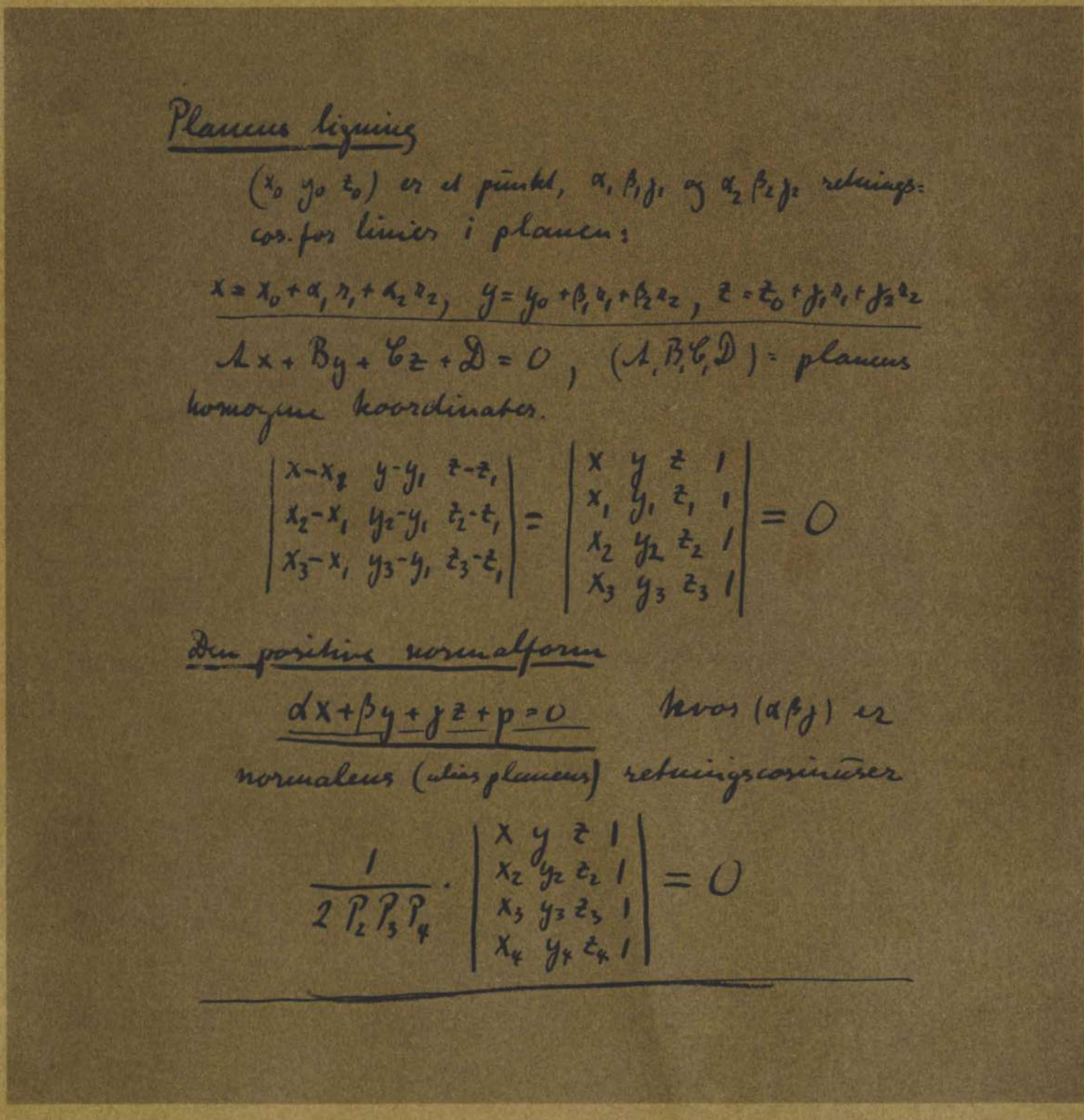
THE ARUP JOURNAL

25TH ANNIVERSARY ISSUE APRIL 1971



THE ARUP JOURNAL

Vol. 6 No. 1 April 1971
Published by
Ove Arup & Partners Consulting Engineers
Arup Associates Architects and Engineers
13 Fitzroy Street, London, W1P 6BQ

Editor: Peter Hoggett
Art Editor: Desmond Wyeth MSIA
Editorial Assistant: David Brown

Contents

Front and back covers: Pages from Ove Arup's notebook on Bohr and Mollerup's *Textbook of mathematical analysis*

Jubilee foreword

Ove Arup

It so happens that on 1 April, 1946, an event took place which may be as good as any to mark the beginning of the firm as we know it today. For on that day I 'went it alone' as consulting engineer by resigning from Arup and Arup Ltd., a firm of engineering contractors founded by my cousin Arne Arup and myself eight years earlier, and from Pipes Ltd., which was Arne's old firm trading in building materials. I still retained the right to the registered name of Arup Designs Ltd., a firm founded at the same time as Arup and Arup Ltd., and used when we carried out work to our own design. I hoped that it might be possible to revive it one day. For I was reluctant to consign to the grave the dream I had when I started it: to achieve the perfect union of design and construction. I had had enough, during my 24 years as a contractor, of carrying out work for designers who didn't know the first thing about the economics of construction or didn't care for it, and of being rebuffed when I proposed alternative solutions. What's the use of all this elaborate machinery of 'fair' competition to squeeze the price down to a minimum when the design is 30% wrong? 'Designing should mean indicating a sensible way of building'—you've heard that before.

But this is a digression—and it won't be the last one. To prove it I may mention that I later gave up this registered name of Arup Designs Ltd., urged to do so by some of my future partners, who feared that it might prejudice our professional status to keep this empty shell in a drawer. A groundless fear, of course, but the matter was unimportant, the climate was still not opportune for such a venture. Now 'package deals' are accepted, but there is an important difference between the present-day package deal and what I had in mind. In my version the emphasis was on design. Then, as now, I recognized that to get the right design is what matters. It is the key to what is built. This necessitates integration of design and construction, and this the package deal can supply. But much more than that is required of a good design. It must first of all satisfy a social function, it must have an artistic wholeness, and the result must harmonize with its surroundings. These are the objects of building. Integration of design and construction is more a means of obtaining economies and thus bringing the objects within reach. In the normal package deal the approach is different. But enough of that. 'Revenons a nos moutons.'

The War years

I said that 1946 was as good a date as any. But on that day the firm was still Ove N. Arup, Consulting Engineer, not Ove Arup and Partners. That came later, and if we were to insist that the birthday should be the start of the partnership, whether in name or deed, the jubilee would have to be postponed. But if we do not, it would perhaps be more natural to make it April 1938, when I left Kiers and set up on my own both as contractor and as consulting engineer. I was not encumbered by membership of any professional institution or association at that time, as my Danish degree was not then recognized in England, but I kept strictly to the rule that when acting as consultant, Arup and Arup were debarred from tendering for the job. This worked very well, and my practical experience undoubtedly improved the quality of my advice, when it was asked for. But the years 1938 to '46 stood in the sign of Mars. They were years of struggle, and for me, to a large extent, of frustration. True, the exigencies of war kept our contracting firm busy on war contracts considered suitable for our size and our experience in reinforced concrete construction. But my eager and persistent attempts to make a more important contribution to the war effort only succeeded on a small scale. It was frustrating to witness the government making a muddle of its shelter policy, wasting precious steel when supply ships were being torpedoed, and later mishandling post-war rehousing, and to know that one could have helped, that one had the answers to many of the problems but could not penetrate the tangle of red tape separating polite listening to our proposals from any kind of action.

It was penetrated on a few occasions when we, as consultants or contractors, got directly involved in problems having a wider implication for the war effort, but only after a prolonged struggle which outlasted the particular emergency, thus robbing our considerable efforts of any commensurate effects. The shelter controversy was an example of this.

Of the assistants I had in those years five are with us still: Ronald Jenkins, who about that time wrote his famous book on cylindrical shells, Peter Dunican, whom I persuaded to take an interest in box-frame construction and housing generally, stressing its social importance, an interest he has never since lost, Henry Crowe, Vic Kemp and George Dell. This was the time when the foundations for the future were laid—so as I said we *might* have chosen April '38 as the birthday. As the bulk of our work since then has been structural engineering, I am even inclined to go further back, say '34, when I collaborated with Tecton on Highpoint, the Penguin Pool and other Tecton jobs, for this was really the starting point for my collaboration with architects on which the firm's future activities were based. But then we should have had our jubilee a long time ago, and the fact is we didn't. So perhaps I should go back to Square One—1 April, 1946—and get on with the job I have been asked to do, which is to write a foreword to this Jubilee Number of the *Arup Journal*.

It is perhaps natural that this job should fall to me, as I am undoubtedly the founder of the firm, but I am beginning to think that from the point of view of suitability the choice may have been unfortunate. I am told that I can say what I like and as much as I like, but this is, with respect, nonsense. It is in fact a most delicate task, requiring the utmost circumspection, infinite tact, and the suppression of any tendency to critical analysis, to dig out facts which need not necessarily be mentioned, and which might give offence to somebody or might not be helpful in the projection of the desired image of the firm. For after all, what is the purpose of all this jubilee talk? Isn't the underlying idea to boost morale, tell ourselves and the world how marvellous we are, be nostalgic about the past and optimistic about the future?

But you mustn't blurt out the fact that this firm is the best in the world of its kind—that would be most unseemly. You must observe the decencies so closely woven into the British character. You mustn't talk about yourself—except in order to disclaim any merit. Any success should always be due to luck or the excellence and generosity of your friends, there mustn't be any 'I told you so', or airing of grievances, and if you praise A—as you should—you must be careful to praise B as well, otherwise the absence of praise would be construed as a slight. In fact you are walking a tightrope. Yet the feat must somehow appear to be the result of a genuine modesty and magnanimity which reflects your sterling character. In short you must manage to convey the impression that you and the firm *are* all that they don't claim to be.

The firm since 1946

You may have noticed that I have already sinned against most of these precepts—hence the doubt I expressed before. But so far I have been dealing mainly with the period before the birth of the firm. These events happened a long time ago, and they at least were all within my ken. If we try now to follow events to the present day, and perhaps even venture a peep into the future, I am on much more dangerous ground. The firm I started in 1946 was a very small firm, perhaps 15 to 20 people, all told. Now it is a very large firm. It has long since grown over my head—I know only part of the members. Moreover I can hardly be blamed for, or take credit for, this spectacular growth. I feel a little like the Sorcerer's Apprentice—well, perhaps he *was* to blame for what happened, but like him I am unable to control the flood. It needs qualities with which I am only sparsely endowed, and which I have no strong wish to exercise either. But I have been fortunate in my partners whose talents cover a wide field and who supply what is needed between them. That we all so far seem able to collaborate on a common front is what has sustained this firm so far and will do so as long as the front holds. But I certainly never planned to create a firm of this size.

I remember, back in 1924, when I was living in digs in Pimlico, I received a visit from Olaf Kier—or Kjaer as he was then—now the head of J. L. Kier and Co. Ltd. We got talking about our future plans. He had it all taped, he wanted to create a big and powerful firm, to rival Christiani and Nielsen, where we were both working at the time. And as it turned out, he did. I had no such grandiose plans. Hardly any at all, in fact. But I told him that his aim had no attraction for me. I thought it more important that the work you did was interesting and that you liked the people you worked with. And I still think that if you have to spend half your waking life earning your living, you had better work in a pleasant atmosphere on things which you feel are worth while. And in that respect I haven't done so badly either.

This is another digression, of course. But it explains perhaps why I don't want to embark on a description of what the firm has achieved since 1946, and who has done what. There are too many facts to cope with and my knowledge of them is incomplete. I would rather look at the scene from my own limited point of view. 'The scene of battle' I nearly said. For I see the whole thing as a battle, the battle for quality. I expect you are tired of hearing this by now, you know only too well about our shortcomings—'We talk a great deal about quality, but we are really not better than other firms', some of you say. That may be true, but if we didn't strive to produce quality—and I admit it is a vague word which requires definition—then there would be nothing to unite us. It should in my view be the corner-stone of our policy.

