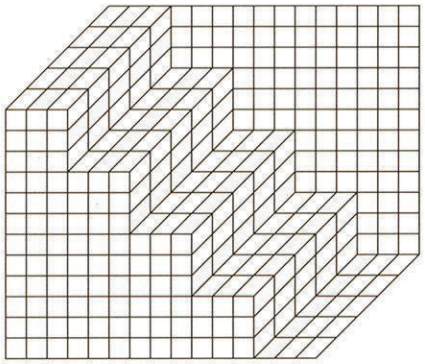
Patterns 12



Buro Happold
Consulting Engineers

On being an Engineer

Sir Ted Happold 1930-1996

Patterns 12

July 1997

Published by
Buro Happold Consulting Engineers

ISSN 1352-2795

Contents

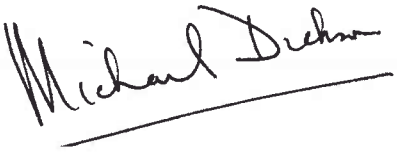
Foreword

This edition of Patterns celebrates Ted Happold's life as an engineer by illustrating the exhibition "On being an Engineer - Ted Happold 1930-1996". The edition, and the exhibition, were compiled and edited by Bill Addis and designed by Dennis Crompton.

The exhibition was first shown at the Centenary Celebrations for the Architectural Review at the Business Design Centre in Islington, London in April 1996 and then, with the support of the Construction Industry Council, was formally opened at the Building Centre, London on Thursday 5th September 1996.

The Partners of Buro Happold would like to thank those who made available material for this exhibition and in particular the Ove Arup Partnership for the material which illustrates Ted Happold's 19 years with that practice up until 1976. Special thanks are due to Eve, Lady Happold, who allowed access to some of Ted's personal effects to assist in the preparation of the exhibition.

This special edition of Patterns also celebrates the posthumous award to Ted Happold of an Honourary Doctorate of Engineering from the Technical University, Braunschweig, Germany, for which the translation of the Honourary Certification from German to English is given on the next page.



Michael Dickson

ON BEING AN ENGINEER

the life and work of Sir Edmund Happold

Born Leeds, 8 November 1930
Died Bath, 12 January 1996

What I know about engineering is that it has to be a group activity. The best work is done by the most diverse group of talents who can still live together.

Ted Happold's Gold Medal speech at the Institution of Structural Engineers, *The Structural Engineer*, 20 October 1992

As an engineer I largely devote my time to economic objectives since my objective is 'to do for one penny what any fool can do for six'. And I have, unlike the architects whose training is largely aimed at ensuring visual and cultural continuity, a firm belief that innovation is a 'good' thing. In other words, I am a professional worshipper of change.

Yet I must believe that mankind has to be satisfied in all four of my categories of happiness – he has to have social, symbolic, intellectual and economic objectives. I believe that everyone has within him a desire to create something – an object, a relationship or what you will – and that this is a basic urge which, if stifled, leads to unhappiness. He needs money, maybe even wants money, but also needs for something of his creativity to be recognisable to himself, and recognised by others.

Ted Happold talking at the RIBA, 1984

True godliness don't turn men out of the world, but enables them to live better in it, and excites their endeavours to mend it: not hide their candle under a bushel, but set it upon a table in a candlestick.

William Penn, Quaker, 1682

Ted Happold was part of the advance guard of engineers who emerged from the 'backroom boy' culture which had pervaded his profession for most of this century, working for and with an architectural clientele only too ready to respond to his brand of enthusiasm, innovation and iconoclasm.

In the flux of design relationships over the past 25 years, Happold stood for, and advanced, the idea of co-operative multi-disciplinary working first promoted by Ove Arup, where the notion of discreet design roles (rather than skills) had little meaning.

In his position as an academic at the University of Bath, Ted Happold was able to push teaching of both architects and engineers in the direction of mutual appreciation rather than arm's length dependency. He both put theory into practice and practice into theory, which alarmed some of the more conventionally-minded of his peers.

In the professional life of both engineers and architects he made a significant difference which will be long felt.

Paul Finch, editor of the *Architects' Journal*

Ted Happold was one of the most distinguished structural engineers in the world and a splendid person who, by energy, charm and force of character, as well a scientific understanding and professional competence, helped to transform structural engineering during the last three decades of his life.

The work in Buro Happold specialised initially in tensile structures, partly through a long and fruitful collaboration with Frei Otto. The organisation became multi-disciplinary and innovative work covered many areas, for instance the potentially revolutionary experiments using green softwood forestry thinnings in the buildings at Hooke Park for John Makepeace, in collaboration with Richard Burton of ABK and Edward Cullinan Architects. The practice has been extending its exploration of ecological matters by investigating creative relationships between architecture and different strands of services and structural engineering, increasingly seen as a continuum. The office intends to continue these studies and Happold's principle of employing people from different disciplines with 'slightly overlapping minds'.

Peter Davey, editor of *Architectural Review*

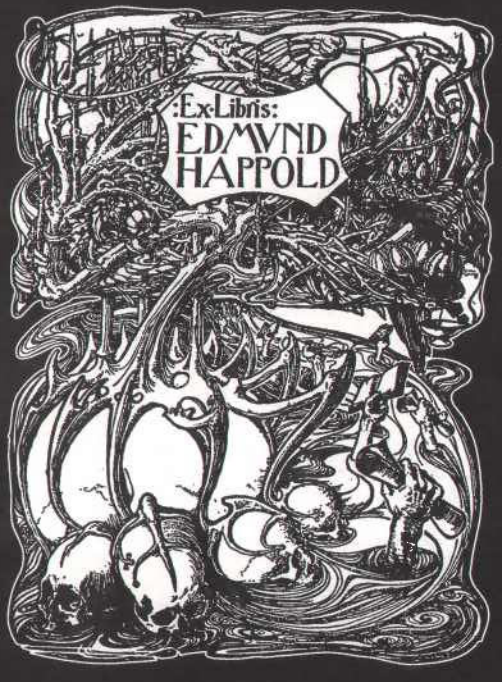
Left to right:
Lennart Grut, Ted Happold and Peter Rice

Over the many years I have known him, I came to realise just how important to him his learned and devout practice as a Quaker was. It shaped his view that work was for the betterment of the public domain and for enjoyment, and that discussion is needed to achieve consensus. I am sure this striving for consensus has helped shape our practice of engineering together, for the better.

It is hard to put into words the energy, enthusiasm and diverse thinking he brought to his work, or the importance of the creative challenge he gave to all who worked with him and in particular the encouragement he gave to all those around him.

Ted believed passionately in the importance of the creative role of engineering. The many projects which bear his mark are a fine testimony to this. As a designer and engineer he had a rare combination of artistic judgement and scientific knowledge which enabled him to put his finger at the centre of a design proposition knowing that the composition could work elegantly, completely and economically. That is a rare talent.

Michael Dickson, Partner at Buro Happold



Ted was a great starter of projects, a promoter of ideas, and a builder of teams. His generous nature and confident personality enabled him to gather round a number of fine engineers and he inspired them to put in the extra effort to make these buildings successful. Five of these people are now still the partners at Buro Happold.

Ted demanded that the partnership at Buro Happold should be a fellowship set up along Quaker lines. Decisions should be made unanimously without voting. He wished the practice to grow and be passed on to future generations of partners so that they could continue for the benefit of the public at large and continue enjoying their work even in the changing world of the construction industry.

He was incredibly generous with his time and his friends, always finding opportunities for people, helping them with their careers and not expecting much in return. He used to say in explanation of his crazy lifestyle, 'life is for living'. He did this to the full and with great gusto. We in the partnership will miss him greatly.

Ian Liddell, Partner at Buro Happold

Ted had enormous energy and he put that energy into achievements with his friends, in building, research, the Theatre Royal in Bath, public service and, sometimes, into working out a different way to travel from A to B because it would be more interesting and more fun.

Ted did not automatically choose the easy route or the stock answer to a problem, but looked at problems from many aspects – social, environmental, as well as scientific and technical – to see if there were new and better ways of doing things. Sometimes the result was to confirm the standard solution to the problem, but often the result was to choose a better environmental or social answer and one that would be more interesting and personally rewarding. He gave encouragement and support to those he worked with to help them believe that they could achieve more than they thought they might, and he used his energy and drive to make things happen.

Terry Ealey, Partner at Buro Happold

Ted's engineering hero (from Leeds, like Ted) was John Smeaton, the greatest engineer of the eighteenth century and a Fellow of the Royal Society (how times have changed). He was the first to describe himself as a 'professional' engineer and found time to combine consulting engineering in the mornings with 'practical experiments, or some other branch of mechanics' in the afternoons and publishing his work through the Society of Civil Engineers. Ted also saw his life in three parts – business, education and engineering. The engineering, he said, was his hobby which he did in the evenings.

So there we have Ted in a nutshell, a supercharged John Smeaton updated for the twenty-first century. Not for Ted just professional duties in the morning and experimental physics and mechanics in the afternoon . . . but a full-time academic, a full-time practitioner, a research guru, a networking genius and an industry spokesman who still found time for his friends, his hobbies and most of all, his beloved family.

Derek Walker

1957-76 EARLY LIFE AND WORK AT OVE ARUP & PARTNERS

Edmund Happold was born in Leeds on 8 November 1930, son of Frank Happold, Professor of Biochemistry at Leeds University and Margaret Happold, who was a housing economist and whose most important influence was in the area of public housing. Both his parents were active in the Religious Society of Friends and the Labour Party in Leeds.

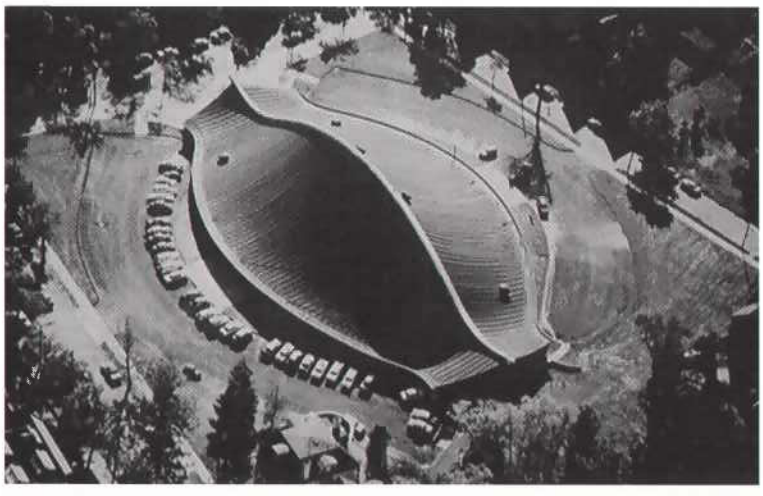
He was educated at Leeds Grammar School and Bootham School in York. Initially he studied geology at Leeds University.

As a Quaker Ted was a conscientious objector and spent his national service working on the land for the Ministry of Agriculture and Fisheries, ending up on the construction of large movable greenhouses. This sparked in him an emerging interest in construction and led to his joining Sir Robert McAlpine and Son as a junior site engineer. He then returned to Leeds to read Civil and Building Engineering.

At Leeds he came across Sir Basil Spence on whose suggestion first he went to work for a short while in Alvar Aalto's office in Helsinki and then, in 1957, joined the innovative engineering practice of Ove Arup & Partners.

At Arups he was surrounded and inspired by projects remarkable for both their engineering and architecture. Ted gained valuable experience as a young engineer working on the cables for stabilising the massive glass screen at Coventry Cathedral.

Coventry Cathedral
Engr: OAP
Arch: Sir Basil Spence
Date: 1955-60



Yale Ice Hockey Rink
Engr: Severud
Arch: E Saarinen
Date: 1958

From 1959-61 he spent a short period away from Arups working for Severud, Elsted & Krueger in New York, mainly on concrete residential buildings. While there he first encountered the tension structures in the pioneering cable roofs that Severud had worked on – the Raleigh Arena with Nowicki, and Yale ice hockey rink and Dulles airport terminal with Saarinen.

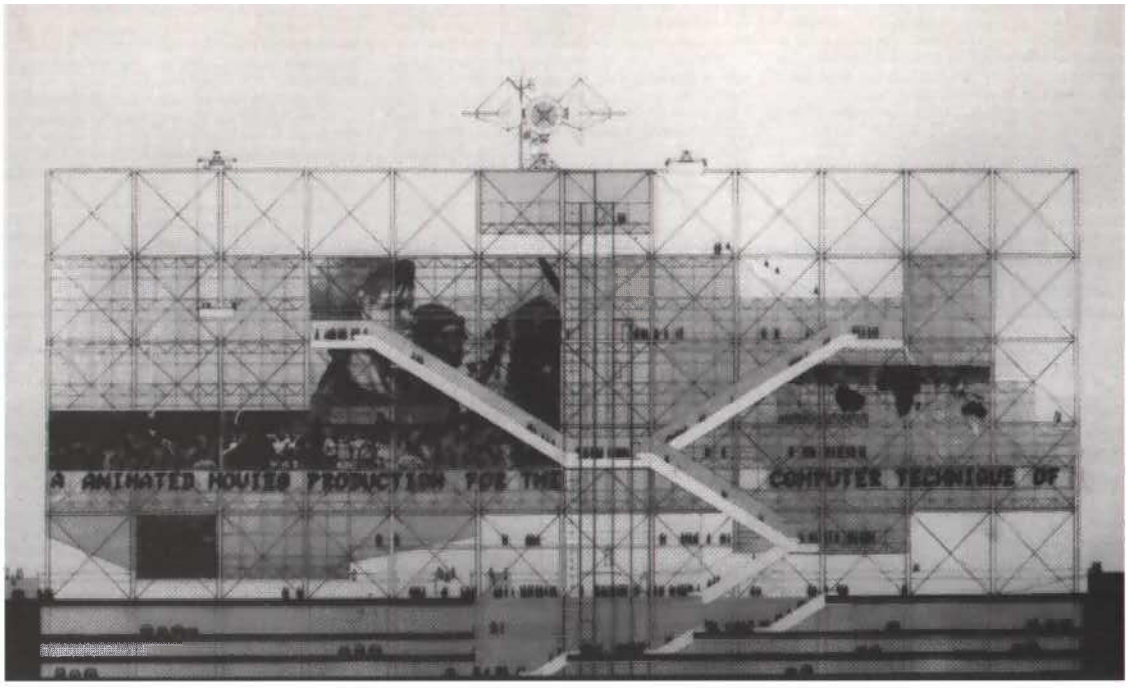
Ted's cylindrical slide rule

At Severuds Ted worked alongside Robert Silman, who later joined him at Arups for a while.

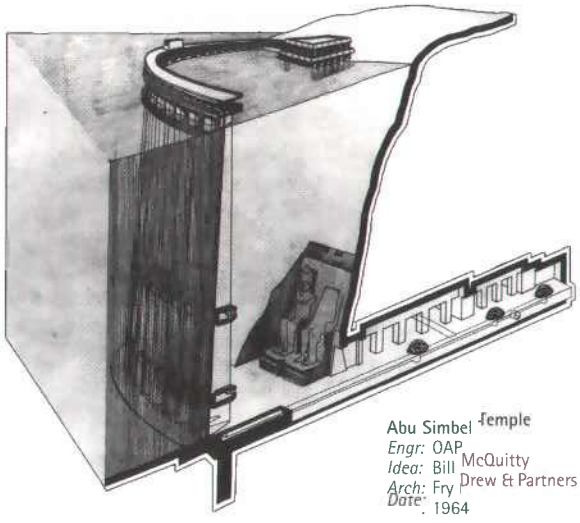
My first vision of Ted was in 1960 in Severud's office in New York. He was sitting at a drawing table manipulating a tubular brass instrument that looked like a telescope, pulling and pushing it in and out, twisting it left and right. When I finally had the temerity to ask what he was doing he promptly replied that he was making very precise calculations with a cylindrical slide rule. This was, of course, in the days before computers or hand-held calculators. Ted explained that if one were to unroll the surface of the cylindrical slide rule it would be three times the length of our normal 10-inch straight rules.

If I have achieved any measure of success professionally, a large part of the credit is due to his encouragement. For Ted, anything was possible and over the years during our many conversations he succeeded in convincing me that I could achieve whatever goals I set for myself.

