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Introduction

The current volume contains the proceedings of the two-day conference held at Queens' College, Cambridge from 6-8 April 2018. This year the first day of the conference is entirely devoted to the history of building services, which is chaired by Dr Henrik Schoenefeldt, Senior Lecturer in Sustainable Architecture at the University of Kent, Member of the CIBSE Heritage Group and National Teaching Fellow. In this conference Building Services were always conceived in the widest terms to encompass not only plumbing, artificial lighting and ventilation, but also the ways that buildings were adapted to provide these without recourse to external sources of power. Historically this was, of course, often the case by necessity. In his Keynote talk, *Towards a History of Building Services*, Dr Schoenefeldt is exploring some of the boundaries between the history of environment design and construction history. This talk draws, amongst others, on his current research project within the Palace of Westminster Restoration and Renewal Programme. The project comprises the first study to systematically reconstruct the Houses of Parliament's nineteenth-century ventilation system, combining site surveys with archival research. This project has revealed the great extent to which its construction had been shaped by the design of the historic ventilation system.[1]

The second day of the conference followed the format of previous years with a more general call for papers on all aspects of the history of construction. We were delighted to receive many papers in the second category that cover a wide range of fields and periods from the ancient world to the present day.

This volume is thus divided into two parts. The first section deals with the first day and the history of built environment and the papers are arranged alphabetically by authors, while the rest of the volume is divided into sections chronologically following the previous volumes in the series.

Preliminaries

This book is timely: Reyner Banham's ground-breaking history of building services, *The Architecture of the Well-tempered Environment*, published in 1969, celebrates its fiftieth anniversary next year in 2019. It thus seems to be a pertinent moment to be holding a conference looking at what has happened since it first appeared. As an area of construction history, despite the increasing literature on the subject outside the field, it seems fair to say that it still remains underdeveloped within it, with comparatively few papers in conferences and journals looking at aspects of building services. This leads naturally to the question of what such a study might contain. Banham's claim in *The Architecture of the Well-tempered Environment* that mechanical approaches only began in the eighteenth and nineteenth century is surely incorrect unless we take a very narrow definition of "mechanical". Plumbing and drainage was integral part of construction since Antiquity, as were methods for heating and removal of fumes. Roman hypocaust systems were every bit as complicated as the air-based heating systems that reappeared in the 19th century and were of course inspired by, and based on, those earlier precedents. Nonetheless the changes in approach and understanding are just as important to note. The mathematisation of science saw the development of workable theories of fluid dynamics that would later influence plumbing and ventilation. Arguably, however, such influences were minor compared to the introduction of steam power and then electricity which had more immediate and profound effects.

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The main argument of the Banham's book is that the development of the building services was marked by a transition from largely structural towards mechanical approaches to environmental control. Whilst structural solutions relied on the intelligent use of built form, methods of construction and materials to achieve an adequate indoor climate, acoustics, lighting or ventilation, the development of mechanical services allowed environmental control to become less dependent on structural solutions. The latter climaxed in the mid-twentieth century in tall buildings combining the hermetically glass-curtain walls with mechanical ventilation and air-conditioning. SOM's Lever House in New York represents one prominent early example.

Although Banham saw this transition as the outward expression of technological progress, his book illustrates that the history of construction and the history of building services are closely intertwined, inseparable. The link between the two, however, is rarely explored. The premise underlying this year's Construction History Conference is that a focus on the interrelationship between questions of construction, materials, environmental design and services has the potential of yielding new insights and a more comprehensive history of building technology.