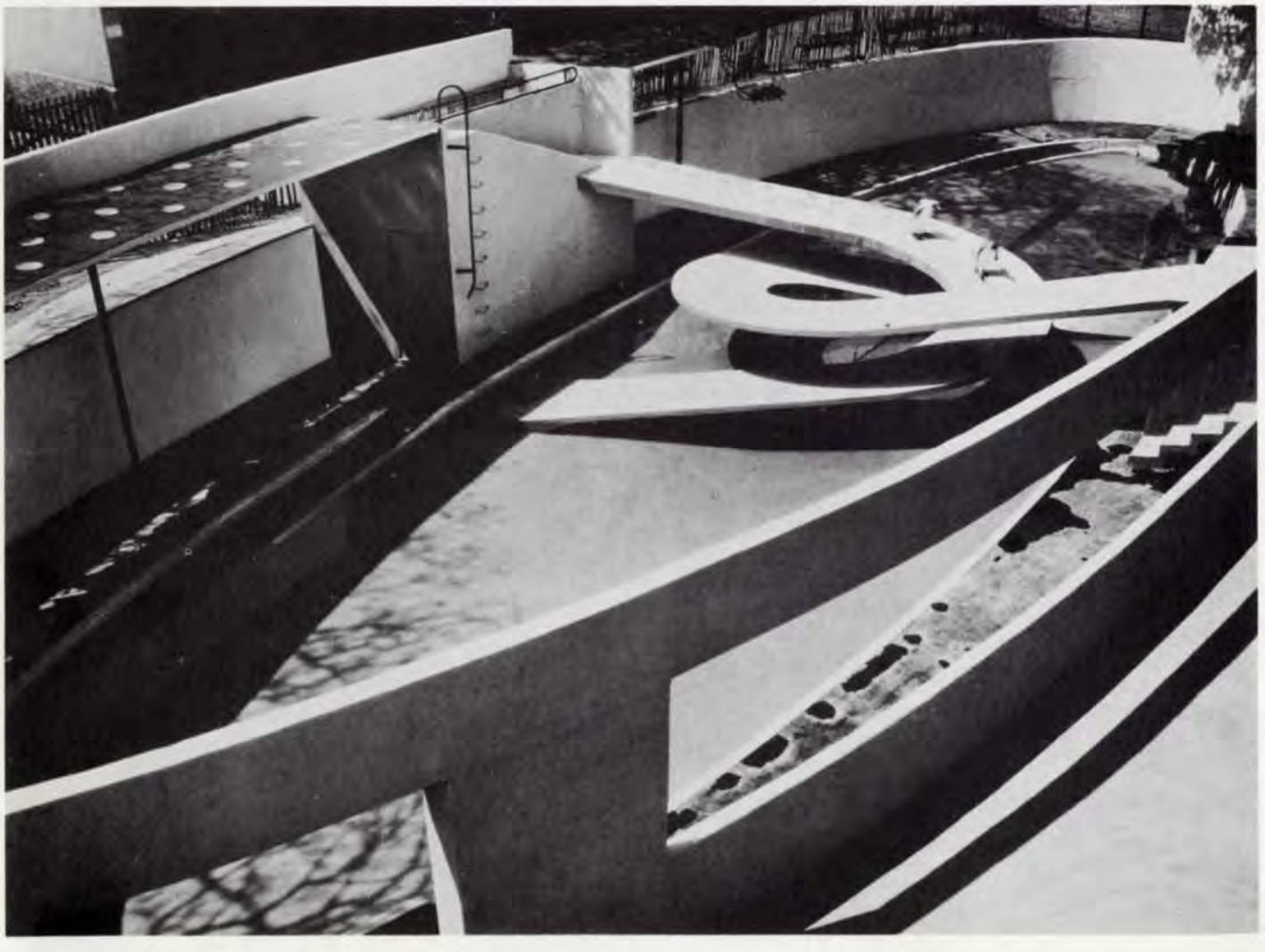
This battle has to be fought on two fronts, internal and external. The internal front is the more important: we must first of all put our own house in order. The size to which the firm has grown makes this more difficult—it complicates internal communications, reduces the role played by personal contact. Yet I do not now see this size as an unmitigated evil, for it puts us in a much stronger position to make progress on the external front. For on this front we face forces: institutions, customs, traditions, prejudices, by-laws, anti-social behaviour or sheer stupidity, which prevent us from producing what we think is the right solution. The proliferation of our multi-disciplinary activities—if you will excuse my language—which has taken place in the last decade, and which is the direct result of our endeavour to improve the quality of our work, has of course largely contributed to our growth, but has also alerted the forces arrayed against us. For in many ways it cuts across established practice, it aims ultimately at a reform of the whole building industry. This would be a hopeless undertaking if the firm were not large and respected. It would be hopeless if we could not deliver the goods, if we could not prove that our methods of integration of design services gave a better result in many cases. And it would be hopeless and even unjustified if we were not in tune with the technological and economic forces which are going to change our institutions in any case, whether we like it or not.

But what, you may ask, has all this got to do with us? Why do we not stick to our last? 10 or 15 years ago we had a very flourishing and respected business as Structural and Civil Engineers. Why upset architects by creating Arup Associates, quantity surveyors by trying to reform the costing system, heating and ventilating engineers by muscling in on their field, and contractors by wanting to know how they intend to carry out their work? It only causes us a lot more trouble and expense. Why not swim with the stream, not against it? Life would be a lot easier that way.

Yes, but also more boring. It is a question of involvement. If you are interested in the work you do, you will automatically strive to remove the obstacles which stand in the way of fulfilment. You become a reformer. It is an itch. It is even a matter of conscience. We are citizens of the world, we should think of more than our own convenience. But how far should we go in this direction?

Penguin Pool, Zoological Gardens, Regents Park, NW1
Architect: Lubetkin, Drake & Tecton
Completed: 1934

A pair of projecting parabolic paths for perambulating penguins.



Highpoint I (above) & II (right)
Architect: Tecton and Lubetkin & Skinner
Completed: Highpoint I, 1935; Highpoint II, 1938

Climbing shutters, exposed concrete, mainly clothed caryatids and inspired architects.

One thing we must *not* do is to lose touch with reality. Our work takes place in a certain social and technological setting. It is work by certain human beings for other human beings inside a legal and economic framework. It is not an easy matter to determine what the ideal framework should be, what people ought to want, what they ought to do. We have no right to impose our point of view, even if we had the power, which we have not. What we can do, or can try to do, is to do our thing well. And only if we are absolutely certain that by making certain changes in the traditional way of doing things, can we do better, not only what *we* would like to do, but what is needed and wanted by our clients and our society. Only then should we move forward and try to convert all those concerned to our view. For there is nothing more nauseating and dangerous than fixed ideologies derived from books or theoretical speculations and pushed down people's throats, without regard for the manifold and diverse needs of human beings.

We have tried persuasion by writing and speech. We have found that this is a very slow process. And if, after 20 years or so, some movement in the desired direction takes place, it would be presumptuous to postulate any causal connection between the two events. In other words, writing and talking may be almost completely ineffective.

Is there a better way? There is one, persuasion by example, by showing what can be done in practice.

Is there any doubt that the work of outstanding architects has had more effect on architectural practice than volumes of critical essays on the theory of architecture?

The integrated practice

The setting up of Arup Associates was an attempt to demonstrate in practice what has been preached for many years with little effect: the beneficial effect of integrating the various design disciplines by combining them in one design team with the common aim of producing what I call total architecture. The attempt has succeeded, because this is not idle theory. That poor integration of design, cost and execution, of architecture and structure, of the services and the building carcass is a major cause of mediocre design is something I know, for I have in my time played most of the roles in the building team. It has succeeded also because of the quality of the architectural leadership provided, and because the whole team has accepted the common aim and has been supported by an 'engineering environment' able to provide almost any specialized service called for. It has succeeded because we were able and prepared to finance this venture from profits earned on other jobs. And finally it has succeeded because on the whole the architectural profession, the RIBA and the architectural press have been generous in their encouragement of this venture, seeing it rightly as a service to architecture. That is exactly what it is meant to be, for Architecture with a capital A must be efficient to survive.

However, in spite of some spectacular successes, this is only the beginning. We have much to learn still, and we have still to bridge the gap between design and construction, a problem which must be solved if industrialized building is to serve humanity. The designers must know the cost and methods of production to evolve the best design. We are tackling this question on a broad front. And we are also trying to build up an integrated engineering service division to assist independent architects in the creation of total architecture. For we are not suggesting that the Arup Associates way is the only one, or the best in all cases. It can only be applied in special conditions. Our main business will still be civil and structural engineering, but the idea of total architecture pervades also this field, for any kind of construction is shaping our environment and, as such, an object of total architecture.

Fortunately we are not alone in this field. Many multi-disciplinary practices have sprung up in this last decade. It is a movement which is rooted in commonsense and attuned to the change in technology. But, as already mentioned, it cuts across existing barriers, procedures, customs, forms of contract, and worst of all, vested interests, and unless these can be adapted to make room for genuine attempts to improve the quality and efficiency of building, the outlook is bleak. For they can so easily be used by sectarian interests and rivalries to stop progress.

That is why I look on it as a battle which is not nearly won yet. And which of course never will be won, for if it were, life would stop.

Inside our own firm there are many who are mainly concerned with advancing the fortunes of the firm in a normal way. Some of these may fight shy of any external battles, viewing them as a rather unnecessary complication. Others are worried because we are not doing enough to take them into the promised land. They fail to see that all this talk about lofty aims is taken seriously. Some think we should refuse work if we or they don't like the architecture or the use to which the building is put, the location of the roads, the country in which the job is to be built, or the client for whom we build. In other words, they dislike any form of compromise.

A large firm like ours is bound to contain all these conflicting views, and we need both kinds—the one to keep us alive, the other to prevent us falling asleep. They reflect the fact that the question of where to draw the line between principle and expediency is a controversial matter, and largely a matter of

temperament. Expediency can be born of cowardice and selfishness, it can also be commonsense, based on an understanding of human beings in all their frailty, and it can be a number of other things. But if I were to strike the balance between partiality and impartiality, as I believe an American Senator neatly put it, I would say that it can never be right to base a decision on a deliberate or unconscious distortion of the facts to suit one's convenience or ideology. If you want to bang your head against a wall, do it with open eyes, and if you want to swindle your neighbours, don't pretend it is an act of social justice, at least don't pretend it to yourself.

To understand your own limitations and those imposed by your milieu, and to be honest with yourself, is I think the basis for sound decisions. Beyond that it is difficult to generalize, except perhaps to say that if expediency is a temporary deviation like tacking in a headwind to reach your goal, it is both justified and necessary; if it deflects you from your goal altogether—it means you are giving up.

I am aware that I am overdoing this battle business. It might give you the impression that we are all the time at war with the people we are trying to serve, and you know that this is entirely wrong. The war we are fighting in our daily lives is the normal one which every designer has to fight: finding the best solution to the brief within the given limitations and in the available time. The itch to query the brief and change the rules of the game hardly affects our daily lives, but I must admit that this reforming activity is what I am particularly interested in for it could have a social importance which goes much beyond that of a single job. It is normal for a professional man to try to further the prestige and the interests of his profession, over and above his own private interests. But we should look beyond this. It is the interest of society that matters in the end, and any sectarian rivalries should be resolved by reference to the whole.

I am happy to say that this view is shared by all the leaders of the firm, and I hope therefore that in future the firm will be able to make a contribution to the comprehensive design of our environment which will in some measure enrich the lives of future generations. This is the battle I have been talking about. It is not a spectacular and exciting battle which provides its own momentum, there is no enemy to speak of, except perhaps indifference, inertia, greed and laziness, the human weaknesses which are pretty evenly spread around. What is needed is to know which side you are on, and to be prepared to make some sacrifices for the cause.

Is it wrong of me to make this jubilee talk into a kind of sermon? Possibly, but my excuse is that it is my last jubilee, if not the firm's, I hope, and it embodies my good wishes for the future of the firm. What is required more than anything else of men when they grow old is that they should learn the art of saying goodbye gracefully. Should I succeed to some degree in learning this difficult art, it will in no small measure be due to the great kindness and help I have received from my collaborators and colleagues. It may be an illusion when I think that there is something special about this firm which promises well for its future—but it is an illusion which I don't want to be deprived of.

An explanatory note
Peter Dunican

The following selection of photographs is intended to give some idea of the work which this firm has done since it began, mainly as structural engineers but latterly also as architects and engineers responsible for the total design.

Choosing the jobs, and the photographs to illustrate them, has been difficult for one reason or another. But then any choice is difficult and to some extent it must be arbitrary and a matter of personal opinion. I am sure that you would have made a different selection. Certainly it has not been possible to include all of the jobs which I think should be included.

However, a selection has been made and here it is. It may not be definitive but I do hope that it gives you some idea of the scope and quality of what our firm has helped to achieve during its first 25 years.