Robert Silman, colleague at Severud, Elsted & Krueger,
now Senior Partner of Silman Associates in New York



Pompidou Centre
Engr: OAP
Arch: Richard & Su Rogers, Renzo Piano
Date: 1971-75



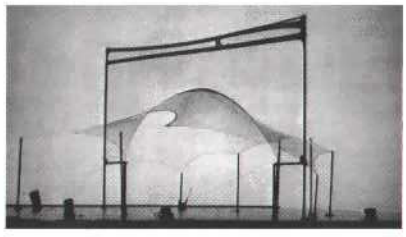
Abu Simbel Temple
Engr: OAP
Idea: Bill McQuitty
Arch: Fry Drew & Partners
Date: 1964

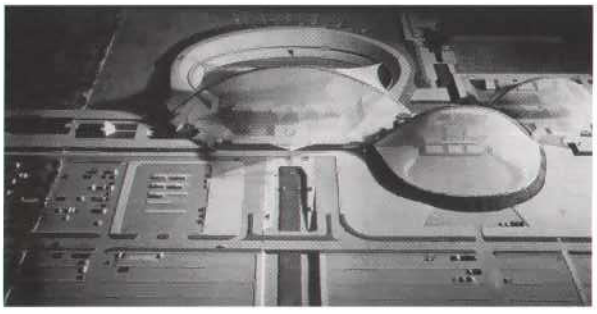
Back at Arups he worked on more buildings by Sir Basil Spence and on his first buildings with Trevor Dannatt and with the London Borough of Lambeth.

In 1968 the internal structure at Arups was reorganised. Povl Ahm was responsible for the group that came to be known as 'Structures 3' and Ted Happold became its executive Partner with Michael Barclay as Associate responsible for Project Management, and Peter Rice, Associate responsible for Analysis. Under Ted's leadership this division gained a reputation for producing unusual and imaginative structures, including many in collaboration with Frei Otto. Perhaps the most remarkable building to come out of this group was Beaubourg in Paris – it subsequently became the Pompidou Centre, after that president's death. It was largely Ted's initiative, enterprise and energy that turned the project from a competition-winning scheme into a real building.

Despite its reputation for innovation, Structures 3 continued to produce a large number of more conventional buildings, including several projects with Sir Basil Spence and Trevor Dannatt and more than thirty with Lambeth.

Ted's enthusiasm for competitions provided Structures 3 with the opportunity to work on a great many unusual and innovative structures. Beaubourg was one; another was a proposal by Bill McQuitty to provide an underwater viewing platform for the statues at Abu Simbel in Egypt that were to be immersed beneath the waters of the Aswan Dam.



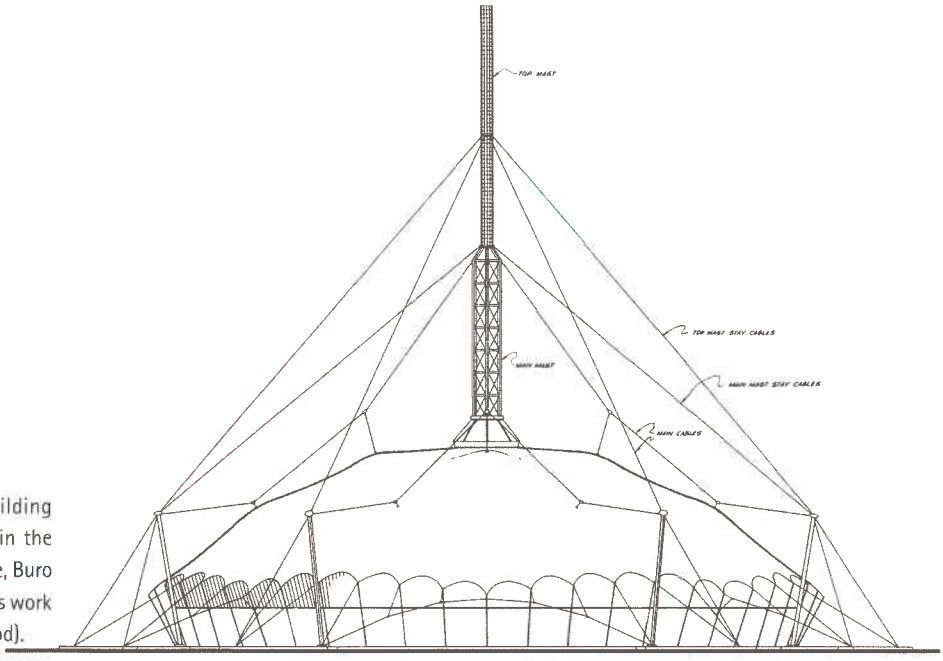


The collaboration between Ted and Frei Otto was particularly stimulating and fruitful and, in 1973, Arups and Otto formed the Lightweight Structures Research Laboratory as a focus for this work. Two results of this collaboration were schemes for a canopy at the Smithsonian Museum and, with Kenzo Tange, for a sports stadium in Kuwait.

Kuwait Sports Centre
Engr: OAP
Arch: Kenzo Tange with Frei Otto
Date: 1969

Smithsonian Museum Tent
Engr: OAP with Frei Otto
Date: 1973

1976-96 HIS TIME AT BURO HAPPOLD



In 1976 Ted accepted the chair of Building Engineering at the University of Bath and, in the same year, left Arups and set up a new practice, Buro Happold (the choice of 'Buro' came out of Ted's work in Germany, especially with Buro Rolf Gutbrod).

The practice has undertaken an enormous range of projects, not only in Britain, but Germany, the Far East, the USA and, especially, in Kuwait and Saudi Arabia. Under Ted's guidance, Buro Happold has grown to 200 staff with four UK offices and five overseas. It has worked with many eminent architects including several – especially Trevor Dannatt, Frei Otto, Derek Walker, Rolf Gutbrod, Theo Crosby, Richard Rogers, Richard Burton (of ABK) and Ted Cullinan – who became close personal friends. A great many projects on which the practice has worked have gained awards.

At the University of Bath Ted evolved a unique educational system in which architectural and engineering students share a core of the undergraduate studies. He also formed the Wolfson Group researching into air-supported structures and was the driving force that led, in 1990, to the establishment of the Centre for Window and Cladding Technology which has become Britain's foremost institute in this field.

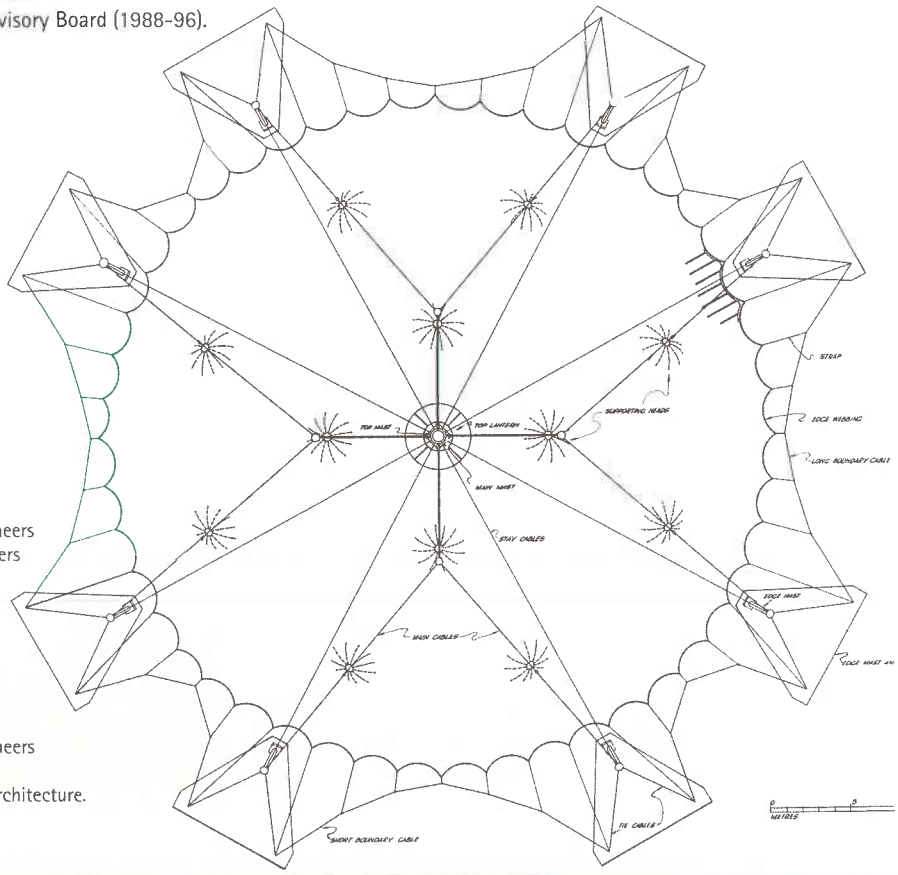
Apart from his work in the practice and at the University, Ted was tireless in his other activities. He chaired the committee in the Institution of Structural Engineers that produced the Appraisal of Existing Structures in 1980 and was a member of the Poppelwell inquiry into the fire at Bradford Football Stadium. Following this he formed the Institution of Structural Engineers' working party on the Appraisal of Sports Grounds. It was after his year as president of the Institution of Structural Engineers that he had the vision to conceive, and the will to bring about, the Construction Industry Council, which he chaired from 1988 to 1991. He sat on both the Property Services Agency Advisory Board (1981-86) and the Building Regulations Advisory Board (1988-96).

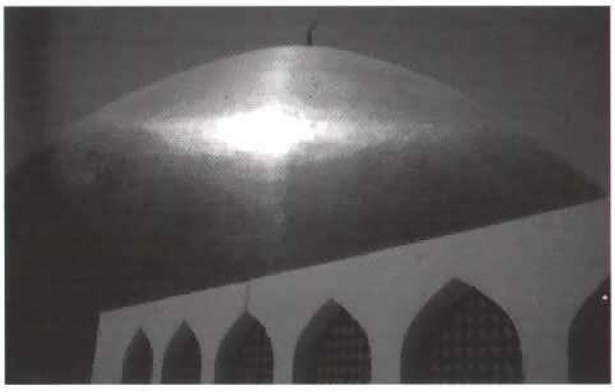
Challenge to British Genius
Engr: Buro Happold
Arch: Theo Crosby/Pentagram
Date: 1976

One of the first projects that Buro Happold took on was a small exhibition tent with Theo Crosby at Pentagram. Its humped form has echoes of the BP Forties Tent that Ted had done at Arups with Frei Otto.

Of his many honours and awards, Ted was, perhaps, especially proud of the following:

1969 Fellow of Institute of Building
1976 Henry Adams Award (IStructE)
1977 Oscar Faber Medal (IStructE)
1982 Leslie Murray Medal (CIOB)
1983 Royal Designer for Industry
1983 Elected to the Fellowship of Engineering
1983 Honorary Fellow of the RIBA
1986-87 President of the Institution of Structural Engineers
1987 Fellow of the Hong Kong Institution of Engineers
1988 Eiffel Medal (Ecole Centrale de Paris)
1988 Kerensky Medal (IABSE, ASCE, IStructE)
1988 Honorary Fellow of the Chartered Institution of Building Services Engineers
1988-91 Chair of the Construction Industry Council
1988-94 Member of the Design Council
1992 Master of the Royal Designers for Industry
1992 Gold Medal, the Institution of Structural Engineers
1993 Fellow of the Royal College of Art
1994 Knighted for his services to engineering and architecture.





Ted developed a particular affinity for the Arabic people and culture. He numbered many among his friends. One was Khalid al Marzook who was influential in helping Buro Happold become the engineers for the Al Marzook Centre for Islamic Medicine in Kuwait, comprising a research institute and mosque for a thousand people.

In order to undertake the massive Tsim Sha Tsui Cultural Centre the practice opened an office in Hong Kong. As well as the centre they also undertook an aviary and the redevelopment of Kowloon Park.

Ted always enjoyed competitions and was particularly pleased to win the competition at Vauxhall Cross working with Sebire & Alsop. He was the sole engineer on the scheme and derived great satisfaction in applying the full breadth of his engineering, architectural, planning, social and economic skills to the project. Like many others, this one failed to materialise.

How does Happold see the Royal Designers for Industry? He stresses the commonality of method which unites the different disciplines of graphic designer, engineer, product designer, typographer, stamp designer, book designer, fashion designer and others. From Jean Muir's RDI address in 1983 he discovered that the way she worked on fabrics was similar to his own approach on his projects: they valued the same steps in the processes in which they were engaged. 'We all have a craft as well as an intellectual element in our work,' he says.

Sarah Curtis, editor of *RSA Journal*, February 1992

Al Marzook Centre for Islamic Medicine, Kuwait
Engr: Buro Happold
Arch: I E Zekaria Partnership
Date: 1979-87

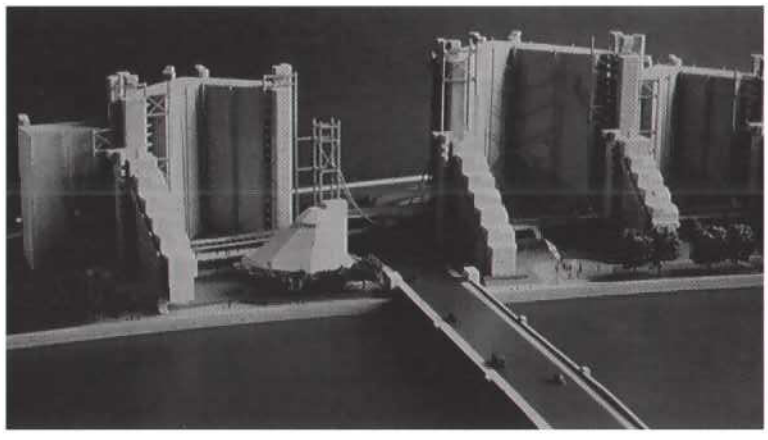
It was not just the inspiration, insight and enjoyment that he invariably brought into design discussions that was so valuable, but also his astute political sense and tenacious diplomacy in much wider policy and organisational debates.

When it came to founding the Construction Industry Council, Ted needed all these qualities and more in order to bring together the essential partners and achieve not just the official launch but positive progress afterwards, so that remaining doubters could be convinced and initial scepticism countered. Ted himself always said that, like all construction projects, setting up the CIC was a team effort and, indeed, it could never have been achieved on any other basis. The fact remains, however, that it was Ted's vision and initiative that provided the first spark and his leadership, good humour, expertise and freely given time that were so often crucial to success.

Hugh Johnston, former Honorary Treasurer to the CIC

Tsim Sha Tsui Cultural Centre, Hong Kong
Engr: Buro Happold
Arch: Hong Kong Public Works Dept. Architects
Date: 1981-89

Vauxhall Cross
Engr: Ted Happold
Arch: Sebire & Alsop
Date: 1982



SIR BASIL SPENCE

Ted had met Sir Basil Spence while a student at Leeds. Throughout his time at Arups Ted worked on a number of projects with Spence's practice – first as a young engineer, on Coventry Cathedral; later on the new science buildings at Exeter University; and in Structures 3 (the Group that Ted led in Arups) Kensington Town Hall and the two projects on which he was most involved, the Knightsbridge Cavalry Barracks and the British Embassy in Rome.

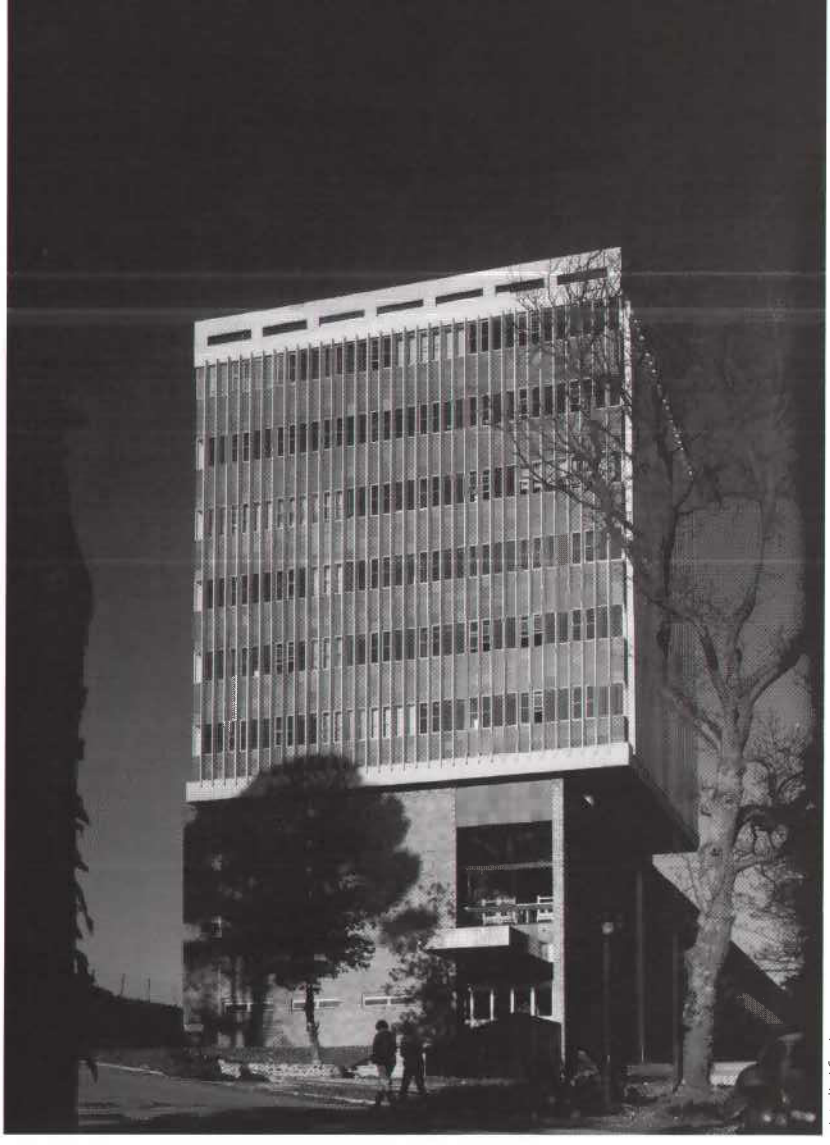


photo: Henk Snoek

Science Building, University of Exeter
Engr: OAP
Arch: Sir Basil Spence Partnership
Date: 1960-65

Kensington & Chelsea Town Hall
Engr: OAP
Arch: Sir Basil Spence, Bonnington & Collins
John S Bonnington Partnership
Date: 1955-60

photo: Arup

photo: Brecht-Einzig Ltd

Knightsbridge Barracks
Engr: OAP Structures 3
Arch: Sir Basil Spence Partnership
Date: 1960-70

Ted on Knightsbridge Cavalry Barracks

I believe the Cavalry Barracks is a good building because it is a building occasion. There is a whole picture in everyone's mind of changing the guard, of ceremonial, of trooping the colour. People expect the Household Cavalry to have a building of value – individual, idiosyncratic and unique. Scale is part of that; in a way the tower is necessary for the imagery people need. Yet it is the small scale invention and complexity which creates enjoyment for people and this building has it.

