

Book Reviews

Fair and Reasonable. Building Contracts Since 1550. A Synopsis

JAMES NISBET, 1993

London, Stoke Publications

115pp. £7.00

ISBN 0 9514725 1 8

A Proper Price. Quantity Surveying in London 1650 to 1940

JAMES NISBET, 1997

London, Stoke Publications

192pp. 13 illust. £16.00

ISBN 0 9514725 2 6

These two books contribute to good effect to the history of construction over a long period. Their subjects complement each other substantially since contracting and measuring have developed in close association. The books also share a distinctive quality of understanding which reflects the combination of Dr. Nisbet's scholarly interest in the industry and its professions with his experience over many years as a quantity surveyor. He moved through private practice to senior positions in the Ministry of Education and the War Office Works Organisation. He was also well placed to view quantity surveying and the industry widely through his active participation in the Quantity Surveyors Division of the Royal Institution of Chartered Surveyors and the Commonwealth Association of Surveying and Land Economy.

Fair and Reasonable, the earlier work, illustrates the historian's debt to contract documents as a means of tracing the changing circumstances and organisation of construction. Without them we should know much less. It is however worth keeping in mind that neither in the past nor today are all building activities based on contracts between independent building owners and contractors: speculative building and self-build are organised differently. Contracts arise where there is a commercial aspect to society together with the specialisation of free labour in crafts and enterprise. In Britain they can be traced at least since the later medieval period as Dr. Nisbet shows with comments which deepen the insight such documents offer. It is important to remember, however, that such documents give only a momentary view of a relationship, the outcome of which cannot be positively established without other evidence. Was the building completed on the terms stated? Was there harmony or conflict between the parties? If a particular organisation of work was indicated was it followed? More evidence is desirable but so often not to be had for any one contract. We can however say that a mode of contracting which was applied on a number of occasions must have had a fair degree of success or it would not have survived. The various forms of contract therefore provide reflections of the changing organisation of the industry which can be combined with a variety of other sources to give credible views of its history. Dr. Nisbet's *Synopsis* does this nicely.

For contracting to be successful the cost of work must usually satisfy both parties. *A Proper Price* shows how measuring and costing developed in concert with the evolution of contracting from the seventeenth century to 1940. At the same time the measurers,

originally with a status no higher than that of a craftsman, eventually achieved professional organisation and recognition as quantity surveyors - but not before 1963 so far as the Royal Institute of British Architects was concerned. The change of name expressed not simply professional aspiration but the underlying reality of the elaboration and intellectual deepening of measuring, estimating and costing that was essential to the efficient procurement of buildings by the more complex contract arrangements which emerged in the nineteenth century.

Those arrangements can be subsumed under the term '*general contracting*'. Originating round about 1800, an interacting set of changes brought about the rise of firms of builders who cut loose from the craft basis of the direct employment of men in particular trades and set up permanent establishments which employed men in all or most of the trades as well as labourers. They sought thereby to be better able to tender for whole buildings, not simply particular craft-related parts, for a fixed cost and completion date. Thomas Cubitt was acknowledged in his time, from the 1820s, to be the prime exemplar of this system. (I cannot find reference to this in *A Proper Price*). Part of the stimulus to take the risks of a more capital intensive, complex organisation came from the increasing interest of building owners, both public and private, in the advantages of this form of contract with its promise for them, of greater simplicity and certainty. Dr. Nisbet is particularly interesting on this subject which he rightly describes as '*the greatest change to British contract procedure*' (p38).

The new system spread gradually but by the later nineteenth century it seems to have been the usual practice across much of England, especially the London area. However it was not adopted in parts of northern England or in Scotland until well into the present century. This contrast has not, I believe, been fully explained. It connects, I suggest, with the complexity of the causation of the change.