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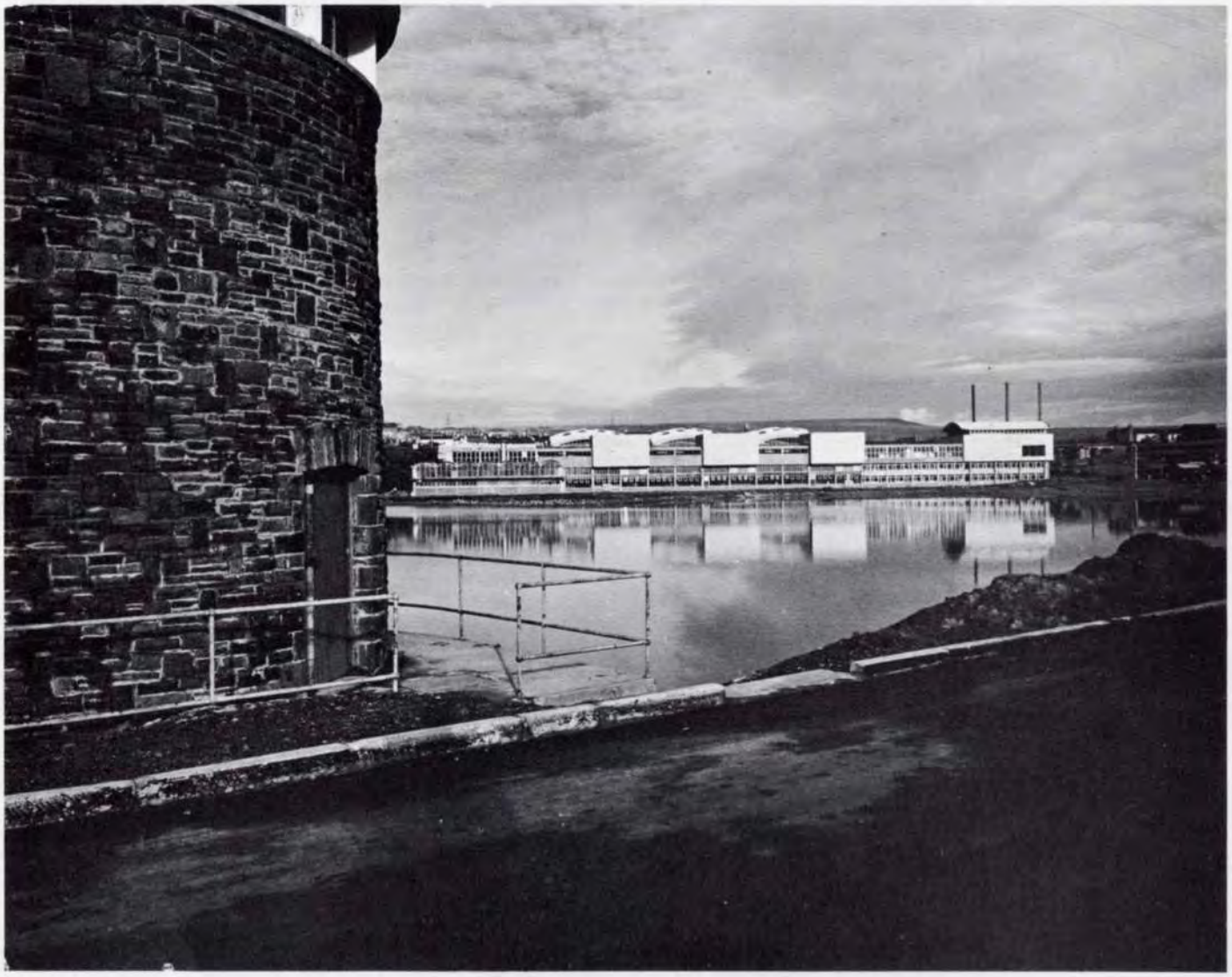

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Fig. 1
Rosebery Avenue Flats, London
Architects: Tecton
Completed: 1949

Contrary to popular belief the first box frame scheme to be completed in England after the war was the block which we did at Kenmure Road, Hackney with the architect, Edward Mills, but Rosebery Avenue, which was completed about a year later, received much more attention because of its historical relationship with its architectural, structural and pre-war predecessors, Highpoint I and II.

Fig. 2
Dublin Bus Station
Architect: Michael Scott
Completed: 1952

This was intended to be the headquarters of the Irish Transport Commission – Coras Iompair Eireann. Due to government changes and indecision the job had a rather chequered career but eventually it was completed as a bus terminal with the offices occupied by the Department of Social Welfare. This building was the foundation of our first overseas practice (1946) and the beginning of our close and fruitful relationship with Michael Scott and his partners.

Associated with the building of the Bus Station was the reorganization of the transport system in Ireland, which included a number of new bus garages all over the country and workshops, locomotive and wagon-building sheds for the railways. Although there were many grand schemes, the only one built was the bus garage at Donnybrook. It was an outstanding structure – a series of 105 ft. span shells with continuous top light; something which had never been done before.

Fig. 3
Brynmawr Rubber Co. Ltd. Factory, Brecon
Architects: Architects Co-partnership
Completed: 1951

This was our first essay in shell structures and it provoked Ronald Jenkins to write his definitive work on the theory and design of cylindrical shells: although the nine major domes which form the focal point of the concept were in fact calculated using the membrane theory.

Fig. 4
Festival of Britain, South Bank, London. Footbridges
Architects: Architects Co-partnership
Completed: 1951

We were responsible for a large number of structures for the Festival of Britain but probably the four most important ones were the Fairway Restaurant roof, which was a precast, prestressed diagrid, and three bridges, one in welded tubular steel, the second in riveted aluminium sections extruded to our own design, and the third an in situ prestressed concrete bridge connecting the Waterloo Bridge entrance with the Royal Festival Hall. This bridge had four spans ranging from 54 ft. to 76 ft. and was post-tensioned with the Freyssinet system. When the Festival closed, this bridge was test-loaded to destruction.

Fig. 5
Hunstanton Secondary Modern School, Norfolk
Architects: Alison & Peter Smithson
Completed: 1953

Some cynics suggest that if an architect wants to win a competition he does not consult with an engineer beforehand, and in any case consultation with someone like us would not ensure success because the best design rarely wins. Hunstanton was an exception to this oversweeping generalization, although perhaps some might consider the maximum exposure of the engineering of the building and its architectural implications somewhat before its time. Certainly seminal New Brutalism, and as Philip Johnson has said 'an extraordinary group of buildings'. (*Architectural Review*, Sept. 1954).

Fig. 6
Ibadan University, Nigeria
Architects: Maxwell Fry & Jane Drew
Completed: 1954

Our West African partnership stemmed in the first place from our immediate post-war collaboration with Maxwell Fry and Jane Drew on the design of a whole range of social buildings, particularly in Nigeria and in Ghana which was then called the Gold Coast. Our initial expatriate representation in the form of Joe Kay, arose from the need for a resident engineer to supervise the building of the university. Our first major tropical hospital, University College Hospital, Ibadan, soon followed as did much else.

7

Fig. 7
Trinity Road Flats, Fitzhugh Estate, London
Architect: Dr. J. L. Martin
London County Council
Completed: 1955

Our first exercise with the London County Council, Architect's Department, Housing Division, where the box-frame structure was terminologically elevated to cross-wall construction. These particular point blocks were also used for the beginning of the Roehampton scheme.

Fig. 8
Mayfield Comprehensive School, Putney, London
Architects: Powell & Moya
Completed: 1955

Cost £187 per place when the Ministry of Education ceiling was £250. One of many comprehensive schools and certainly one of the most successful, mainly because of the planning.

8

9

Fig. 9
Cement and Concrete Association, Research Laboratories, Wexham Springs, Bucks.
Architect: W. R. Oram
Completed: 1956

This was our first attempt to produce a thin shell roof without using any water-proofing layer. This was successfully achieved through prestressing mainly in the valleys.

10

Fig. 10
Bank of England Printing Works, Debden, Loughton, Essex
Architects: Easton & Robertson
Completed: 1956

In structural and constructional terms the new printing hall was well in advance of its time, if only for the manner in which the techniques of precasting and prestressing structural concrete were exploited to achieve a solution which would otherwise have been unattainable. Also it underlined – if underlining is necessary – the important contribution the contractor can make as a member of the design team.

11

Fig. 11
Trades Union Congress Memorial Building, London
Architect: David Aberdeen
Completed: 1956

Most successful structural solutions are so integrated with the totality of the building that the existence of the structure is not apparent. It is easier to make this statement than to fulfil it, but it was certainly achieved here, despite the initial difficulty that it was the exceptional winning design in the second major post-war architectural competition. The depth of our post-competition collaboration with David Aberdeen confirmed the validity of the important principle of total commitment to the building and the overriding need for the maximum attention to the minutest detail.

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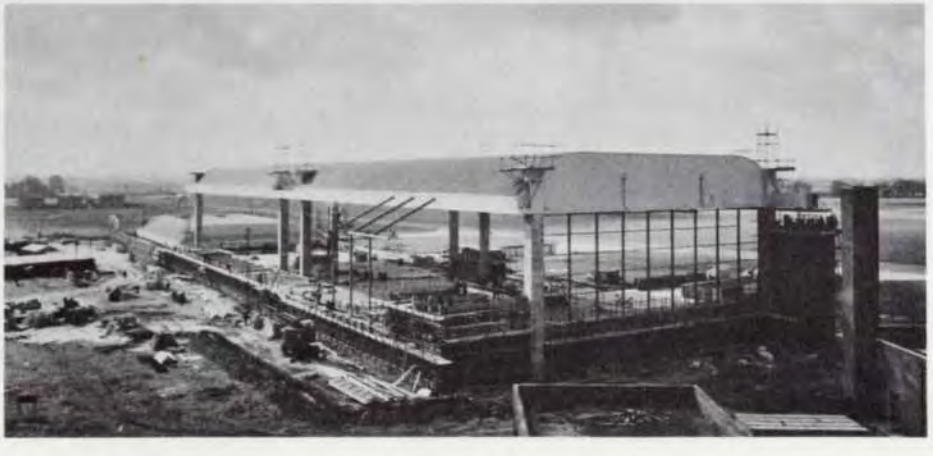


Fig. 12
Abingdon Hangars, Berkshire
Completed: 1958

Following our success in an Air Ministry design and build contract for the Gaydon hangars with a simple structure of welded tubular steel, three pinned space frames thrusting onto concrete buttresses, our contractor collaborators asked us to prepare a wholly concrete design for the next competition for the Abingdon Hangars. Once again we were successful, this time with a system of precast prestressed shells which were jacked into position via their supporting columns.

13

14

Fig. 13
UK Pavilion, Johannesburg, South Africa
Architects: Fleming & Cooke
Completed: 1959

One of our first South African jobs. Very reminiscent of the Festival of Britain but technically in advance of its time.

15

Fig. 14
Municipal Market, Salisbury, Rhodesia
Architect: Salisbury Municipal Architect
Completed: 1958

In the 50's, following Brynmawr and Donnybrook and some other jobs, circular shells of one sort or another were very much in vogue, although they could be expensive because of the cost of the curved shuttering. To overcome this disadvantage the earlier idea of the folded plate was developed, either in concrete or in steel, and widely used by us, particularly in Southern Africa. This one is in concrete.

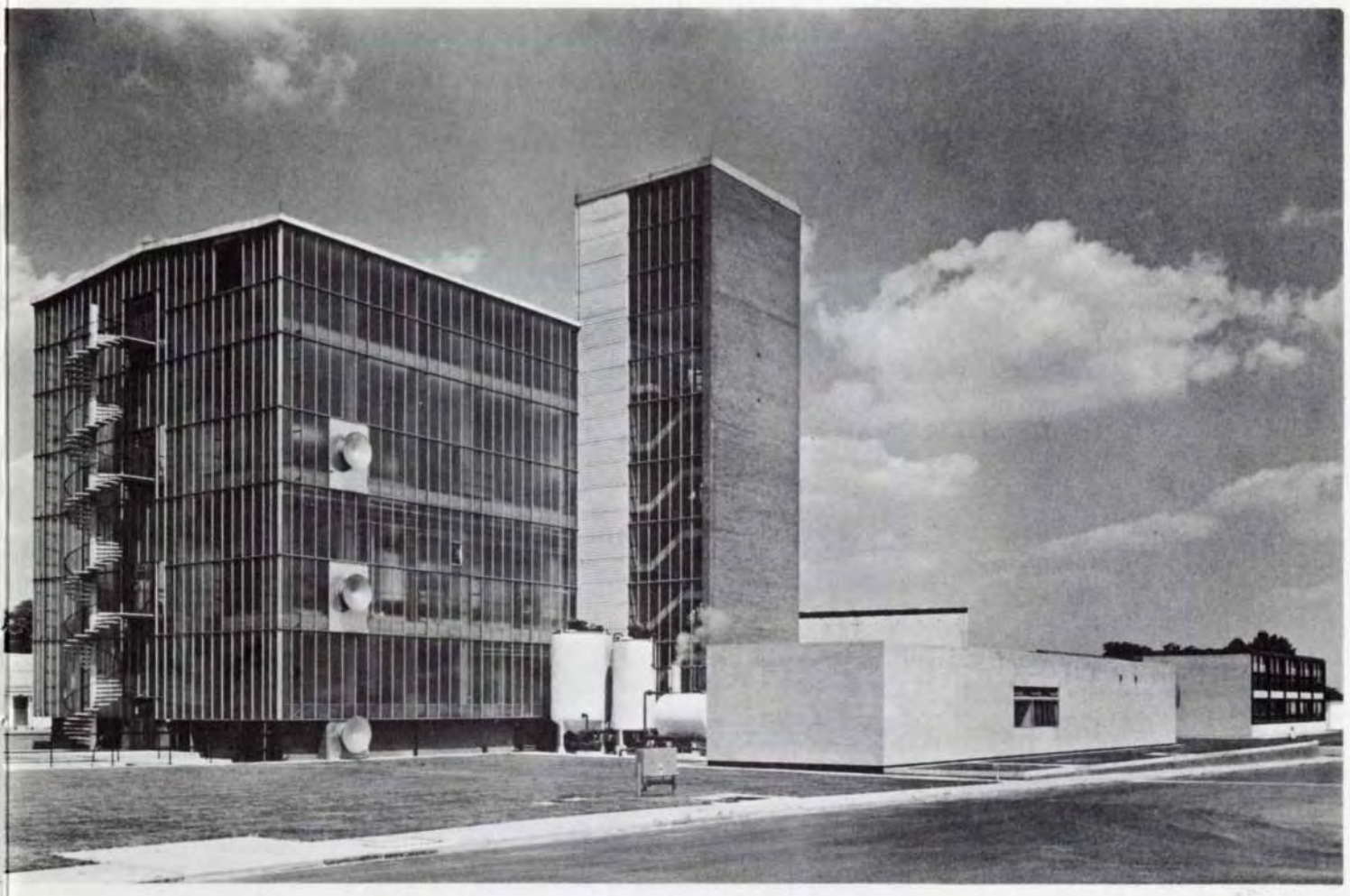


Fig. 15
CIBA (ARL) Duxford.
Research Building
Fig. 16
CIBA (ARL) Duxford.
Araldite Building
Architects & Engineers: Arup Associates
Both completed: 1959

Part of our very first real architectural-engineering commission designed by the Building Group and a part of the reason for the subsequent birth of Arup Associates.