Arup Journal, September 1971

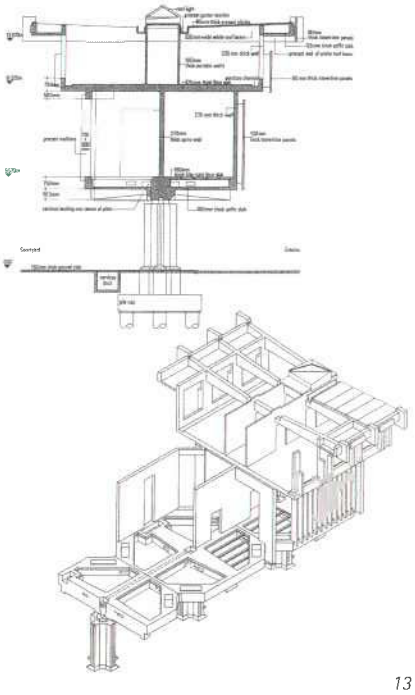
photo: Brecht-Einzig Ltd

Designing the temporary stabling at Wellington Barracks at that time was extremely useful in the element design of Knightsbridge Barracks. If a client wants something and the designer has a chance to produce a solution and watch the client use it, then it is probable that the client will get a better solution the next time. It was also useful because it is not very common for architects and engineers to be asked to design stables. Literature on the subject tends to be conservative and does not usually cover why something is done, but only that it works. For example, the live loads horses apply to structures are ill-defined in Codes of Practice. The consultants had to discover that a charger is an officer's mount and so is bigger than a trooper's horse. The largest horse is a drum horse, which carries two kettle drums on parades. These horses may weigh over a ton and it was soon obvious that all columns had to be designed for possible impact of either rump or hoof of the largest of these. The risk of a horse injuring itself against a structural member is also important and in some areas timber cladding was imperative.

Paper at Public Works and Municipal Services Congress, 1970

photo: C Bruno De Hamel

British Embassy, Rome
Engr: OAP
Arch: Sir Basil Spence Partnership
Date: 1961-71



Ted Happold on the Rome Embassy

At the time we were first shown this building – and it was during a meeting with Ove Arup and Povl Ahm which I attended as the junior member – the building looked as though it sat on the cruciform beams. I think anybody who read the analysis section of the paper will realise that it would have been very easy to have designed this building if it had been carried purely on the cruciform beams at first floor level. At the time of the preliminary design the architect put a very strong case that he did not want to increase the depth of these beams and I think we congratulated ourselves when we had the idea of using the first floor, second floor and spine wall as an I beam. I think if we had realised what we were getting into, we would not have been so pleased. I almost retitled this paper 'How we tried to reduce the stresses of Beam 1 and Beam 2' because that is practically how the analysis ended. Speaking personally I believe we should have fought much harder to have those cruciform beams made deeper. By that I do not mean that it is a bad building structure – I just mean that it would have been much easier to have analysed.

The Structural Engineer, June 1971

TREVOR DANNATT

photo: Frank Donaldson

Bootham School Hall
Engr: OAP
Arch: Trevor Dannatt & Partners
Date: 1962-64

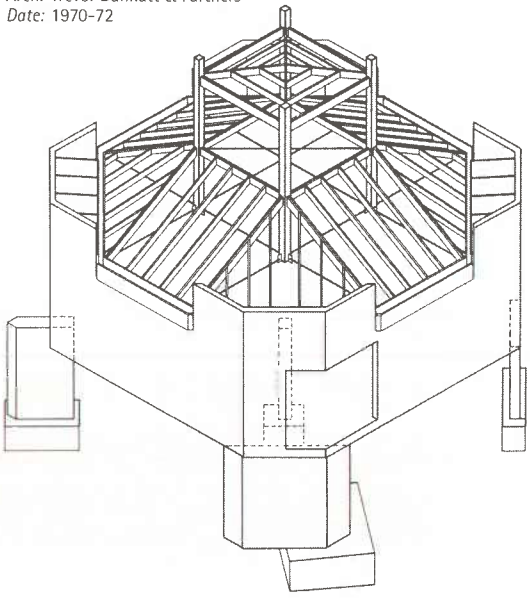
In 1963 Ted Happold noticed one day that a project had come into Arups for a new assembly hall at Bootham, the Quaker School he had attended in York, and he asked if he might take on the job. This request was granted and so he came to meet and work with Trevor Dannatt, a relationship that was to continue over a number of projects that were important for Ted and which developed into a close friendship between the two.

In a later collaboration, Ted, with Ian Liddell in Structures 3 at Arups, had the opportunity to make his contribution to the design of another building very close to his heart – a Quaker meeting house at Blackheath.

Quaker Meeting House, Blackheath, London
Engr: OAP
Arch: Trevor Dannatt & Partners
Date: 1970-72

The secondary constraints which are discovered during analysis have implications on the original proposal. Bootham was really an exercise in deflections, the engineers refusing to do it unless the architect dispensed with glazing bars. The resulting window strip round the hall posed a nice problem in cambering, to cope not only with time deflections but also with visual distortions, i.e. the tendency to 'see' the corners drooping.

International Conference on Space Structures, University of Surrey, 1975



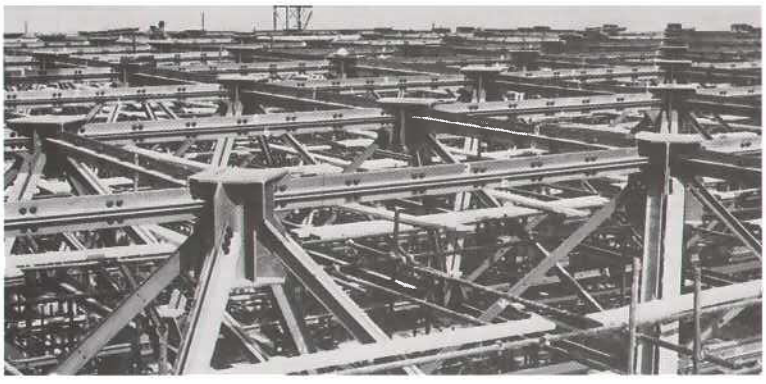
Ted Happold on Bootham School Assembly Hall

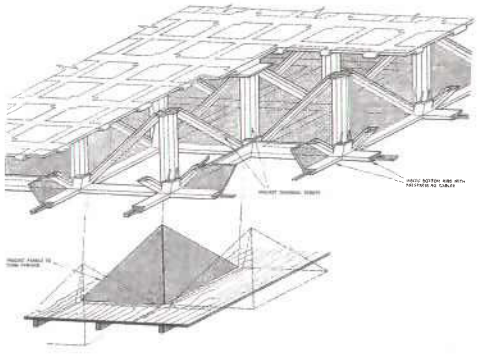
I think the most satisfying building that our group (at Arups) worked on last year (1964) was an assembly hall for Bootham School in York. There are two reasons for this feeling. Firstly my family have many connections with the school and I was a pupil there myself. Secondly I found a great understanding and sympathy for what the architect was trying to achieve. And, by and large, I feel that he has achieved it.

The roof was really the first part of the building designed. Trevor Dannatt felt that it was important, in order to be able to achieve a uni-directional feeling in the hall related to the stage and a centralised feeling related to worship, to form a higher central roof with clerestory lighting right round it and wished the hall itself to have no columns through it.

Arup Journal, March 1966

photo: Henk Snuck





Hotel & Conference Centre, Riyadh
Engr: OAP
Arch: Trevor Dannatt & Partners
Date: 1966-73

The story of our [Arup's] entailment in Saudi Arabia dates back to 1966 when Trevor Dannatt joined a group of us entering for the United States Steel Bridge competition. Trevor must have enjoyed it because when, immediately afterwards, he was asked to take part in a limited (UIA) competition for the design of a conference centre and hotel for Riyadh in Saudi Arabia, he asked us to join him.

Our entry went off and we half forgot about it until a cable arrived, rather to Trevor Dannatt's horror, asking him to build the Riyadh project and to come out to discuss it. So on New Year's Day 1967, Trevor Dannatt and Ted Happold went out. They were in Riyadh about three weeks and there met Professor Rolf Gutbrod, with some of his staff who, in partnership with Professor Frei Otto, had also been a competitor and who was asked to build his scheme in Mecca. Obviously many of the problems of the two projects were the same and when Rolf Gutbrod and Frei Otto asked us if we would be their engineers as well, we agreed and jointly signed the contracts on both buildings.

Arup Journal, September 1971

Riyadh was a great achievement, both technically and in overcoming the difficulties that always arise when working in an unknown culture and construction environment – this project was started at a time when very few Europeans were working in Saudi.

One of the main sources of technical problems was the large temperature changes that occur between night and day – a particular difficulty for large areas of concrete, both during construction and afterwards. The roof over the auditorium was a steel space truss, the design of which was largely driven by the joint details and the tolerances needed for assembly. A particularly ingenious solution was found for supporting the roof. In order to carry wind loads and yet be able to accommodate large expansion movements the columns were given thin rectangular sections so they could bend easily in one direction but not the other.

Some years later, in 1982, Riyadh was the location for a further collaboration between Trevor Dannatt and Ted, now with his own practice.

British Embassy & Housing, Riyadh
Engr: Buro Happold
Arch: Trevor Dannatt & Partners
Date: 1981-86

LAMBETH - TED HOLLAMBY ET AL

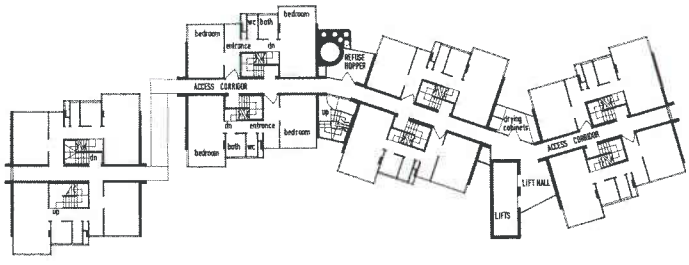
Ted's mother, Margaret Happold, also a Quaker, was for many years a Labour member of Leeds City Council, during which time she was chair of the Housing Committee. In the 1930s, when Ted was a young boy, she had taken an active part in the massive campaign to clear the slums in Leeds, one result of which was the building of Quarry Hill Flats. These events had a great influence on the development of Ted's feelings of social responsibility and this clearly drove Ted in his approach to many of his jobs. It was, perhaps, best manifested in the long-standing relationship that Ted helped build up between Arups and Lambeth, and with Ted Hollamby in particular. In a period of about a decade he was involved in more than thirty projects in various capacities.

The project at Central Hill was a massive residential development with accommodation for more than 500 families.

Central Hill Housing
Engr: OAP
Arch: Ted Hollamby, Lambeth Borough Council
Date: 1965-73

photo: Sam Lambert

Mixed Development, Lambeth Road
Engr: OAP
Arch: Ted Hollamby, Lambeth Borough Council
Date: 1965



Apart from being another interesting project, the Library at West Norwood held a special place in Ted's life for it was where the wedding reception was held after his marriage to Evelyn Matthews in 1967.

West Norwood Library
Engr: OAP
Arch: Ted Hollamby, Lambeth Borough Council
Date: 1964-69

photos: Eric de Maré

ROLF GUTBROD

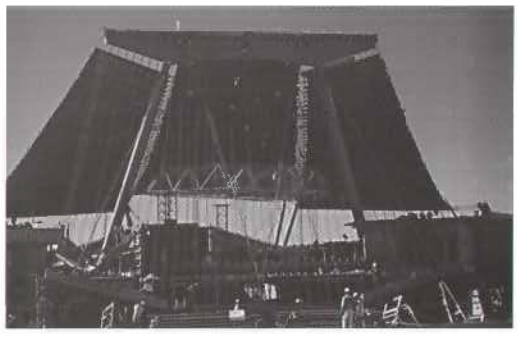
Rolf Gutbrod had been the architect, working with Frei Otto, for the German Pavilion at Expo '67 in Montreal. Ted Happold first met them in 1967 as joint winners of the UIA competition for a conference centre in Saudi Arabia. Dannatt and Arup's scheme was to be built at Riyadh and Gutbrod invited Structures 3 to engineer his scheme at Mecca – a typical example of the way Ted managed to inspire enthusiasm in others.

Hanging cable net structures were direct descendants of Severud's structures with Saarinen, with their stability achieved by virtue of their own self weight. Their design was a particular challenge – in the days before form-finding software and non-linear analysis programs, models and hand-calculations were all there was to rely on.

Gutbrod's method of working was unusual. His practice had a total application to the process of building and insisted on full co-operation between architect and contractor from the very beginning of the project. He was thus able to develop unique results specific to local building methods and materials.

A particular complication for the Arup team was that, being non-Muslims, and the site being in Mecca, they were not allowed to visit it during construction. Monitoring of the operations by remote TV cameras was investigated but, in the event, satisfactory results were achieved using intermediaries and good site photographs.

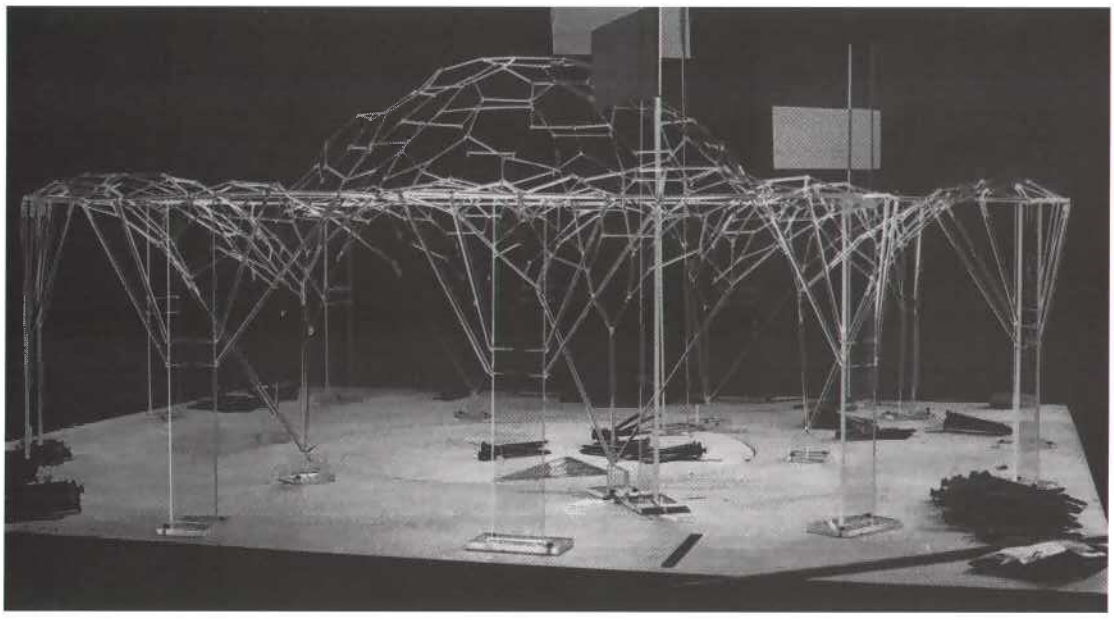
The project won the Aga Kahn Award for being 'the most technically innovative building of a decade in the Muslim world'



Conference Centre, Mecca
Engr: OAP
Arch: Büro Gutbrod, Frei Otto
Date: 1967-73

A similar experimental approach was adopted for the scheme for government buildings in the Kingdom of Saudi Arabia – the King's Office, Council of Ministers, Majlis Al Shura complex (KOCOMMAS). Samples of shading structures and other components were made and tested, from the architectural point of view, from the earliest stages in the project. The greatest technical challenge was the project's three domes, the largest of which was to be 92 metres in diameter. The funicular shape was derived, in the first instance, from models made by suspending networks of rods and then by using Arup's newly-developed dynamic relaxation computer software.