There is no space here for an extended discussion of possible causes of the general lump sum contract. Dr. Nisbet notes a number of ideas such as the growth of large-scale contractors employing all trades and the advantage of dealing with one man (citing an article by Professor Port) and an increase in demand for buildings (referring to an article by me). In his view, '*A more persuasive explanation is an insistence on obtaining an assurance of the final cost and of a date for completion*' (p40). This insistence arose, he says, from the uncertainty of measure and value, the increase of public building and, as a result, the need for better accounting for expenditure. While I do not believe that adequate explanation can be derived by concentration on one cause there must be an important place for the evidence of emergence of insistence on greater certainty. In the later part of the article to which Dr. Nisbet refers it will be found that I outline a view that is, I believe, very much the same as his. (No dates are given for the two articles, both in the *Economic History Review*, which are cited on p.40. That by Port appeared in 1967 and mine in 1955). Whatever view may be taken of the causes of the change Dr. Nisbet writes about its progress with the authority of professional insight. The capacity of the new system was soon challenged by the huge task of rebuilding the Houses of Parliament. Dr. Nisbet devotes a chapter to this, which shows how such a complicated project was still for the most part beyond what lump sum contracts could cope with.

Lump sum general contracts carried disadvantages for architects, as Dr. Nisbet explains. They brought with them a barrier between the designer and the craftsman in the form of the contractor which was not welcome. Even more stressful, perhaps, they required the architect, before any work on the ground was done, to provide sufficiently detailed plans and drawings for tenderers to make credible estimates of the final cost. Dr. Nisbet traces the

struggle to allocate responsibilities in a situation where mistakes could put large losses onto architects and contractors rather than the building owners as under the old system. This was the world in which quantity surveying was born. Its practitioners were on the whole not welcome in the eyes of the architects, certainly not professional equals, which is one of the themes Dr. Nisbet follows into the present century.

E W COONEY

James Green. Canal Builder and County Surveyor (1781-1849)

BRIAN GEORGE, 1997

Tiverton, Devon, Devon Books

189pp. 73 illust. £12.95

ISBN 0 86114 914 9

James Green, the subject of this biography, was an important civil engineer in Southwest England and South Wales for more than three decades of the early nineteenth century. He received his early training from his father, a civil engineer of Birmingham, and then spent six years as an assistant to John Rennie. In 1807 at the age of twenty-six he settled in Exeter to begin a long and fruitful career there. In 1808 he obtained the appointment of County Bridge Surveyor for Devon, the first person to hold that post in the county. In the course of the next thirty three years he rebuilt more than one hundred bridges for the County and for local turnpike trusts, a figure exceeded only by such national figures as Thomas Telford.

Green's work was by no means confined to the design or construction of bridges. He took over responsibility for the County buildings, shortening his title to County Surveyor, and undertook several architectural commissions for private clients. He successfully completed several schemes of land reclamation and land drainage and developed new routes up to fifteen miles long for turnpike roads, matched by only a few schemes elsewhere. The other main strand in his career, however, was canal building. He had built a sea lock in Essex during his time with Rennie and within four years of his arrival in Devon he was involved with the abortive Crediton Canal. In the early 1820s he built the Bude Canal for tub boats, the hilly country requiring six substantial inclined planes. Later in the decade he extended and upgraded the Exeter Canal, which gave that city a fine access for the ships of the day and may be regarded as Green's finest achievement. Other canal projects about the same time failed to materialise, for the Canal Age was over, but Green completed the Grand Western Canal in the 1830s and had the distinction of engineering the last main line canal in England, the Chard, at the end of the decade. On these two schemes he encountered severe technical problems with the canal lifts he had designed. A dock wall at Burry Port in South Wales collapsed and the County magistrates in Devon were increasingly concerned about the absence of their Surveyor. His removal from several of his appointments was followed by his bankruptcy; though he managed to complete the fine dock at Newport. He moved to London, where his West Country rival James Rendel had preceded him, but a new generation of railway engineers had established themselves and Green undertook no more major projects.

Brian George's book is based on many years' research into original records, as well as first hand knowledge of the fine legacy of bridges which remain to this day in Devon. The result is an exhaustive review of the many and varied works for which Green was responsible, arranged topic by topic within decades. The book has useful appendices giving leading facts about the Devon bridges and the indexes are adequate, though not quite

comprehensive. The many illustrations are biased a little too heavily perhaps towards bridges, though there are some interesting diagrams too.