17

Fig. 17
Princess Margaret Hospital, Swindon, Wiltshire
Architects: Powell & Moya
Completed: 1960

The first major hospital project to be completed in England after the war, and 'among the architecturally significant hospitals in Europe today'. (G. E. Kidder-Smith. *The new architecture of Europe.* Pelican, 1961.)

18

Fig. 18
SKF Laboratories, Hertfordshire
Architects & Engineers: Arup Associates
Completed: 1960

'The result of some six years' work, these laboratories and offices, were constructed in two stages allowing for future extension of the office block. They illustrate the problem of maintaining architectural unity over a period of years while allowing for flexibility of growth and change'. (*Architects' Journal*, November 1964.)

Fig. 19
Coventry Railway Station Reconstruction
Architect: W. R. Headley
British Transport Commission (London Midland Region)
Completed: 1961

Less is more in the Midlands, opened just in time to allow the Queen to arrive in suitable state by train to attend the consecration of the Cathedral.

19

20

Fig. 20
Eton Boat House, Windsor, Berkshire
Architect: Michael Pattrick
Completed: 1961

A simple structure in laminated timber beside 'where the cygnet feeds'.

21

Fig. 21
Park Hill Housing Scheme, Sheffield, Yorkshire
Architect: J. L. Womersley, Sheffield City Architect
Completed: 1961

The first major deck access housing scheme built in England which has had considerable impact on the architectural and sociological approach to public authority housing ever since. It was also the first major housing scheme which we did without a cross-wall structure.

22

Fig. 22
Radiation Headquarters, North Circular Road, London
Architect: Dennis Pugh
Completed: 1961

This is considered by many as a good example of the sort of building which we should work on and it did give pleasure to those who did. Certainly not a square building in a circular road.

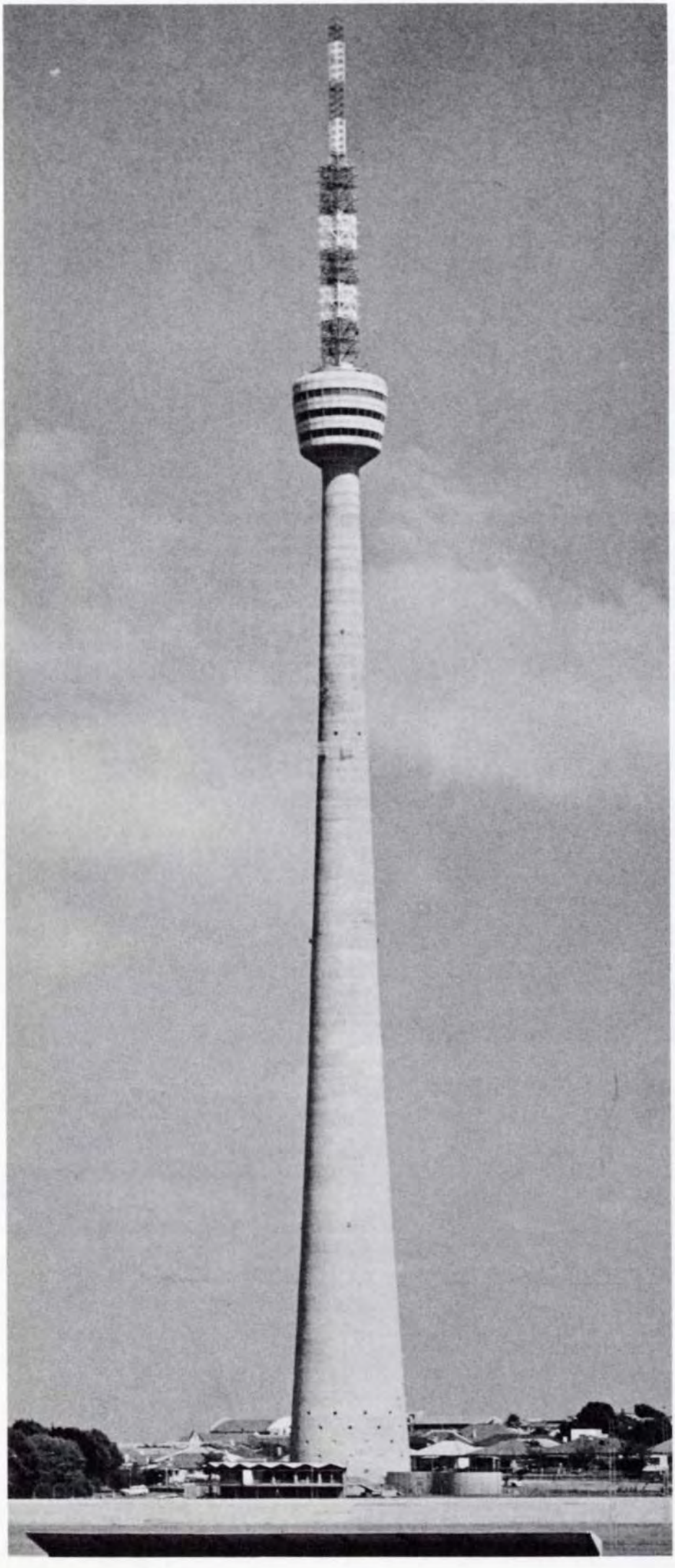
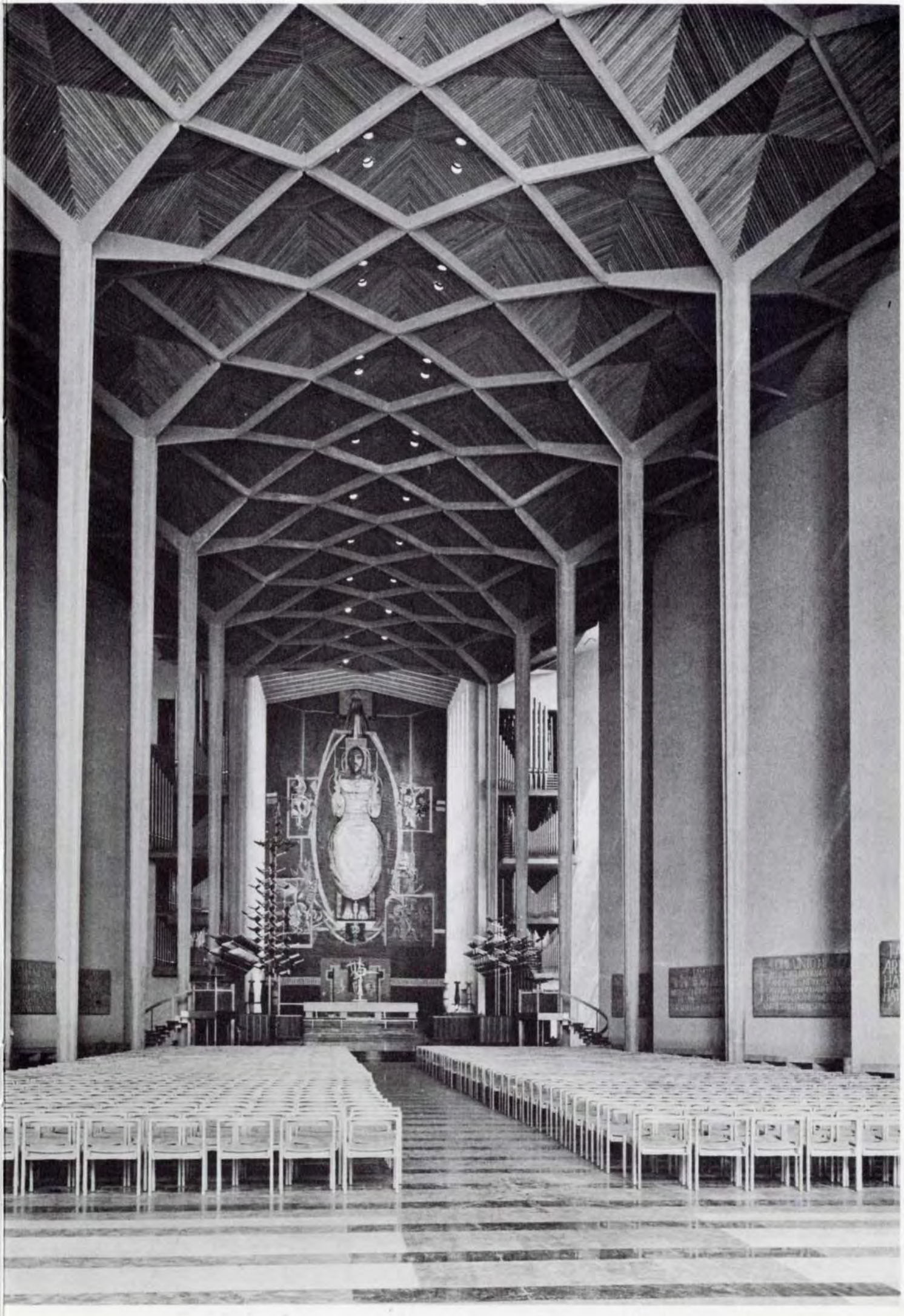


Fig. 23
Albert Herzog Tower
Architects: South African Broadcasting Corporation Architects Department
Completed: 1962

When this tower was built it was the highest concrete structure in Africa and the tallest one for which we had been responsible. It was also a very rapid construction in that only 13 months elapsed from the time when the client first started talking to us until VHF radio transmissions began.

Fig. 24
Coventry Cathedral
Architect: Sir Basil Spence
Completed: 1962

Another successful competition design. Perhaps our most important contribution was the design of the nave canopy with its vertical structure of precast prestressed elements with epoxy resin joints. Apart from any technical or aesthetic importance which this canopy may have, it underlines the essential interdependence of geometry and structure. It was also here that we used a helicopter for the first time in construction to lift the spire onto the roof.



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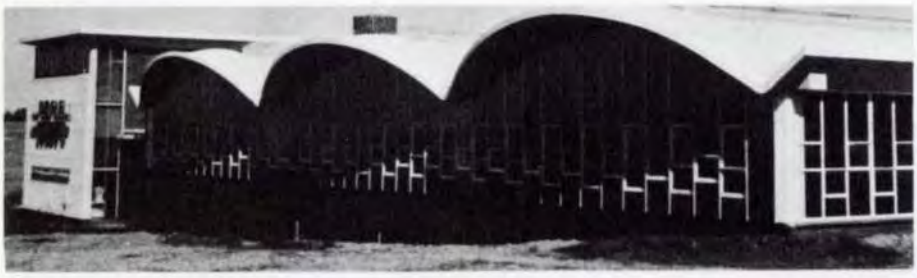

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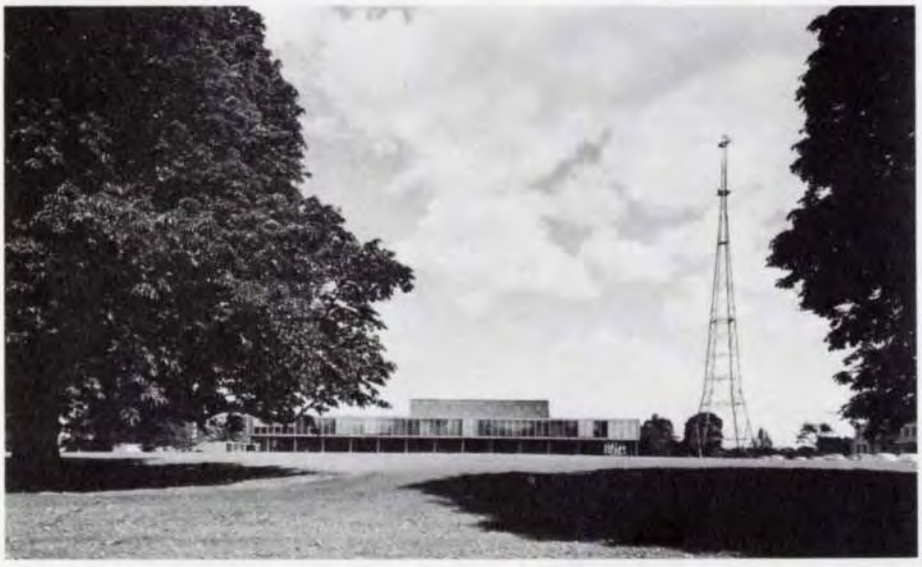