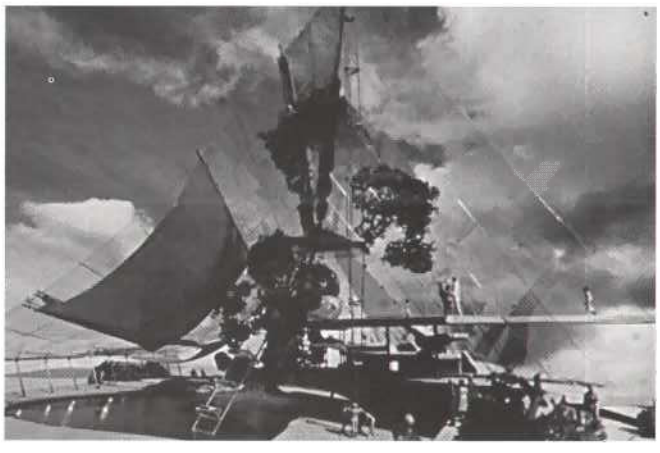
The project began at Arups not long before Ted left to form Buro Happold. It was a mark of the close friendship between Ted and both Gutbrod and Otto that the project was renegotiated to incorporate the new firm alongside Arups and to provide it with a challenging project as one of its first jobs. Sadly King Faisal, who had commissioned the original building, died and the project was never undertaken.



KOCOMMAS (King's Office, Council of Ministers, Majlis Al Shura
Engr: OAP, later Buro Happold
Arch: Büro Gutbrod with Frei Otto
Date: 1976-79

Badensweile
Engr: OAP
Arch: Büro Gutbrod, Frei Otto
Date: 1973

Another collaboration between Ted, in Structures 3, and Gutbrod was an imaginative scheme for the climatic control of the baths at a health spa in Germany. It was planned to use solar heating to warm the water – at a time before many people were thinking of such things.



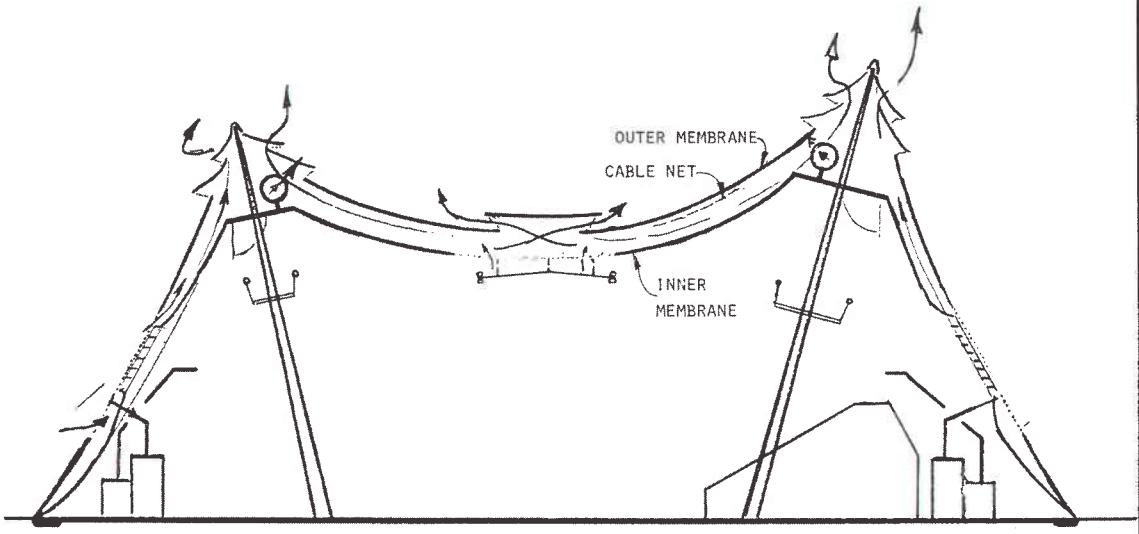
FREI OTTO

Within the last few years I have lost four of my friends – Bucky Fuller, Ove Arup, Peter Rice and now Ted. Among these four gentlemen Ted was in my opinion the greatest. He was so human, so understanding, sympathetic and appreciative. He belonged to the so-called silent geniuses who never advertise themselves but always help others to enter upon friendly relations. Ted had a good feeling and taste in arts. He was a man of science living in the world of history and arts. I will never forget his advice when we tried to find the form of our buildings. He was often the central figure at finding the beauty of a building without making compromises.

Professor Frei Otto

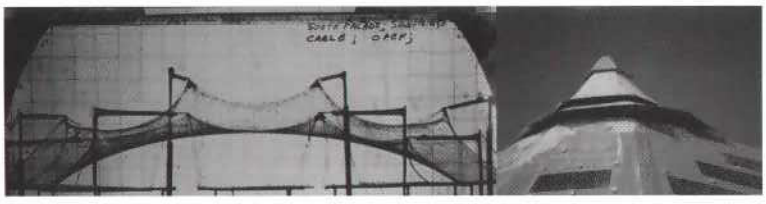
Having met Frei Otto through Rolf Gutbrod, Ted went on to work on many other projects with him, sometimes in collaboration with other architects. Arups was approached in 1975 to provide a temporary structure for the 1,000 people attending the opening ceremony in Aberdeen of the BP Forties Oil Field. With the total time for design and construction at ten weeks, the design process had to be very streamlined. A humped tent was developed to give adequate rigidity in the windy climate, first with Otto using 1:200 and 1:100 models for form-finding and geometric patterning, and then using quite simple calculations based on the experimental studies to increase confidence about the structural behaviour.

Dyce tent, Forties Field
Engr: OAP
Arch: Design Research Unit, Frei Otto
Date: 1975



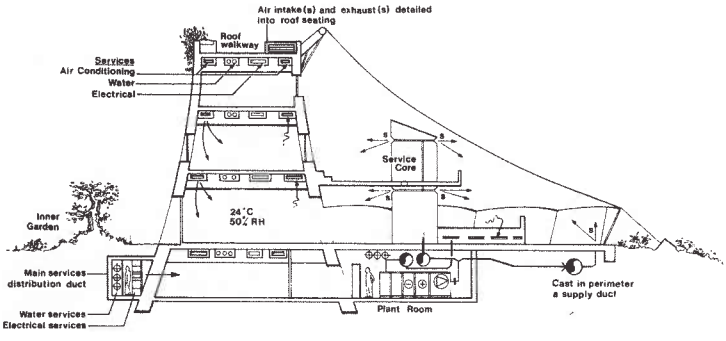
The sports hall for the King Abdul Aziz University was another collaboration project with Rolf Gutbrod and Frei Otto, this time with Ted at Buro Happold. After the project's budget had been drastically cut, the only building to be completed was a massive tent designed to cover a playing area of about 85 x 40 metres and providing seating for approximately 2,300 spectators.

The roof covering is a cable net structure supported by masts which support two parallel PVC fabric tensile membranes – the space in between serves both to insulate and to allow ventilation of the interior space. Its innovative architecture and unprecedented size could only be developed by close collaboration between Gutbrod and Buro Happold with the invaluable form-finding modelling by Frei Otto at the Institute of Lightweight Structures of Stuttgart University. As it was undertaken before modern analysis and form-finding software was available, the most efficient form first had to be found experimentally using soap bubble models – some as large as a metre in length. Arups designed the foundations and the concrete reinforced seating structures.

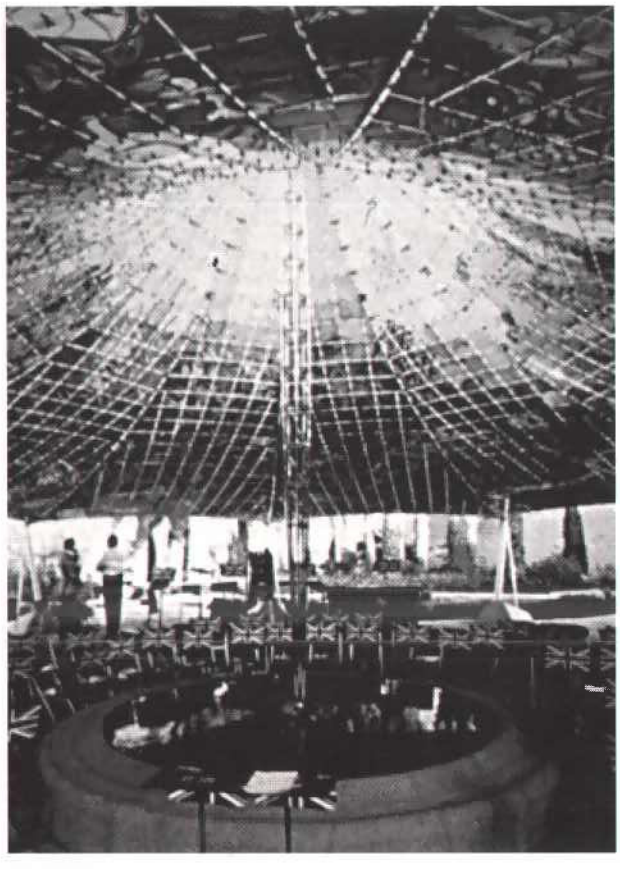


King Abdul Aziz Sports Centre, Jeddah
Engr: Buro Happold (tent)
OAP (concrete & foundations)
Arch: Büro Gutbrod with Frei Otto
Date: 1976-79

Another major project with Frei Otto, this time in collaboration with Omrania Architects, was the Diplomatic Club in Riyadh. Again experiments by Otto helped establish the forms of both the tension structures and the compression structure of the 'wall' – a ribbon building surrounding the central garden which contains most of the rooms. Thus the local architectural traditions were respected while achieving a thoroughly modern building with full internal environmental control.



Tuaig Palace (Diplomatic Club), Riyadh
Engr: Buro Happold
Arch: Omrania with Frei Otto
Date: 1981-86



BEAUBOURG 1971 - 6

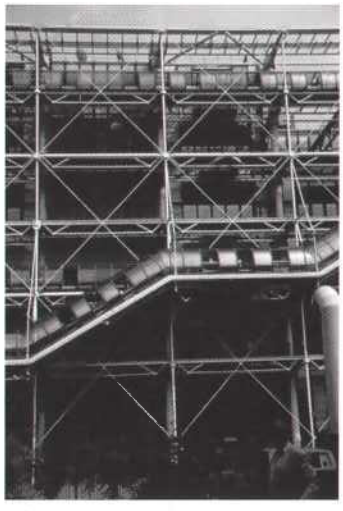
Early in 1971 the French Government announced an architectural competition for the design of the Centre Beaubourg, a big cultural centre for Paris. The brainchild of President Pompidou, it was intended as the great centre of artistic exchange both for Paris and the whole of France.

At the time I was the Executive Partner of Structures 3, Ove Arup & Partners, and we asked Richard and Su Rogers if they would be interested in entering the competition with us. The Rogers brought in Renzo Piano, an Italian architect, as the two practices were merging. The calibre of the judges, including Philip Johnson, Jørn Utzon, Oscar Niemeyer and Jean Prouvé as Chairman, ensured a high standard of judgement. We felt that the French love of originality would enable an unusual answer to be accepted…

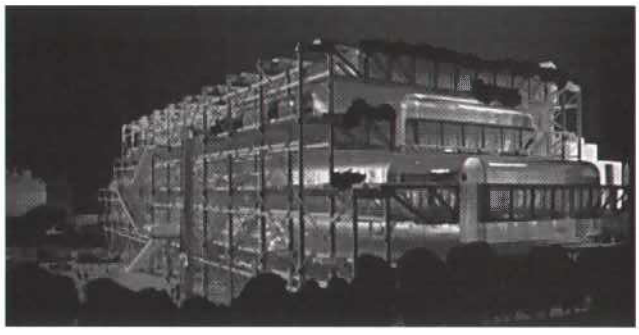
The vertical structure was provided by two 'walls', longitudinal bays assembled from elements which would be used for the information displays and, at the rear, for services as well. Between these bays was a 48m span, within which hung sections of floor which could be raised and lowered within the 'walls', so providing maximum flexibility. The steel structure was to be exposed [an unusual idea in 1971], fire-proofing being provided by water-cooling, heat-shielding, or intumescent paint [for the main trusses].

Ted Happold in *Architectural Design*, February 1977

Ted set up and was responsible for Arup's office in Paris from 1971 to 1973 as the competition scheme was developed by a whole team of engineers including Peter Rice, Michael Seargent and Lennart Grut. Ted also directed the interviewing and appointment of many of the sub-contractors. Even Ted, however, did not manage to win over the French to their idea of protecting the steel trusses using intumescent paint. He would be pleased to hear that, in the recent refurbishment of the structure, the original bulky fire protection has been removed to reveal the slender steel sections which are now protected in the manner originally proposed.



Centre Pompidou
Engr: OAP
Arch: Richard & Su Rogers, Renzo Piano
Date: 1971-76



The logic of the structure [of Beaubourg] was that we would build exposed steel scaffolding – like a Victorian structure, Crystal Palace, or a petro-chemical refinery. The reason that the concept of such a simple structure had disappeared [in some early schemes] was firstly because of the need for fire protection … and secondly because of the problems of protection against rust.

So our design provided fire protection by [a combination of techniques including] having the main columns water-filled and the main trusses covered with intumescent paint. . . . The joints would be cast – partly because castings not only develop a patina but perform well in fire and can be made massive enough to be exposed, and partly because they could now reflect the 'human hand' reasonably cheaply since the moulds could be hot-wire cut from polystyrene.

In 1969, Structures 3 (at Arups) had helped Kenzo Tange and Frei Otto win the Kuwait Sports Centre Competition. Tange's partner, Koji Kameya, and I spent an August in the almost empty Hilton Hotel in Kuwait, meeting with the Minister of Works for half an hour a day. It is a 'dry' country but fortunately I had friends there who supplied us with the necessary brandy, whisky and gin, so we spent the rest of our time alternating between ten pin bowling and long, long drinking and discussion sessions on our balcony, talking about engine block castings – and how we would use the idea for structural joints. Kameya went off to use it for the joints of the space frame roof for Osaka and I took the idea back to use on the structure for the Beaubourg competition.

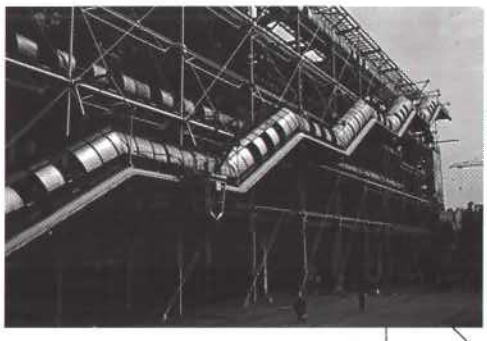
From Ted's book review of *An Engineer Imagines* by Peter Rice, in *RSA Journal* 1995

We, the engineers – Ted Happold and I – were not the main stars: that was the role of the architects. But we had our role, we were part of the team, accepted, necessary, stars-to-be perhaps. It was very exciting. . . . In those first three months we had talked ourselves into a real role as engineers; now we had to deliver.

This was not how the French Government planned it should be. They foresaw French engineers and architects as the executive designers with the competition winners around to ensure that the intentions of the design were maintained. We argued that in a design like ours it was all in the detailing. It was impossible to separate execution from intention.