The development of mechanical services, including modern concepts of central heating and ducted air, had an increasingly strong influence on the development of architecture from the early nineteenth century onwards. Two important journal articles in the history of building services that build directly on Banham's narrative were published in the 1970s. The first was '19th Century Mechanical System Designs,' by Donald Prowler and Robert Bruceman in 1977, and 'Central Heating and Forced Ventilation: Origins and Effects on Architectural Design' by Robert Bruegmann in 1978.[2] Covering pioneering developments within late eighteenth to mid-nineteenth century these papers have addressed significant gaps in Banham's work with its strong focus on later nineteenth-century and the modern movement. Moreover, some of the most significant buildings within the history of nineteenth-century environmental design were not covered in his book. The first is the Palace of Westminster, which, created after the fire of 1834 as a purpose built parliament. It was the earliest building where the principles of warm air central heating and stack-ventilation were applied on a large scale, providing a precedent for the servicing of many public buildings from 1850 until the early 20th century before the introduction of electrically-powered fans. These included, amongst others, the Natural History Museum (1873), the Royal Albert Hall (1871) and Glasgow University (1870). Individual building case studies looking at the integration of building services have been published since. Significant studies, include, amongst others, Jeffrey Cook and Tanis Hinchcliffe, 'Designing the well-tempered institution of 1873' (1995) and 'Delivering the well-tempered institution of 1873' (1996) are significant as they also critically review the performance of the historic system.[3] Todd Willmert's article 'Heating Methods and Their Impact on Soane's Work: Lincoln's Inn Fields and Dulwich Picture Gallery' (1993), explores the role of technical experimentation within the work of the architect John Soane.[4]

Another significant pair of buildings excluded from Banham's book was Joseph Paxton's Crystal Palace in Hyde Park (1851) and Sydenham (1854), which are significant as they illustrate how innovative principles of environmental control, initially developed at a much smaller scale within the context of glasshouse horticulture, were exploited to adapt fully-glazed structures climatically for human, non-horticultural purposes. In his book 'The Glasshouse' John Hix has explored how the challenge of cultivating rare non-native plants in Britain's temperate climate was driving extensive experimentation with central heating and solar design principles.[5] The application of these principles to the Crystal Palace, however, has only been examined more recently in two articles, 'The Crystal Palace Environmentally Considered' (2008) and 'Adapting Glasshouses for Human Use: Environmental Experimentation in Paxton's Designs for the 1851 Great Exhibition Building and the Crystal Palace, Sydenham'(2011).[6] The work of John McCean, Henry Russel-Hitchcock, and Bill Addis have illuminated its significance within the history of production engineering and structural design, but it also exemplified a synthesis of structural and environmental thinking in Victorian engineering.[7] The idea of using glass covered public spaces to create microclimates with no or little mechanical heating became widely deployed in the second half of the

nineteenth-century. A notable examples are Horace Jones's design for the Smithfield Market, completed in 1868. Its climate was regulated following similar process of environmental monitoring and control. It operated on a principle that Dean Hawkes described as the 'Selective mode' of environmental control. The horticultural glasshouse, and its later adaptations, represented a site where both structural and mechanical engineering approaches could co-evolve as two major traditions of environmental design.

Our opening paper in this volume, the keynote lecture by Professor Dean Hawkes on day one, examines how Banham's *The Architecture of the Well-tempered Environment* was somewhat biased in its treatment of services and their relation to architecture, championing an approach that brought the mechanical to the foreground and expressed it visually. This he compares to the approach of Louis Kahn and others where the architecture is no less dependent and determined by the services but where (unlike for instance Richard Roger's Pompidou) the services are concealed rather than exposed.

Section One: Services

The first section of the book takes the papers from the first day of the conference. They are arranged here alphabetically, rather than in the sessions that were used in the conference itself, simply for clarity. The book thus opens with Jørgen Burchhardt's paper, *The Hidden System: how District Heating came to Town* which examines the development of district heating systems in Denmark. District heating systems are becoming popular once again in Northern Europe, where they are now being championed as a more sustainable solution than local heating systems. This paper shows how such systems were first installed in Denmark in the 19th century and how the country now has a very extensive network of district heating systems from which much can be learned.

Some of the same problems of producing extensive heating systems are explored in Jozefien Feyaert's paper, *Building Services in Nineteenth-Century Belgian Cellular Prison Architecture*. As Feyaerts shows in this well-illustrated paper, the wish to have single occupancy of cells in large prisons in the 19th century created considerable challenges in terms of plumbing, heating and ventilation. The results were systems of considerable complexity that aimed to keep cells warm but adequately ventilated and free from smells, which were an obvious problem when the water closet was housed within the cell itself.

By contrast, John Gelder's paper, *Roman Building Services and Architectural Manuals* provides a survey of the treatment of building services in Roman treatises, covering not only aqueducts and water supply, but also hypocausts, sounding vessels in theatres, water clocks and sundials. His useful tables show that the authors were far from accurate in their descriptions of Roman practice and not even consistent amongst themselves.

