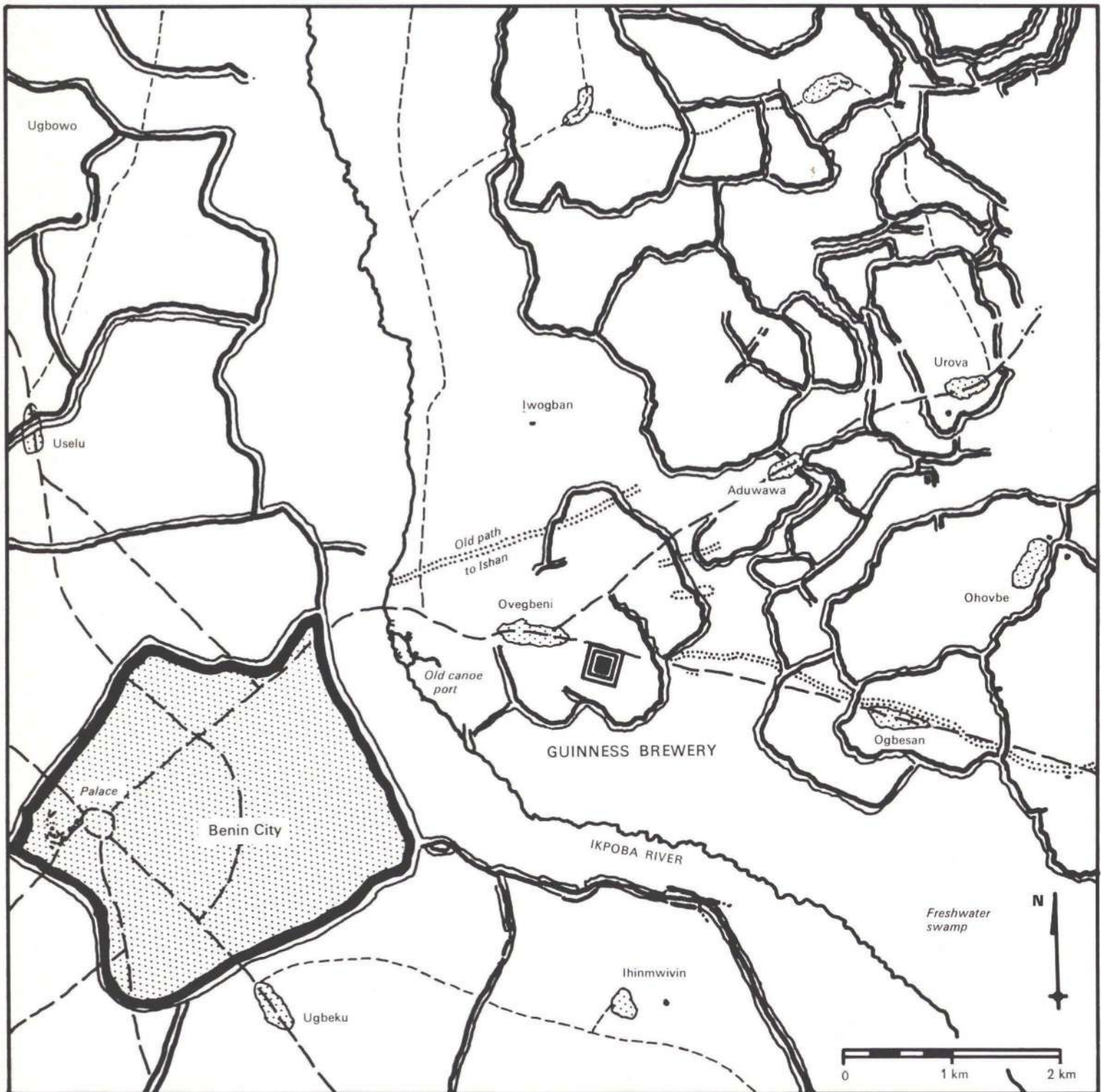


# THE ARUP JOURNAL

JUNE 1978



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Front cover: A part of Patrick Darling's map of the longest known system of earthworks in the world, in the Benin area, estimated to be between 8000 and 13000 km long and covering some 4000 km<sup>2</sup>. (See the *Guinness Book of Records*)  
Back cover: Reflection of the auditorium of Theatre Royal, Nottingham (Photo: John Donat)

## The Danish Embassy

Ove Arup

*A talk given to the Society of Danish Engineers, 21 March, 1978*

There has been a great deal of criticism of the new Danish Embassy. That is not surprising. No building is perfect; it is always possible to argue that it could have been better in some respects. And the scope for un-informed criticism – criticism which takes no account of the many restraints imposed on a building – is simply endless. Naturally most criticism is of the latter kind; one can't prevent a layman from criticizing to his heart's content, and it would be undesirable to do so, for his opinion carries weight, even if un-informed.

There is also much wrong with the world in general, and in my youth I thought it was my duty to find out what exactly was wrong. I found I had to lower my sights and confine myself to finding out what was wrong with structures and buildings, with our built environment which is built to make us happier, but which often has the opposite effect. I found to my dismay that this was almost just as difficult.

The reason is that it is almost impossible to define 'Quality' in building: we have no yardstick with which to measure it. Moreover, we have many demands on a building; some can't be satisfied because they conflict with other more important ones, others because we can't afford them or because bye-laws forbid them or for one of many other reasons. And of course, some like this and some like that, and most want to have their cake and eat it.

To reach a decision about what should be built, the client therefore must make up his mind about what he wants to have and how much he can pay for it, and the architect and his other technical advisers must tell him if and how he can get it. But the architect, if he is worth his salt, has his own ideas of what the building should look like, and they may not please the client at all, as we see

too often. He wants to produce 'Architecture'; something he can put his name to without blushing. The choice of architect is therefore the most important decision the client has to make; it will determine what kind of building he gets for his money. Unfortunately, he is rarely aware of this importance, and he is generally ill-equipped to make the right choice. In the present case, the then Ambassador, Erling Kristiansen, talked to me about the problem of finding a new home for the embassy, about 10 years ago, when the old lease was shortly running out. Would it be possible to convert an existing building, or could one find a suitable site on which to build, and what would it cost to build, assuming that what was required was just a good class office building, nothing fancy, for money was scarce.

We helped him to investigate the possibilities

and get some costs together, but beyond saying that we obviously ought to choose a Danish architect, I was not prepared to suggest any names. But I did suggest, or we both agreed, that it would be best to hold a competition, which would make it much easier to make the right choice. To find an architect who could produce an embassy worthy of Denmark on a shoestring was not easy.

### Arne Jacobsen

When I heard later, that the authorities in Denmark had chosen Arne Jacobsen I was both relieved and worried, because I was sure that he would produce a building of quality, but it would most likely be expensive. In May 1971, after Arne Jacobsen died, I published an article about him in the *Architects' Journal* and I will quote to you

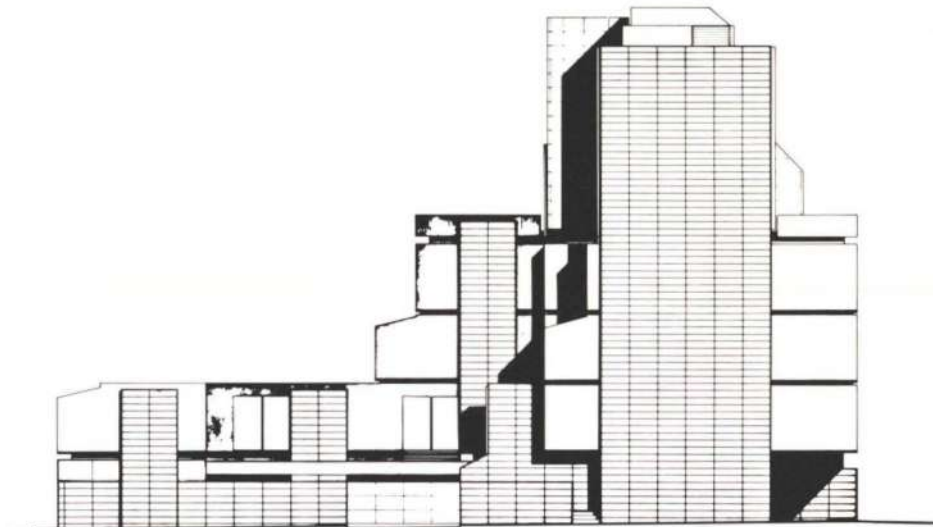


Fig. 1  
Hans Street elevation

a paragraph from this article to show you what I thought about Arne Jacobsen:

..... 'Perfection for him meant first and foremost aesthetic perfection, a strict discipline of form, space, texture and colour until there were no loose ends left. He never doubted the value of this kind of perfection, and he gave hardly a thought to its place in the whole gamut of human endeavour. He felt that he built for people, but this tended to mean *his* kind of people, people who could, or could be taught to, appreciate what he did for them. He valued such appreciation highly, and could be very hurt by adverse criticism. But he could also pour scorn on people who lacked his sensitivity and offended against good taste. He found it hard to accept the fact that a foul stench does not offend somebody who has no sense of smell. That he didn't query his own priorities was both his limitation and his strength. Inside his chosen field he knew no limits; he believed that an architect should control every detail of a given environment, the buildings, the equipment and furniture down to doorhandles, the cutlery and curtains and the layout of garden or landscape. He was eminent in all these fields. His kind of architecture really demanded total control to reach perfection, and when he fought hard with recalcitrant clients to be allowed to retain such control, or with contractors and suppliers to insist on it, he gained a reputation for being difficult. But it was all done in the service of architecture, or as a result of his passion for perfection; the two cannot, in the end, be separated. ....'

How can you give an architect of this calibre the task of designing the Danish Embassy in London and expect him to come up with just an ordinary office building at very low cost? Obviously he would do his utmost to create a building worthy to become Denmark's most important embassy. Obviously economy would not be his first priority. And it wasn't; the façade in natural stone and bronze clearly showed that.

This came out very clearly at a meeting in the Danish Foreign Office in Copenhagen, when it had become obvious that the cost would far exceed what the government could accept. All the government agencies involved, plus architects and engineers, were represented at the meeting. I was not there myself, but according to Svend Jensen, one member after another of the Finance Committee stood up and suggested how savings could be made. When it was Arne Jacobsen's turn to speak, he agreed that it was perfectly possible to make a building which met the budget, but added that then he would not be the architect. And that was that.

Obviously this financial stringency was one of the difficulties we had to deal with. But there were plenty of others. Besides the clients, all sorts of authorities were involved, such as the Royal Fine Arts Commission, and they all had to give the scheme their blessing. As their interests were far from identical this was not too easy to obtain. And of course there were real problems to face as well.

### Views of The Cadogan Estate

But in early 1974, when we thought that the coast was clear, and the tender documents had been sent out, another ominous cloud appeared on the horizon, which I was called upon to deal with. I received a letter from the Ambassador which explained that when the detail plans were sent to the Cadogan Estates for their approval, an impasse had been reached. The Cadogan Estates expressed reservations regarding the following issues:

(1) The Cadogan Estates are of the opinion that the fifth and sixth floors (the Ambassador's residence) are out of proportion to the Chancery and Consular

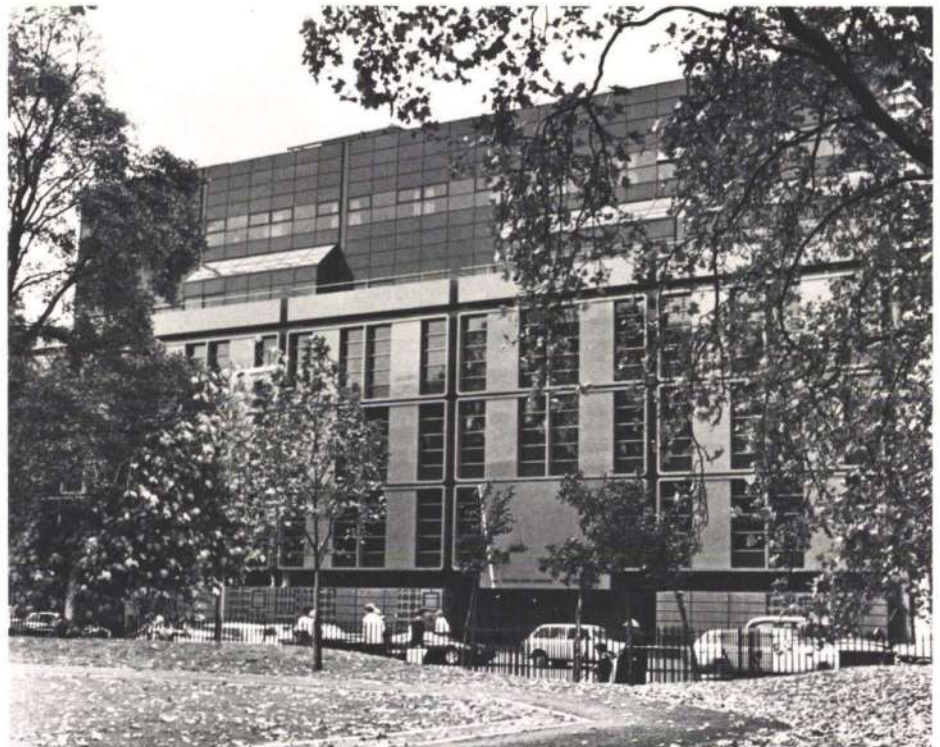


Fig. 2  
Sloane Street elevation (Photo: Colin Wade)

Offices beneath. Furthermore the Estate considers that the separate treatment of different materials on the fifth and sixth floors is out of keeping with the proposed elevational treatment beneath.