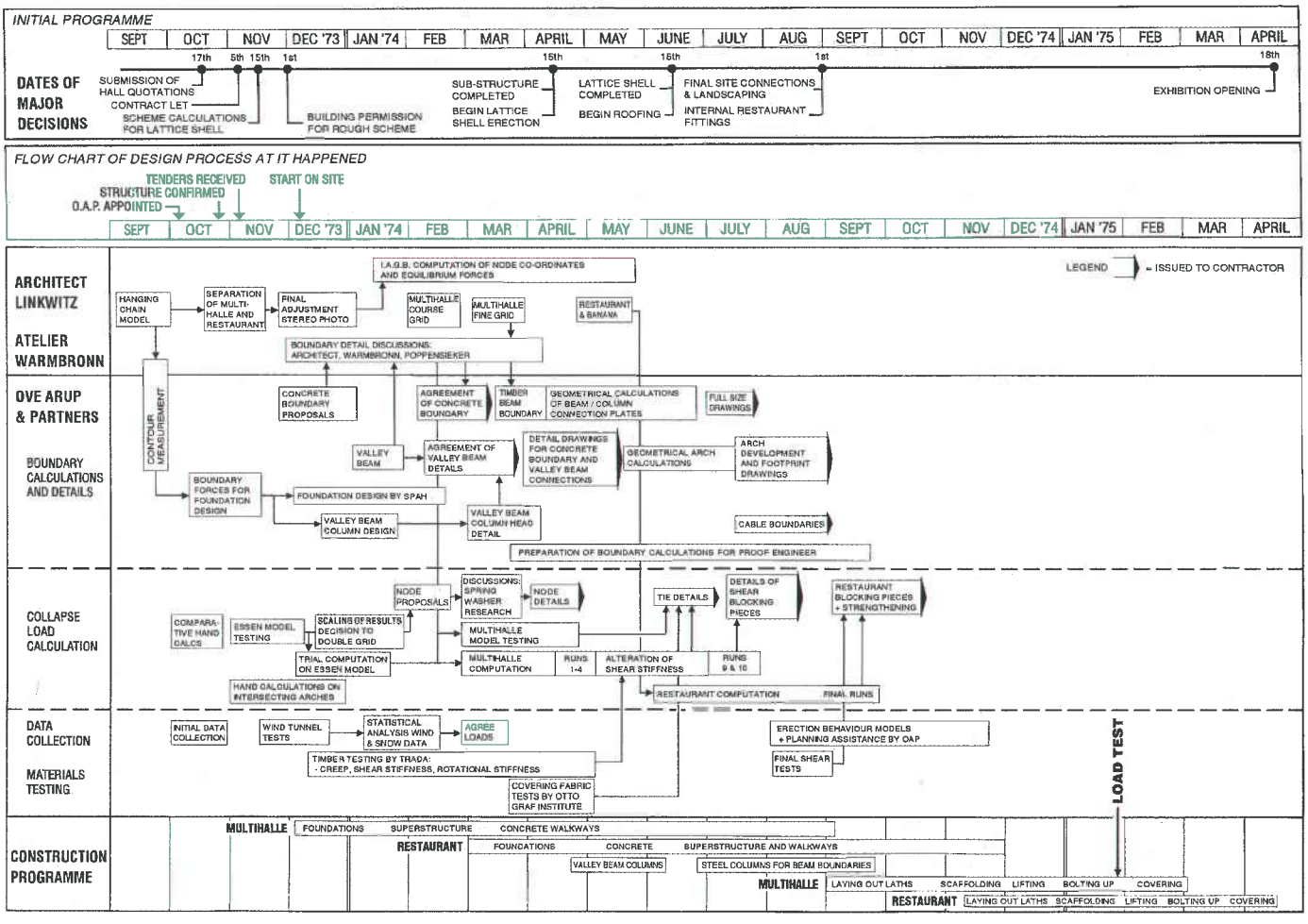
The negotiations with the client and the authorities, with Ted Happold representing Arups, were complex and hard. I was slowly realising the scale of the task we were so blithely insisting we could do. . . . The essential engineering problem was becoming clear: a large, 44.8m span, carrying a heavy library, which could occur anywhere in the building.

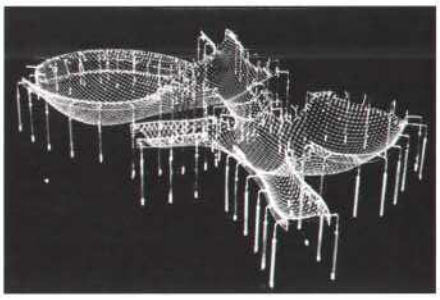
Peter Rice in *An Engineer Imagines*, Artemis 1994



Structural scheme by Ted Happold and Peter Rice in competition entry

MANNHEIM BUNDESGARTENSCHAU (GARDEN FESTIVAL) 1973-75



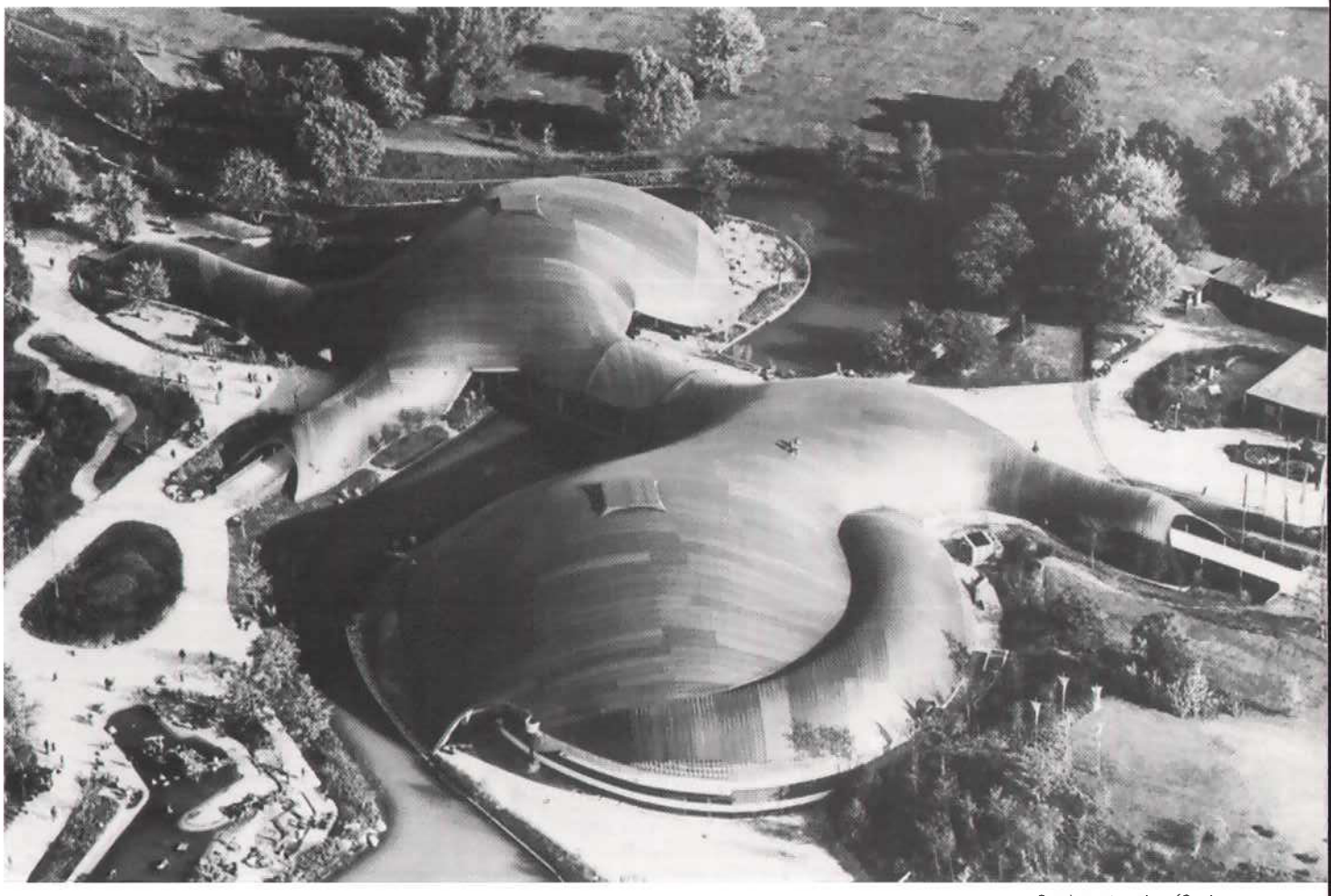


One of the most remarkable buildings to come out of Structures 3 at Arups was the exhibition hall and restaurant building for the Mannheim Bundesgartenschau with architects Carlfried Mutschler & Partners and specialist input from Frei Otto.

The architects' competition scheme had shown the hall as a tent supported by balloons. In the light of local building regulations this scheme was not considered feasible and Otto suggested a grid-shell – a free-form curved surface created using stiff rods, like a hanging cable net structure, but inverted. The span would be unprecedented – about 60 x 80 metres for the larger hall; the material would be timber.

The principal question was what to do when faced with a type of structure upon which there was no existing knowledge to draw; all this while constrained by money and a deadline just seventeen months away. Ted realised that it would be necessary to plan carefully an entire research programme, not only into the technology of the material and unusual construction methods but also into the very way in which the structure could be designed – a genuine case of 'designing from first principles'. Furthermore the research programme would have to converge towards a goal in a predictable and controllable way.

In completing this project Ted and his colleagues made a valuable contribution to our understanding of the nature of design – just what it is that engineers are doing when they design and how it is they can progress from initial, often vague concepts towards ever more precise and workable solutions.



Bundesgartenschau (Garden Festival), Mannheim
Engr: OAP
Arch: Buro Mutschler Et Partners, Frei Otto
Date: 1973-75

[It is widely held] that the design process is cyclical and convergent, one in which the broad outlines of the problems are tackled first, and then the subsidiary ones. The authors now doubt that this is really so.

We believe that the design process can be seen as a series of decisions which lead progressively towards the built reality. Each decision is made to satisfy the known requirements at that stage and to take into account those items of information which require further analysis before they can be fully defined. We believe that the process is a stage-by-stage one, and that the process in each stage can be described in the same terms – even though the content of each stage is different.

The need for communicating the reasoning and philosophy behind the decision is paramount. If this cannot be communicated then it is more than likely that difficulties will arise in the future. The corollary is that the decision must be communicable.

Ted Happold, Ian Liddell and Michael Dickson
'Design Towards Convergence', *AD* July 1976




In 1986 Ted Happold was elected President of the Institution of Structural Engineers. He began by suggesting that all presidents make the same speech. Characteristically he then contradicted himself and proceeded to deliver a unique address. He entitled it 'Can you hear me at the back?' alluding to the fact that many structural engineers choose to take a subordinate role in the processes of designing and constructing buildings. He used the address to convey a rare appraisal of what good structural engineering is all about and, by implication, what more people in the industry should aspire to and achieve. He touched on many points, but much was directed towards the subject that preoccupied him for most of his working life – education; the process of becoming an engineer.

Can you hear me at the back?

Presidential Address, *The Structural Engineer*, December 1986

on architect and engineer –

Architects do not feel secure – a profession that is trying to sell 'value' without quantifying it is bound to be vulnerable – though it might be the right way to sell it. It is perhaps not surprising that some architects imply to clients that they not only have their own skills but the engineer's as well – surprisingly enough, helped by engineers who see themselves as dependent on the architects for work.

It is easy, of course, to exaggerate this. Just as my partners and I chose each other because we saw our differences in knowledge, interest and abilities as being complementary, so are the skills of most engineers and architects complementary. I have been extremely fortunate in my partners and many other engineers I have worked with whose achievement I am often embarrassed by being given credit for, and whose generosity of support has led to my standing here. Equally, I have been extremely fortunate in the many architects who have allowed me to share in their building problems and who have not only been extremely able but highly enjoyable to work with.

on education –

To teach our [engineering] students to state clearly to non-specialists what they do and why, is the test of our education. Our position in society and our skills are related – if we have declined in any area, it is in being an effective part of the decision-making process. If you look at the diaries of such as Jessop [a civil engineer active around 1770-1810] you will see how much of their time was spent convincing clients or Parliament – yet we do not now teach students those skills.

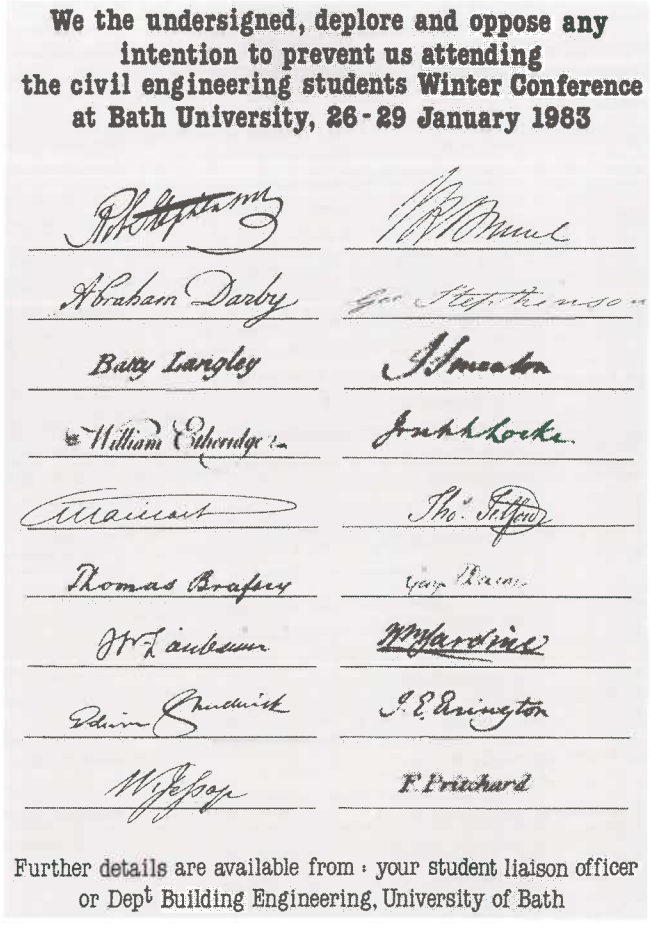
This skill is developed by practising producing solutions, testing them, explaining them and defending them. It calls not only for exercises in synthesising, using knowledge learnt from formal lecture courses, not only testing and using laboratory methods or numerical ones, but also for beginning to develop client-handling skills, since judgement between independent variables is so dependent on broad evaluation.

on the role of the engineer –

We must explain that we are not 'just the structural engineer' but jointly designers, bringing a knowledge of structure, materials and construction to the problem. We must claim our history – in journals, in exhibitions, on TV; we must explain the qualities we provide. We must demand the right to be allowed also to take a lead in building competitions, we must debate our educational needs and ask the University Grants Council for its support. We must examine more broadly our research needs. We must examine working abroad; we should consider how better to serve the Third World. . . .

I nearly called this address 'Would you at the back like to come and sit in the front?'

Because that is the question.



We the undersigned, deplore and oppose any intention to prevent us attending the civil engineering students Winter Conference at Bath University, 26 - 29 January 1983

Abraham Darby

Batty Langley

William Etheridge

Thomas Bradley

J. E. Errington

F. Pritchard

Further details are available from : your student liaison officer or Dept Building Engineering, University of Bath

It has been said that Ted almost made it a condition of accepting the Chair of Building Engineering at Bath in 1976 that he be allowed to change the structure of the undergraduate courses to have students of different design disciplines – architecture, structural and services engineering – studying together with large parts of the courses in common.

By and large he achieved this, but it is worth reflecting that it took a man of his energy and purpose to do so. There are still only a few other universities where a similar integration has been realised, and their achieving this was made easier by being able to follow the path blazed at Bath.

Even in Bath there were moments of doubt by students and even staff. Ted's response was typical:

Bath University has a joint school of architecture, structural and environmental services engineering. It has an entirely joint course in the first year and has considerable joint teaching in succeeding years.

In 1982 the engineering students questioned why their course was both harder and different from the courses of their contemporaries at other universities, and we had an interesting discussion about this.

I offered to close the school for three days and to try and seduce some of the 'greats' of engineering to come and talk to them. I had no money for this purpose – it would have to depend on the generosity of those engineers. The students and staff conceived a student conference, free to all comers. They wrote to all schools of civil and services engineering. We sent the attached poster out – it became a cult object.

Nearly every invited speaker came and over 300 students. What evolved was a conference on 'The Nature of Engineering Design'. Lecturing went on for ten hours continuously each day to a packed and enthralled audience. Discussions and design exercises, with public crits, went on simultaneously.

One thing was clear – very few engineers are ever asked to philosophise on their work. As Stefan Tietz said: 'I felt like a centipede trying to describe how he walks; I know how I got here, but I'm not too sure which leg I moved first.' Yet the attempts fascinated the students.

Design Workshop, Proceedings of IABSE Congress, 1984

Ted had a fine vision of creating an environment in which student architects and engineers could learn together, could learn in common some of the technical and aesthetic aspects of their subjects, could learn a little of each other's languages and in this way come to understand each other's problems and perhaps respect each other's professionalism rather more than is still the norm. Ted believed that 'a world which sees art and engineering as divided is not seeing the world as a whole'.