The next paper Silvia Groaz's, *Ducts and Moldings: the Ambiguous Inventions of Franco Albini and Franca Helg* could hardly be more different. It looks again at the expressive facades of the period 1957-1972 of La Rinascente store in Rome (described briefly in Banham's *The Architecture of the Well-tempered Environment*) and the SNAM offices at San Donato Milanese both of which incorporated elaborate ventilation systems within their façades. This paper relates directly to the one that follows. Again following on from Banham, Boris Hamzean's *The Evolution of the Pompidou Centre's Air-Conditioning System: Towards a new Figure of Architecture* discusses directly how Renzo Piano and Richard Roger's designs were influenced by La Rinascente. It tells the fascinating story of the interaction between the engineers and the architects over the final forms of the system which so dominates the façade.

Over the past six years Dr Schoenefeldt has developed and delivered a specialist module in the history of environmental design and technology, 'AR828: Rediscovery: Understanding historic buildings and past environmental technologies,' which forms part of the MSc in Architecture and Sustainable Environment. At this

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conference seven students are presenting the findings of research undertaken within the context of this module during Michaelmas 2017. Hala Roshdy Hegazy's paper, *The Open air School as a Typology [in the] 20th century*, is the first of the student papers from Kent. It traces the extraordinary development of Open Air schools. These have been studied in the English and German context, but Hegazy looks at those in the USA. Within the context of the modern movement the Open Air Schools movement can be interpreted as a counterpart to the hermetically sealed and mechanically serviced environments. Composed of lightweight structures, capable of being opened to the open air to a point where their function was reduced to no more than simple shelters against rain, represented an alternative environmental architecture. These structures were not created to immerse the human body within an artificial climate, but to expose it to the outside air and the sun. This practice of exposing the body was part of a historic method of tuberculosis treatment, which, alongside its architecture, became obsolete and superseded by drug-based treatments of TB, following the discovery of streptomycin in the 1940s. The particularly notable features of this paper are the extraordinary photographs of children sitting in outside classrooms, wrapped up against the freezing temperatures of the northern US winter. The photograph of the Open Air School sits in sharp contrast to the sun shining down on Steve Baer's strange Zome house in Albuquerque, New Mexico with its water drum solar collecting wall. This is the subject of Mariam Itani's appropriately titled paper, *Case Study Analysis on the Baer House*, a building that is introduced in the second edition of Banham's *The Architecture of the Well-tempered Environment*, published in 1984. The last of this first group of papers from the Kent school is Alisa Kahn's *Sanatoria for treatment of tuberculosis and the aftercare colonies*, which looks at three 20th century tuberculosis hospitals: Dr Varrier Jones's *Papworth Village Settlement (1916-1920)*, Jan Duiker's *Sanatorium Zonnestraal, Netherlands (1925-31)* and Alvar Aalto's *Paimio Sanatorium, Finland (1929-33)*. The paper includes some delightful hand-drawn explanatory sketches by the author. Similar to Hegazy's study of Open Air schools, this paper explores a strand of environmental design that was concerned with therapeutic use of natural light and air, yet it also challenges the modern movement's claimed association of transparency with heliotherapeutic treatment. As the glass of Duiker's transparent patient wings intercepted ultraviolet light, patients still had to be stationed on open balconies in order to gain access to fresh air and direct sunlight.

Dr Randal Lawrence's paper, *The environmental role of transition spaces in Victorian architecture*, uses three examples, the lobbies of the Houses of Commons (1852), the Natural History Museum (1873) and the Glasgow School of Art (1910), to explore the use of intermediate spaces inside nineteenth-century public buildings, displaying interiors with climatic diversity. The latter co-existing with early attempts to create spaces with uniform artificially conditioned spaces. The next two papers return to the twentieth century. The first, Samuel Leatt's *Owen Williams's Boots' "Wets" factory [1930-1932]* - a case study on the daylight factory typology provides a fascinating insight not only into the environmental design of this extraordinary building, which is still in use, but also shows how its construction and form was influenced by the work of Albert and Mortiz Kahn, with whom Williams had worked in the United States. It stresses how, before the widespread use of the electric light, daylight was an essential aspect of factory design. Kan Liang's *Case Study: The Norris Cotton Federal Office Building [1970-1976]* looks at another concrete building, this time one which is deep plan and lit by artificial light. Liang's paper looks at the early computer control and solar collection systems for this HVAC-dependent building, which attempted to make it state-of-the-art for the time. Designed and built between 1973 and 1976, it was built within the same political context as Steve Baer's experimental solar house, but instead of aiming to achieve full autonomy from oil through the use of renewable energy and passive solar design, the Norris Cotton Federal aimed to demonstrate how far mechanically serviced buildings could become more energy efficient. Its performance was also monitored by the National Bureau of Standards, addressing questions of energy efficiency addressed as well as user satisfaction.