- (2) Further, the Cadogan Estates believe that it would be advisable to change the treatment of the ground floor. They find that, seen from a pedestrian point of view, the proposed treatment would create a 'dead area'.
- (3) Finally, the Cadogan Estates consider that with the proposed treatment the south flank wall facing Hans Street would have too stark an appearance and would, furthermore, be in too sharp contrast with the building located south of Hans Street.'

But to make such alterations at this stage was something the Danish Government could not possibly agree to. And then came a most astonishing proposition. To quote from the letter:

..... Because of the difficulties which have arisen, the Cadogan Estates have suggested that the Embassy approach you in order to obtain your opinion on the objections raised by them. Both parties have agreed to attach the greatest importance to your opinion in their respective considerations, and I hope very much that you will give us the benefit of your great expertise. The Cadogan Estates have agreed to the text of this letter. In case you can agree, all the material handed over to the Cadogan Estates will be at your disposal. You will probably find it necessary before you give your opinion to have meetings with both representatives of the Cadogan Estates and of the Danish Government in order to give them an opportunity to elaborate on their respective points of view. ....'

In other words, I was to be a kind of judge in the dispute between the Cadogan Estate and the Danish Government, and both parties had agreed to attach the greatest importance to my opinion. I was in a quandary about what to do. I did not consider myself to be an authority on architectural quality, and my credentials as an independent witness were also a bit shaky. On the other hand, I did not want to disappoint the Ambassador or Lord Cadogan, and I could probably arrive at an

honest opinion if I studied the matter – in fact, what troubled me slightly was that I already seemed to have such an opinion without studying anything other than Cadogan Estate reservations. But if both parties wanted my opinion why not give it to them? I could certainly make sure that it would be my honest opinion, in the sense that it would really be my opinion, but I would also have to give my reasons for it, in the hope that they would convince the other parties that I was talking sense.

So I studied the material and had my meetings and wrote a report which seemed to do the trick. But not quite, as we shall see.

I had intended to read this report to you, because it might help you to understand the issues involved better, but it is quite long and I have not enough time for that, so I will only give you a résumé of it, spiced, perhaps, with a few quotations.

To begin with, after having stated the rival positions, I straightaway declared my hand; I thought the Danish Government had the better case; I thought they were wise to adhere to the architect's design. Not because a better solution could not be found – there are hundreds of possible solutions, and some might be 'better', whatever that means, but they would have to be found first before one could compare them to the existing solution.

That would not be an easy matter, considering that they presumably all would have to provide the required accommodation, conform to the bye-laws and restrictions imposed by the authorities, and meet the various functional requirements. If we could find somebody to do this, which was doubtful, it would take a long time and it would probably be necessary to alter the basic layout – which at this stage would be tantamount to putting a stop to the whole thing. This is of course not what the Cadogan Estate had in mind; they were thinking of a superficial rearrangement of the façade of the building which would be more to their liking. But to do that to a highly disciplined design such as this would in my opinion have been extremely dangerous and would most likely have made matters worse.

This was the gist of my report. Of course, I didn't dismiss their objections entirely.

I sympathized with the first reservation. I also

thought that it would be better if the top storey could be lopped off somehow – which the architects didn't – but that is one of the things which can't be done now. I didn't agree with points 2 and 3, however. I explained, as well as I could the reasoning behind the architect's scheme. For instance that it was a deliberate intention to make the recessed façade as inconspicuous as possible, with just a faint indication of the basic grid, to make it act as a neutral background, merging with the sky because it reflects the sky. I stated '..... that the more I study the drawings the more I appreciate the skill with which the architect has managed to meet the many functional and other requirements, including environmental considerations and yet retain strict sculptural and spacial discipline ...'

I also stated that the anatomy of the main building was clearly expressed in the Sloane Street façade as a tall, fairly narrow, rectangular slab from which the metal-clad side portions are cantilevered, and that any blurring of Arne Jacobsen's clear sculptural statements would have been a mistake.

I explained that the wall at the ground floor was there for security reasons but had a psychological effect as well. It proclaimed that this way no ordinary dwelling or business premises; it was important, an embassy, and I discussed the materials which had to be used because the original stone and bronze façade was too expensive, and explained that Arne Jacobsen's architecture derived its beauty or appeal from the way every detail was controlled and filled into an overall framework. The beauty was not just skin-deep; it penetrated every part of the scheme. That is why it was so difficult to make alterations once the scheme had reached a stage when the architects felt that a satisfactory synthesis had been reached.

#### Report extracts

I think I will read now the closing paragraphs of my report:

'..... I suspect that what troubles the Cadogan Estate is really that the architectural style of the new building differs from that of the Cadogan Estate as a whole. This is undoubtedly true. How could it be otherwise?

The new embassy is a contemporary building by a leading architect. You could not possibly expect Arne Jacobsen to produce a pastiche of Georgian, Victorian or Edwardian architecture. Modern architecture has many facets. I doubt if one can talk even talk nowadays about a distinct modern style – but the

aesthetic sensibility of the age has certainly changed since the bulk of the Cadogan Estate was built. It would be wrong to imitate the other buildings on the Estate, but it is right to show consideration for the environment, to show architectural good manners. This I think Arne Jacobsen has done.

But what really matters is not whether this design conforms to some style which is in fashion at the moment, or whether it can be criticized from some aspect or other, for no design can be perfect in every respect. What matters is whether it is a serious work of art, which, when executed, will make a valuable addition to the Estate. I have no doubt that it is and will.

I suppose that all the buildings which have been acclaimed as great architecture have met with opposition, sometimes even with violent opposition, when first proposed. Then, when people got used to them, they were first tolerated, and if they stood the test of time, later hailed as great architecture. People like what they are used to. Therefore there will very likely be some protests in this case as well, but I do not think they will continue for long after the building is up, for it shows good manners and I believe its quality is of a kind which will not suffer with age.

I have often been critical of the work of contemporary architects, and also of some aspects of Arne Jacobsen's work, but in the latter case not on aesthetic grounds. On the contrary, my complaint has rather been that he could be too much of an aesthete, that he pursued his aesthetic aims with a determination which sometimes could lead to a neglect of functional or economic claims. But here we *are* discussing aesthetics. In this sphere I think it would be presumptuous of me to challenge Arne Jacobsen. And in any case I like his design, I believe it will be classed amongst his best work.

Reading through my submission, I am somewhat worried by the fact that it sounds more like a plea for the defence than the summing-up of a judge. I am sorry about that.

I would have welcomed an opportunity of demonstrating my independence. But I can't help it, it *is* my opinion, and this is what I have been asked to give. But there is no reason why anybody should take any notice of it if they don't agree with it, for it is only an opinion.

May I conclude by quoting the warning which the Duke of Albany in vain addressed to Goneril in *King Lear*, for it expresses my feeling in the matter very neatly. It is this: "Striving to better, oft we mar what's well".

As I said, this report did move the Cadogan Estate to give permission to go ahead with the scheme as designed by the architects, but there was still a hurdle to overcome. They insisted that something should be done about what they called the 'dead area' of the protective wall facing the pavement. They suggested that there should be some show-cases showing Danish products or a kind of sculpture or something to make it more interesting. And I was again to negotiate a solution acceptable to both parties, this time as representing Ove Arup & Partners.

#### The Sculpture

Show cases were out, as far as the embassy was concerned – for many good reasons. Sculpture, – well, what kind of sculpture, and who should do it? Commissioning a sculpture is like choosing an architect; you buy the cat in the bag. The building didn't need a sculpture it was a sculpture, and to tack one sculpture on to another is rarely successful. From my talks with Lord Cadogan and Paterson-Morgan, the agent, it was obvious that something had to be done to respond to their generosity in waiving all their main objections. But what?

I was very afraid of anything like a bronze structure tacked onto the wall; it would take a long time, would cost too much and might very well make matters worse. I thought we should not introduce any new materials but should treat the concrete wall itself to create the desired interest.

The architects with whom I discussed the matter suggested that we should approach Ole Schwalbe, Rector of the Royal Academy of Fine Arts, Copenhagen. At a meeting in my hotel room in Copenhagen with Schwalbe, the architects and Miss Ammentorp, the Danish Foreign Ministry's representative, I put the problem to Schwalbe and emphasized that there was very little money or time available.

Schwalbe agreed and so did Inge Ammentorp; in fact she sent me next morning the most beautiful and exotic bouquet of flowers I have ever received. (Not that I am in the habit of receiving flowers).

Time was running short, so I had a meeting with Paterson-Morgan, the Estates Manager for the Cadogan Estate, to tell him about our intention to get Professor Schwalbe to decorate the wall and suggested that he might give us the go-ahead on the strength of that. This, not unreasonably, he would not do. But if Professor Schwalbe would submit a proposal to him he would be pleased to look at it and try to be as reasonable as possible.

The meeting was arranged later, when Lord Cadogan had returned from a trip to Australia, and it went fairly well, as did subsequent meetings with the Fine Arts Commission and other interested parties and then at last we were given the green light to go ahead.

I think that Schwalbe has solved this difficult problem very successfully. I didn't really think that any decoration was necessary, and a purist may prefer the starkness of a plain wall, but Schwalbe's solution does respect the spirit of the architecture, and makes a positive contribution where disaster was all too likely.

#### Credits

##### Client:

Danish Ministry of Foreign Affairs

##### Architects:

Arne Jacobsen/Dissing & Weitling

##### Main Contractor:

Harry Neal Ltd.

##### Editor's note:

A detailed account of the design and construction of The Danish Embassy will appear in a future issue of *The Arup Journal*.

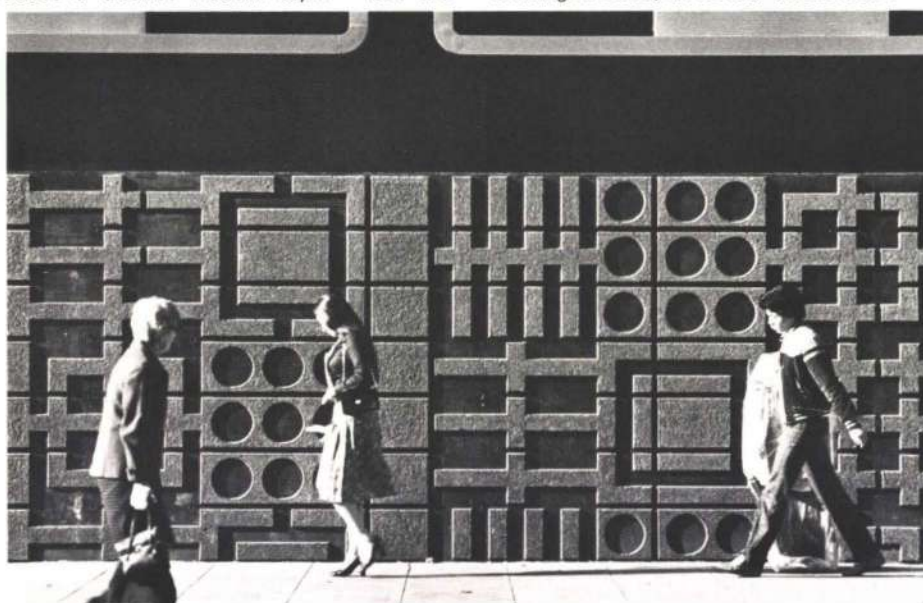


Fig. 3  
Chancery: detail of block concrete mural wall, Sloane Street  
(Photo: Harry Sowden)

# Bradford Transport Interchange

Ralph Stephenson

## Introduction

In the late 1960s Bradford City purchased the 3.44 ha site of the derelict Bridge Street rail freight yard which was adjacent to the city centre ring road and on the southern fringe of the central shopping and commercial area (Fig. 1). The City's Development Committee then commissioned British Rail to report on the suitability of the site for a combined road and rail transport interchange.