His approach was truly holistic.

Professor Bryan Harris, University of Bath

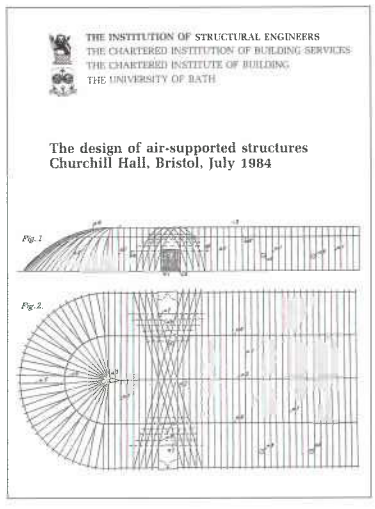
One of Ted's motives for taking up his chair at Bath had been to influence the type of research undertaken in the University environment.

Ted on research at Bath

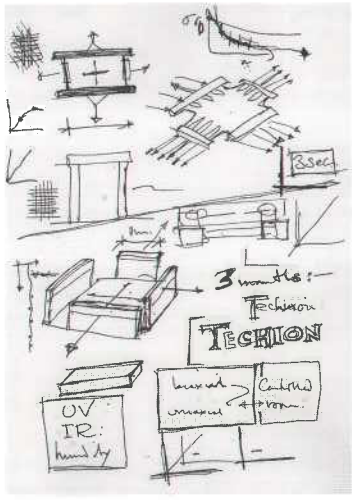
When I first arrived at the University of Bath in 1976, it seemed right to try to set off in a field of research in the same way as one approaches design in that I should try and gather together a group of friends with different interests and skills and together we should take one type of structure and examine as many aspects of it as we could in order to provide a basis for integrated design methods.

Perhaps the problem with university research in this country is that it encourages many small pieces of individual study, yet there is little attempt to relate them together so that their relevance is tested and so that they can be used in practice.

Introduction to *The Design of Air-Supported Structures*, ISE Report, 1984


THE INSTITUTION OF STRUCTURAL ENGINEERS
THE CHARTERED INSTITUTION OF BUILDING SERVICES
THE CHARTERED INSTITUTE OF BUILDING
THE UNIVERSITY OF BATH

The design of air-supported structures
Churchill Hall, Bristol, July 1984



With funding from the Wolfson Foundation, he set up a research project into the stability and behaviour of air-inflated buildings. He found such a building (that someone else had paid for but not used), erected it at the University and several researchers proceeded to measure and investigate everything they could think of. The result was a broad range of information useful to the designers of such buildings.

Ted put the results to good use and was able to build upon work with Frei Otto that he had undertaken some years earlier at Arups (Arctic city). This extraordinary project with Arni Fullerton, known colloquially as 58 Degrees North, was to cover 36 acres of northern Alberta with an air-inflated cable-stabilised dome in order to achieve the dramatic result of creating an artificial climate equivalent to a town 10 degrees nearer the equator. The skin of the dome itself was an inflated structure, a series of foil cushions that would provide an excellent heat barrier – an idea that has found application in some recent Buro Happold buildings (Chelsea & Westminster Hospital, Schlumberger and Eastleigh Health and Tennis Club).

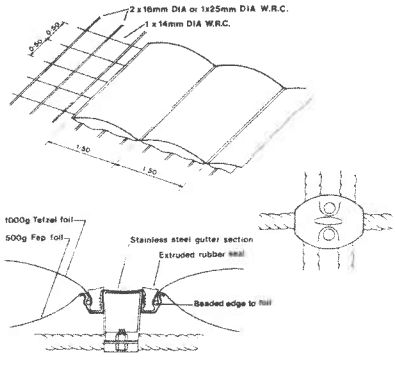
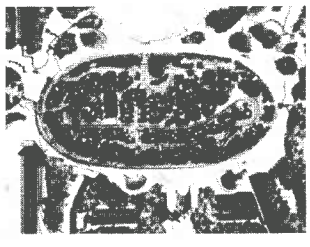


Fig 9.4 Cladding – Option 3, foil cushions

58 Degrees North
Engr: Buro Happold
Arch: Arni Eullerton with Frei Otto and Dennis Wilkinson
Date: 1981

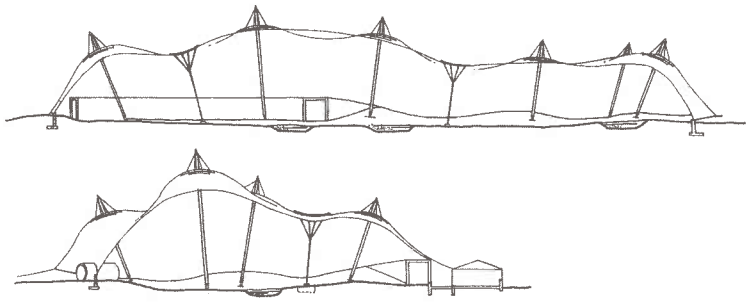


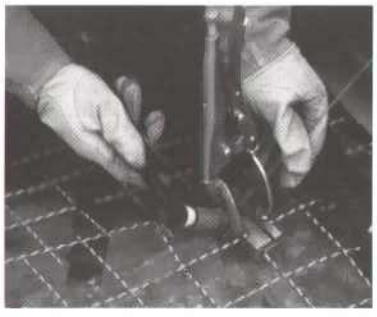
The aviary at Munich had to be, in the architect's words, 'a structure like a cloud' to cover 4,500 square metres: making clouds was just the sort of challenge to appeal to Ted.

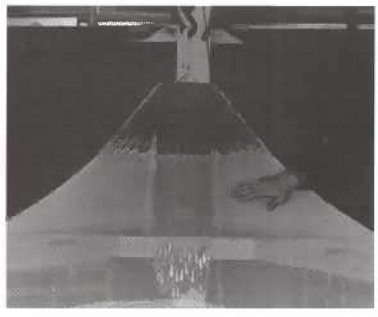
The steel-mesh structure has some resemblance to the timber gridshell at Mannheim, but that was a compression structure; Munich is a tensile structure. Finding a form it was possible to make depended on finding a material for the mesh. Inspiration was found in a type of fencing using corrugated wires that would allow the angle between the weft and warp to vary a little – an essential feature to form a curved surface. A whole range of research had to be undertaken with this new material

- how strong were the corrugated wires?
- how could you weld rolls of the mesh together?
- how could you concentrate loads in the mesh to the points of attachment at masts and tie-downs?
- how could you lift it into position?

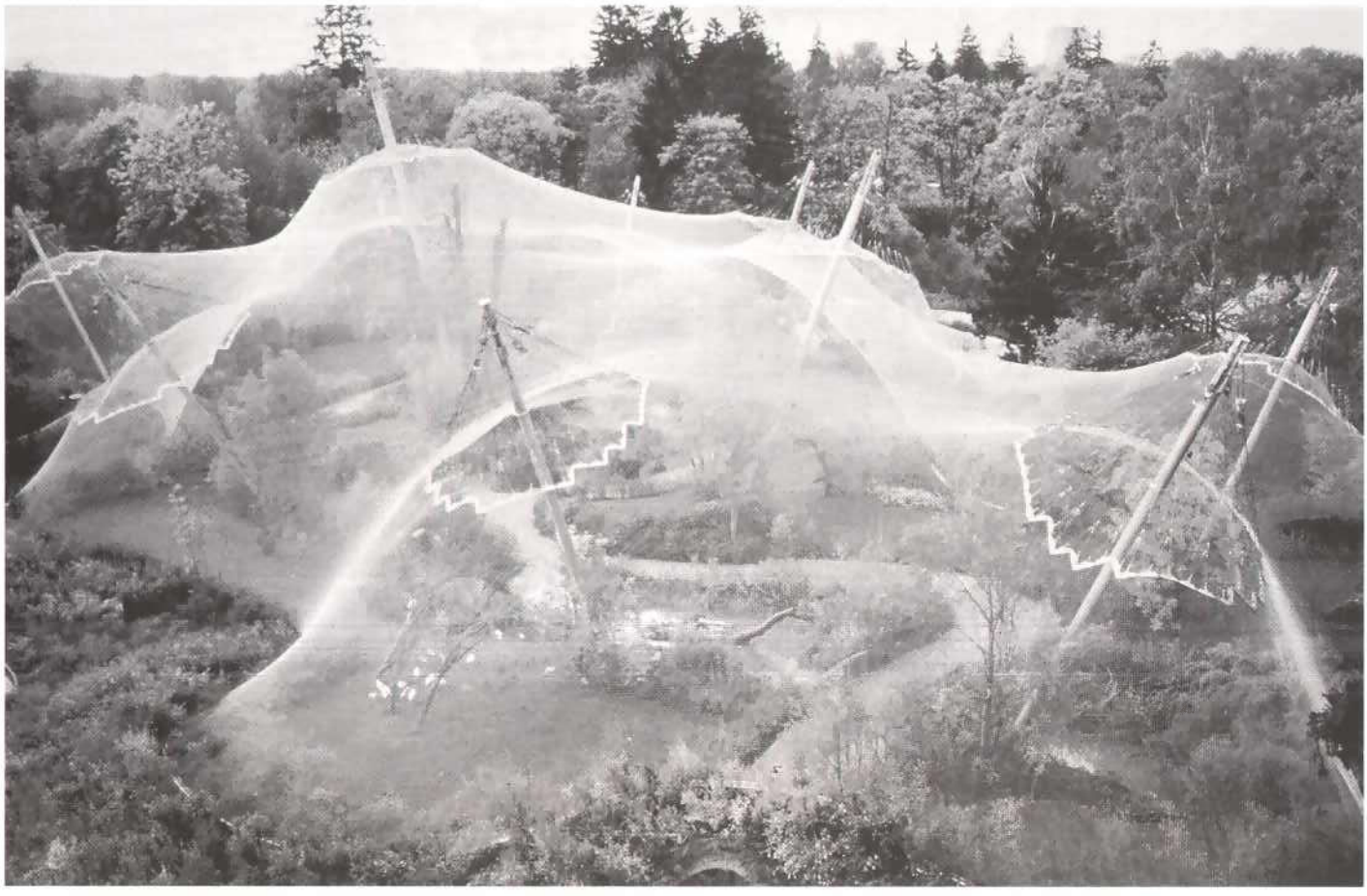
The result speaks for itself.







Munich Aviary
Engr: Buro Happold
Arch: Jorg Gribl with Frei Otto
Date: 1978-82



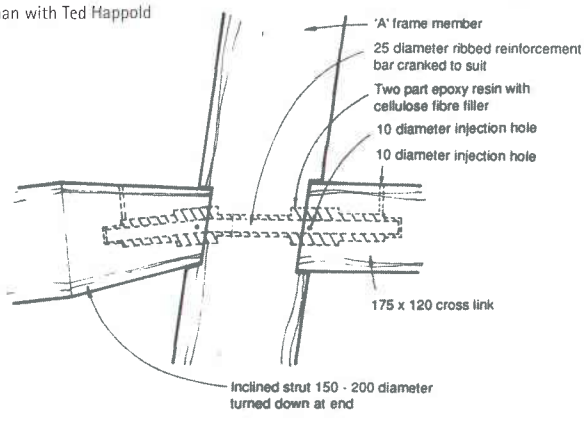
Ted Cullinan with Ted Happold

John Makepeace had approached Ted to help devise a plan to transform 330 acres of low-value woodland by forming a school for woodland industries at Hooke Park. Makepeace approached Richard Burton of ABK Architects to prepare a masterplan with Buro Happold as engineers. An essential characteristic of the buildings was that they should be created from products of the wood itself and achieve a consistent architectural and engineering aesthetic. Three buildings have now been completed on the site.

One of the keys to the success of the projects was the development of a type of joint that could be used for green timber. Just drilling a hole would not enable a glued joint to develop sufficient strength in tension – the glue would be stronger than the fibres and could easily pull out by shearing.

Ted helped develop an ingenious solution.

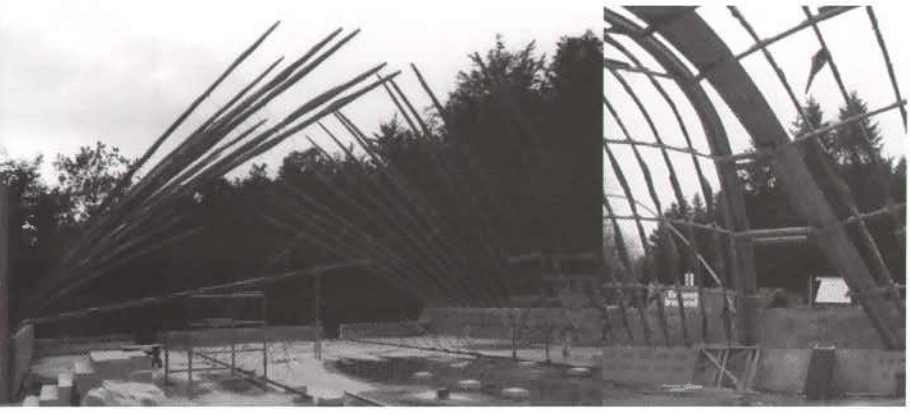
If a stepped hole were made, some of the glue could be forced into the fibres themselves and enable them to carry tensile stresses, which they can do more effectively than shear stresses – simple but effective.



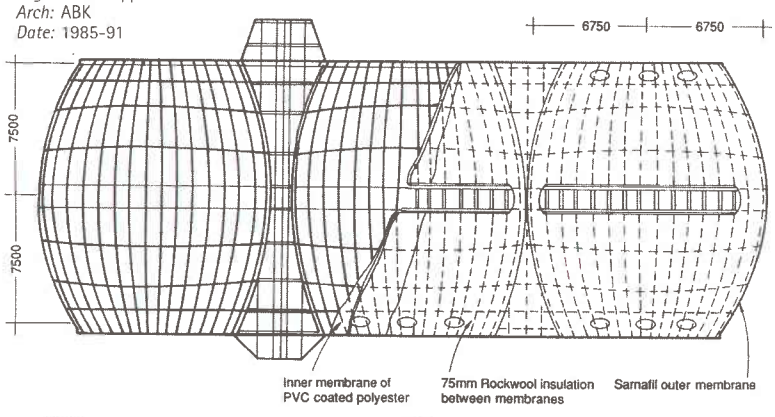
Detail of steel rod joint in stepped drilled hole

Roundwood Structures at Hooke Parke for John Makepeace.
Lodge and Workshop
Engr: Buro Happold
Arch: ABK
Date. 1985-91

Mireille and Richard Burton



Roundwood Structures at Hooke Parke for John Makepeace.
Lodge and Workshop
Engr: Buro Happold
Arch: ABK
Date: 1985-91



Plan of shells showing arches, windows and membranes of roof

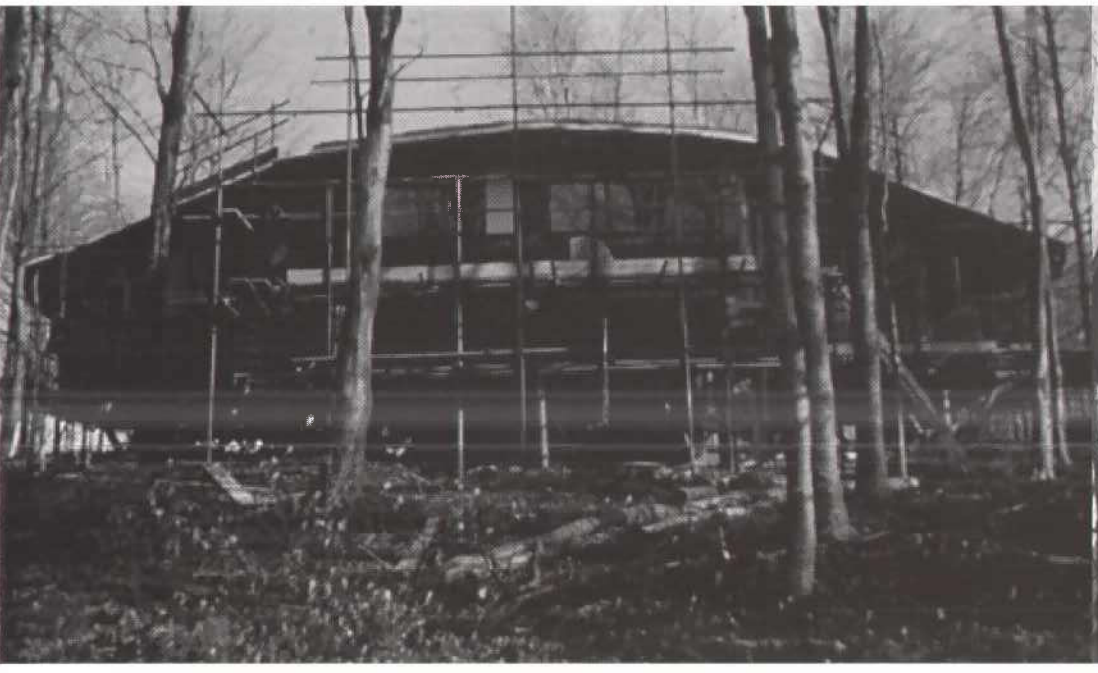
It will be Ted Happold's contribution to building engineering that we will always remember and learn from.