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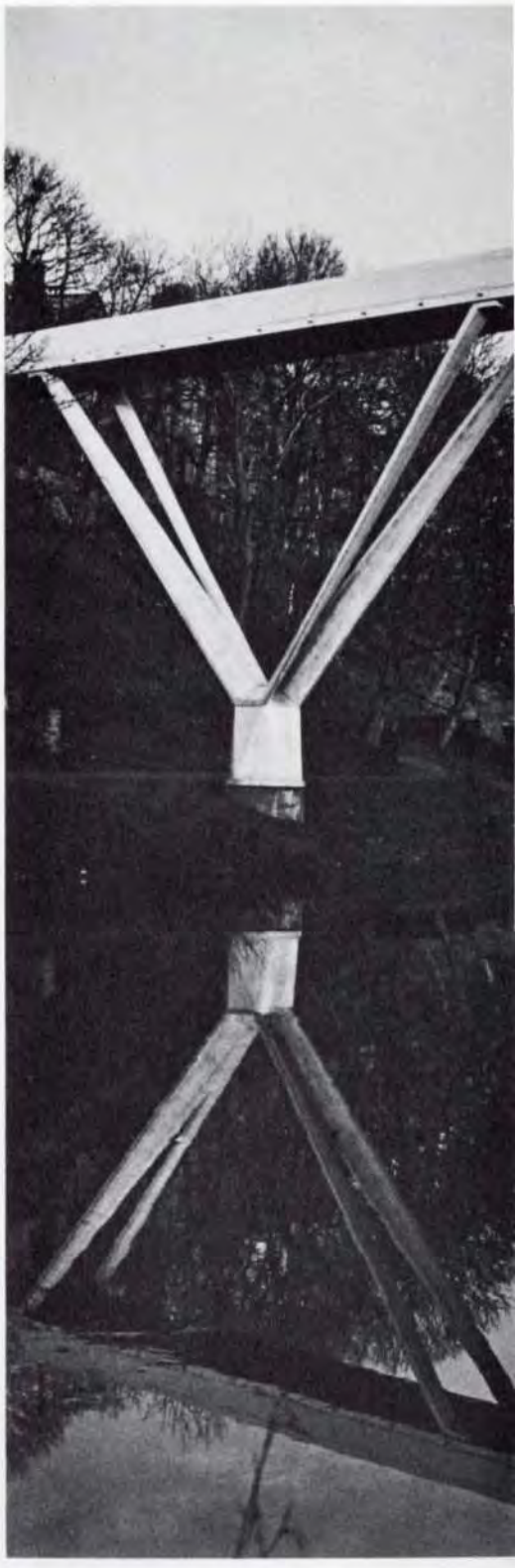

Fig. 25
Mine Safety Appliances, Aeroton, Baragwanath, Johannesburg
Architect: James Watson
Completed: 1962

A further refinement in shell structures, the so-called flexible shell with pre-stressed ties at the gables. Here again no water-proofing layer was used.

Fig. 26
New Mulago Hospital, Kampala, Uganda
Architects: John L. Hope and K. P. Smith
Completed: 1962

The beginning of our work in East Africa and remarkable not only for the expeditious way in which it was designed, but also for the use of labour-intensive industrialized building methods devised by the designers.

Fig. 27
Radio Telefis Eireann, Dublin
Architects: Michael Scott & Partners
Finish: 1962 (Phase 1)

Genuine Irish concrete Mies in the steps of the master.

Fig. 28
Kingsgate Footbridge, Durham
Completed: 1963

Structural originality, constructional ingenuity and architectural inspiration.

29

Fig. 29
Warwick Crescent Housing, Paddington, London
Architect: Hubert Bennett, London County Council Architects Department
Completed: 1962

Part of the then London County Council's tall block programme. We produced the type design in collaboration with the Development Architect of the Housing Division in 1955–6. We made about 18 of these, but it was at Warwick Crescent that eventually we were able to completely industrialize the superstructure and thus bring about the birth of the Wates system.

30

Fig. 30
Smithfield Market, London
Architects: T. P. Bennett & Son
Completed: 1963

An elliptical paraboloid concrete shell dome which was considerably larger and flatter than any such dome previously built.

31

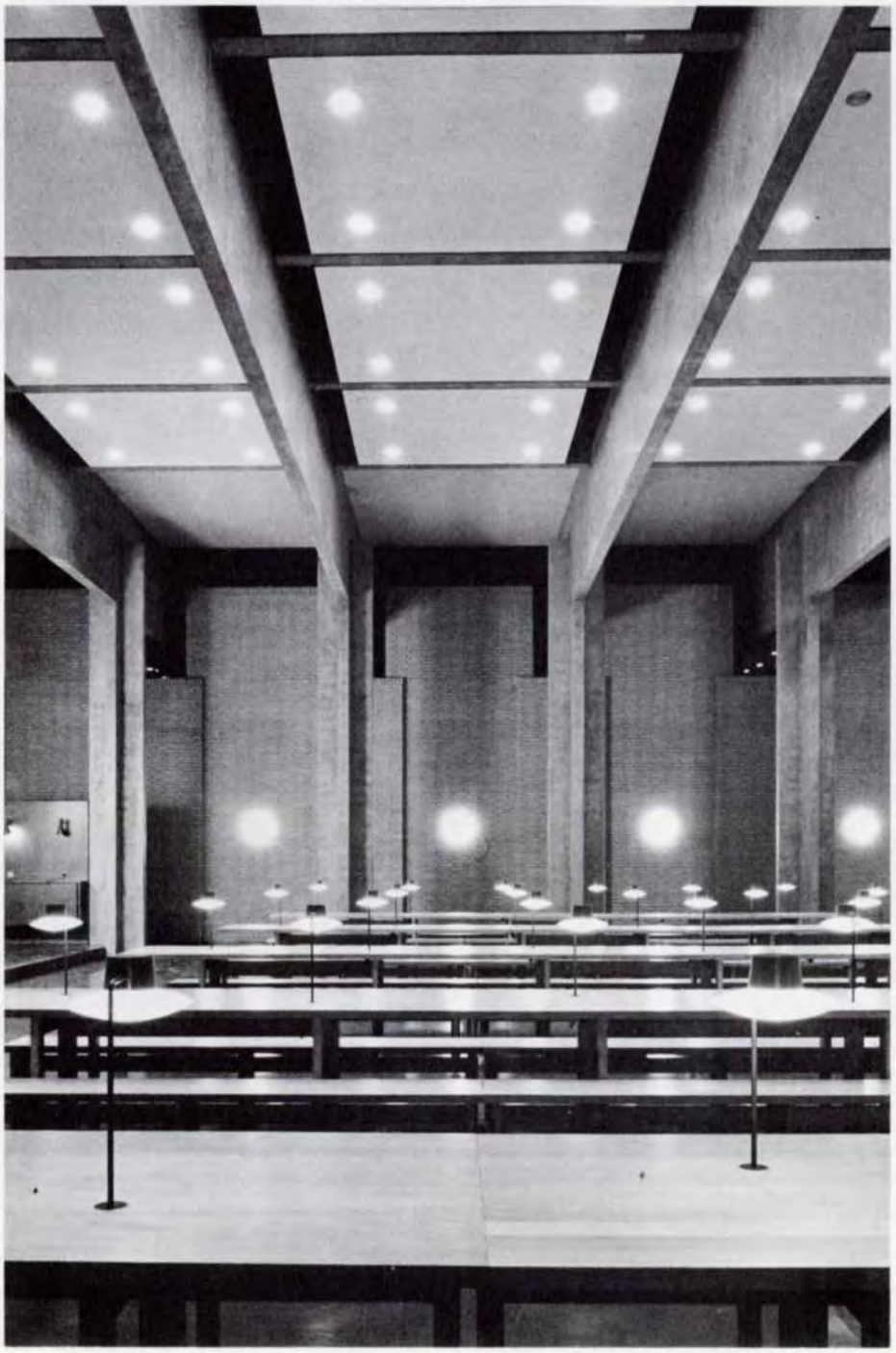

Fig. 31
St. Catherine's College, Oxford University
Architect: Arne Jacobsen
Completed: 1964

Precision, perfection and clarity in precast concrete.

Fig. 32
Corpus Christi College, Cambridge
Architects and Engineers: Arup Associates
Completed: 1964

An architectural vernacular for housing undergraduates, post-graduates and Ph.D's. The design follows on from Somerville although the latter was built four years earlier. 'The repetition of identical elements creates a discipline around which other threads are woven'. (Philip Dowson, *RIBA Journal*, March 1966.)

Fig. 33
Crystal Palace Sports Centre
Architect: Hubert Bennett, London County Council Architects Department
Completed: 1964

An architectural essay in structural geometry providing Olympic sports facilities for the Central Council for Physical Recreation. The structure speaks for itself.

32

33

35

Fig. 34
Point Royal, Bracknell, Berks.
Architects and Engineers: Arup Associates
Completed: 1964

A turning point in the work of Arup Associates' precursor – the Building Group – which up to then had been mainly concerned with industrial building.

Fig. 35
Birmingham University.
Metallurgy, Mining and Mineral Engineering Department
Architects and Engineers: Arup Associates
Completed: 1965

The exploitation of the notion of an all-embracing three dimensional geometry of multiple and related, but not coincident, grids which led to an economic 'one-off' industrialized system using 17 ton precast concrete units. The breakthrough which led to Loughborough.

Fig. 36
University of Sussex
Architect: Sir Basil Spence, Bonnington & Collins
Completed: 1965

'I was tremendously impressed by the Coliseum, not as it was, but *as it is now.* It exposes a structure with great arches. I think it is an absolutely marvellous building. I owe a great deal, too, to Corbusier's vaulted houses. It was a combination of these influences which made me go for the Sussex design.' (Sir Basil Spence, *Architect and Building News,* 13 April 1960.)

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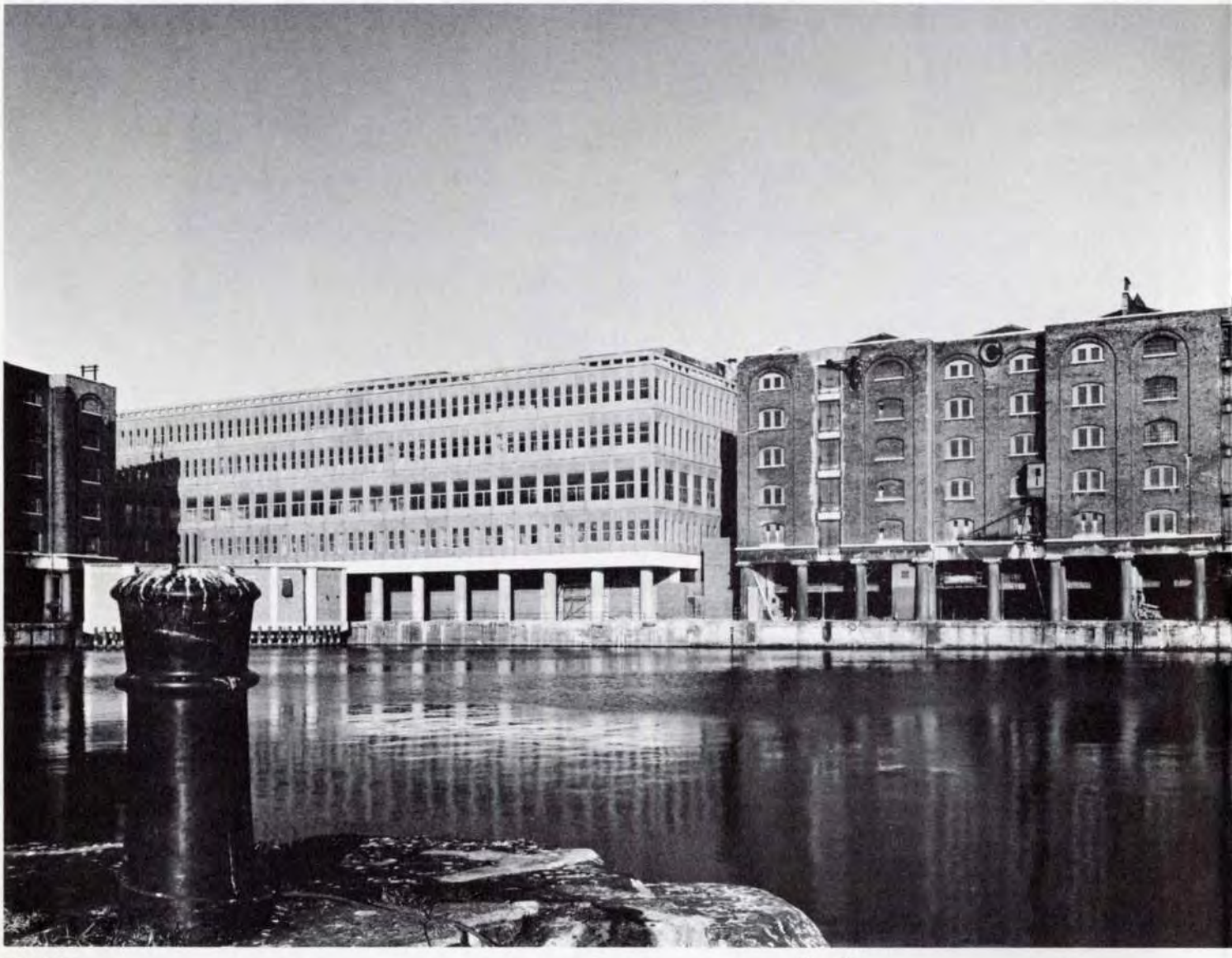

Fig. 37
St. Katharine Dock House, London
Architect: Andrew Renton & Associates
Completed: 1965

A worthy companion to the work of Thomas Telford and Philip Hardwick and a very early and elegant use of precast load-bearing mullion wall elements.