The time was right for several reasons. British Rail were considering rebuilding Exchange Station, Bradford City Transport wished to improve its bus depot and workshop facilities and there was a national move to reverse the decline in the use of public transport.

The report, which confirmed the feasibility of the proposal, was published in June 1970 and British Rail were chosen by Bradford City Transport to work as private architects for the development of the scheme. In June 1971 the Department of the Environment announced its decision to contribute 50% of the cost of public transport facilities, and tenders were invited in January 1973. Taylor Woodrow Northern, who submitted a tender of £7.5 m., moved onto the site in June of that year and the Interchange was officially opened in the autumn of 1976. The scheme came under the wing of the West Yorkshire Passenger Transport Executive during the 1974 national reorganization of transport undertakings.

## Planning

The client dictated certain operating principles which, when added to his other requirements and the restrictions caused by marked changes in level of surrounding streets, imposed severe limitations on the planning options. Some of the principles associated with traffic movement were:

- (1) There had to be two-way traffic with through routing. Head-on loading and peninsular islands were not permitted.



**Fig. 1** The interchange nearing completion showing its relationship to the city centre, looking north; Centre right – what remains of the old Exchange Station. Centre left – City Hall and Law Courts (Photo: *Bradford Telegraph and Argus*)

- (2) Separate set down and pick up points were not permitted.
- (3) 12m x 2.5m double-deck buses had to be capable of being manoeuvred without undue driver effort, with good clearances and without the need to reverse.
- (4) Buses going in opposite directions between passenger islands had to be able to pull out and pass with rare likelihood of restriction. Trials resulted in an agreement to 15.5 m roadways.
- (5) The depot had to be capable of housing 180 12 m x 2.5 m double deck buses.
- (6) There had to be 62 stands in the bus station and additional, separate accommodation for private operators.

Referring to Fig. 3, which shows the relation-

ship of the various items, the main elements of the interchange are:

### Item 1

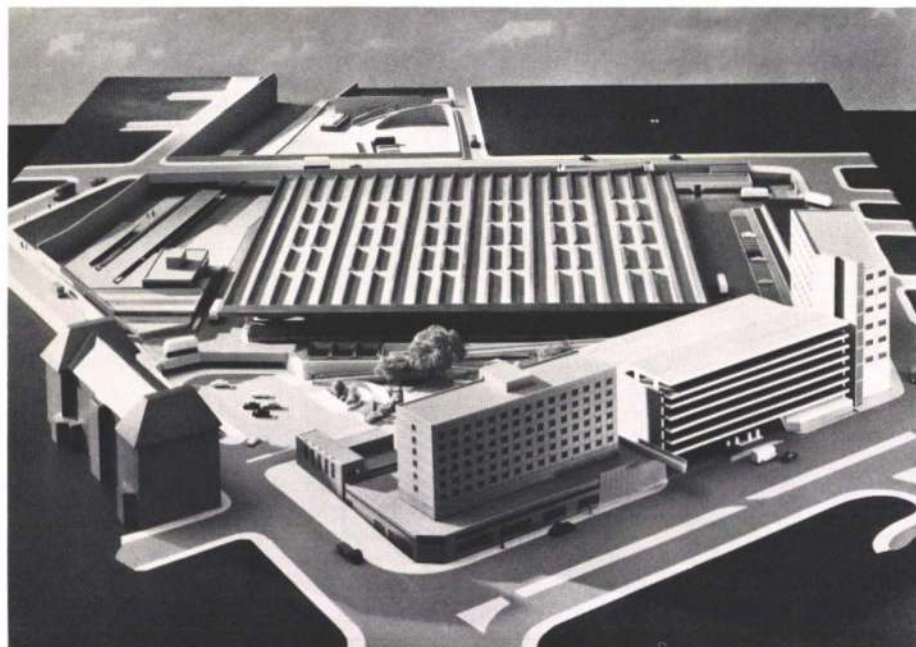
Main pedestrian entrance and forecourt with taxi ranks at concourse level. Underground park for 50 long-stay cars below.

### Item 2

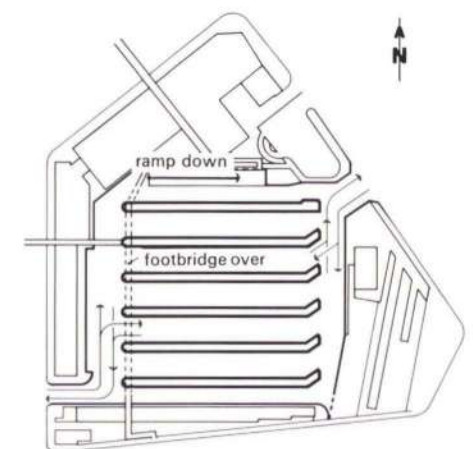
Concourse. Placed midway between depot and station levels, it is connected to each bus passenger island and to the railway station by stair, escalator and lift. Facilities which include cafeteria, small shops, ticket offices for coach operators, left luggage, etc., are shared by road and rail passengers.

### Item 3

The new Bradford Exchange Station. Railway management accommodation was part of the



**Fig. 2** View looking south (Model by British Rail. Photo: John Maltby Ltd.)



**Fig. 3** Block plan

Interchange contract but the four platforms were built under a separate contract and designed entirely by British Rail.

**Item 4**

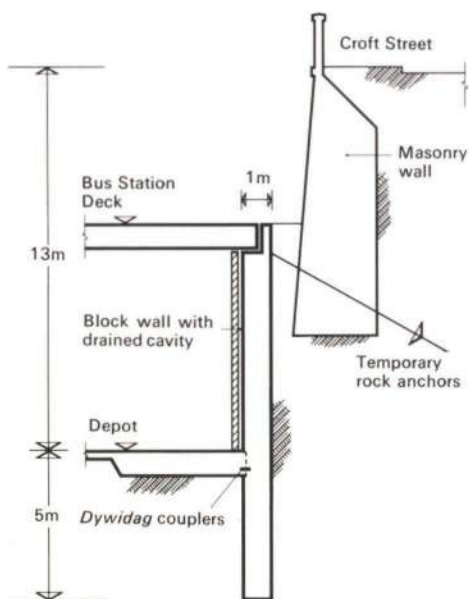
Long-distance coach park for private operators. This is at bus station level with stair access to the concourse and a ramp up to Croft Street.



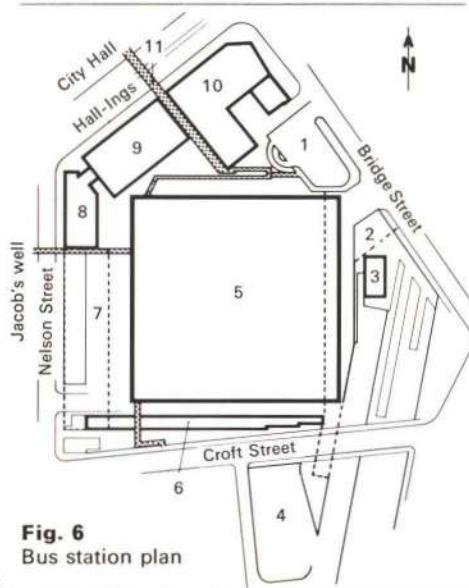
**Fig. 4**  
Croft Street bridge before underpinning  
(Photo: British Rail)



**Fig. 7**  
Bus station deck under construction with underpinned bridge and diaphragm wall in background (Photo: M. T. Walters, Mexborough)



**Fig. 5**  
Section at Croft Street boundary



**Fig. 6**  
Bus station plan

**Item 5**

Roofed bus station with depot below. The underground depot houses 180 buses and includes fuelling, washing, brake testing and tyre changing areas. Street access to the depot is from the lower entrance in Nelson Street and passes through the office building (Item 8). Internal ramps connect the depot with the bus station above and the coach park outside. The structure is designed to have four hour fire resistance; fire walls and doors subdivide the depot and also separate it from the workshops. There is an extensive sprinkler system and direct alarm links to the fire brigade. Air is extracted at high and low level to give six changes per hour, and a temperature of 13°C is maintained by direct gas-fired units operating in the input air streams. The lighting level is 200 lux.

The bus station (Fig. 6) includes six enclosed and underfloor heated passenger islands (Figs. 10 and 11) which are 5.5 m wide x 120 m long, connected to the concourse at their eastern ends and by a footbridge at the west. Two-way traffic access is provided near the Nelson Street/Croft Street junction and halfway up Bridge Street, where buses run in over the concourse roof. Stands for 62 buses accommodate all out-of-town and 50% of the local services with stands positioned to minimize the need for people to change islands when they change buses.

The provision of the 130 m square overall roof at a cost in excess of £1m. was an emotive subject. More flamboyant or structurally exciting solutions than that finally adopted were rejected on cost grounds at a very early stage in the design process. Thoughts of making the roof starling-proof were also rejected after discussions with British Rail infestation officers. In common with many Northern city centres, Bradford suffers the effect of millions of these birds flying in to roost every evening. Flashing lights, noise, poison, sticky substances to itch their feet and wrapping vulnerable structures such as roof trusses in fine mesh have little effect, other than to chase your starlings to someone else's patch and vice versa. The bus station has escaped to date, although the odd cheep can sometimes be heard above the traffic.

What would have been the effect of having no roof? Certainly 3.44 ha of the centre of Bradford would be very drab, the bus station would lack presence and more money would have had to be spent on the island housings to ensure the comfort of waiting passengers.

**Item 6**

Main plant room. This is a single storey building which sits on the bus station deck at the end of the large, long ventilation ducts in the depot below.

**Item 7**

Workshops at depot level with 15 pits and body repair shop. Natural lighting is provided at roof (bus station) level and the lighting level is 400 lux. Vehicle exhaust gases are fed directly into a piped extract from each pit.

**Item 8**

Eight-storey air-conditioned building shared by the Interchange operating staff, district officers of the West Yorkshire PTE and the National Bus Company.

**Items 9 & 10**

Multi-storey car park and hotel respectively. These were designed and built by others before and during the interchange contract.

**Item 11**

Footbridge circulation across the site from City Hall and Jacobs Well Development to Croft Street.

**Structure**

The site investigation indicated varying depths of made ground overlying boulder or laminated and gravelly clays. Lower coal measures rocks were represented by an interbedded series of shaley mudstone, laminated siltstone and fine grain sandstone. The rock, which was weathered to a depth of between 1 and 3 m, sloped down to the west at an average gradient of 1 in 13. Whilst pad foundations were possible in the eastern area of the site, the slope necessitated large diameter bored piles elsewhere. Pads were founded at the surface of intact rock at a bearing pressure of 1300 kN/m<sup>2</sup>; piles were generally socketed into intact rock at a bearing pressure of 2100 kN/m<sup>2</sup>, but in the north west corner of the site the rock weathering was found to be considerably deeper than elsewhere and the bearing pressure had to be reduced to 1070 kN/m<sup>2</sup>, despite increased penetrations.

Whilst the site is large, the depot had to be placed below the bus station and the building extends to the backs of pavements. This imposed temporary works problems on three of the four boundaries: Nelson Street, Bridge Street and Croft Street. On Croft Street these included the permanent underpinning of a bridge and the holding back of an elevated road (Fig. 7). The bridge (Fig. 4)

was supported on shallow masonry footings which were relieved of their load by piling, jacking the bridge up slightly off the footings with the columns suspended, replacing the footings with a pilecap and then releasing the jacks. Original drawings of the 1860s bridge were obtained and X-ray and metallurgical examinations of the hollow cast iron columns were carried out before jacking took place. The elevated road is held back by a diaphragm wall (Fig. 5). The wall is a cantilever in its final state because of a design requirement to allow movement of the bus station deck over its top, and because the City Engineer ruled out the use of permanent rock anchors.

