the material, on the contrary there seems every reason to expect it to droop further under the weight of rainwater. There is no reason why the roof should be exactly this shape: it could sag a little more, or be a little tauter. Or to take another example, at Zaha Hadid's recent extension to the Ordrupgaard Museum in Copenhagen (completed 2005), where the roof and walls appear to be a monolithic slab of curving concrete, the structure is in fact a 33-cm-thick skin of concrete on the inside, above which there is a void, and then another outer skin of 15 cm of concrete. There is no particular need for the outer skin to be made of concrete – the choice of material is arbitrary and makes no difference to the structure, only to the appearance. Whereas in the last century, the expectations were that when concrete was used it should be used to its technical limits, and with no redundancy in the material, this no longer seems to matter. Concrete suffers no ignominy now in being faint-hearted.

It is much more rare than it was to see concrete being used to demonstrate technical innovation. Although innovations are still being made in the design of concrete structures, there seems less need to put them on show. Compared to the 1960s, much concrete today is relatively unadventurous in structural terms, even if inventive in other ways. Whereas in the late 1950s and early 1960s, architects and engineers wanted every work in concrete to be a structural experiment, now structural innovations are much more commonly found in lightweight materials, or innovative cladding systems. The role of concrete is more commonly to supply effects of density and mass than to prove how 'advanced' architecture is.

Outside and Inside

Exposed concrete is now more often found inside than outside buildings. Whereas in the 1950s and '60s exposed concrete was commonly used inside and out, it is now less usual to find it used as an exterior finish. In more northerly climates, this has been partly on account of recognition of the weathering problems of concrete, and of the hostility towards concrete that this is said to have created. A number of architects have felt that it was unwise to use concrete externally, even if the technical problems of staining and disfigurement could be successfully controlled, because of the low opinion of the public towards older exposed concrete buildings. When it has been used as an external finish, for example in Peter Märkli's La Congiunta, or Herzog & de Meuron's Rudin House at Leymen (1996–7), it has been precisely because it *would* stain and discolour. However, this is a high-risk strategy for all but the smallest commissions. More characteristic though of the recent use of concrete are buildings where the exposed concrete is exclusively on the interior, such as the Kunsthaus (1994–7) at Bregenz, Austria, by Peter Zumthor, clad in translucent glass on the outside, but inside the walls and floors are fair-faced concrete: soft outside, hard inside, an inversion of the 1960s norm. As well as avoiding the problems of staining and vegetable growths that were characteristic of 1960s buildings, internally exposed concrete acts as a thermal mass that, as described in chapter Two, reduces energy consumption bycooling the building in summer and retaining warmth in winter. Although not itself an aesthetic justification for exposing concrete internally, thermal mass has become an important reason for the choice of concrete as an internal finish.

Compared to the all-or-nothing attitude towards the use of concrete that was characteristic of the 1950s and '60s, now it is common to find the concrete only partially exposed and occupying a more subtle and ambiguous role in the total ensemble – not something that would have been countenanced before. At the New Art Gallery Walsall (1995–2000), designed by Caruso St John, a building that exemplifies many of the changes in approach towards the use of concrete since the early 1990s, concrete is part-hidden, part-exposed.[15] The concrete structure on the outside is entirely clad with large terracotta tiles or stainless steel sheeting, but on the interior the concrete is exposed above dado level and below is covered by narrow Douglas fir boards, of exactly the same width (and material) as was used for the formwork of the shuttering. The result leaves a doubt as to whether what one sees on the interior is a lining that has been attached to the interior of the building, or whether it is the timber that is the true surface of the interior – a fictive formwork left in place, but cut away in places to reveal the concrete that lies behind. Great care was taken with the detailing of the timber lining around doorways and windows so that it would not look like wallpaper trimmed to fit the building, but rather appear as a crafted structure in its own right, equal in importance to the concrete behind; the fact that the boards of the dado do not align with the board marks on the concrete mattered far less to the architects than the need to give the impression that the entire timber interior had a structural integrity of its own. The concrete that one sees on the interior walls of the building is presented entirely as a surface: the absence of reveals that might allow one to see the depth of the concrete, and the vertical placing of the shuttering instead of the more usual horizontal arrangement, mean that the concrete never appears solid or massive, but purely as surface. This is quite different from the concrete of the 1950s and '60s where depth, and in consequence weight, is always apparent.

Only in the soffits of the ground floor and the upper-level galleries does one see concrete in relief. Deep beams, and many of them, lie close together, as if they were timber. Following the dictum of Louis Kahn that 'the soffit makes the room', the beams were scaled not by structural requirements but according to the size of the rooms beneath, as the architects had observed in a building that they very much liked, the Palace of the Popes in Avignon. The engineers were horrified by the disregard for constructional consistency and the redundancy of material present in this arrangement.