There are precious few biographies of the second rank civil engineers who worked alongside Smeaton, Jessop, Telford and Rennie, to provide a more rounded view of the profession at that interesting period in its development. Equally, the literature devoted to county surveyors, since the pioneering chapters in the Webbs' *Story of the King's Highway* eighty years ago, has been very sparse, an exception being the biography of James Johnson in Essex. The standard works of Thomas Telford, who held this post in Shropshire for many years and whose first major appointment it was, treat the subject most inadequately. Researchers will be aware of the difficulties of fleshing out the dry bones of the Quarter Session minutes and the like. The emphasis in this book is on the record of Green's career, though the author writes with affection for his subject. The failings which led to the problems at the end of Green's life are dealt with fairly, without detracting from his substantial body of achievement. Brian George is to be congratulated on producing a pioneering work, which it may be hoped will stimulate others. It ought to find a place on the bookshelves of anyone interested in construction history.

PETER CROSS-RUDKIN

The Thames Embankment, Environment, Technology and Society in Victorian London

DALE H. PORTER, 1998

Akron, Ohio, University of Akron Press

318pp. illust. \$49.95 (hardback), \$24.95 (paperback)

ISBN 1 884836 28 3

Victorian engineers and their works have been fairly well-served by historians from Samuel Smiles onwards. The epic qualities of their works and, sometimes, careers having an obvious appeal. However, some engineering works lend themselves to narrative treatment more readily than others. Professor Dale Porter has rightly identified the Thames Embankment as an important but hitherto unstudied work, which sheds light on several aspects of Mid-Victorian society. His book aims to use the construction of the Embankment, and more particularly the twenty years or more of negotiations which preceded it, as a way into the planning politics of the age.

A study of the Embankment has to be more about planning and planning politics than about engineering *per se*, for, as Professor Porter points out, this is where its real interest lies; its construction was not technically innovative, relying for the most part on methods developed in dock, harbour and canal works half a century before. The larger part of the book is thus concerned with the social and political aspects of the subject. However, the book is marred by a lack of historical perspective. The Thames and the tidal Pool of London are the origin of the city; the existence of a low island rising out of the southern mudflats probably led to the positioning of the first London Bridge, and thus the position of Londinium itself, while the topography of the two banks, dry and hilly to the north, low and marshy to the south, has conditioned the relative status of London and Southwark from the first. Thus, the south bank in particular has a two thousand year history of gradual reclamation and embankment. None of this background is present. Professor Porter gives a

patchy chronology of relevant dates at the back of the book, but he seems unaware that the first embankments were Roman and that there is rich archaeological evidence for the Roman port. Indeed, at one point he states that the first embankment projects were medieval.

The complex economy of the city and the river before the Victorian Embankment, the world of wharfingers, lightermen and ferrymen, of industry and warehouses clustering by the Pool of London, is considered, but only very briefly, and the book would have benefitted from a more detailed treatment of all this, the world that was lost or pushed downstream by embanking, the world conjured up in *Our Mutual Friend*.

On mid-century planning politics Professor Porter is on surer ground, describing how the shift of large-scale wharf and dock facilities downriver, and the development of suburban railways, were undermining the importance of the cramped wharves upriver from London Bridge. There is much interesting material here on the history of proposals for embankment, notably failed or half-completed initiatives by both the Office of Works and the City Corporation. Professor Porter is also good on London's sanitary history, giving a lively account of the progressive worsening of the situation, culminating in the '*Great Stink*' of 1858, which brought the problem to the attention of Parliament in the most direct and unavoidable way. Here again, there is a certain lack of perspective; the debate over pollution of the Thames had been in progress for rather longer than this account suggests; the scandals of the grossly polluted water-supply provided by the private companies, in particular the Grand Junction, Lambeth and Southwark companies, are barely touched on.