The bus station deck is approximately 160m square and vehicle circulation and parking requirements in the depot resulted in a column grid of 19.5 x 22.5m. Very large ventilation ducts run in a north south direction from the main plantroom and the beams of the deck are placed parallel to them, the overall 2m structural depth zone being shared with the services (Fig. 8). In situ concrete main beams span 22.5m, and 0.85m deep ribs at 3m centres span between them. Various methods of designing and building the deck were considered, and tenderers were given the opportunity to price a totally in situ scheme,

a semi-precast scheme based on the use of *Omnia* bridge deck units, or to suggest a scheme of their own. In the event they all opted for the in situ scheme. To avoid having many long, costly and possibly leaky roadway expansion joints across its centre, the deck is formed as a single unit with only a perimeter joint. Wherever possible an open-drained movement joint has been provided, but *Maurer* expansion joints are used at access points. Main beams are supported on pairs of Andre bridge bearings, giving a total load capacity of 12000 kN at each column position. The majority of these allow free horizontal movement, overall restraint being provided by a cruciform arrangement of unidirectional guided bearings. The order of building was planned to avoid horizontal overload of the columns during construction; this took account of anticipated shrinkage and thermal movements of the deck, friction value of the bearings and stiffness of the formwork supports based on test results. An attempt has been made to give the bearings the same degree of fire protection as the concrete structure by providing a collar of *Vicuclad* around the column tops and sealing it against the beams soffits with ceramic fibre.

Roof columns are on the same grid as those supporting the deck and they cantilever from

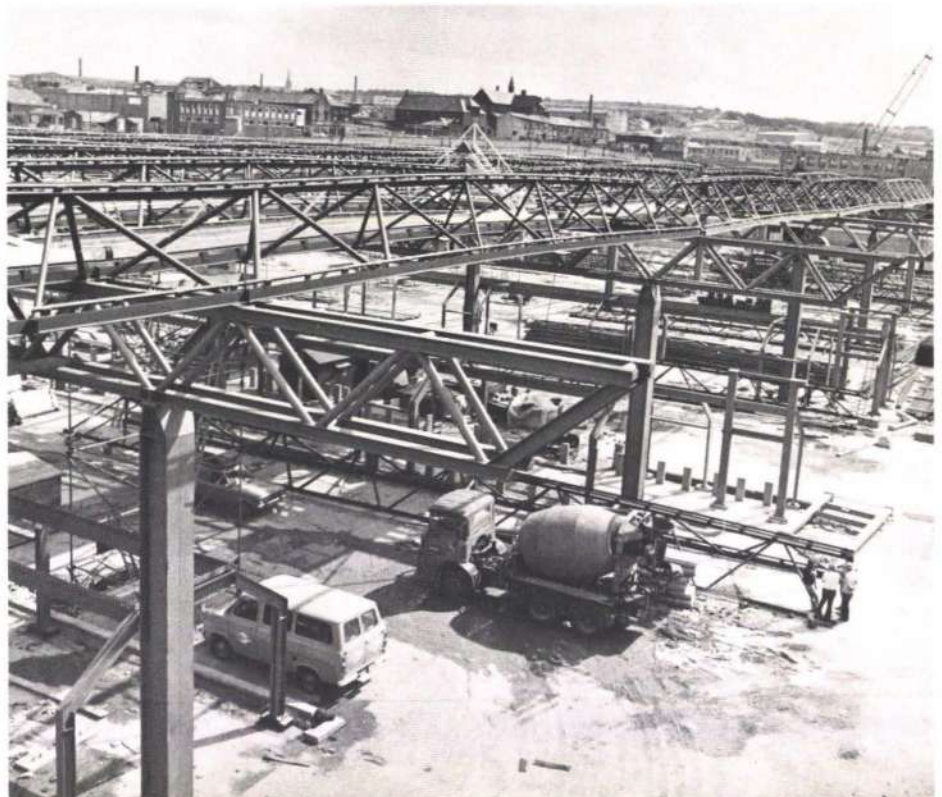
it. The roof itself consists of twin main lattice girders spanning 19.5 m and supporting inclined lattice roof light trusses which alternate with strips of horizontal metal deck (Fig. 9). The City Engineer, acting on the client's behalf, requested a good quality system of protection for the steelwork, suggesting that we should aim for a major maintenance-free life of 12 to 15 years. Tenderers priced a metal spray and two paint systems. The metal spray system was based on British Rail Surface Coating Laboratory thinking at that time and consisted of grit blasting, aluminium metal spray applied by the electric arc process, etch priming and a site-applied 80 micron coat of high-build chlorinated rubber. This was designed to have a 15-year life, but it was rejected on cost grounds being approximately 50% more expensive than the paint systems. The paint system chosen, with an expected life of 10 years, was shot blasting, *Epilux* primer, two 125 micron coats of high-build micaceous iron oxide phenolic and a site-applied 50 micron coat of the same material.

### Conclusion

At the official opening ceremony the Minister of Transport, Mr. William Rodgers, said the Interchange is certainly the largest in Britain and probably in Europe, that he understood it to be working satisfactorily and that more buildings of its kind were required. He also said that it would be unique in this country for a considerable time and until more pressing needs have been catered for. Criticisms from the 35,000 passengers per day have been few. Inadequate pavement widths leading to the main entrance, too few shops, some sections of footbridge exposed to the weather and lack of facilities in the coach park, are the most common complaints. Looking to the future, changes in the design and use of public transport vehicles will take place during the life of the bus station. Larger vehicles can be accommodated but with reduced margins and increased crew effort, and there is some spare capacity in that not all stands are currently in use. Bus throughput can be speeded up to a certain extent but the critical aspect is the accommodation of passengers in the queuing areas of the islands. The design is suitable should a change be made to driving on the right.



**Fig. 8**  
Depot during installation of services  
(Photo: M. T. Walters)



**Fig. 9**  
Main roof and passenger island steelwork  
(Photo: M. T. Walters)



**Credits**

*Client:*  
West Yorkshire Passenger Transport Executive

*Architect:*  
Chief Architect, British Railways Board,  
in Association with the Chief Architect,  
City of Bradford

Project architects were the Architects Department,  
British Rail Eastern Region, York

*Mechanical & electrical engineers:*  
F. C. Foreman and Partners

*Quantity surveyors:*  
Rider Hunt and Partners

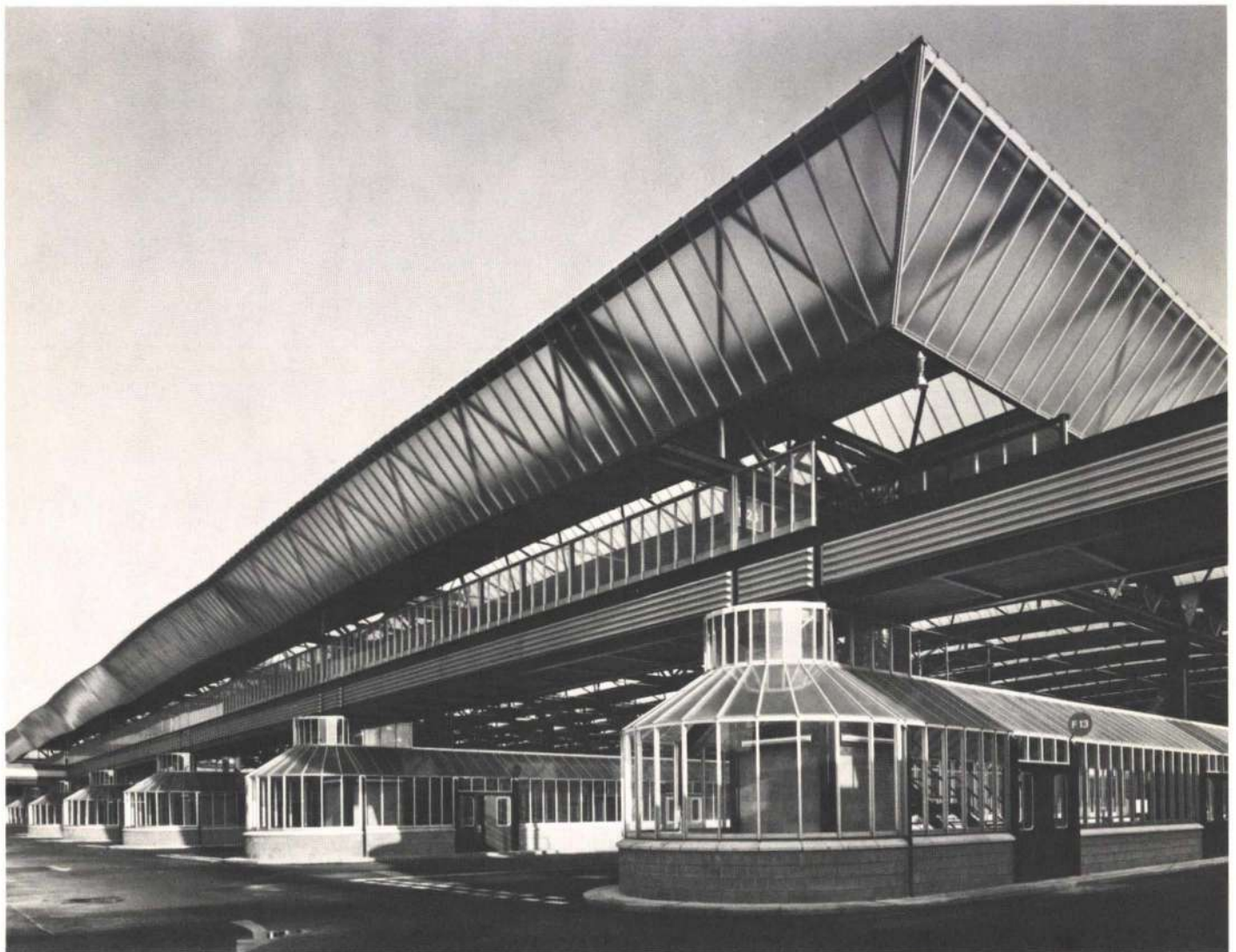
*Main contractors:*  
Taylor Woodrow (Northern) Ltd.

**Fig. 10**

Passenger island; passenger operated sliding doors give access to buses  
(Photo: M. T. Walters)

**Fig. 11**

South west corner of bus station  
(Photo: Pickard, Leeds)





# Guinness Breweries, Benin, Nigeria

David Brunt

Amongst the various Guinness beer mats is one that features the first Guinness brewery to be built outside Ireland and England, this being the Ikeja stout brewery built in 1962 on the industrial estate not far from Lagos International Airport. The foundation stone for this brewery was a cornerstone taken from the main gate of the original Guinness brewery in Dublin.

The success of this venture in a rapidly expanding market led to the decision by Guinness Nigeria Ltd. at the beginning of the 1970's, to build a Harp lager brewery with an initial annual production of 350,000 hl.

A number of possible sites were investigated and a site on the outskirts of the city of Benin, famed for its ancient civilization, bronze castings and mile upon mile of earth ramparts, was then selected as being the most favourable, despite the fact that apart from a small rubber plantation the site was predominantly bush.

In 1972, Ove Arup & Partners were appointed prime agents for the design and supervision of the building and civil engineering work for the new lager brewery, by Guinness Overseas Ltd, the brewery and engineering consultants responsible to Guinness Nigeria for the provision of the completed brewery. The basis of the appointment was that the Nigerian and UK practices of Ove Arup & Partners would participate jointly.

The Guinness Overseas approach to the project was to undertake the design work at Park Royal, London, where close contact with process plant manufacturers spread across Europe could be maintained, and then to move key members of their design team to the site for the construction and plant installation stages. To fit in with this arrangement, all the initial design of the building and civil works was carried out in London in conjunction with Godwin and Hopwood the Lagos-based architects, who we had appointed as our consultant architects. They visited London frequently during the early stages of the design development and made periodic visits throughout the running of the project.

## Our brief

During our initial discussions with Guinness Overseas we were given a scheme layout showing the size and form of the major buildings and internal layouts of the two main ones, these being:

- (1) The process building which contained the brewhouse, fermentation and maturation tanks, the engineering support services, i.e., boilers, refrigeration plant, a workshop, and lastly, three storeys of air-conditioned office accommodation
- (2) The bottling hall building, which consisted of a middle portion in which two bottling lines run parallel to each other down the length of the building and a storage area at each end, one being for empty bottles and the other for full bottles packed in cartons and ready for distribution and sale.