At Hooke Park in Dorset, in collaboration with Richard Burton and Frei Otto, Ted designed the brilliant woodworking shop for John Makepeace, the furniture designer. It was made from one of the cheapest and most available of all products, but one that had not been used before – forest thinnings, the thin, sometimes tall, trees which are cut out of forests to allow the big ones to grow on. If a way could be found to use this green 'waste' for building purposes, instead of burning it or pulping it, we would be truly caring for the planet.

When he died, Ted was involved with a continuation of this work, in the design of a single house or lodge using the product of the forest. It was a tiny job by some standards but to the last he was optimistically, energetically, lovingly engaged in it – an inspiration to the whole team.

Ted Cullinan

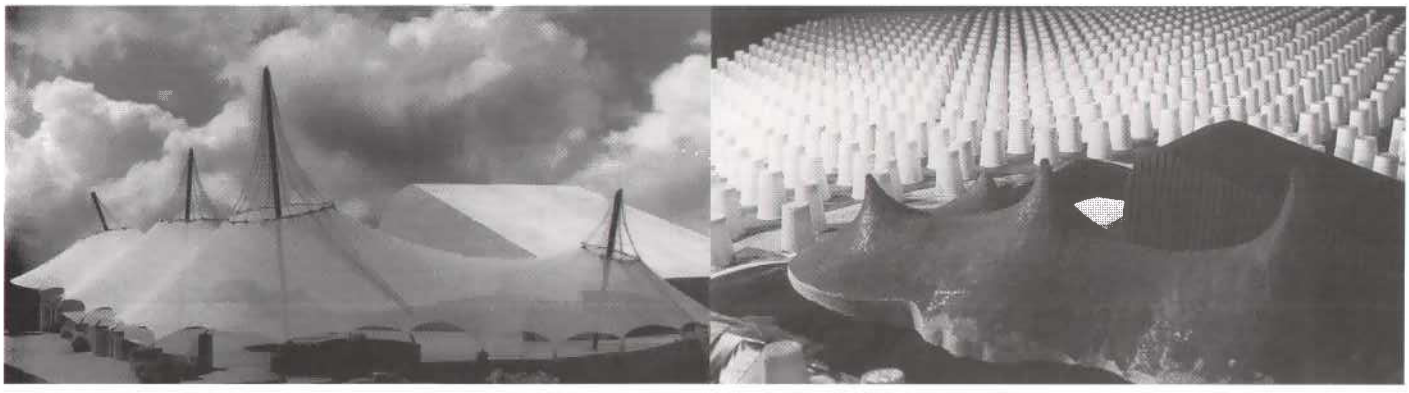
Westminster Lodge
Engrs: Buro Happold
Arch: Edward Cullinan Architects
Date: 1994-96



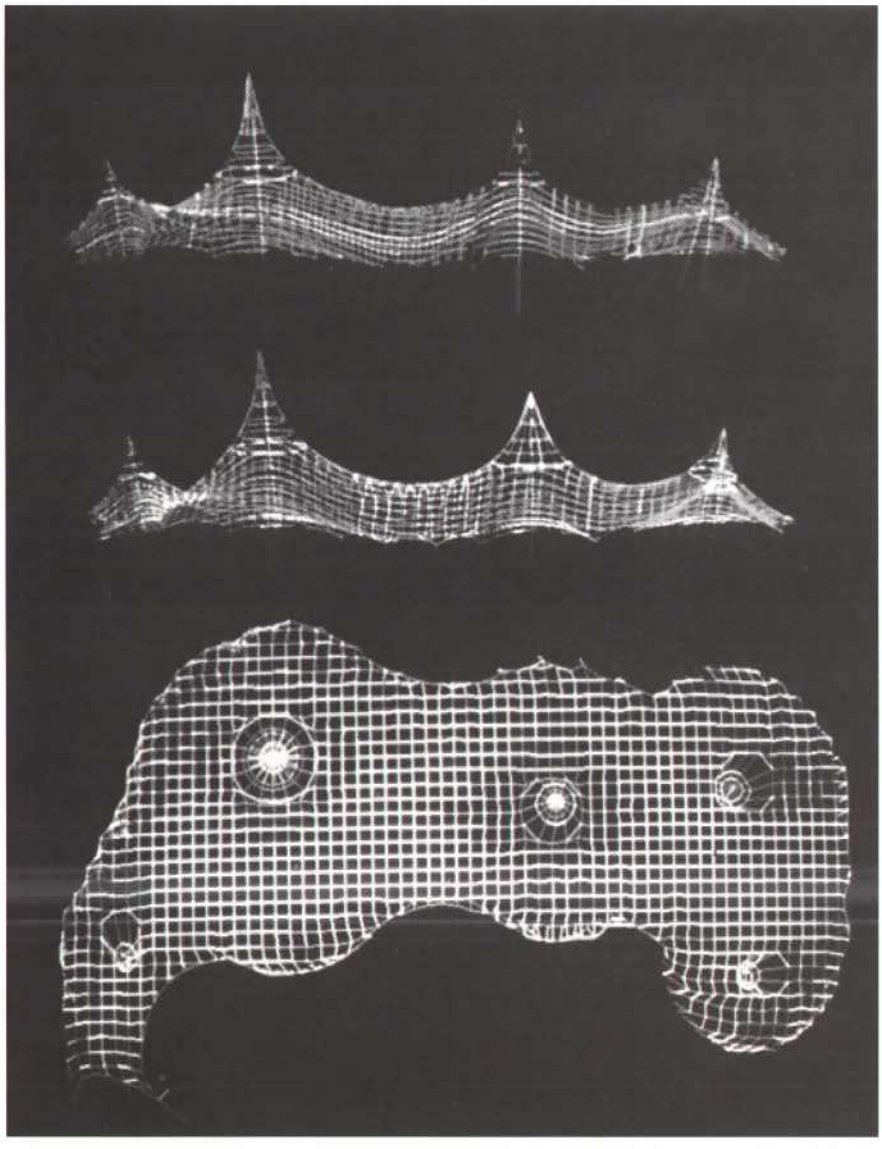
Community Centre, Vail, Colorado, USA
Engr: Buro Happold
Arch: Sprankle Lind Sprague with Frei Otto
Date: 1976-77

Ted was passionate about the importance of making models as part of the design process. Throughout his time running a busy practice, he continued to pursue his love of exploration and no one was a more suitable partner than Frei Otto. They knew each other for twenty-six years and the match was a rare one. Each found in the other an ideal complement to himself; each could help the other to achieve what either alone could not. Both had a remarkable imagination, but in different aspects of the world of materials and structures – one more geometric, perhaps, the other more statical – but then statics is really only a branch of geometry tempered by the real world!

Model making – Ted Happold, Michael Dickson, Bob Sprague

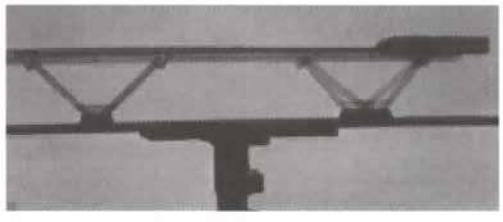


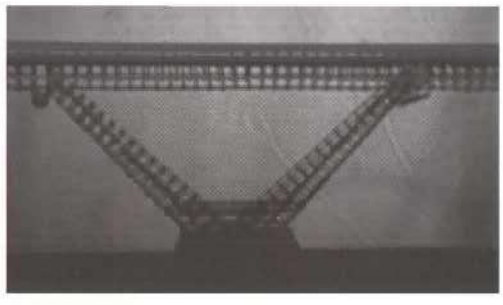
Gatlingberg Centre, Tennessee
Engr: Buro Happold
Arch: Sprankle Lind Sprague with Frei Otto
Date: 1980



In the 1980s in Germany an experimental test track was built for a high-speed, magnetically-levitated railway. One conclusion from the pilot study was that a solid viaduct for the track would be visually too heavy and would have an unacceptable impact on the countryside. Frei Otto was asked to investigate alternatives that would be less intrusive and more attractive. He was on the 'phone to Ted immediately.

Bridges for Transrapid, Magnetbahn, Germany
Engr: Buro Happold
Arch: Frei Otto
Date: 1992



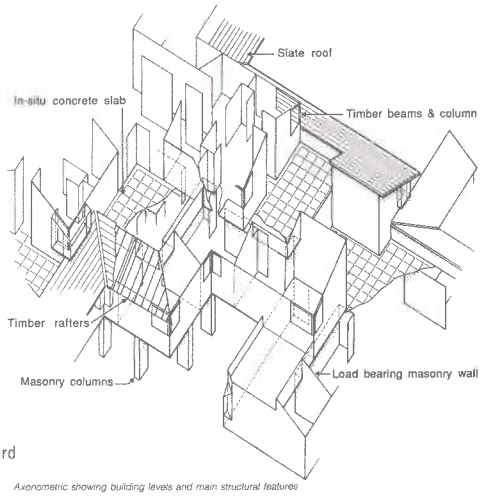


RESEARCH INTO ENVIRONMENTAL ENGINEERING

The Centre for Window and Cladding Technology (CWCT) at the University of Bath will be a lasting testament to Ted's interests and energies and his ability to make things happen. He had visited a research institute for the building envelope at Rosenheim in Germany and at once recognised its value. With the collaboration of a broad selection of specialists in the industry, including his old firm Arups, he generated the enthusiasm and used his influence in the University to find it a home.

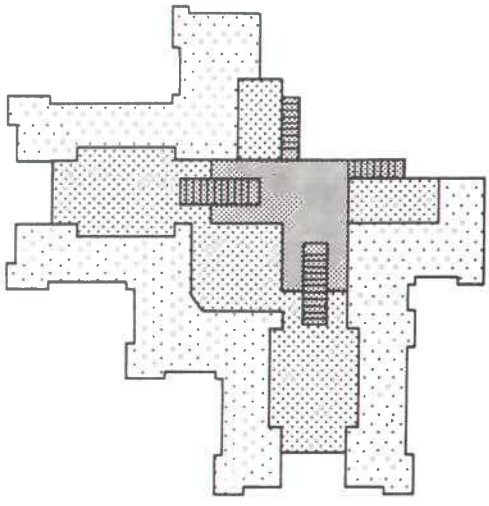
The CWCT in fact represents just one strand of Ted's long concern with the internal environment of buildings. Very early he had recognised the importance of reducing energy consumption in buildings and perceived the sense in using the layout of a building and the materials of which you make it to help you achieve this – he had, after all, seen plenty of Arabic architecture where this had been standard practice for centuries.

Sainsbury Building,
Worcester College, Oxford
Engr: Buro Happold
Arch: MacCormac Jamieson Prichard
Date: 1980-82



Axonometric showing building levels and main structural features

Working with Rod Macdonald, Ted put this approach to good effect at the Sainsbury Building in Worcester College Oxford with MacCormac Jamieson Prichard. As a response, perhaps, to student poverty, he helped develop in this building a hierarchy of temperature zones so that the warm, inhabited spaces are adjacent, wherever possible, to the cool, public corridors rather than the cold world outside. By giving the structure of the building a high thermal inertia it would retain its heat at night in winter and heat up less quickly during the day in summer. A similar approach was used at the Solid State Logic building with Michael Hopkins & Partners.

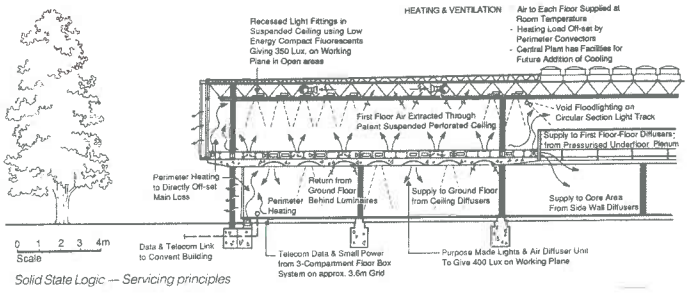


Semi-public circulation (at lower temperature)

Kitchens, bathrooms and internal corridors (at normal room temperature)

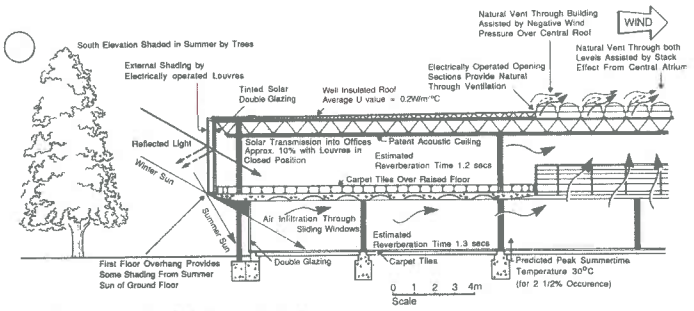
Student rooms (at 13°C, but can be boosted)

Heating plan for varying internal environment



Solid State Logic — Servicing principles

Solid State Logic
Engr: Buro Happold
Arch: Michael Hopkins & Partners
Date: 1986-88

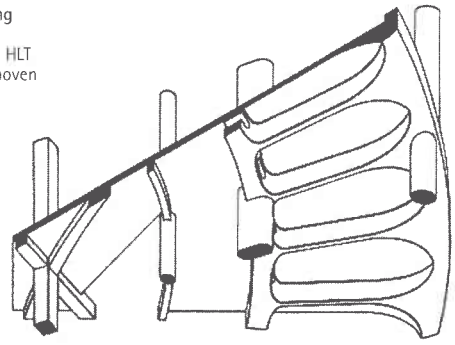


Solid State Logic — section displaying building physics

A significant step towards the future of low-energy buildings was made in the competition entry that Ted and others at Buro Happold made with Christof Ingenhoven for the Commerzbank competition for a 200 metre naturally-ventilated office-tower in Frankfurt. Their design came second (to that of Arups and Sir Norman Foster & Partners) but they have been able to use much of the imaginative thinking in another project that is being constructed in Germany – the headquarters for RWE in Essen. The external glazing of the building facade provides a barrier to wind and creates a buffer air zone onto which relatively conventional double glazing can be opened. Circulation of the fresh air is kept within each storey to prevent the spread of smoke in the event of a fire.