Reading *The Thames Embankment*, one does get a strong sense of the pragmatic, even haphazard way in which the project grew out of several different factors. On the one hand, there was a history of embanking proposals, mostly for the smarter north bank and primarily for urban and architectural reasons. Then again, there was the issue of navigation and silting, and changes in the river pattern caused by the rebuilding of London bridge. There was the health risk presented by the filthy river, and there was the need to complete the Main Drainage, the heroic sewerage system designed and planned by the new Metropolitan Board of Works under Joseph Bazalgette. The Main Drainage emerges as the catalyst which made the thing happen. A route was required for the low-level sewer; Bazalgette prepared four options for constructing the low-level sewer, but attached a firm recommendation that it should be built within a new embankment, and a Royal Commission accepted the recommendation. A solution was found to the funding question, in the face of Gladstone's parsimony as Chancellor of the Exchequer, by appropriating the London Coal Duties, which had paid for St Paul's and the Wren churches. Acts of Parliament were then passed in 1862 and 1863, to allow the MBW to borrow money against this source, providing a precedent for funding of large-scale public works.

This, of course, is to make the process sound much more rational and easy than it was, and Professor Porter provides much that is valuable on this subject. However, the book is strangely ill-organised. Although the author states in the Preface that in writing this book:

"I hoped to refute the notion, fashionable in the early 1980s, that narrative was a false and perhaps pernicious way of representing the past."

the narrative is all over the place. Chapter I is a rather general introduction. Chapter II describes the geography of the Thames valley, with a history of Thames crossings but not of its banks. Chapter III launches straight into the history of London's drainage, right up to the building of the Main Drainage in the 1860s. Chapter IV, '*The First Thames Embankment*', then tells the history of the Office of Works' project for embanking the Thames under Thomas Page, c1853-64, which built the Chelsea Embankment, Chelsea and Westminster Bridges. This is interesting, but out of sequence, and it is not by any definition the '*first*

Thames Embankment". Chapter V, 'The Genealogy of the Thames Embankment', then jumps back to tell the history of embankment projects from the 18th century on, including an ambitious and serious proposal by the City Corporation commencing in 1840. Then Chapter VI, 'The Financial and Institutional Environment', is concerned with finance and politics, much of it of very doubtful relevance. Chapter VII, 'Relevant Interest Groups' belies its uninspiring title by being one of the best parts of the book: it is here that we get most of the discussion and description of London's riparian economy before the Embankment. Narration of the construction work comes in Chapter VIII, oddly entitled 'Contingencies'. Chapter IX, 'The Historical Future', is probably the worst, containing a very uneven account of London's changing relationship to the river, and including a weird misunderstanding of the reasons for conserving historic warehouse buildings. Professor Porter refers to the re-use of historic buildings as 'Disneyfication', without the least attempt to examine what this might actually mean in this context and opines that:

"The aesthetic of leaving pieces of the original brickwork, support beams, and plumbing fixtures on display within an otherwise modern edifice could hardly have made sense to a generation (i.e. the Victorians) dedicated to moral and civic 'Improvement' as well as to 'finish' in its works of art. In this respect, the South Bank has a split personality. Half of it, from Albert Embankment gardens to the National Theatre at Waterloo Bridge, celebrates growth, innovation, and the future in a civic context, the other half represents retrenchment, privatization and the exploitation of historic images."

This hardly suggests careful consideration of either architecture or history. Finally, seven pages (pp.251-7) are devoted to a rambling discussion of the problems of imposing interpretative periods or epochs on history, by way of introducing his historical chronology of the Embankment.

If Professor Porter had followed his own convictions and presented us with a clear narrative, the book would have been very much improved. It lacks a sense of international perspective; the author makes reference to Paris, St Petersburg, Venice and Copenhagen, and to London's being unfavourably compared to them, without any consideration of the obvious differences in London's status and circumstances. Some comparison with Paris might have been valuable. This was the city to which London was most regularly compared, and Baron Haussmann's vast reconstructions, including huge new sewers and embankment works, were going on at the same time as the Embankment project. Yet neither 'Paris' nor 'Haussmann' appear in the index.