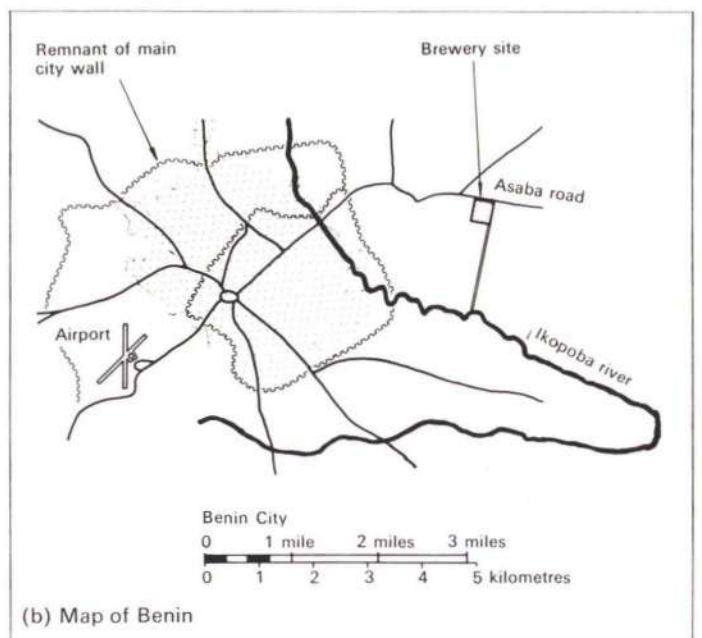
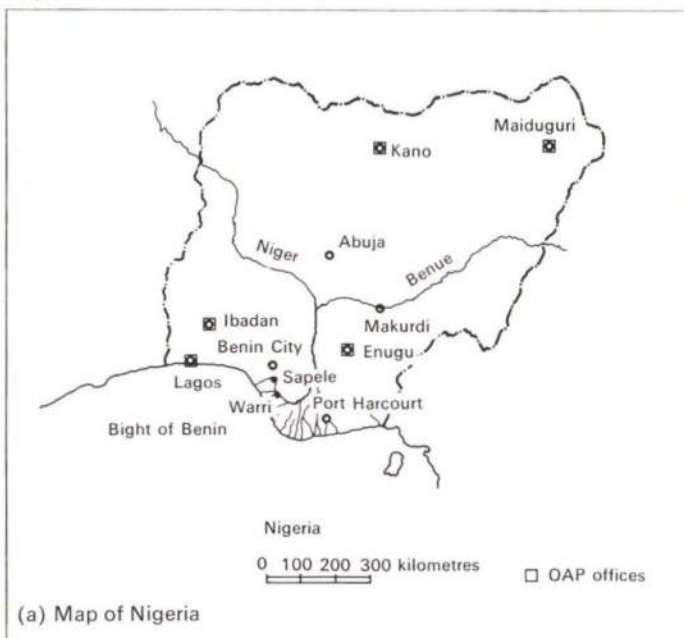
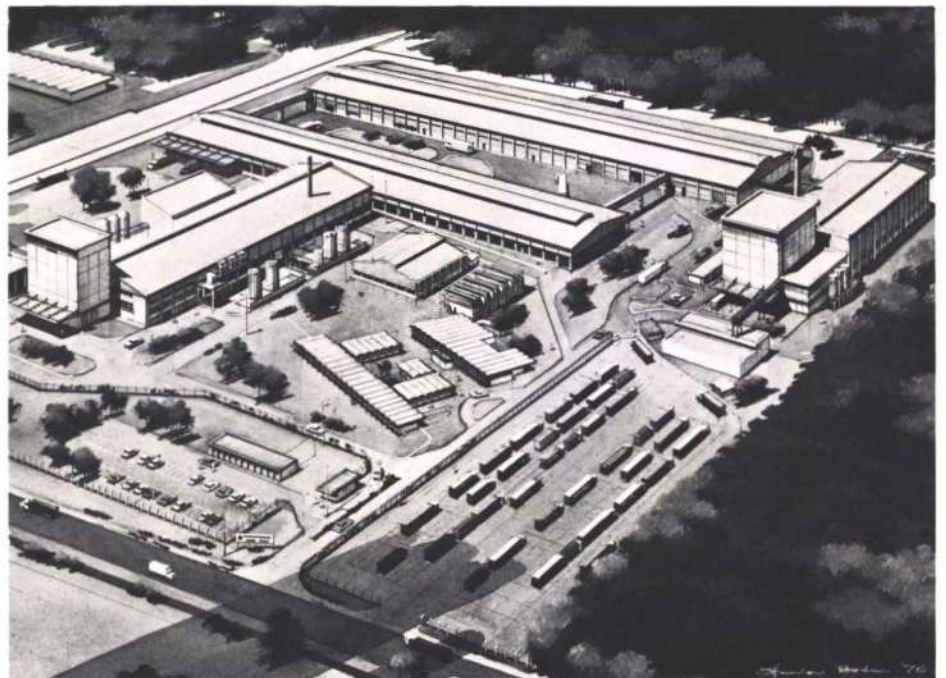
One of the factors which had led to the selection of the site was a suitable supply of borehole water, and the brewery required storage for 1200m<sup>3</sup> in a compartmented reservoir with provision for treatment, prior to the use of the water in the brewing process.

A reinforced concrete silo block for storage of approximately 2,000 tonnes of malt was to incorporate vertical liquor tanks and a cooled hop store in addition to the conveyors feeding the individual silo bins from the intake point below ground level.

The only remaining building linked directly to the process plant was a by-products building to house equipment, including spent grain driers, and the spent grain silo was positioned immediately adjacent to this building.

The amenity buildings which were required for a workforce of approximately 600 people,

**Fig. 2** Architects' perspective looking from north west, prepared during initial design of stout brewery (Architects' perspective: Stanley Boden)



**Figs. 1(a) & (b)** Site location

many of whom would be shift workers, included a canteen, large locker rooms with shower facilities, a clinic and medical treatment rooms.

The brief included some provision for a major future extension of the lager brewery in terms of space and layout and initial utilization of the 14 ha site was to give a working environment separated from the amenity buildings by a landscaped area. Conservation of a significant proportion of the site for unspecified future use was also a requirement and football pitches proved to be a good way of getting initial use out of this remnant area.

### Design development of the site for the lager brewery

The rectangular site, some 410 m by 330 m, has its longer side running approximately north-south and the northern boundary is immediately adjacent to the Asaba road which is one of the main arterial routes from Benin City. At the outset of site development this road was 10 m wide and susceptible to deep potholing during the rainy season, but in 1975 the road was reconstructed and widened to trunk road standard, to provide a fast and reliable route to Onitsha and the Niger river and on to Port Harcourt. The ports of Sapele and Koko are connected to Benin by a good road which enters the city on the southern side.

Located near the crest of the northern side of the Ikpoba river valley, this site sloped usefully down from north to south at a fairly uniform gradient of 1:40 and the site area included at its south easterly corner a 6.5 m wide connecting strip running directly down the valley through a swamp to the river, so that natural drainage of the site would be provided.

The fact that road transport is the only means of supplying the brewery site, and despatching its products from it, demanded early consideration of the accommodation of lorries which, being outside the direct control of Guinness Nigeria, would be arriving around the clock from all parts of the country to unload their empties and return home with replenishments. To allow for this traffic, and to discourage the hazardous parking of large vehicles alongside the public highway, an appreciable area very accessible to the Asaba road was allocated for a lorry park. It was decided that the lorry park would be outside the brewery security fence, but arranged so that lorries could enter the brewery from the lorry park, without having to re-use the Asaba road.

The advantages of a main, one-way traffic system within the brewery, coupled with the other traffic considerations of lorries laden with malt, oil tankers, private cars and brewery personnel, gave rise to a periphery route for most of the traffic which consists of lorries carrying bottles. This route would take them straight to the empty bottle store, directly on to the loading area in the same building and thence to the exit gate. Provision for lorry queues to form before entry into the brewery, and also prior to goods checking before exit from it, were made by the lorry park itself and the length of road between the full bottle store and the exit gate.

The changeover from left-hand driving to right-hand driving occurred towards the end of the construction of the lager brewery, but it followed a considerable period of notice and very little amendment was needed to make the layout ambidextrous.

The plan was to keep vehicles bringing raw materials and fuel into the brewery off the periphery route and, as the majority would be bringing in malt or fuel oil, it was not difficult to provide a layout that preserved the separation and permitted easy access to the malt silos and the oil tank farm respectively.

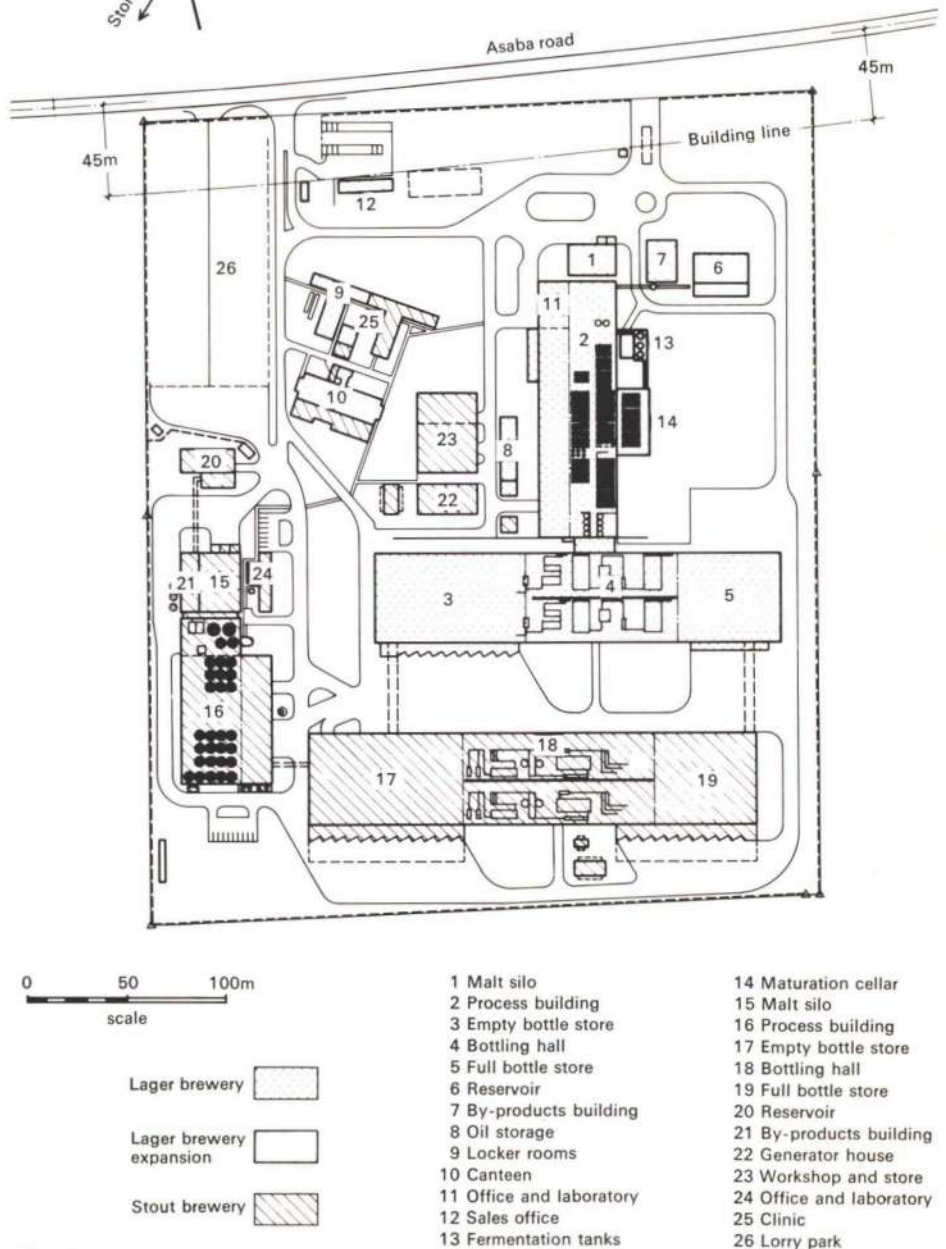
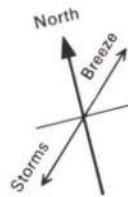