Fig. 38
Manchester United Football Stand, Lancashire
Architects: Mather & Nutter
Completed: 1965

Probably our longest horizontal cantilever in structural steelwork.

38

39

Fig. 39
Volta River Bridges
Completed: 1965

In anticipation of the damming of the Volta river, two bridges were built at Morno and Yapei. They were designed in steel to satisfy the Export Credits Guarantee Department's financing arrangements and high tensile bolted open lattice girders were used instead of continuous plate girders because access to the site imposed a length limit of 40 ft. The twin circular column piers were necessary to reduce the effect of the heavy angular current during the rains.

Fig. 40
Glasgow Airport
Architect: Sir Basil Spence, Glover & Ferguson
Completed: 1966

Streamlined Sussex airborne over the Border.

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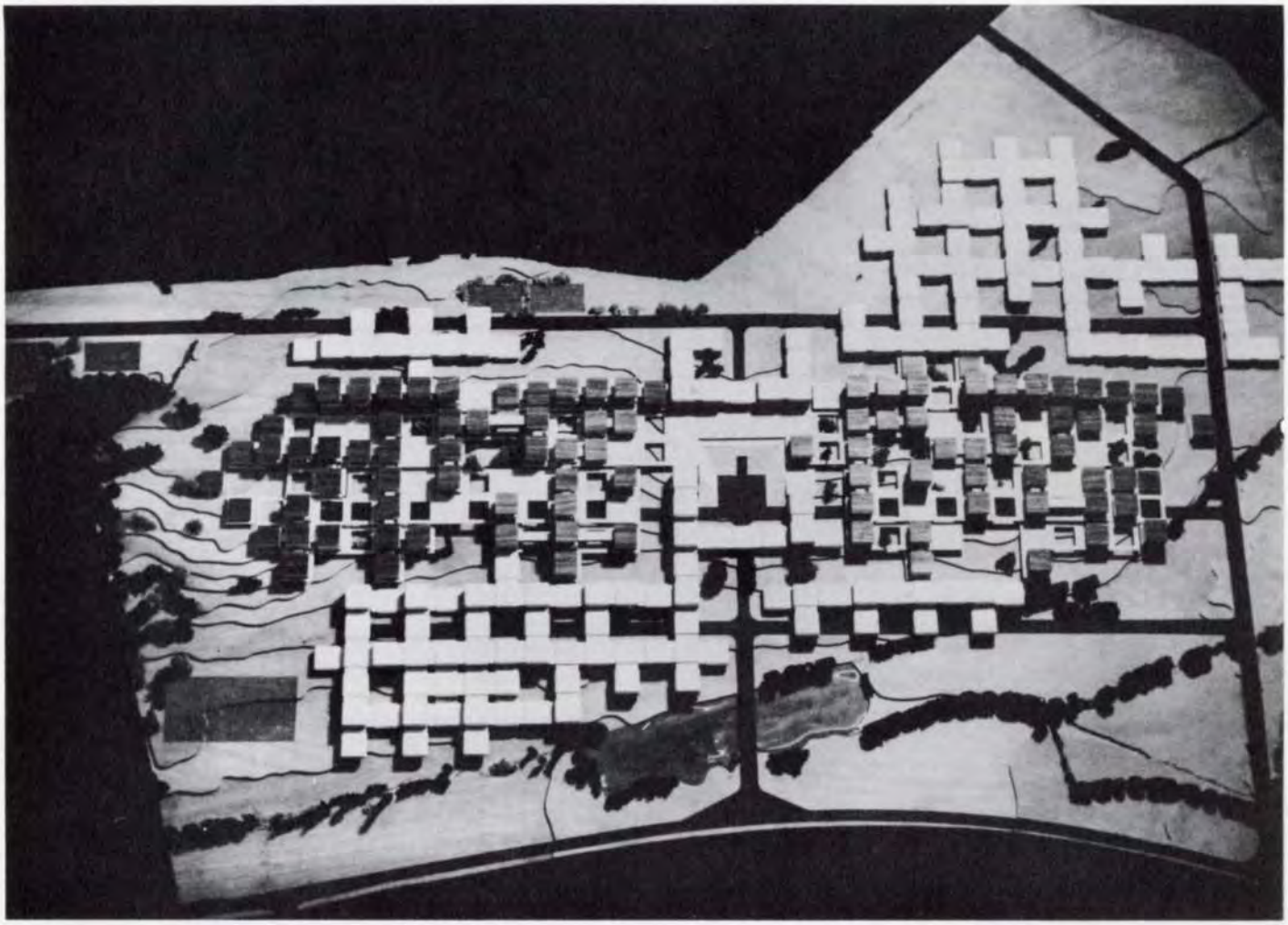

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Fig. 41
Loughborough University. Master Plan
Architects & Engineers: Arup Associates
Plan published: 1966

On one level, a plan based upon a set of disciplines within which a randomness can exist – where the solution consciously reflects the indeterminancy of the problem – on another level the technical triumph of producing a 50 ft. square span industrialized structure within UGC cost limits.

Fig. 42
Independence House, Lagos
Architect: Nigeria Public Works Department
Completed: 1966

When this 26-storey block was conceived, no building higher than seven storeys had been built in Lagos and not without some reason – mainly those geotechnical four letter words like silt, sand, clay, and clayey sand, which extend for at least 100 ft. below Lagos Island. Impending independence provided the challenge; vibro-flotation and a cellular raft provided the answer.

43

Fig. 43
Somerville College, Oxford, Stage 3 (The Wolfson Building)
Architects & Engineers: Arup Associates
Completed: 1966

Further weaving within the repeating warp.

Fig. 44
Edinburgh University Library
Architect: Sir Basil Spence, Glover & Ferguson
Completed: 1967

The largest university library building in Britain. 'The library is an outstanding building which clearly fulfils its function well. There is a marvellous consistency of detailing throughout the buildings and the workmanship is of a very high order'. (Jury's report, RIBA Awards, 1968.)

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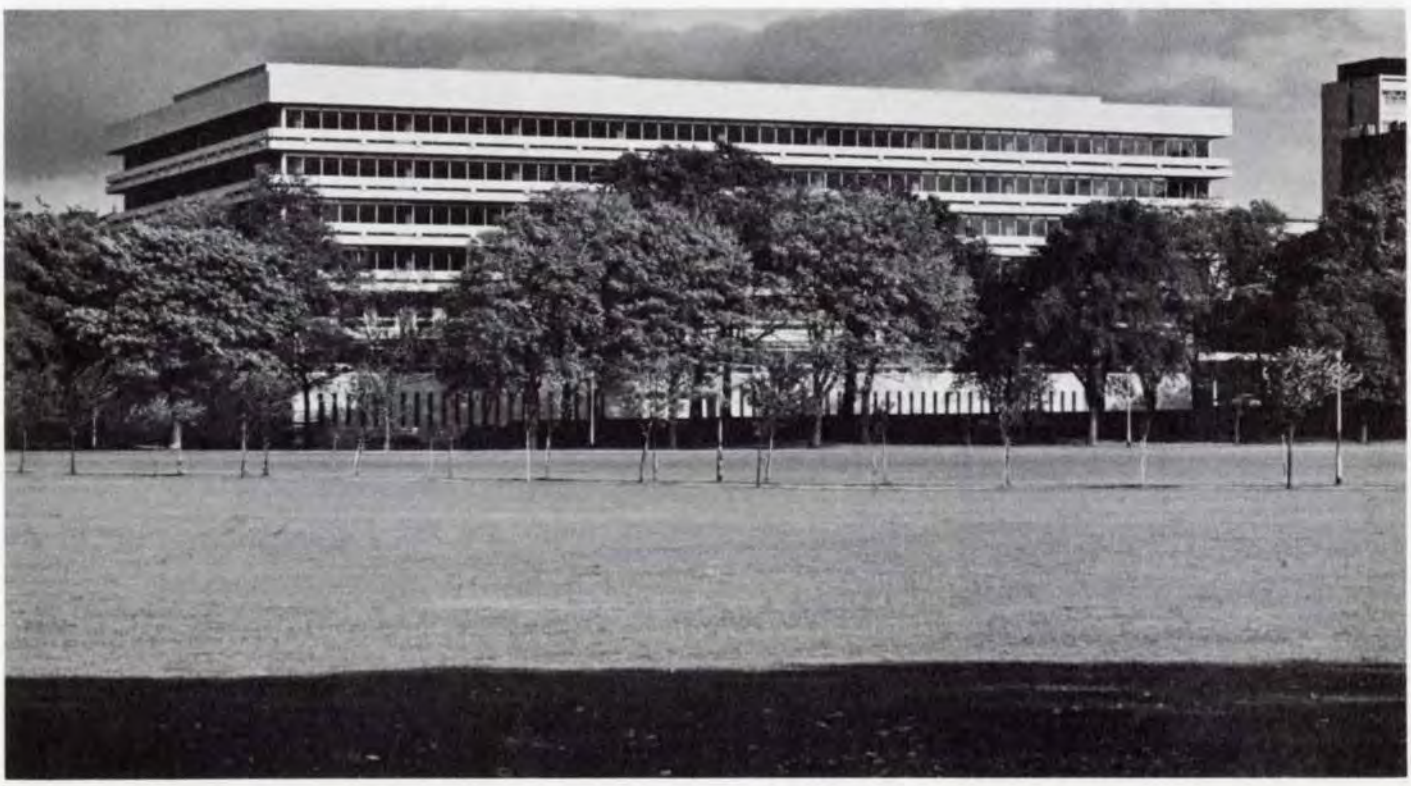

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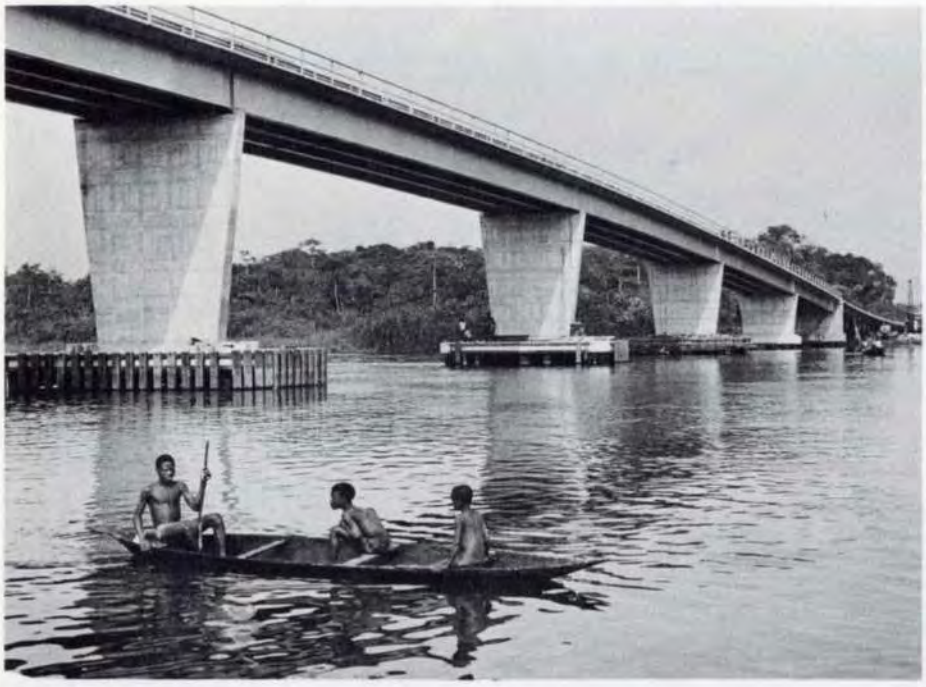