The worst thing about the book is Professor Porter's frequent lapses into tiresome and redundant jargon. For instance we are told that:

"...the engineering technology of the Embankment acts as an interface between society and the environment within each phase of construction." (p.20), or that:
"The concentration of excrement and the water pollution, miasmas and disease that led Londoners to build a sewer system and consider using its contents for agricultural fertiliser would not have existed without a previous history of human intervention in the natural environment based on specific ideas about rivers, sanitation and engineering." (p.76)

Translated, this appears to mean that the Thames wouldn't have been full of crap, if there hadn't been a long history of people putting crap into it. We further learn that:

"The meaning or meanings attached to an artifact at its first appearance often change or evaporate; meanings attributed to it by advocates when it is finally constructed may not be shared by those whose perceptions or aspirations were denied." (p.108), and that:

"The business of historians is not to describe the external features or objects or situations as they are now, but to explore the interactions through which they emerged out of antecedent conditions. And it should be evident by now that uncertainty and chance play a significant part in all events, even carefully planned events such as construction projects." (p.213).

It is also the business of historians to write clearly; it is difficult to imagine many readers finding this kind of thing particularly helpful. If this style of writing is still obligatory in American universities, then that is so much the worse for them.

This reviewer, then must return a mixed verdict on *The Thames Embankment*. Professor Porter has chosen an excellent subject, which as he rightly points out, in its low-key way offers much insight into mid-Victorian Britain and the ways it addressed large and complex urban problems. He has marshalled some very interesting material, but the book lacks historical perspective, is weakly constructed, and the text is frequently weighed down with banal and redundant passages of "theoretical" writing. There is, nevertheless, a good book in the midst of all this, trying to get out.

STEVEN BRINDLE, English Heritage

Structural Iron 1750-1850

R J M SUTHERLAND (ed.), 1998

Aldershot, Surrey, Ashgate Publishing (Studies in the History of Civil Engineering)

382pp. illust. £85.00

ISBN 0 86078 758 3

This is the ninth volume in the series Studies in the History of Civil Engineering. It brings together seventeen articles written by fifteen authors, which were originally published in eight different journals and publications over the past fifty odd years. The earliest one appeared in 1941 during the war, when as the author explained, the times were 'not favourable to travel and the taking of photographs'. The articles explore aspects of this very broad subject, covering buildings and bridges in Britain, the United States, France and Russia.

James Sutherland, formerly a Senior Partner of Harris and Sutherland, Consulting Engineers, has always been deeply fascinated in the history of his profession. His particular interest is in the development in the use of wrought iron for structural purposes, which largely replaced the use of cast iron in the 1840s, as he explains in his perceptive and illuminating introductory essay. James has always given generously of his knowledge and time to offer guidance, direction and advice to students and others who are interested to learn more about the history of this development and other aspects of the wider subject.

The past fifty years have seen a growth in interest in the subject of structural iron which may also be perceived as one aspect of a wider historical interest in the nineteenth century. The intention of the publishers and the General Editor of the series is to form an invaluable reference collection of articles along with a select bibliography. Some of these are from foreign publications which would be difficult to find except in the most comprehensive of reference libraries. However, the volume has a British perspective and gives an account of

the development and achievements of this nation, and acknowledges the interaction of people and ideas. Ten of the seventeen articles are specifically devoted to the British achievement, but the wider international story is also touched upon in the context of developments within different countries and the adaptations of ideas to suit other situations. The volume is of immense value to those who are new to, and to those with a long interest in the subject.

Some of the articles are published in facsimile though others have been rearranged to suit a different page format. Though the quality of the illustrations sometimes is not as clear as in the original article, and the text is reduced to a size small enough to fit upon the 8vo page format, the articles are all legible. The glue binding, however, may limit the long term use of the volume which is intended for reference and therefore regular use.

The volume is divided into four parts, the first two dealing particularly with the structural use of iron in buildings, the third on suspension bridges and the last section on the use of iron in bridges. The selection of articles covers the development of structural iron from the arch and beam to that of the tied arch and truss, from the intuitive approach of the earliest designers to the introduction of calculations for structural analysis and the testing methods adopted on models to determine the efficiency of form.