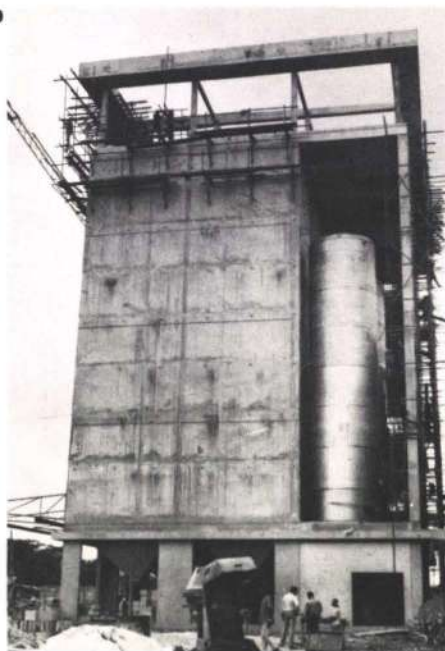
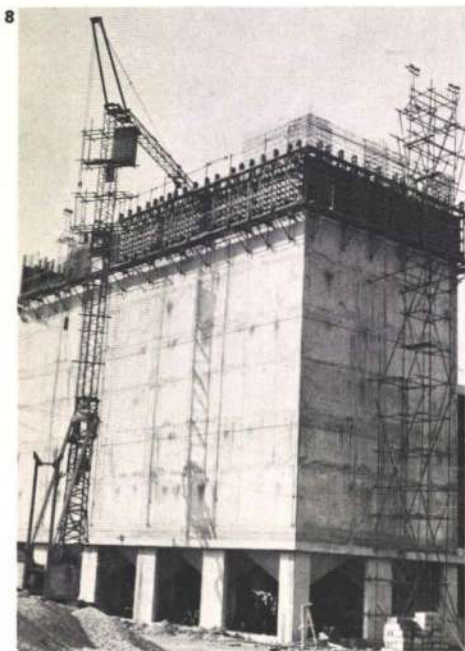
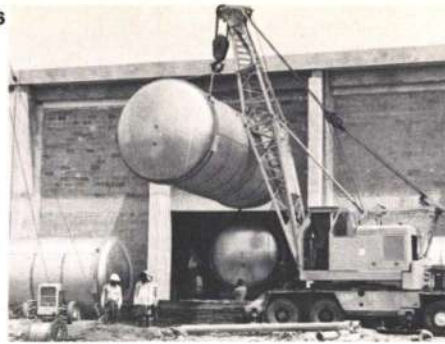
Fig. 3 Site plan

### Design development of the buildings for the lager brewery

The main criteria influencing the design of the buildings included the following:

- (1) Economic construction that could be completed quickly
- (2) A type of construction, and phasing of site work, to minimize the detrimental effects of the rainy seasons
- (3) Use of readily available and locally-made materials
- (4) Use of the permanent structures to temporarily support plant during the installation stage
- (5) A phased completion and handover of those buildings containing a lot of plant, so that the plant manufacturers specialist erectors could carry out their work with minimal hindrance and with reasonable access and working space
- (6) Good natural ventilation and minimal solar heat gain.

Apart from the silo block and the reservoir, it was natural to think in terms of lightweight construction and structural steelwork for both of the main buildings. However, with a high duty on imported fabricated steelwork (a total levy of over 70% of the supply and shipping costs) and with the few major local fabricators already very committed, the structural scheme for the first major building required, which was the process building, developed into a hybrid of reinforced concrete columns and beams up to eaves level, supporting shop welded steel roof trusses, reduced for road transport to manageable lengths, which were then to be bolted together on site. Part of the reasoning behind this choice of a hybrid solution was that completion of main frame in situ concrete work to eaves level could be expected to coincide with the first delivery to site of structural steelwork, so that work on and off site would be carried out simultaneously to give a minimum construction time.



**Fig. 4**  
The site before clearance  
(Photo: Geoffrey Wood)

**Fig. 5**  
The process building framework  
(Photo: Nick Tompkins)

**Fig. 6**  
Installation of the lager fermenting vessels  
(Photo: Nick Tompkins)

**Fig. 7**  
The fermenting vessels in place  
(Photo: S. O. Alonge)

**Fig. 8**  
The lager brewery silo block during construction  
(Photo: S. O. Alonge)

**Fig. 9**  
Liquor vessels installed in the silo block  
(Photo: S. O. Alonge)

**Fig. 10**  
The lager brewhouse control room  
(Photo: Alistair Reid)

**Fig. 11**  
The office and laboratory area within the lager process building  
(Photo: John Welling)

**Fig. 12**  
The north west corner of the empty bottle store  
(Photo: John Welling)

**Fig. 13**  
The unloading bay of the empty bottle store  
(Photo: John Welling)



The typical cross-section of the process building was required to envelope an area 9 m high and 45 m across, with almost  $\frac{2}{3}$  of the width taken up by the cold cellars containing horizontal vessels stacked in two vertical layers. Some thought was given to dividing the 45 m width into two roof spans, each with a bi-pitched roof, but this involved having a central valley gutter in a long building containing a lot of sophisticated plant as well as a lot of thermal insulation needed to keep the cellar temperatures down to 0 C. Although generous sizing of gutters and downpipes would reduce the risk of overflow, there would always be the danger of a tropical rain storm arising unexpectedly before maintenance staff had had the

opportunity to make sure downpipes were clear after a long period of drought during which blockages might well have occurred, whether aided by animal and insect life or not! The chosen alternative of a single bi-pitch roof across the two structural spans of the 45 m width not only avoided the central gutter but encouraged better natural ventilation of the service strip adjacent to the cold rooms, and of the roof space itself.

In designing and detailing the interior of the part of the process building containing the cold cellars, considerable attention was given to the complete integrity of the vapour barrier which was placed on the external face of the thermal insulation.

The roof trusses were designed to support two temporary longitudinal runway beams in each cellar. These would carry the empty vessels weighing approximately 3 tonnes each, which were to be fed through low level apertures in the cellar walls, and then hoisted by chain pulley blocks, so that they could be transported down the cellar to their final position.

At the northern end of the process building, adjacent to the brewhouse and within the main building envelope, a three-storey reinforced concrete structure provides accommodation for managerial and administrative staff as well as the brewery laboratory.

The brewery bar, considered by some to be the most popular accommodation on the site, is at ground floor level in this office area. Part of the internal finishes are in carved wood and illustrate the skill of local craftsmen. The location of the bar permits easy access in and straightforward access out! (Fig. 11 illustrates the elevational treatment of the office accommodation within the four end bays of the process building).

#### Floor levels

When considering the floor levels of the process building and the bottling hall building, the natural contours of the ground suggested a cut and fill earthworks approach for the former and a step in the ground floor level of the latter. Fortunately such a step could be introduced without much inconvenience at the junction between the bottling hall and the full bottle store. Furthermore, with little adjustment in floor levels, the ground floor level of the process building could be equated to the mezzanine floor level in the bottling hall building. Generally, the gradual slope of the natural ground provided good drainage without at the same time creating problems. In a number of instances it rendered an advantage, for example along the northern edge of the bottling hall building where the ground floor level is at the level of the roadway, whilst along the southern edge of the same building, the ground floor of the building, compared with the roadway, is at a convenient lorry tailboard height.

The choice of material for the structure of the bottling hall building made it almost identical to that of the process building as the external columns were again to be reinforced concrete up to eaves level. However, here the similarity ended, as trusses would create more dust traps than a solid web portal member and would be more difficult to paint. Central columns did not interfere too much with the use of the interior of the building and by introducing a longitudinal ridge beam, every alternate internal column could be dispensed with.

The bi-pitch roof was favoured once again, but this time because the ridge height provided a large volume into which steam and hot air from bottle washers and pasteurizers could rise, and let the limited amount of light entering through the monitor roof spread more evenly over the floor area.

The monitor roof gave ridge ventilation above the top of the vertical translucent sheets which form the side cladding to the monitor, and direct sunlight is prevented from entering by the generous overhang on the monitor roof sheeting. The eaves height of 6.7 m was governed by the height of cartons stacked on pallets.

The bottle stores at each end of the bottle hall are relatively simple buildings, having little need for floor drainage. Fork lift trucks operate in both these stores and a few drainage gulleys placed strategically in the level floor area were all that were required.

By contrast, a bottling hall is a wet area and an underground drainage system with frequent gulleys was necessary. In very wet

machines, floor tiling was called for and, elsewhere, falls in the granolithic floor finish feed into the drainage system.

The amenity buildings provide a good example of economic construction, utilizing locally manufactured materials. They are all single-storey and the architect wanted them to contrast with the main brewery buildings in shape, orientation and grouping. Use of trough-sectioned aluminium roof sheeting, rolled longitudinally to a fixed radius and supported by valley gutter beams without the need for purlins, provided the contrasting shape. The barrel vault roofing created by these curved sheets is ideal for through ventilation from gable end to gable end and a generous overhang of the roofing at the gables provides rain protection without detriment to the ventilation.

The orientation of the buildings was determined by three main factors; the prevailing breeze from the south west, the desire to avoid noise from brewery plant in the main buildings, and the advantage of a view which would be across a gentle, grassed slope to trees and the jungle beyond.

For the vertical structure in the amenity buildings, hollow sandcrete blockwork was used, with cavities reinforced with steel and filled with concrete at points of concentrated loading. It is worth noting that sandcrete blockwork walls are still a comparatively cheap form of construction, being considerably cheaper per m<sup>2</sup> of wall area than aluminium sheeting.

The locally-made *Amiantus* deep trough asbestos cement sheets which were used as roof sheeting for some of the minor buildings, external wall sun shield cladding for the cold cellars and for cantilever canopies, are capable of spanning almost their longest manufactured length of 7.5 m.

#### Work on site

Possession of the site was not allowed until an official government enumerator had assessed the number of rubber trees (for which compensation would have to be paid) in the small plantation amongst the otherwise overgrown area (see Fig. 4) and this meant that clearance work, topographical surveys and

geotechnical investigations were carried out simultaneously as soon as access to the site was permitted on 7 March 1972.

Costain (West Africa) Ltd. were awarded the contract for site clearance and priority work commenced on the process building and a permanent site establishment office, which was designed to also function later as a sales office once the brewery went into production.

The awarding of this contract followed the submission of schedule of rate tenders by a number of contractors and it provided a brief time during which precise information on the site and its topography could be established for the first time. This was a most hectic period as the contractor was programmed to complete foundation before the rains broke in earnest and, having cleared the site, was expected to continue with construction of foundations whilst the foundation design was completed in a matter of days. Although only partially successful in beating the rainy season, the contractor progressed steadily and after tenders had been received for all the remaining building and civil works on the site, he was successful in winning the main contract.

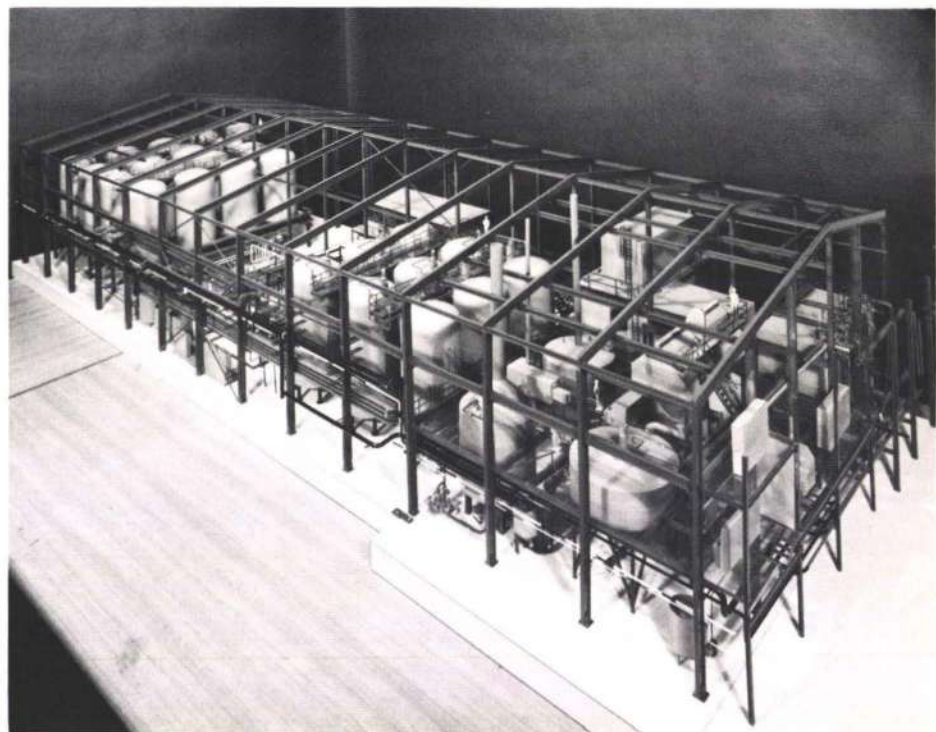
Two separate sets of tenders for structural steelwork to the process building and bottling hall building were obtained, and nominated contracts awarded accordingly, the other significant nominated sub-contract being for thermal insulation to the four lager cellars and the hop store.