Dermott O'Dwyer's paper *The Drainage of the Fucine Lake in Antiquity and in the Nineteenth Century* tells the fascinating story of how the Romans tried, and nineteenth century engineers succeeded, in draining a completely landlocked lake in central southern Italy. The Lake used to fill a hollow in the mountains about 100km East of

Rome. As a piece of water it was a breeding ground for mosquitos and malaria. O'Dywer's paper explains the extraordinary lengths the Romans went to under the Emperor Claudius to construct a tunnel 5.6 km long under a mountain. Although the Romans succeeded in building the tunnel, it failed to drain the lake. He goes on to show how nineteenth-century engineers then followed the Roman tunnel, making a much larger tunnel between 1824 and 1835, when the lake was particularly low. This tunnel succeeded in draining it entirely, creating the flat area of arable land which still exists today.

Libraries, before the widespread availability of electric light, had to deal with the conflicting problems of providing windows large enough to read by with a source of heating to allow readers to work while avoiding any of risks associated with naked flames in buildings full of highly flammable materials. Most early examples in Northern Europe just ignored the heating problem entirely. Surabhi Pandurangi's, *Understanding Preservation and Comfort in the British Museum Reading Room*, discusses how the architect Sydney Smirke and the head librarian Antonio Panizzi transformed the central courtyard of the old British Museum into a magnificent new reading room, surrounded by top lit iron book stacks and a hot air heating system installed to provide comfort for the readers. This scheme was significant in that the architect had taken the lead in designing the defining features of the ventilation and warm air central heating system. They were determined prior to engaging Phipson as contractor and specialist building services consultant. The plans, submitted for competitive tender in 1855, provided the contractors with exceptionally detailed specifications for the design of the system, including precise specification of the temperature range, ventilation rate and air velocities to be maintained within reading room. Having introduced the services into his architectural plans from an early stage, Smirke succeeded in delivering a scheme in which the construction, architectural plan and building service infrastructure were closely intertwined. This contrasts with many other public buildings constructed in the mid and late nineteenth century. In buildings such as the Royal Courts of Justice, the Natural History Museum, the Royal Albert Hall or the Palace of Westminster the challenge of integrating modern building services within the architectural fabric only received serious consideration at a relative late stage.[8] This resulted in architectural plans having to be altered or the design of the building services being constrained.

The penultimate paper in this section, Fiona Smyth's "*Symphony for Full Orchestra and Asbestos*": *Tuning Albert Hall during WWII* tells the unusual story of the move of the Proms from the now largely forgotten Queen's Hall to the Albert Hall after the former was bombed in the Blitz in the Second World War, and the subsequent modifications to improve the acoustics of the Albert Hall.

The section ends with Qian Wang's Case Study: *The Temperate House at Kew—Controlling the climate under a glass sky*. The Temperate House's construction was plagued with problems and completed in 1899, 30 years after construction began. This paper examines how its design integrated central heating and natural ventilation to maintain, both in summer and winter, the climate conditions required to sustain an extensive collection of temperate plants. It also shows that the adoption of a timber-frame glass envelope was a conscious departure from the sophisticated wrought-iron technology adopted for the construction of the Palm House in the 1840s.

This collection of papers is interesting not only in showing how much work remains to be done on building services but also in how much of what can be learned from past projects is still applicable to day. In many ways the current interest is the very opposite of Banham's. Banham reveled in the expression of modern mechanical engineering and promoted an architecture that not only incorporated as much plant as possible but positively celebrated that plant. In the second edition of *The Architecture of the Well-tempered Environment* the Pompidou is thus very much an example for Banham of good practice. In a world where conspicuous celebration of energy profligacy is no longer appropriate such an approach seems outmoded, but what is striking is how relevant Banham's book still remains. Many of the papers in this volume used his examples as a striking off point and in highlighting the importance of so many early technical solutions he was a undoubtedly a pioneer in the field. What these papers have also revealed is how by digging deeper there is so much more left to be discovered and that current research

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has barely scratched the surface of the fascinating field.