The first part in particular looks at cast iron. 'The Use of Cast Iron in Building' by S B Hamilton offers an overview of the period in question and acknowledges the work of early writers on the subject, including Eaton Hodgkinson, William Fairbairn and Thomas Tredgold. It also describes cast iron structures in the London Docks which during the war were being destroyed by enemy bombs. 'The First Iron Frames' by A W Skempton and H R Johnson, published in the *Architectural Review* in March 1962, is one of the most important articles of its time. This historical account established the chronology for the use of cast iron in early iron framed mills in the Midlands and in the North, explaining the influence of William Strutt and laterally Charles Bage in the transfer and exchange of ideas.

Ron Fitzgerald's article, 'The Development of the Cast Iron Frame in Textile Mills to 1850', chronicles the subsequent development to Bage's experiments, and the theories of Tredgold and Hodgkinson through to William Fairbairn's work. James Sutherland's article 'The Age of Cast Iron 1750-1850: who sized the beams?' from the catalogue of the exhibition held at the RIBA Drawing Collection's Heinz Gallery in 1990, looks at the introduction of iron into buildings during the early 19th century, and earlier examples of the late 18th century.

Part Two of the volume contains three articles about the introduction of wrought iron into buildings. The first on the Palm House at Kew, 1844-8, is followed by an article on the work of Matthew Clark in St Petersburg, written Sergey Fedorov. Clark's remarkable career was until recently little known if not unknown by English readers. Fedorov's article, which was originally published in *Construction History*, reveals the range and diversity of Clark's highly innovative wrought iron structures such as those which he designed in the late 1830s and early 1840s to roof over the halls and grand ceremonial spaces in the Winter Palace following the terrible fire in 1837 which had destroyed the earlier spaces. The third article in the second part is on the great long-span wrought iron naval ship sheds which provided an enclosed environment for the construction of ships. James Sutherland traces their development in Britain from the wooden examples of the early 19th century.

In the third part of this volume on suspension bridges, Emory L Kemp considers the earliest examples in the United States designed by the engineer James Finley. Though none of his bridges survive, Finley's patent was an important influence on later American engineers. Kemp also covers the later development within this period and the introduction

of long-span wire suspension bridges in the United States in an article on the works of the engineer Charles Ellet, who travelled to France in the early 1830s to study at the École des Ponts et Chaussées and in particular to look at suspension bridges then being erected in France. The article by Thomas Day, 'Samuel Brown: his Influence on the Design of Suspension Bridges', examines the bridges built in Britain during the second and third decades of the 19th century by Samuel Brown, who was one of the most prolific builders of bar-chain suspension bridges in this country.

Antoine Picon's fascinating article on the French contribution to this development, 'Navier and the Introduction of Suspension Bridges in France', during the years between 1820 and 1830, is particularly revealing for explaining the different approach of French engineers during this period to their British counterparts, which helps to illuminate the achievements in Britain much more clearly, and to explain its more intuitive, commercial, and pragmatic approach.

Part Four of the volume, *Iron Bridges Other than Suspension Bridges*, covers a range of topics from the first cast iron bridge erected at Ironbridge, in Barrie Trinder's article 'The First Iron Bridges', to John James' wide-ranging article on 'The Evolution of the Iron Bridge Truss to 1850', which was when it appeared in 1981, and still remains today, a remarkable chronicle of this development throughout the world. His deep interest in the subject led him to search widely for information in published references, obscure journals, and primary sources.

The more widespread introduction of wrought iron to bridge design in Britain, through the experiments carried out by William Fairbairn and Eaton Hodgkinson is explained in complementary articles, one by James Sutherland, 'The Introduction of Structural Wrought Iron', and in Denis Smith's 'Structural Model Testing and the Design of British Railway Bridges in the Nineteenth Century'. Together these describe the remarkable and unprecedented achievement represented by the Britannia and Conway tubular bridges. A broader international perspective is found in the article 'Early Nineteenth Century Developments in Truss Design in Britain, France and the United States' by D A Gasparini and Caterina Provost, which looks at the different approaches of 19th century engineers in these countries, from the theoretical approach in France, to a more empirical one in Britain. In the case of the United States, the early adoption of French theoretical understanding was first applied to timber structures and later to structures of timber and iron in combination.