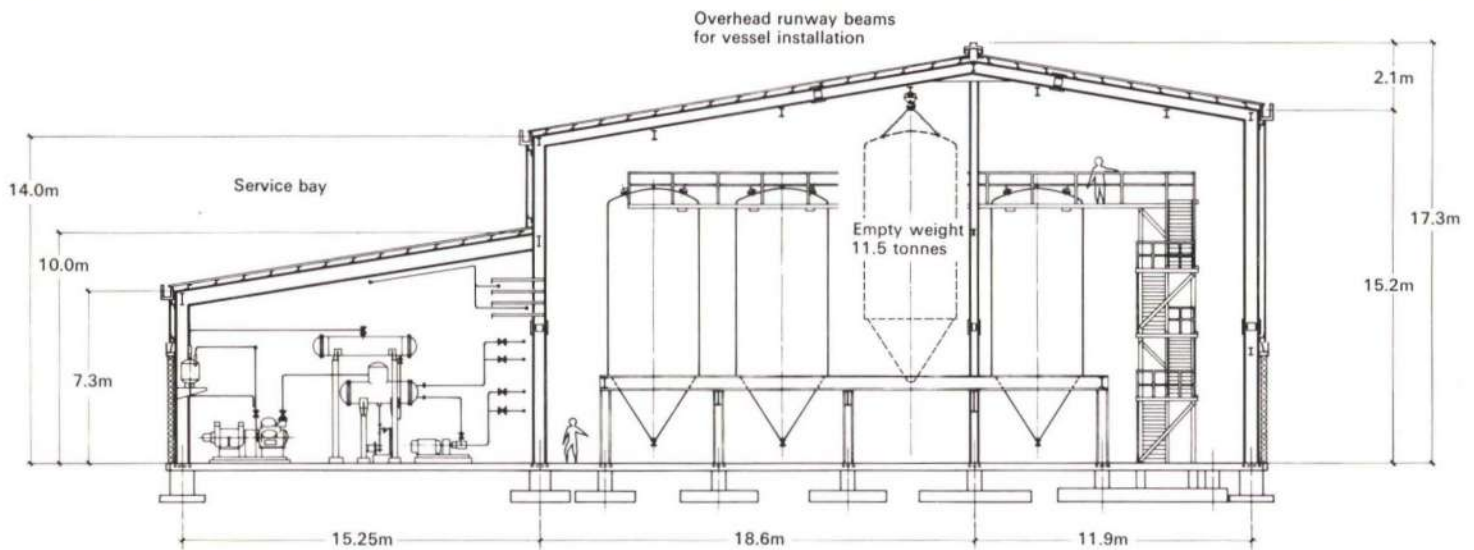
The fact that no geotechnical investigation could be carried out until after a contractor arrived on site to commence construction, meant that assumptions had to be made before site possession in the hope that the investigation results would confirm that the assumptions were sound. This led to a somewhat conservative design approach initially though the investigation results confirmed the expected presence of good laterite at a depth of approximately 1m.

Construction work continued throughout 1973 and 1974 and the first brew, always a critical time, took place in April 1974. The nature of the civil works was not demanding from the innovatory point of view so much as from the need to maintain flexibility in the

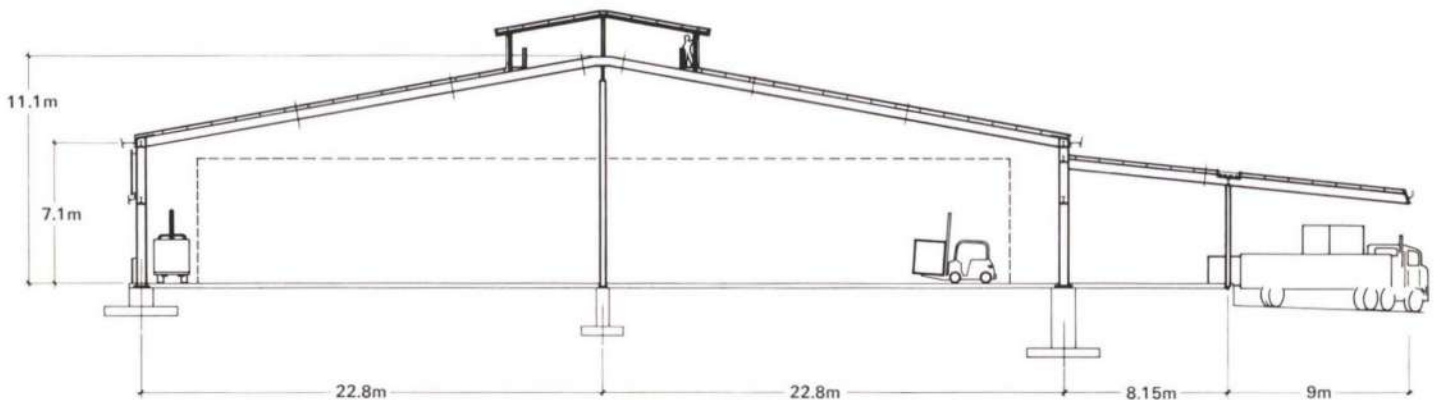
Fig. 14

Model of the stout brewery process building made by Guinness Overseas Ltd. (Photo: Courtesy of Guinness Overseas Ltd.)





**Fig. 15**  
Typical section through the storage vessel area of the stout process building



**Fig. 16**  
Section through empty bottle store

design of the interiors of the buildings to meet the expected, or unexpected, building requirements for the plant which was being designed simultaneously. In other words the art of the game was to ascertain the extent to which one could spend time on refining the design without incurring a delay in the supply of information to the contractor on site. The policy of Guinness Overseas to move key members of their project team to site for the plant installation stage helped considerably when last minute design changes were necessary to suit either plant or pipe-work, because decisions could be made on site by people having a full knowledge of the design and its background.

One of the on-site activities worth a mention was the sandblasting of the structural steelwork for the bottling hall building. This was carried out successfully in the open during the dry season, with simple and very portable manual plant consisting of a charcoal burning sand drier, a sand hopper, the air compressor/receiver unit connected by flexible hosing to a hand-held nozzle. The operator was protected by a special masking hood and apron.

Communications between London, Lagos and Benin during the running of this contract were aided by the contractor's radio link between the site and his Lagos headquarters, as well as his 'day lorry' which brought materials, drawings and messages to and from the site. Telephone calls between Benin

and London were on most occasions very demanding on time spent waiting for a connection and hence little used. The UK High Commissioners office in Benin was helpful in allowing telex messages to be sent using their equipment on a standard charge basis and if we had been aware of this available service early on in the contract it would no doubt have been used a good deal more often.

#### Phase I Expansion of the lager brewery

In January 1975 Ove Arup & Partners were commissioned to design the building and civil engineering works for an expansion of the lager brewery which would take its annual production up to 500,000 hl., the conditions of the appointment being identical to those governing the earlier involvement. At this time the most economic arrangement of process plant led to external vertical fermentation vessels which were individually jacket-cooled, and supported just above their conical bottoms by a frame of structural steelwork which, when enclosed in blockwalling, formed a working undercroft that could be air-conditioned. For economic reasons, the additional maturation vessels were larger in capacity and hence in diameter. This resulted in a higher cellar which prevented the complete mirror image extension that had been anticipated at the time of the design of the lager brewery. The same principle of a concrete structure to eaves level was adopted and as the contract programme was minimal

(nine months), the availability of local stocks of steel was a governing factor in arriving at a solid web rafter single slope roof, which would be sufficiently strong to support runway beams carrying the horizontal vessels during the plant installation stage.

Costain (West Africa) Ltd. were awarded the contract for this work and prior to completion, a decision had been made by Guinness Nigeria to commence work on a new stout brewery on the undeveloped area of the original site. The contract was therefore extended to include priority work on foundations, drainage and ground-bearing flooring for this second brewery.

#### The stout brewery

When the decision to proceed with the second brewery was taken late in 1975, the brewery plant manufacturers in Europe were offering very short delivery periods because of the slump in their workload, resulting from the general recession in Europe. It was realised that an opportunity existed to break a few records on completion times and discussions took place on the extent to which programming of the building civil works could be compressed at a time when contractors were already extended due to the economic expansion in Nigeria.

This time the basic requirement was twofold; firstly for the new stout brewery having an annual production of 500,000 hl to be constructed without loss of production on

the first brewery, and secondly for half of the bottling plant for the stout brewery to be available for use within a period of nine months, so that it could be used as a standby for the two bottling lines in the lager brewery. Guinness Overseas, under whose direction Ove Arup & Partners were appointed as for previous work on the site, set up a design team in London which included a model maker, as it was realised that with minimum

design and construction time available, a model of the process plant would be a very valuable design aid.

Although the basic building requirements were similar in nature to those of the lager brewery, there was no need this time for cold cellars to house the maturation and fermentation vessels and keep them at low temperature.

New boreholes were sunk to provide the additional water for the stout brewery and a second reservoir was required for the storage of  $\frac{1}{4}$  million gallons.

In general terms the stout brewery required similar types of building to those constructed on the site, but the detailed requirement was quite different and this time an office/laboratory building independent of the main process building was needed. In addition the electrical standby generators for both breweries were to be accommodated in an independent generator house, located where cable lengths and routes would be ideal and where the high noise level could be controlled so as not to cause too much inconvenience.

Although there was a close similarity between the requirements for the lager and stout bottling halls, a few improvements were given in the brief such as more extensive overhead weather protection to lorries loading and unloading, and high level roof walkways to facilitate cleaning of the translucent side sheeting in the monitor roof. A similar degree of improved weather protection was required over the malt silo intake grilles where driven rain could otherwise interfere with operations.

The other new building of significant size that was required to serve both breweries was the engineering workshop where engineering training could also be carried out. An engineering store was to be combined within the same building.

Elsewhere it was possible to double up existing facilities by extensions to the amenities buildings and the lorry park as extensions to these had been foreseen when they were originally designed.

A large reduction in the import duty levied on fabricated steelwork, bringing it down to 25%, favoured structural steelwork as the right choice of material for the complete superstructures of all the main buildings, and tenders obtained for the 600 tonnes of steel required for the first building to be erected, i.e. the bottling hall building, showed that supply from the UK was considerably cheaper and likely to be on a shorter delivery period than local supply. At this time shipping materials into Nigeria was somewhat unpredictable. The major ports were all becoming very congested and the build-up of cement-carrying vessels amongst others was contributing to long queues of ships, particularly outside Lagos harbour, where waiting time was in many cases many months and where the number of ships in the queue at one stage reached a peak total in excess of 400.

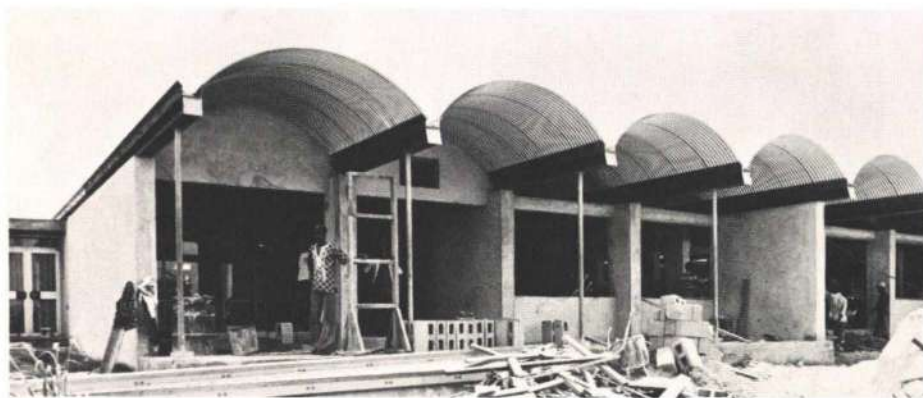
The recommendation that butyl rubber linings be provided in the two compartments of the new reservoir was accepted as the additional cost of these was reasonable, even without taking into account the savings that could be achieved by not having to design the reservoir structure itself as water-retaining.

These linings, which are under a 10-year guarantee, were considered to be a good investment as leaking problems had already been encountered in one of the compartments of the lager brewery reservoir.