Section Two: General Studies in Construction History

The second half of this volume is devoted to studies in the general field of construction history. As past volumes of this series have shown, construction history is a broad field. It is not just the history of building technology or the history of civil, mechanical and structural engineering, although it includes these, and they remain a dominating area. It also encompasses archaeology and economic and social history, as it examines how those building in the past thought about building problems and the factors that influenced them. The flow of money into building projects, for instance, had a profound influence on the physical form of the results as did the supply of labour. The richness of the subject of construction history lies in its ability to bring together radically different approaches in the analysis of building projects to draw new insights. Just as there are many ways in which buildings can be analysed so there are many in ways in which the papers collected together here could be arranged. Again they were arranged thematically in the conference itself. Here, however, they are arranged for simplicity, chronologically, as in previous volumes.

Ancient World

Despite its huge importance in construction history, archaeology remains underrepresented in these volumes. Only three papers look at the world before the Middle Ages. Two are in the first section and both look at Roman technology: John Gelder's paper *Roman Building Services and Architectural Manuals*, and Dermott O'Dwyer's *The Drainage of the Fucine Lake in Antiquity and in the Nineteenth Century*. The only paper in this section is Alessandro Pierattini's *The beginnings of stone construction in archaic Greece* looks at the technical problems of stonemasonry in early Corinth in ancient Greece, which provides important new evidence from stone markings on the ways stone was cut and lifted into position.

Middle Ages

The six papers in this volume that cover the period broadly termed the Middle Ages look at surveying, stonemasonry and carpentry. The first of the three papers on stonework, entitled *The Vault over the Crossing Tower in Lincoln Cathedral in the Context of European Gothic Architecture* uses digital photogrammetry. This new process shows great promise for recording historic buildings. A series of standard photographs are taken and fed into a computer programme (in this case Agisoft PhotoScan Professional) which works out the geometry of the surfaces photographed and then stitches the images back onto a computer model of the photographed surfaces. The result is a fully-coloured 3D scan of the vault. Here the process is used to show that Lincoln's vault is similar but not the same as examples elsewhere. The process of influence was the visible rather than by movement of craftsmen.

Michael Wood's *King's College Chapel Vault: Movement, Restraint and Foundation Loading* looks at the interesting question of whether the various iron straps and reinforcements added above the vault of King's College Chapel are necessary. Structural calculations showing that existing buildings stand up are not normally accepted in Construction History journals or conferences. The emphasis should always be on how the builders understood what they were doing. Here they are justified in exploring whether Scott's interventions are necessary and suggest that they were, or at least (thanks to recent movement) now are.

Karl-Magnus Melin's *Medieval Counter-Rebated Doors: a Door from the Diocese of Lund compared with English examples* is a brilliant investigation of a very peculiar type of timber door construction, previously thought to have been confined to 11th and 12th century England but shown here to have also existed in Southern Sweden in the early

15th century and thus presumably also used elsewhere.

In *Trace Methods of the Romanesque Churches of Val D'Aran*, Mónica López Piquer and Josep Lluís I Gionovart, looks at the fascinating problem of orientation of churches. Roman basilicas were orientated with the throne in an apse at the West end. Christianity chose the reverse. The apse was moved to the East end, the church orientated to the sun rise or supposedly to the date of the martyrdom of the relevant saint. This has always been difficult to establish. This paper uses new survey data to explore this issue.

Churches also form the subject of Mattias Hallgren and Robin Gullbrandsson's paper. They tell the fascinating story of the discovery of a decorative 12/13th century timber roof concealed by a 15th century vault. Lastly, Shirley Markley's, *Earth-Mortared Masonry Construction – its Symbolism and Functionality – an Irish and United Kingdom Perspective* shows how earth mortar, too easily assumed to be the poor-person's alternative to lime mortar, used only for houses, was also used for ecclesiastical architecture.

Seventeenth and Eighteenth Centuries

Lee Prosser's *The Roofs of Inigo Jones Revisited* provides a hugely important survey of Jones's surviving roof structures in the light of the roof Prosser has himself discovered and surveyed in Hampton Court Palace. The introduction of the King Post Truss into England by Jones had already been noted by David Yeomans in his book *The Trussed Roof*, and my own PhD studied Wren's use of the structure, surveying a great many of his roofs in the later seventeenth century, but here Prosser adds significantly to what was previously known, establishing that Jones was responsible for popularising the form. Carpentry is also the theme of Aikaterine Maria Chalvatzi's *Theatre Construction in Eighteenth Century France* which looks specifically at the influence of the Palais-Royal and goes on to show how the wooden structures gave way to iron ones in the 19th century.