With the surface appearance of the concrete, the architects were keen to avoid the 'mechanical' effect of concrete that has been cast in steel formwork, where the regularly spaced holes left by the tie rods give walls the appearance of being made up of panels fixed to them; and they were critical of 1960s buildings like Denys Lasdun's National Theatre in London, where concrete was used inside and out, which they saw as too 'macho', an inappropriately muscular demonstration of strength. Instead, the surface effect they wanted was that of Rachel Whiteread's sculptures, where slight traces of the mould materials left on the otherwise smooth surfaces add to the mystery of the works. At Walsall, the minimum of finishing was done to the concrete after the shuttering was struck so as to allow salts to appear on the surface. In areas where the quality of the concrete was simply not good enough, the timber lining was extended to cover it.

In the interior of the New Art Gallery Walsall there is a constant uncertainty as to whether timber is more important than concrete, or vice versa. Such calculated hesitancy and indecision would not have been considered acceptable in the 1950s and ’60s, but no longer seems troubling.

It may seem perverse, or eccentric, to end a book about concrete not with a catalogue of recent great engineering achievements, but with some relatively minor buildings in out-of-the-way places. Yet this provides an opportunity to make a final comment on architects and their relationship to concrete, a subject that has figured so large in this book. Only a fraction of the world’s concrete is touched by architects, but their impact on the medium has been disproportionate to the very slight control that they have over the totality of what is built the world over. As the cosmeticians of concrete, those who give it a face, architects are responsible for mediating concrete to us, for causing it to be seen in one way rather than another: it is architects, more than any other trade or occupation who are most involved in bringing out our longings and loathings through the material, in giving expression to all the things that we either believe, or refuse to believe about concrete and the world within which it is used. In their role as the scenery-makers of everyday life, architects have shown us how to accommodate this synthetic, compound substance into the everyday landscape, how it could be accommodated into our thought processes, and how it might allow us to see things about who and what we are.

In reinforced concrete’s first century its versatility as a structural medium has been used to make all sorts of things, while its pliability as a cultural medium has allowed it to serve many purposes, some of them entirely at odds with one another. What has been described in this book is not the end of the story, for one thing of which we can be certain is that as culture changes, so will concrete. The apparently inexorable rise in cement production, the shift in the balance of economic power from West to East, the solutions that emerge – or do not emerge – to restrict carbon emissions, will all cause concrete’s role in global culture to change. But the instability of the relation between concrete and culture will remain.

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INTRODUCTION

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ONE MUD AND MODERNITY

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6 This interpretation is emphasized by Cyrille Simonnet, *Le Béton, histoire d'un matériau* (Marseilles, 2005), especially in chs 2 and 3. The following discussion is largely based on Simmonet.

7 Ibid., p. 22.

8 Ibid., pp. 62–3; Gwenaël Delhumeau, *L'Invention du béton armé: Hennebique, 1890–1914* (Paris, 1999), p. 65; Saint, *Architect and Engineer*, p. 217.

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12 Collins, *Concrete*, pp. 60–61.

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14 The activities and relationship to the firm of Hennebique's British agent, L. G. Mouchel, is described by Patricia Cusack, 'Agents of Change: Hennebique, Mouchel and Ferroconcrete in Britain, 1897–1908', *Construction History*, III (1987), pp. 61–74.

15 Collins, *Concrete*, pp. 65–7; Gwenaël Delhumeau, Jacques Gubler, Réjean Legault and Cyrille Simonnet, *Le Béton en représentation*: *la mémoire photographique de l'entreprise Hennebique, 1890–1930* (Paris, 1993), p. 10; Delhumeau, *L'Invention du béton armé*, p. 22.
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17 The word Magne used was *appareil*, untranslatable into English, for as well as the literal meaning of 'apparel' or 'raiment', it also means 'apparatus'; in the context of building, it refers to the manner in which stones are laid, or the 'bond', as well as in a more general sense the finishing process for any product, such as a fabric; and in a general sense, 'appearance'. See Réjean Legault, '*L'Appareil de l'architecture moderne*: New Materials and Architectural Modernity in France, 1889–1934', PhD thesis, MIT (1997), pp. 213–14; and R. Legault, 'L'Appareil de l'architecture moderne', *Cahiers de la Recherche Architecturale*, XXIV (1992), p. 62.
18 Walter Benjamin, *The Arcades Project*, trans. H. Eiland and K. McLughlin (Cambridge, MA, 2002), pp. 4, 9, 16. See also the comments of Theodor Adorno, *Aesthetics and Politics* (London, 1979), p. 118.
19 Charles Rabut, *Cours de béton armé* [1910], quoted in Legault, '*L'Appareil de l'architecture moderne*: New Materials and Architectural Modernity in France, 1889–1934', p. 110.
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23 Ulrich Conrads, *Programmes and Manifestos on 20th Century Architecture* (London, 1970), pp. 36–8.
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TWO NATURAL OR UNNATURAL

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THREE A MEDIUM WITHOUT A HISTORY

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FOUR THE GEOPOLITICS OF CONCRETE

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FIVE POLITICS

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