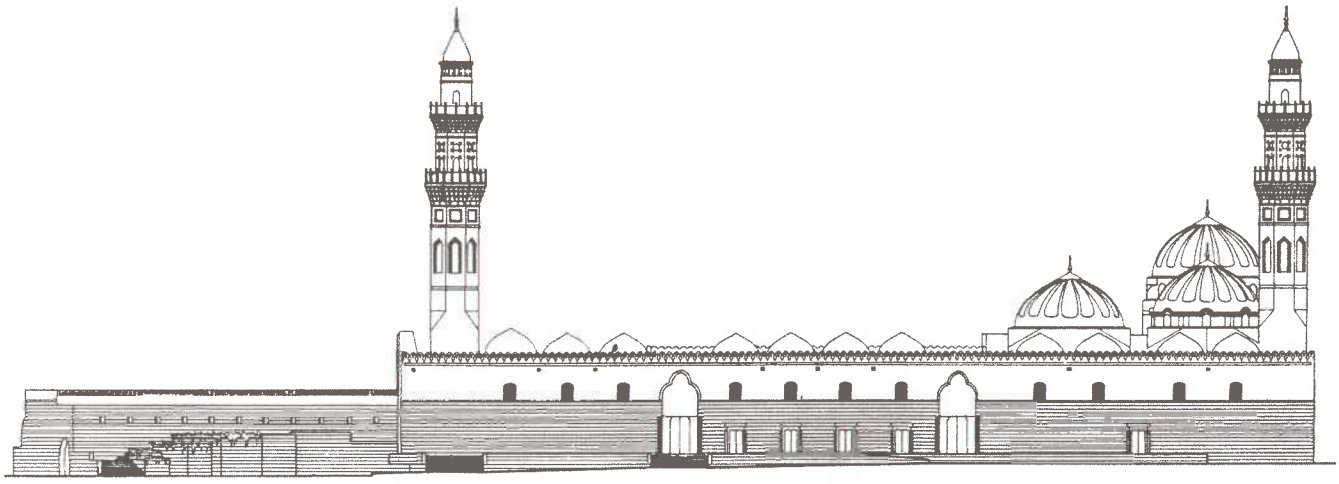
Commerzbank, Frankfurt
Engr: Buro Happold
Arch: Christof Ingenhoven
Frei Otto consultant
Date: 1991

Headquarters Building for RWE, Essen
Engr: Buro Happold + HLT
Arch: Christof Ingenhoven
Date: 1992-94



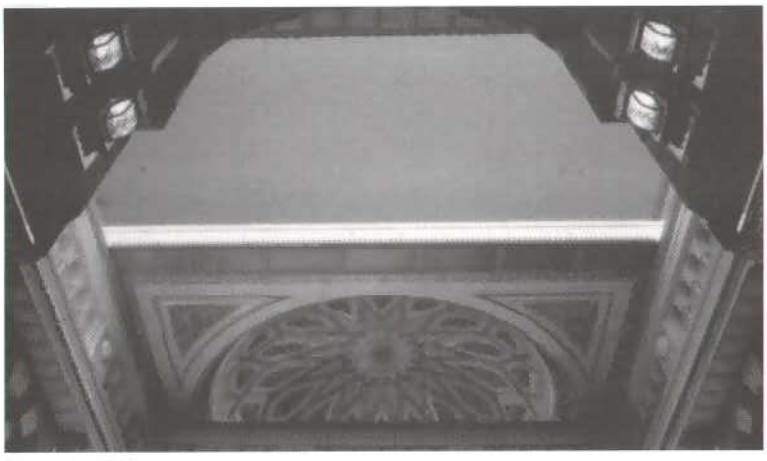
Just a few days before Christmas (1995) Ted rang me in order to tell me that Eve and he were planning to build an ultimate low-energy house, just like our home in Warmbronn with a greenhouse and a huge glass door which could be opened to have the sky inside. I sent him some sketches and then went skiing for a week. Afterwards we were going to discuss my plans in detail but the bad news of 12 January put an end to these hopes.

Frei Otto



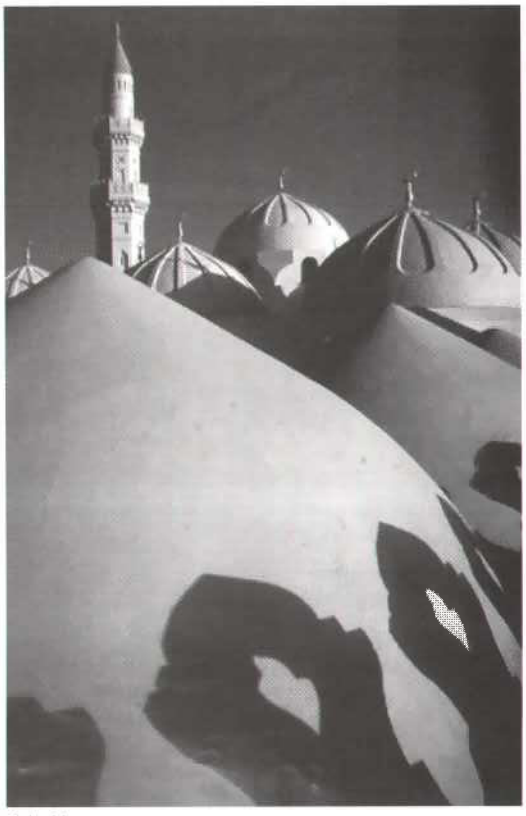
Ted Happold built a special relationship with the Muslim world, especially Saudi Arabia and Kuwait. There were, perhaps, empathies arising out of his own Quakerism. Certainly he went back time and time again, initially for an increasing number of projects, but later to see friends also. He has probably been involved with more projects – well on the way to a hundred – in the Islamic world than any other British building engineer. Apart from any technical skills Ted had, he was appreciated for his qualities as a human being.

Over thirty years, both at Arups and Buro Happold, Ted's input to Islamic projects has covered the full range from structural and environmental engineering to master planning and redevelopment (Riyadh city centre), environmental assessment and judge of international master plan competition (Pearls of Kuwait), damage assessment (after the Iraq war in Kuwait), structural appraisal (Cairo), project and construction managers (Half Moon Bay in Saudi Arabia).



The Prophet's Holy Mosque, Medinah
Engr: Buro Happold
Arch: Dr Kamal Ismail, Cairo
with Bodo Rasch
Date: 1990-92

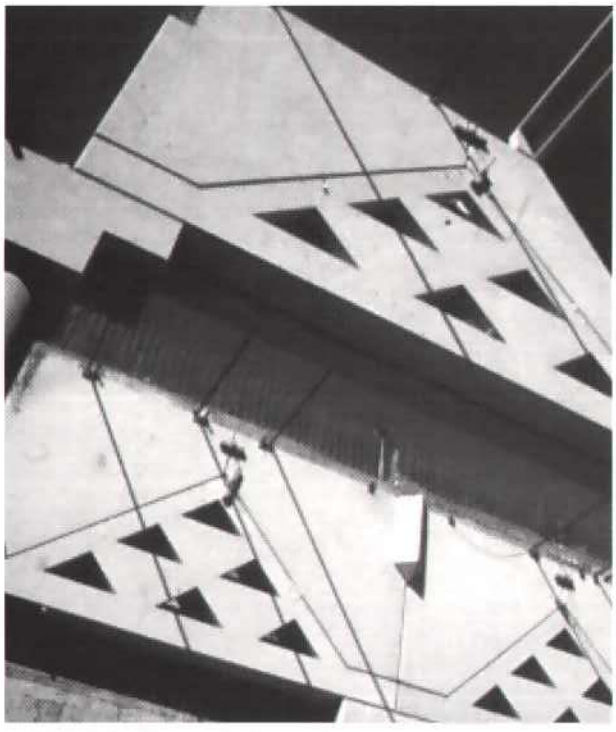
Research on large umbrellas and parasols with Frei Otto and Bodo Rasch led to further work, in Medinah, as project managers for the twenty-seven sliding domes at the Prophet's Holy Mosque and as engineers for the 18-metre-square unfurling parasols.



Quba Mosque, Medinah
Engr: Buro Happold
Arch: El Wakil Associates
Date: 1984-86

Ted had many friends in Saudi Arabia where he was the engineer for many notable and innovative buildings. His friendship in Kuwait with Khalid al Marzook was of particular importance to me because they also shared their friendship with me. I took pleasure in being the conduit of that friendship at a time when they did not see as much of each other as they would have liked.

Terry Ealey, Partner at Buro Happold



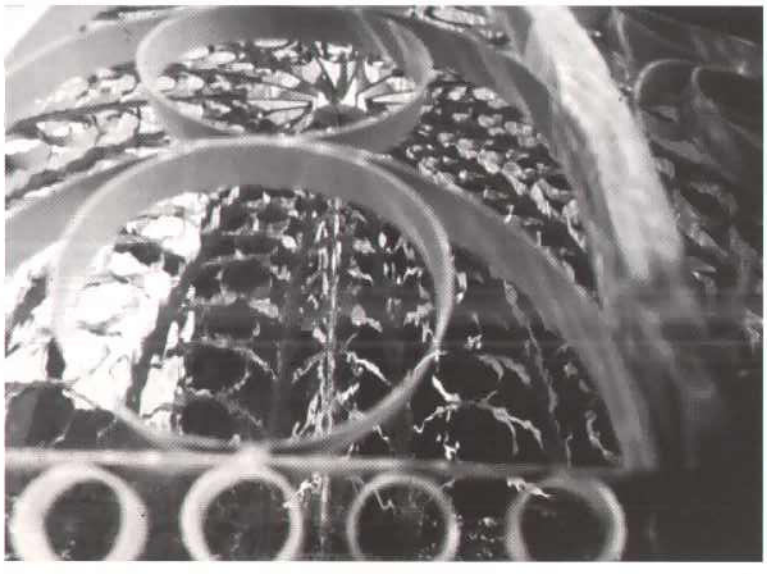
The State Mosque of Sarawak at Kuching, Borneo
Engr: Buro Happold
Arch: Sami Mousawi International/ Perunding Utama
Date: 1985-89

In 1995 Ted was invited to present a paper at the IABSE conference in Birmingham on Long-Span Structures; in his hands this opportunity became a talk about mosques.
He gave three reasons:

- because the basic type of mosque evolved in Arabia and their construction elsewhere needs both the cultural connection – Islamic Design – and the national element related to the worshippers;
- because the enclosure of space in the design calls for economic and simple climatic moderation;
- because I have not heard many engineers talk about them and they should because they are important buildings, major ones, for attendances of 20,000 or so people.

The Grand Mosque in Sarawak was designed with Sami Mousawi. The dome is made from a large laminated-timber, lattice grid-shell and is supported by a complex precast-concrete structure.

Ted worked with his life-long friend Theo Crosby on the competition for the mosque in Brussels.



TED HAPPOLD'S LEGACY

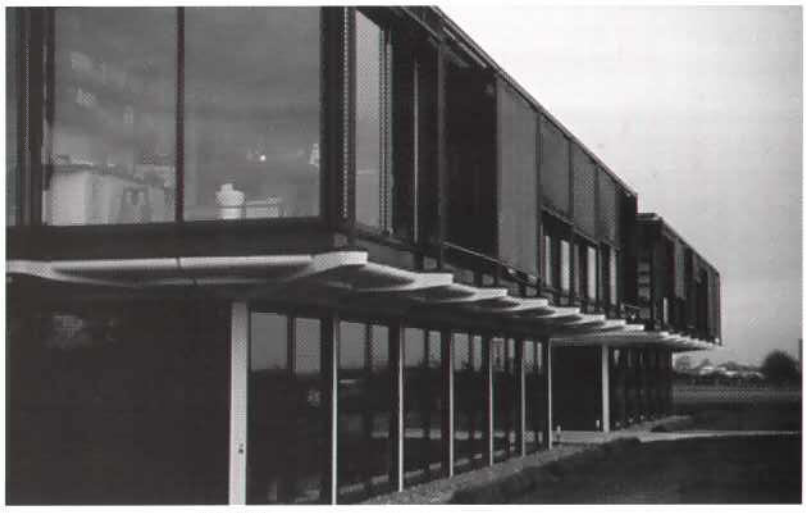
Carlos Moseley Music Pavilion
Arch+Engr: FTL-Happold
Date: 1989-91

Buro Happold has formed a joint venture with Future Tents Limited (FTL) in New York to create an architectural engineering practice that specialises in lightweight and special structures. Its recent work includes a deployable tent that arrives at a site in a lorry and can be erected in six hours.

Ted Happold has left behind him a successful practice of engineering consultants that looks to have a healthy future in front of it – this is no mean achievement. He has managed to create something permanent, something that works (he was, after all, an engineer). His Statement of Intent for the practice gives an idea of how he has achieved it:

We are committed to quality firstly in our meetings and information systems which enable clear and united purpose to be understood and subscribed to by all. Not all work for all staff is at all times enjoyable, but subscribing to its purpose makes it fulfilling.

But most of all he has achieved success by getting people to want to work together while allowing them their own space: 'let them sing with their own beaks' as he used to say.

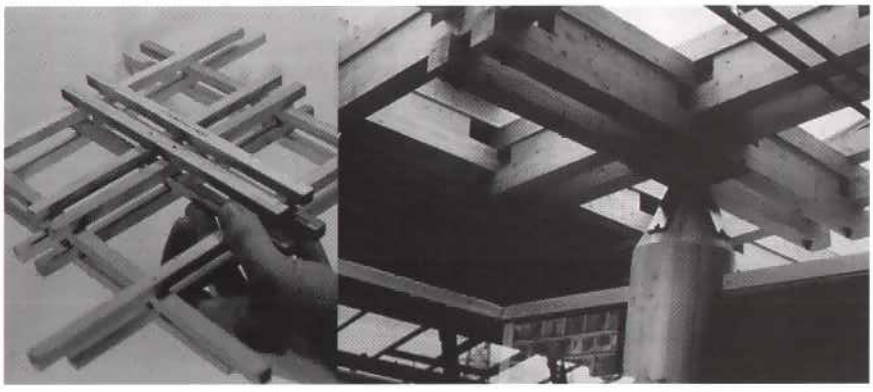


Schlumberger Cambridge Research
Engr: Buro Happold
Arch: Sir Michael Hopkins & Partners
Date: 1990-92

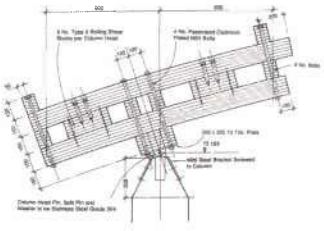
In the research laboratories building in Cambridge, for Schlumberger, high quality ferrocement serves as permanent formwork for the highly sculptural ceiling.

Head Office, Camden Mill, Bath

Name plate on Ted's door



Totton First School
Engr: Buro Happold
Arch: Hampshire County Architects
Date: 1988-90



Ted was proud of the practice's achievements, even when he himself had had little or no input, and was proudest of all when he was made Master of the Royal Designers for Industry. A part of this honour was to be allowed to choose an illustration for the cover of the Journal of the Royal Society of Arts. He did not choose the biggest or the most complex project. He chose a modest primary school with a timber structure; for him it exemplified good engineering – engineering elegance, honesty and economy. The same could be said of many of Buro Happold's projects.

To his colleagues at Buro Happold his best epitaph is to continue always the search for an intelligent engineering solution, commit to the standards he demanded and search for that perceptive and inventive streak that illuminated all his solutions.

Derek Walker

The Royal Armouries has been recently completed in Leeds. At the end of the central street through the building is the Tower of Steel made from stainless steel tubes and plate glass within which is a concrete tube supporting the staircase and a hanging display of armour.

Royal Armouries Museum, Leeds
Engr: Buro Happold
Arch: Derek Walker
Date: 1992-96

Globe Theatre, London
Engr: Buro Happold
Arch: Pentagram
Date: 1989-96

Be patterns, be examples in all countries, places, islands, nations, wherever you come, that your carriage and life may preach among all sorts of people, and to them; then you will come to walk cheerfully over the world, answering that of God in everyone.

George Fox, founder of the Quaker movement, 1656

The Faculties
of Architecture
and
Building Engineering
of the
Technical University Braunschweig

Hereby award on behalf of
The President Prof.Dr.Jur.Bernd Rebe

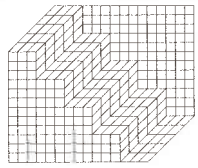
and on behalf of
The Deans
Prof. Dipl.-ing Gerhard Auer
Prof. Dr. Rer.Nat.Manfred Wermuth

with the approval of the senate
the following certificate

In honour of
Professor Sir Edmund Happold - Bath, England
The Degree and Title of
Honourary Doctor of Engineering (Dr.-Ing. E.H)

In acknowledgement of his research in construction and his innovative achievements through which he has, together with architects, produced construction of an exemplary nature, setting new directives for the future.
Co-operation, with a view to creativity, among engineers and architects during academic study and in the practical sphere has been a cultural and social challenge for Professor Happold; one which he has met with admirable dedication and devotion.

Braunschweig, 5th December 1994



Buro Happold
Consulting Engineers

Head Office
Camden Mill
Lower Bristol Road
Bath BA2 3DQ
UK
Tel 01225 320600
Fax 01225 320601

Glasgow
20/21 Woodside Place
Glasgow G3 7QF
UK
Tel 0141 307 0290
Fax 0141 332 4927

London
41-43 Praed Street
London W2 1NR
UK
Tel 0171 298 5700
Fax 0171 298 5701

Leeds
Brodricks Building
51 Cookridge Street
Leeds LS2 3AW
UK
Tel 0113 204 2200
Fax 0113 204 2201

Berlin
Heerstraße 2
14052 Berlin
Germany
Tel 4930 3011 9030
Fax 4930 3011 9033

Kuala Lumpur
59-m Medan Setia 1
Plaza Damansara
50490
Kuala Lumpur
Malaysia
Tel 603 252 1135
Fax 603 253 2308

Kuwait
PO Box 6249
Hawaly
Kuwait
Tel 965 476 2940
Fax 965 476 2940

Muscat
PO Box 997
Muscat 113
Sultanate of Oman
Tel 968 564 300
Fax 968 560 324

New York
157 Chambers Street
New York City
NY 10007
USA
Tel 212 732 4691
Fax 212 385 1025

Riyadh
PO Box 34183
Riyadh 11468
Saudi Arabia
Tel 9661 462 6919
Fax 9661 465 6043

Warsaw
Biuro Happold
Sp.z.o.o.
Aleja Wyzwolenia 8
00-570 Warszawa
Tel 22 621 5031
Fax 22 6293274

www.burohappold.com
postmaster@burohappold.com