As a reference work, the contents of this volume will be extremely useful to students and to those interested in this subject, providing the reader with a perceptive introduction to the subject. Through the extensive bibliography and wide range of articles with numerous notes and references, it identifies the important works and sources of information on the subject for further study, as well as more recent articles and publications.

EDWARD DIESTELKAMP, The National Trust

Air-Conditioning America. Engineers and the Controlled Environment 1900-1960

GAIL COOPER

Baltimore, Maryland, John Hopkins University Press

229pp. 8 illust. £29.00

ISBN 0 8018 5716 6

In any modern building it is the engineering services that represent the largest proportion of the capital cost, and of this air conditioning, when it is applied, tends to be the largest subsection. The impact of air conditioning on building design is all pervasive - form, shape, external envelope performance, internal space planning, and all the energy aspects. It is, therefore, an important subject, worthy of study by anyone interested in the general technology of building construction. One might extend this to include a wider audience, on the basis of C P Snow's assertion in his famous 'Two Cultures' lecture, that thermodynamics is the most appropriate scientific knowledge to be shared by everybody - and thermodynamics is the root science that air conditioning draws upon.

History is a key factor in the understanding of many things in life, and air conditioning, despite its axiomatic invisibility, even ephemeral nature, is no exception. So, Gail Cooper's extensively researched and well written book, focusing on the core years in the industry's development is welcome. That the scope of consideration is geographically limited to the USA does not make it irrelevant to readers in Europe or elsewhere. The original home of air conditioning is the USA, in terms of analytical definition, practical applications, and technical developments. The wide climatic range of the country, particularly its summer humidities, was surely the reason for this.

The building physics and thermodynamics of air conditioning are fairly complex, and often made more so by the interaction of human physiology. A full appreciation of the relationships inherent to air and water vapour mixtures, and their effects on industrial process environments or the comfort of people tended, in the early days, to be held by relatively few engineers. One can detect in the ways that air conditioning started to develop in the USA (a process very clearly charted by Gail Cooper's analysis of the textile and motion picture theatre fields) that it became something of a 'black art', with overtones of secrecy. The Carrier Training School rather encouraged this trend probably in the interests of commercial advantage. It may be of interest to record that the UK organisation set up in the 1920s as Carrier Engineering Company Ltd sent young graduates to New York for training, and for a little of the secrecy indoctrination that helped to maintain the company's dominance in the UK air conditioning field for the next half century.

Gail Cooper's work strikes a most interesting balance between the actual history of air conditioning and its wider significance to the expanding socio-economic life of America. All the key pioneering players are there - Alfred Wolff, Stuart Cramer, and the towering figure of Willis Carrier. It was Cramer who gave the industry its name, derived from his novel idea of 'conditioning' textile materials by exposing them to artificially raised air humidity, to the right level. But it was Carrier who became known as 'the father of air conditioning'. He was the first to set out its fundamental science in a practical way, before going on to lead the industry's largest contracting and equipment manufacturing company. The centrifugal liquid chiller, still dominating the field for large scale applications, was his invention in the early 1920s. These technical developments, new ideas for air conditioning plant arrangements, control systems and the moves towards mass produced 'off the shelf' unit air conditioners are described very clearly. But it is the way in which public awareness

and acceptance of the benefits of air conditioning gradually took root that enhances the narrative. The story includes many of the technical issues that were argued about, researched, and resolved, along with the conflicts of interest between engineers, clients and plant operators. Needless to say, the regulatory authorities were much involved in the process, particularly in relation to outdoor air ventilation rates. Apart from problems of establishing a general understanding of what air conditioning could, or should, try to do there were many serious economic factors, particularly the Depression of the 1930s and the Second World War, that hindered progress. Nevertheless, air conditioning has become an integral part of American life. Indeed, in Reyner Banham's view, as expressed in his *Architecture of the Well-Tempered Environment*, air conditioning, with its ability to create internal environments that make productive work possible, and allow people to sleep well at night, despite the heat and humidity of summer, has been a prime contributor to the country's economic strength. This book records how it all happened, and it makes most interesting reading.