Mark Samuel's paper, *The Dry Dock at Ramsgate: Smeaton or Rennie* grew out of archaeological examinations of the surviving remains which forced a search of the documentary sources. As this paper shows the dock had a much longer history. A new dry dock had been constructed by John Smeaton in the 18th century and then a John Rennie had carried out extensive works and the question is whether Rennie's works entirely replaced Smeaton's or were simply repairs. This question provides the answer.

The Nineteenth Century

The nineteenth century usually proves to be an abundant source of papers for the CHS conference and this year was no different. Six papers cover diverse subjects. The first, by Chris How, looks at the First Wire Nail machines and their origins traces the development. How's story starts in the eighteenth century with pin and needle making. He goes on to show that the headed nail was patented in the early years of the 19th century in Paris, thirty years earlier than previously believed. Beatrice Lampariello, *Cells and Epines-Contreforts for a New kind of Vaulted Roofing: the Church of Saint-Jean-de-Montmartre in Paris* looks at innovative brick and reinforced concrete vaulting system developed for the church at the end of the 19th century. Iva Stoyanova's paper, *Scaffolds for the Iron Glass Roof of the Gallery Vittorio Emanuele II: challenges, design and evolution* discusses the various scaffolding systems that have been used to construct and later repair this remarkable structure. The gallery will remind many of the Crystal Palace, built for the Great Exhibition but sadly later destroyed in a fire after it was moved to Sydenham. Although most people associate Joseph Paxton's name with the building of the Crystal Palace, the firm in charge of its construction and its subsequent move was Fox Henderson. As Robert Thorne's *The Rise and Fall of Fox Henderson*

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1840-1856 shows, this made the engineering firm famous. What was surprising is that the practice then lasted only 16 years. This paper traces the reason for its rise and subsequent dramatic fall.

Ignacio-Janvier Gil-Crespo's Military Reports about the wall and fortification projects in Havana, 19th century, tackles a very different rise and fall, that of a large fortification. It follows the marvellous trail of maps and drawings tracing Havana's now almost entirely demolished fortifications.

In his paper *From the drawing to the wall: the operational chain of building stone on the restoration worksite of St Martin's church in Liège during the nineteenth century*, Antoine Baudry tells the story of the supply of stone for the restoration of a medieval gothic church in the then newly-formed kingdom of Belgium.

Twentieth Century

The division between nineteenth and twentieth centuries is an entirely artificial one and many of the papers in the previous section cover developments in this period, just as many papers in this section start by looking backwards to earlier changes. Matthijs Degraeve and Frederik Vandyck's paper, *Spatial analysis of timber construction SMEs in Brussels (1880-1980)* is a case in point. It maps the prevalence of timber fabrication companies in the period in question in Belgium, focusing in on a narrower area to look at surviving buildings. This is an unusual piece of construction history. The study of the changing form of building industry and its economic and social background has always been an important part of construction history and an important counter-balance to studies which all too easily concentrate on the technology used to construct buildings. A building site can only be understood properly by looking at both aspects and indeed also drawing in wider factors such as political and legislative structures and problems of material supply. What is interesting here is that the study of the businesses turns back to a study of the buildings in which they operated.

Continuing the theme of studies that look at how building sites operated, Michael Mulvey's paper, *'Once Hard men were heroes': Masculinity Cultural Herosim and Performative Irishness in the Post War British Construction Industry* represents a refreshingly new approach which draws on literary sources to explore the mindset of post-war Irish economic migrants workers in the building industry and in particular their "tough-guy" self-image. In a political environment today where the reliance on cheap migrant labour in the building industry is a critical point of discussion in the United Kingdom, these issues could hardly seem more relevant.