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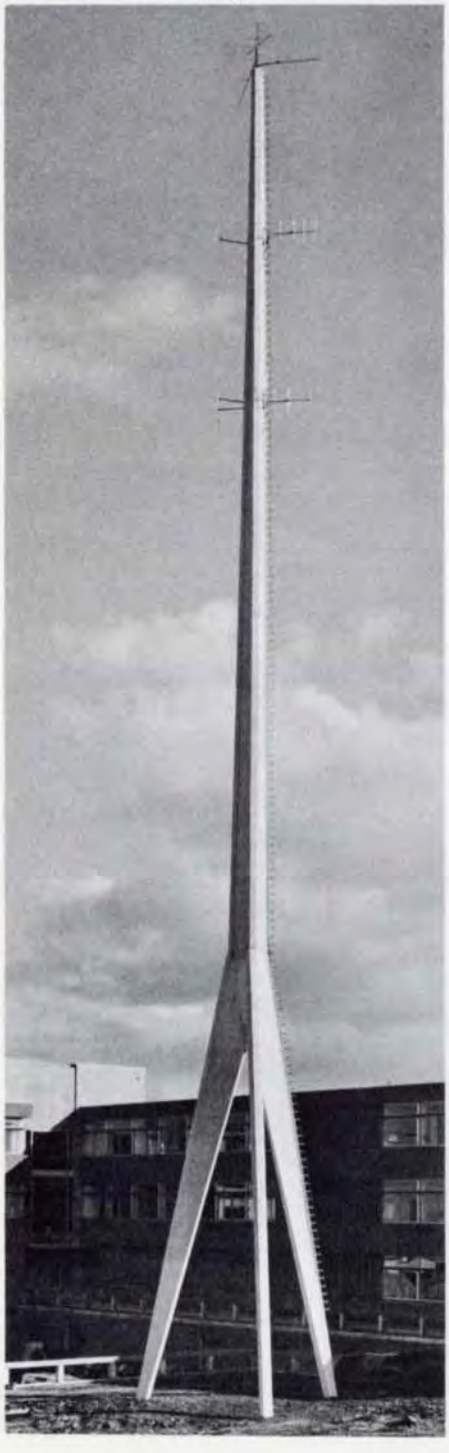

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Fig. 45
Sapele Bridges, Nigeria
Completed: 1967

Although of the same order as the Volta Bridges the use of continuous steel plate girders, with a semi-precast composite deck, was possible because up to this point the Benin River was navigable by deep sea vessels which meant that long sections could be delivered by barges and erected directly from them.

Fig. 46
Wharf at Yandina, British Solomon Islands
Completed: 1967

A maritime structure 'in a pattern of islands'.

Fig. 47
Durham Police HQ Radio Mast
Completed: 1968

One precast success leads to another.

Fig. 48
Kasama Cathedral
Architect: Julian Elliott
Completed: 1968

A do-it-yourself cathedral following from a gentle priestly enquiry of an architect on how to design a timber roof truss and resulting in a 76 ft. square, prestressed, hyperbolic paraboloid built by completely unskilled labour directed by three theologians, White Fathers, more experienced in conversion than in construction.

Fig. 49
Penguin Books Ltd., Warehouse, Harmondsworth, Middlesex
Architects & Engineers: Arup Associates
Completed: 1968

Precast prismatic forms for housing Penguins ... and Pelicans, etcetera.

50

Fig. 50
Roxburgh County Council Offices, Scotland
Architect: Peter Womersley
Completed: 1968

Modelled, modulated and textured concrete, strong in character but light in weight.

Fig. 51
South Bank Development Scheme
Architect: Hubert Bennett, Greater London Council, Department of Architecture and Civic Design
Completed: 1968

An introverted, articulated architectural sculpture with probably the most outstanding use of exposed concrete surfaces in London today. It provides one of the two best small concert halls which have been built in Britain since the war.

51

52

Fig. 52
West African Highways

Since our practice in this part of the world diversified into civil engineering we have been responsible for the design, construction and supervision of over 2,000 miles of highways and the associated bridges, culverts and other works. The illustration shows the Biu-Gombe road under construction. It was completed in 1969.

53

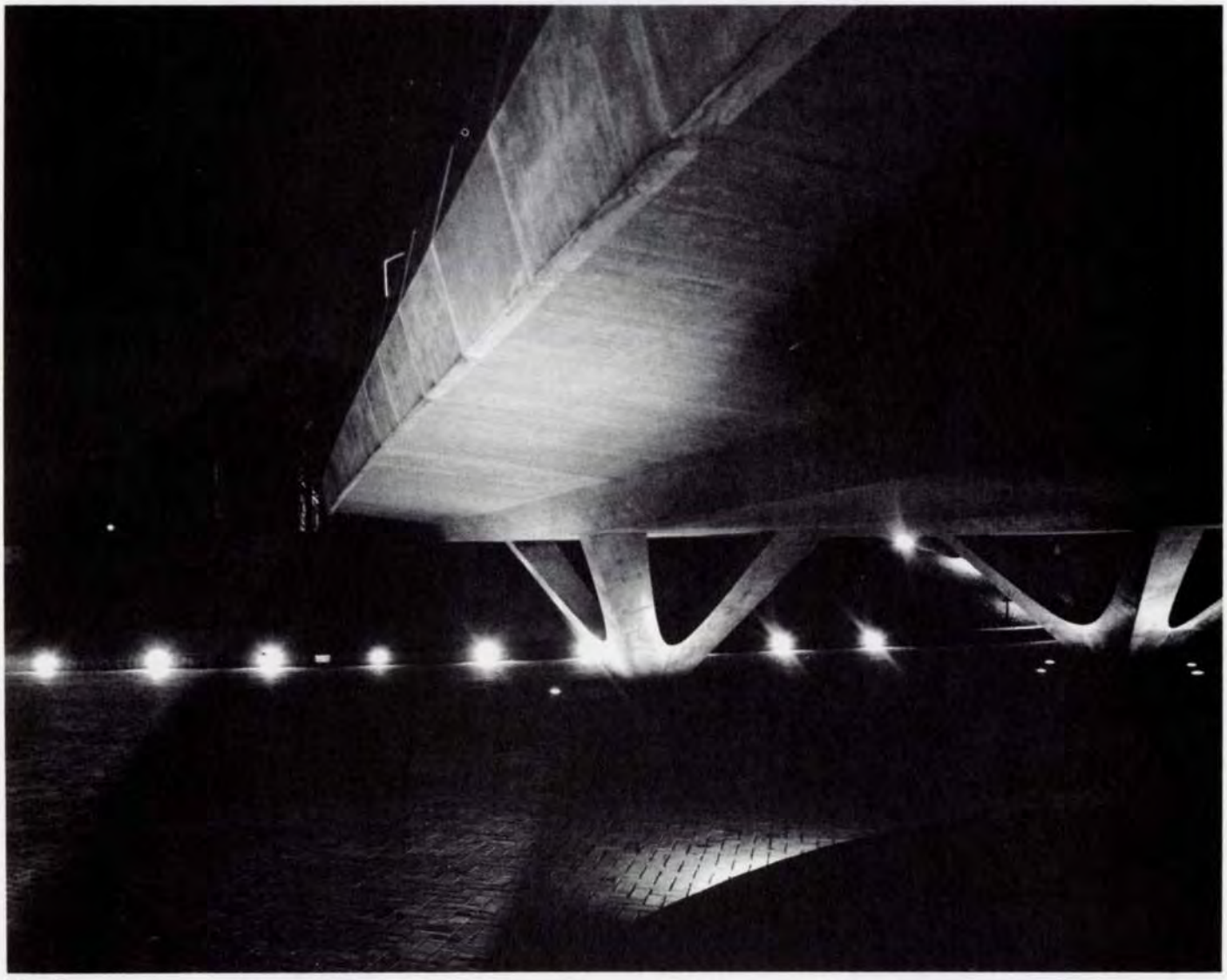

Fig. 53
Sheffield University Concourse
(Western Bank Bridge)
Completed: 1969

Twin tailored slabs, each supported at five points with a quadrupedal centre point, separating overpassing traffic from underpassing pedestrians, and connecting students with the Union.

54

55

Fig. 54
King Edward's Road Housing, Hackney
Architects: Yorke Rosenberg, Mardall
Completed: 1969

A mixed development scheme for the GLC with deck access at 3rd floor level in the Wates system, confirming, if confirmation is necessary, Denys Lasdun's statement that 'there is no dichotomy in the architectural design process between "one-off" and "system-built".' (*RIBA Journal*, April 1965)

Fig. 55
Microwave Towers for GEC and others

During the last six years we have designed towers for microwave and other networks all over the world. Networks have been completed in Bahrein, Hong Kong, Dubai, Fiji, Greece, Malawi, Nigeria, Zambia and Chile. The latter was completed in 1969 and is illustrated here.

56

Fig. 57
Birmingham University
Arts and Commerce Building,
Architects & Engineers: Arup Associates
Completed: 1970

The way it works is more important than the way it looks—but the way it looks is not unimportant. Twin blocks with double columns supporting massive beams, each carrying triple floors.

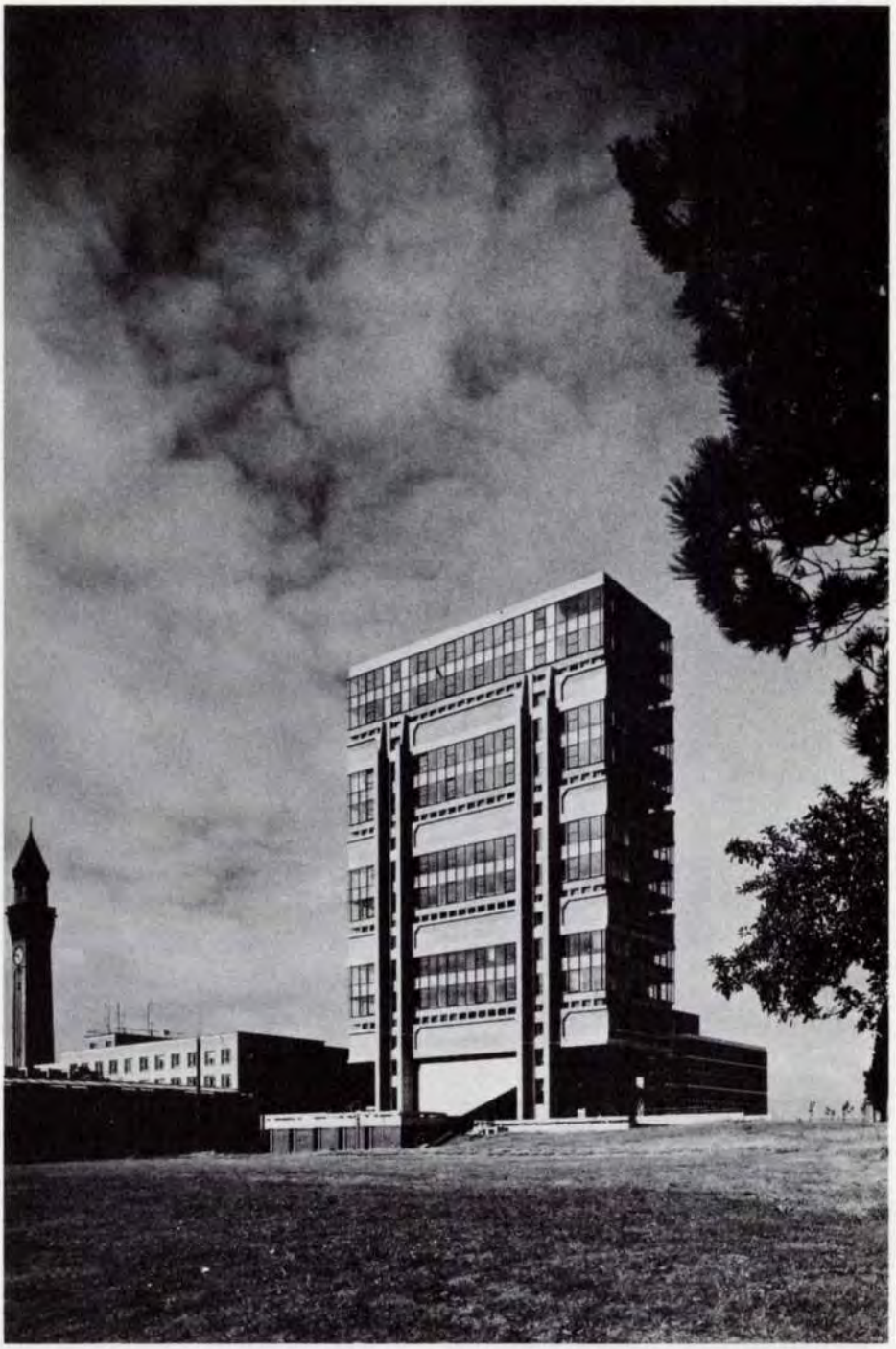

Fig. 56
Aldeburgh Concert Hall, Snape
Architects & Engineers: Arup Associates
Completed: 1967
Destroyed by fire: 1969
Rebuilt: 1970

The first real venture into the science and art of acoustics and resulting in the other best small concert hall built in Britain since the war—twice with loving care.