No industry can stand still, or ignore the influences upon it. The period following that covered by this book has seen the 'energy crisis' of the 1970s, and a groundswell of opinion identifying air conditioning as one of the villains of energy consumption - a Bad Thing, to be avoided in building design, or even legislated against. The fluorine based refrigerants used by cooling equipment - hailed in the 1930s as the perfect solution to the dangers of ammonia - have been condemned for cooking the earth's atmosphere, and burning holes in the sky. Fortunately, research and development are once again reacting. New refrigerants are being developed, and more energy-efficient low cost compressors are extending the application market. Building designers are using air conditioning in new and thoughtful ways. Progress will continue to be made. As so often, it is the background to progress that makes it interesting, and Gail Cooper has provided a fascinating example of such a background.

LOREN BUTT

Robert Maillart - Builder, Designer and Artist

DAVID P BILLINGTON, 1997

Cambridge, Cambridge University Press

331pp. 190 illust. £50.00

ISBN 0 521 57132 4

In this book, David P Billington of Princeton University presents a combined biography and catalogue of works of the seminal Swiss bridge and structural engineer, Robert Maillart. Descriptions of the projects of the Maillart oeuvre are interwoven with an account of the engineer's life.

The book is arranged chronologically, the nine chapters dealing with successive periods of Maillart's life. It starts with a brief description of his childhood years, but the author gets his teeth into the first bridge design by the middle of chapter one. A format of project descriptions set in biographical context then follows throughout the book, which finishes with copious notes and listings of Maillart's works and writings.

There are three main strands that Billington pursues, the first being the engineering innovations in bridges and building structures - the thin reinforced concrete arches for

bridges, using the parapet walls of the bridge deck to stiffen them, the flat slab floors and the prototype shell roof for the Cement Hall at the 1939 Zurich Exposition. Plentiful illustrations are given of each of Maillart's works, together with the descriptions of how Maillart developed his ideas with each new project.

Unfortunately the general omission of drawings showing design and constructional (particularly reinforcement) details makes it difficult for the reader to appreciate fully the significance of each development and just how sophisticated Maillart's handling of reinforcement design and detailing was.

The second strand is the history of Maillart's life, principally gleaned from his daughter, Marie-Clair Blumer-Maillart. Here we are able to build up a picture of both Swiss bourgeois life in the early part of this century and to see the effects on an engineering designer's life of world events such as the Russian Revolution, the two World Wars and the 1930s Depression. Maillart started out as an engineer-contractor taking on high-quality and profitable projects firstly in Switzerland and then in Russia. The revolution there brought economic ruin and he returned to Switzerland and practised from then until his death in 1940. In this latter part of his life he worked as a consultant only and on smaller scale projects, although these turned out to be his most admired works, including the Salginatobel and Schwandbach bridges.

The third strand in the book deals with the development of the Swiss civil engineering profession through the early decades of this century, Maillart's colleagues, collaborators and rivals and the public debates and feuding throughout his life over whether justification of reinforced concrete design should be based solely on complex analysis (the academics were still developing the theories needed at the time) or Maillart's approach of more simplistic calculations backed up by load testing of the completed structures. Here Professor Billington provides excellent thumbnail portraits of the principal figures in Swiss engineering life, but frustratingly omits much of the technical substance of the arguments - he tells us that Maillart published articles attacking the establishment views, but we are not told what the articles said!

In summary, the book, which is very well produced and illustrated, gives a capable review of Maillart's life and works. It does not however allow much critical enquiry or thought on the part of the reader through the omission of the technical details of the development of the design ideas and of the debates with the authorities.

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