Mario Rinke and Roshanak Haddadi's paper, *The Riding Arena in St Moritz and the locomotive depot in Bern – a comparative study of early glulam construction in Switzerland*, returns to more traditional construction history territory, exploring the development of new materials, here glue laminated roof structures in the first few decades of the twentieth century. New materials became critical in war time and the two World Wars in the twentieth century drive technical innovation in many areas including building materials. This is immediately apparent in the supply of temporary war time buildings. Karey Draper's research *Armstrong Huts in the Great War (1914-1918)* grows out of her pioneering PhD (which I supervised) which identified over 60 temporary hut types in the First and Second World War in Britain. Here she focuses on one of the best known but least understood: the Armstrong Hut in the First World War. Draper's work has been strongly dependent on archival research, which for Government works is thankfully abundant, although a surprising quantity of material has been lost.

Archives form the subject of the next paper. This looks at the archives of Cecil Hewett (1926-1998). This conference marks the twentieth anniversary of Hewett's death. Hewett dominated the study of Medieval structural carpentry

in the 1970s and 1980s in Britain, producing a series of beautifully illustrated volumes on the many aspects of structural carpentry but particularly of church and cathedral roofs. He had a woodworking background and a sharp eye for details, particularly the forms of joints and he became known for his theories of dating buildings by these joints, before dendrochronology became common or indeed viable. Trained as an artist, his drawings were works of art in their own right. This year's conference is accompanied by an exhibition of previously unseen drawings. Ming [Charmaine] Shan Ng's paper provides an insight into the contents of the substantial archives of his drawings and papers that he left to the Essex Record Office in Chelmsford. These include many drawings of structures for books that were never published and in some cases form the only record of now lost structures. Hewett's work remains controversial and was debated at the conference. The chief problem is that his drawings were not based on accurate measurements and are thus beguiling but unreliable and in many cases potentially misleading. As his work becomes accessible to a new generation of researchers a proper study of what he produced and its limitations is overdue.

Valdimir Ladinski's Immediate Housing Construction Following the 1963 Skopje Earthquake shows the problems of lack of archival material. Here he identifies prefabricated houses erected after the 1963 earthquake as temporary accommodation after the 1963 earthquake in Macedonia, at the time part of Communist Yugoslavia. The scale and speed of reconstruction is impressive but it would be interesting to know more about the types of prefabricated buildings, where they came from, who designed them and what were they originally designed for. Ladinski's paper provides the groundwork for such further research. The next paper, Joel Audefroy's History of Early Twentieth Century Anglo-Caribbean Wooden Houses in Chetumal City, Quintana Roo, Mexico traces similar low-rise construction, here focusing more on techniques than any notion of prefabrication. As reinforced concrete becomes all too prevalent across the globe, the question here is how far to document this vernacular construction and protect it despite the fact that it is not very old.

In Roberta Lucente and Laura Greco's The Montreal Stock Exchange Tower by Luigi Morretti and Pier Luigi Nervi (1961-1965) continues Greco's studies of Nervi buildings which have appeared in previous volumes in this series, using sketches and drawings from the archives to show how Nervi and Moretti thought through the design of this high rise concrete structure.

The Twenty-First Century

Luciano Cardellicchio's The Italian engineering contribution in the technical development of the new Hertziana Library by Juan Navarro Baldeweg, draws on documents of the time to trace the role of the engineer in the decision-making process. Studying such decision-making processes forms the back-bone of construction history and in documenting this process for a building built within living memory Luciano is able to call upon the direct recollections of the individuals involved. This paper is thus not only a useful contribution in terms of recording process for future historians but also poses a very useful question: how recent can a building be for it to be considered history? Can studies of contemporary buildings such as this be considered construction history at all? When is a building historical? This introduction is probably not the place to discuss any of these issues in detail. Perhaps the most obvious response is that it is a question of approach: it is possible to analyse any completed project in a number of ways, and it is construction history if approached from that point of view.

Concluding Remarks

In a year that could have easily been short of papers the devotion of the first day of the conference entirely to the History of Building Services has led to what we hope our readers will agree is a substantial volume. At over 550

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pages it is the largest volume in the series so far. The forty-one papers summarized here thus provide an overview of the broad range of just some of the research being carried out in the growing field of construction history, while the papers on building services show how fruitful this area of research is and how much — as in every area of construction history — there remains to be done. We hope you will enjoy this volume and find in its varied contents material that is both useful and interesting in stimulating further debate and research in the growing field of construction history.

James W.P. Campbell
Conference Chairman

Henrik Schoenefeldt
Chairman of Day One
(History of Buildings Services)

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