58

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60

61

62

Fig. 58
Royal Commonwealth Pool, Edinburgh
Architects: Robert Matthew, Johnson-Marshall & Partners
Completed: 1970

'Style is form, and good style is form which flows: it is organic: it fits.' And so it does. (*Architects' Journal*, 16 Sept. 1970)

Fig. 59
Hillbrow Microwave Tower and Telephone Exchange
Completed: 1970

Because the usefulness of the Herzog tower was being reduced by the high-rise developments taking place in Johannesburg, a much higher, and undoubtedly more impressive, tower was necessary. This is now the highest concrete tower in Africa and our tallest structure until the next one.

Fig. 60
IBM Respond Centre, Havant
Architects & Engineers: Arup Associates
Completed: 1970

The first building – housing computers of course – of an extensive development for IBM.

Fig. 61
Northwick Park Hospital, London, Stage 1
Architects: Llewelyn-Davies, Weeks, Forestier-Walker & Bor
Completed: 1970

'The structurally complex job of arranging the mullions was done by a team of structural engineers . . . and the only architectural requirement was that the arrangement should be diffuse rather than pyramidal. There is no proportional or dimensional control other than a minimum interval. The elevations have not been altered in any way since they came from the engineer's office. Each elevation was a surprise and a delight to us.' (John Weeks, *RIBA Journal*, December, 1964.)

Fig. 62
Standard Bank, Johannesburg
Architects: Hentrich and Petschnigg in association with Professor E. W. N. Mallows
Executive Architects: Stucke, Harrison, Ritchie & Partners
Completed: 1970

'Another brilliant example of the creative integration of design and construction methods.' (Peter Scher, *Architects' Journal*, 26 January 1966.)

63

64

Fig. 63
Sunderland Civic Centre
Architects: Sir Basil Spence, Bonnington & Collins
Completed: 1970

'A recognizable addition to the scene of the industrial and maritime character and history of Sunderland . . . this unusual collection of hexagons truly graces the eminence on which it stands'. (H. A. N. Brockman, *Financial Times,* 6 November 1970.)

Fig. 64
The Stock Exchange London
Architects: Llewelyn-Davies, Weeks, Forestier-Walker & Bor and Fitzroy Robinson & Partners
Completed: 1970 (Phase A)

A precast and cast in situ, polygonal, monomorphous monolith.

65

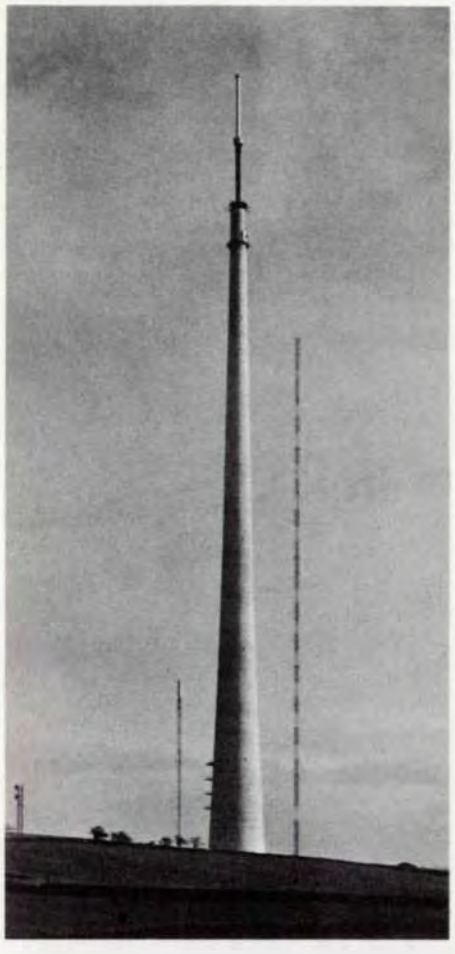


Fig. 65
Emley Moor Television Tower, Emley, Yorks.
Completed: 1971

The next one after Hillbrow and at 1080 ft., 199 ft. higher, and 316 ft. higher than Herzog, replacing the tallest structure in Britain which collapsed in March 1969. The third highest concrete TV tower in the world.

66

Fig. 66
Barbican Redevelopment Scheme, London
Architects: Chamberlin, Powell & Bon

This is probably our most important urban development which will more than double the permanent population of the City of London and thereby reverse a century-old trend when it is eventually completed.

Fig. 67
Gateshead Viaduct A1 Route

A refined and elegant structure of multi-cellular, prestressed, in situ concrete boxes supported by hexagonal piers in a variety of arrays.

Fig. 68
East-West Motorway, Johannesburg

A simple structural solution to accommodate extensive ground movements, arising from mining operations. A monitoring system has been installed to measure the actual ground movements so that when either of the design deformations of 20 in. vertically and 10 in. horizontally are reached, the structure can be re-aligned by jacking at predetermined points.

Fig. 69
Sydney Opera House
Architect: Jorn Utzon (Stages 1 & 2)
Hall, Todd & Littlemore (Stage 3)

'Her Majesty the Queen has been graciously pleased to confer Her Award in 1969 upon . . . Ove Arup & Partners Consulting Engineers, for technological innovation in prestressed concrete roofing'. Sydney can be so described but it is not only roofing, it is a triumph for technology in the service of art.

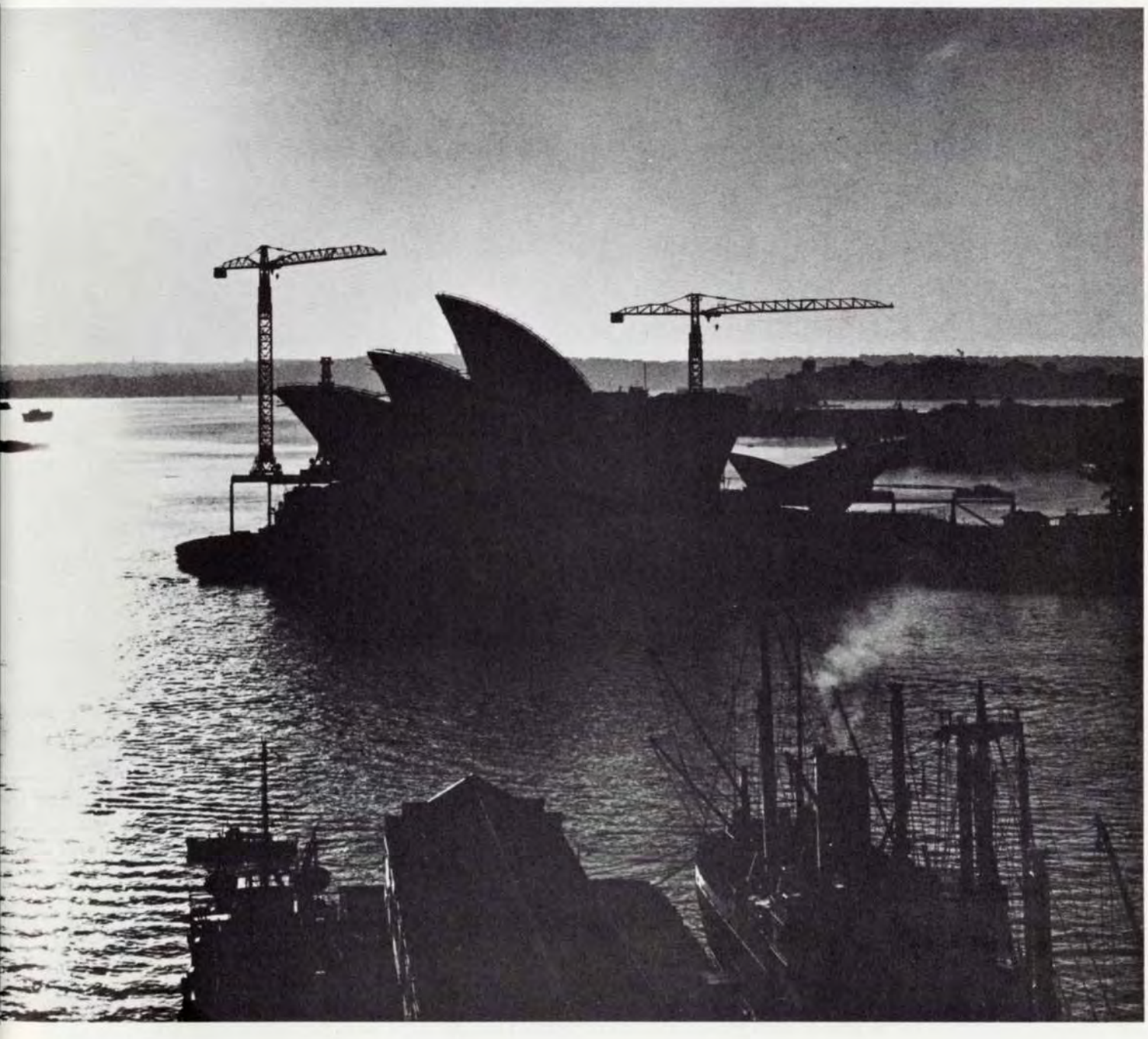
67

68

69

Fig. 70
York Minster Preservation
Architect: Feilden and Mawson

Norman foundations, Gothic superstructure and Elizabeth II technology – a problem in building pathology in four dimensions.



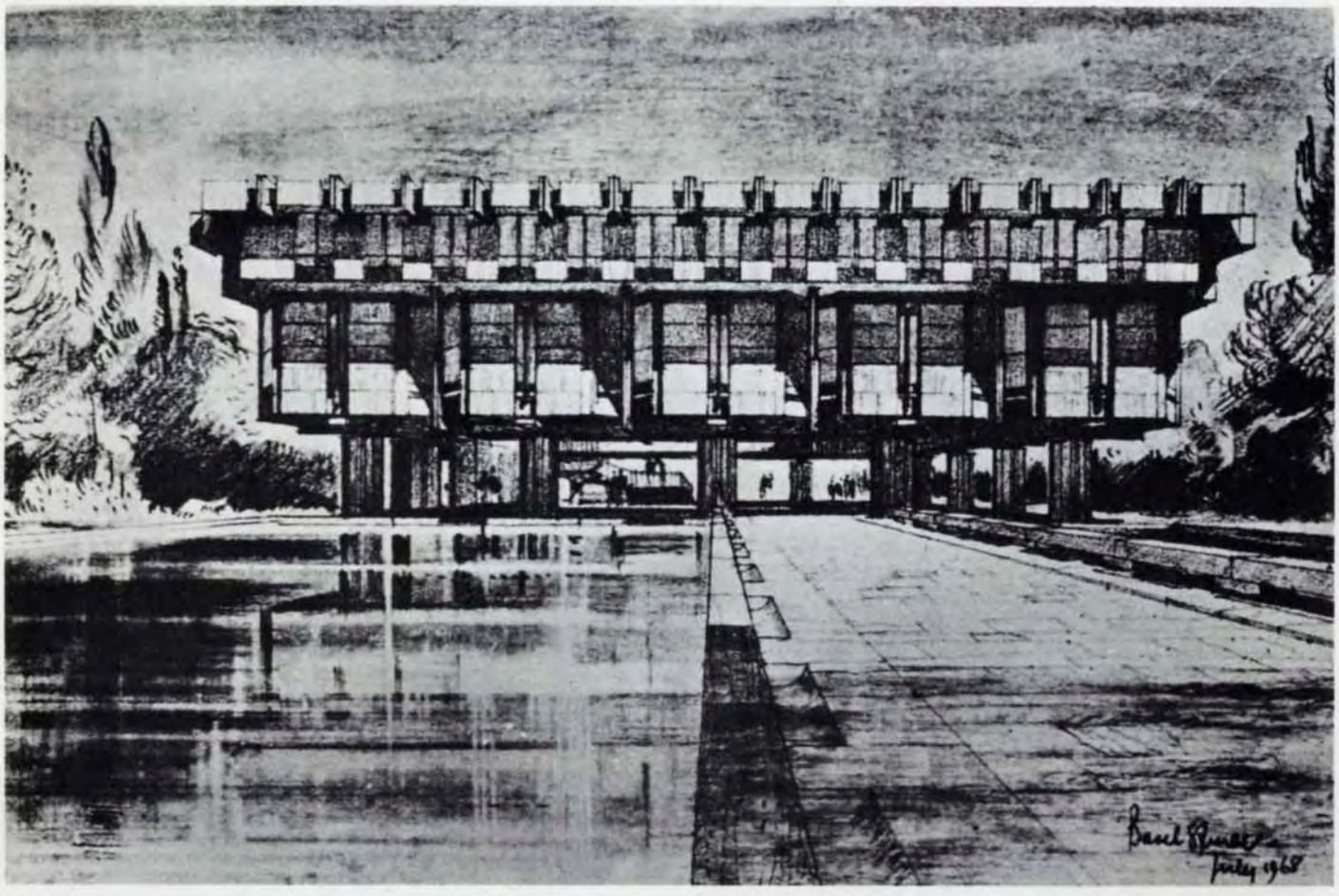


Fig. 71
British Embassy, Rome
Architects: Sir Basil Spence & Partners
Our first major project on the Continent.

Editor's note
Peter Hoggett

It has not been possible for Peter Dunican to give detailed information for any of the jobs described in the captions for the photographs.

Anyone wishing to read fuller accounts of these jobs can obtain references from the Fitzroy Street library.

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