**Fig. 17**  
Excavation for the stout brewery malt intake substructure

**Fig. 18**  
Amenity buildings with aluminium roofing spanning between valley beams



**Fig. 19**  
View during extension of amenity buildings

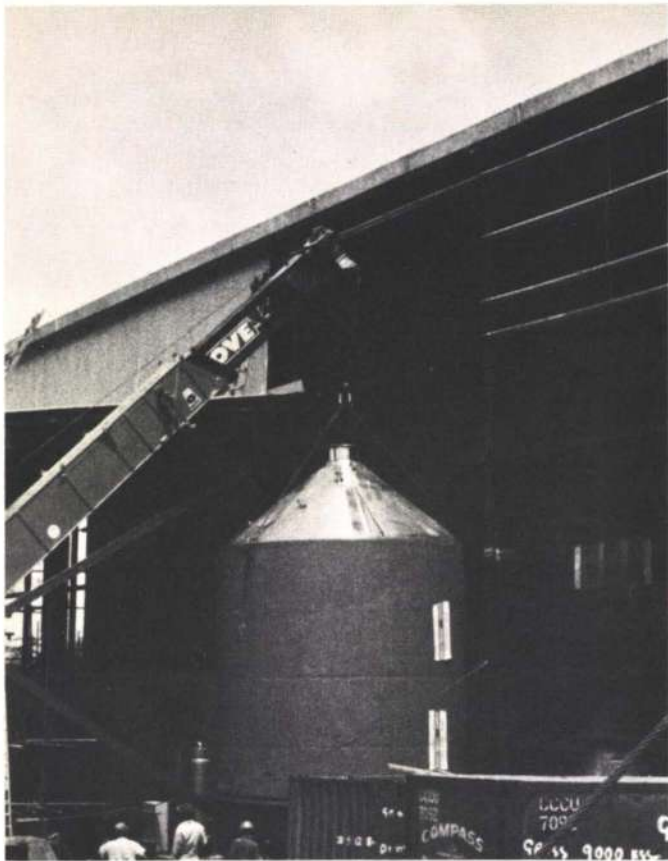
#### Work on site

Extending the Lager Phase I expansion contract to include the initial priority construction for the new stout brewery, rendered a few months time advantage and provided time in which tender documents for the main contract could be prepared. The tenders submitted in May 1976 led to A. Micheletti Ltd. being awarded the contract and by June they had set up their site establishment which later included a radio link to their head office in Port Harcourt.

The Guinness Overseas project team from London started transferring to the site individually towards the end of 1976, the Ove Arup & Partners resident engineer for the lager brewery expansion having stayed on from 1975 to supervise construction on the stout brewery.

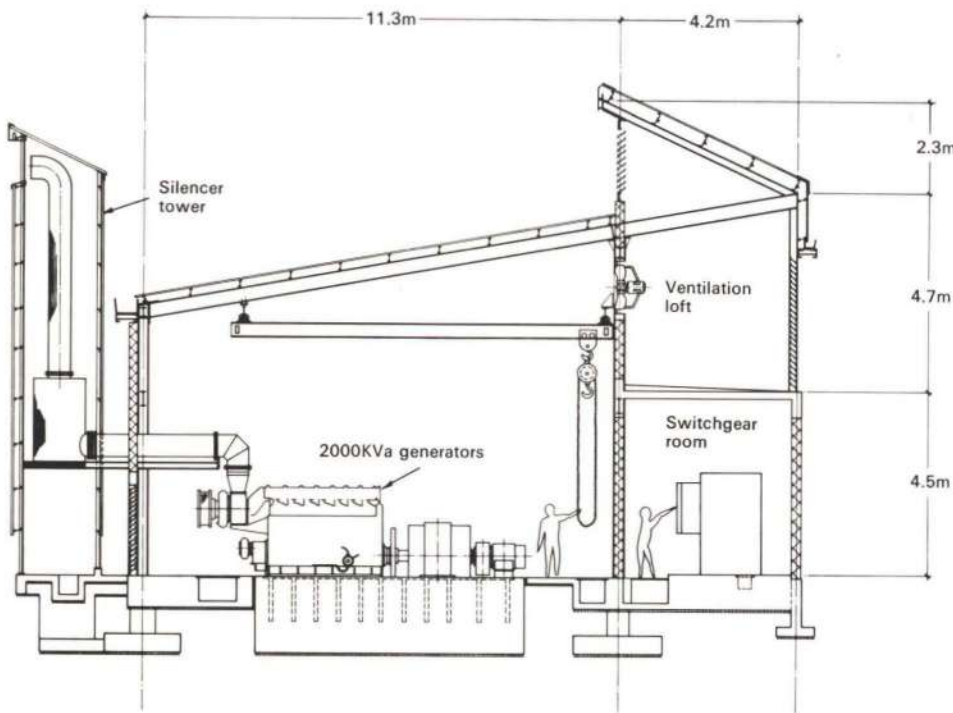
A delayed shipment of structural steelwork during June and July 1976 was a setback which could only be remedied in part by an accelerated steelwork erection programme and the rainy season interfered more with foundation work than was to be expected.

Problems with cement were not as great as at one time feared, for the glut of cement-carrying vessels had by now unloaded their long-standing cargoes and some deterioration in quality had been anticipated. Cement testing equipment was flown out so that site tests could be carried out on deliveries and a system was set up to ensure that any questionable consignments were either removed from site or used in situations where strength was not so essential, such as in concrete blinding. For the concrete in the silo block where specified strengths had to be maintained, particular attention was given to the cement quality and arrangements included, where possible, the utilization of cement manufactured in Nigeria.



**Fig. 20 left**  
Installation of brewhouse plant

**Fig. 21 below**  
The two bottling hall buildings  
linked by conveyor bridges



**Fig. 22**  
Section through generator house

#### Problems overcome

The use of secondary ports such as Koko and Sapele assisted considerably in overcoming the shipping problem, the worst aspect of which appears to have been the loss of the M V *Sirena*, a Cypriot-owned cargo vessel

which was reported as having sunk after hitting a semi-submerged object off the African coast. Although no hands from the vessel were lost, a complete consignment of rainwater pipes and fittings destined for the site went down with the ship!

The original programme for the stout brewery called for a first brew on 31 October 1977 and, despite the problems encountered over weather, shipping delays and at times poor communications, it actually took place on 22 November 1977, establishing a period of two years for both the design and construction up to the production stage. The external works will be completed in a few months' time and before this article appears in print.

#### Acknowledgments

Throughout the design stage of both breweries, Guinness Overseas Ltd. and Guinness Nigeria Ltd. were helpful by their open-mindedness and enthusiasm towards achieving the right design solution. Close co-operation by the Guinness Overseas project team led to the integration of process plant with the buildings and an interesting time of joint effort.

The practical assistance both organizations provided, particularly during the construction stage, resulted in better communications between design office and site than would normally have occurred and this was a contributing factor towards the completion of work in such a short period.

#### Credits

*Client:*  
Guinness Overseas Ltd.  
*Building engineering design & quantity surveying:*  
Ove Arup & Partners  
*Consultant architects:*  
Godwin & Hopwood  
*Main contractor (lager brewery):*  
Costain (West Africa) Ltd.  
*Main contractor (stout brewery):*  
A. Micheletti Ltd.  
*Electrical consultants for process work:*  
McLellan and Partners  
*Process pipework consultants:*  
Brown, Crozier and Wyatt

# Our Lady's Priory

Charles Milloy

## Background

The Priory of Our Lady of Good Counsel belongs, rather surprisingly, to a monastic order stemming from the English Convent in Bruges, Belgium. As a result of the Reformation, English girls were prevented from becoming nuns and, in 1609, a group of English women went to Belgium and founded a monastery in Louvain. In 1629, they founded another House in Bruges. In 1886 another branch of the order was established, back in England at last, at Haywards Heath. It is an order primarily orientated to a monastic life and, in the past, to education. At Haywards Heath the sisters purchased a large manor house on the outskirts of what was then a small Sussex village. They opened a school which functioned until 1972.

During the 20th century Haywards Heath expanded, surrounded the Priory, and various other factors led to the need for a change of role and location, so when the sisters were offered a good price for their existing premises, the means to make the change became available. After prolonged searching, a large country house called Kingsland, near the village of Sayers Common was bought.

Surrounded by a few acres of secluded farmland, it is set back from the main London-Brighton trunk road. Near the house is an artificial pond in the old garden. The lay-out of the new priory is based upon the existing house and the pond, starting off as an extension of the former and then curving round the latter and back to the house to complete the full circle.

With their new building the life of the community will change. Instead of teaching, the sisters provide conference centre facilities for groups of different types, nationalities and religions which help to finance the day-to-day running of the community. To accommodate the visitors, part of the project is a guest wing to be built to the east of Kingsland.

## Building concept

The new buildings are made up of three distinct sections, the monastic arc, the church and the guest wing. The monastic arc is designed to preserve the secluded life of the Community, being divided into private areas for the sisters' exclusive use and communal areas shared by both religious and secular users. The Narthex, where both worlds meet and can communicate freely, is reached directly from the main entrance. This is the main hall with high ceilings and wide spans where the structure of substantial laminated timber beams and timber cruciform-shaped columns form the basis of the architecture and immediately impress upon the visitor the religious nature of the building. The entire building is designed with all roof pitches, sloping structure, etc., at 40 degrees to the horizontal.

The Narthex continues onto a balcony overlooking the secular refectory where the secular guests will eat and converse. From the refectory there is access by means of a covered walkway to the church.

The area used by the nuns lies to the right of the main entrance, the only part of this section which is shared with the secular users being the library. This area is composed of living quarters built in a cellular structure with the offices and infirmary arranged to fit into the main grid system. Silence is preserved in the dormitory cell area apart from essential communications. Separating the blocks are

staircases areas which are intended to be less formal and where more spontaneous conversation is allowed. At these locations on the ground floor are situated small alcoves with seats for the purpose of reading and contemplation.

On the ground floor at the entrance to the dormitory cell block is the infirmary. The external cloisters deliberately encircle the cells to provide a silent mantle around the dormitory area.

The architects, Michael Blee Whittaker Partnership, spent considerable time identifying the primary functions of the community's life and as accurately as possible, have attempted to embody these themes into the building lay-out. To assist the planning, a questionnaire was filled in by the sisters in which they were able to state their requirements for the new building.

The architectural themes are:

- (1) The breaking of bread – the refectory
- (2) Prayer and worship – the church
- (3) Community life – the community room where the sisters can live as a family.

The architects' aim has been to create an atmosphere which complements the philosophy of the order so that simplicity and austerity are maintained and encouraged, without detracting from the quality of the building. The community participates in the world outside and so the building must be outward looking, whilst at the same time being a refuge and maintaining privacy for the occupants.

The architecture, structure and services are coordinated to give an insight into the building's composition and only the more unsightly elements of the services have been covered up.

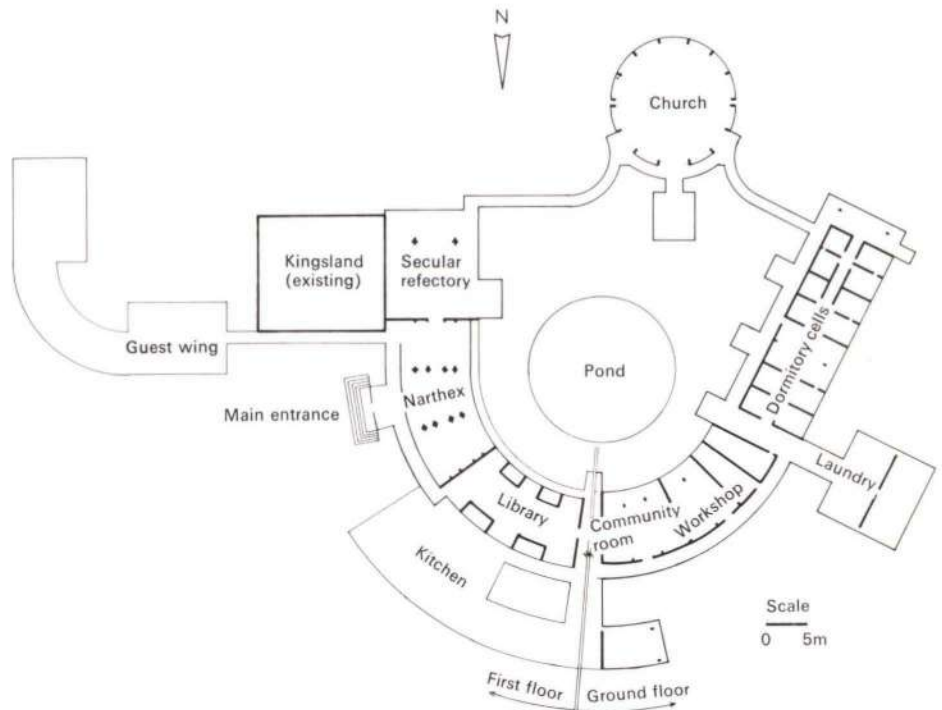


Fig. 1 Our Lady's Priory: plan

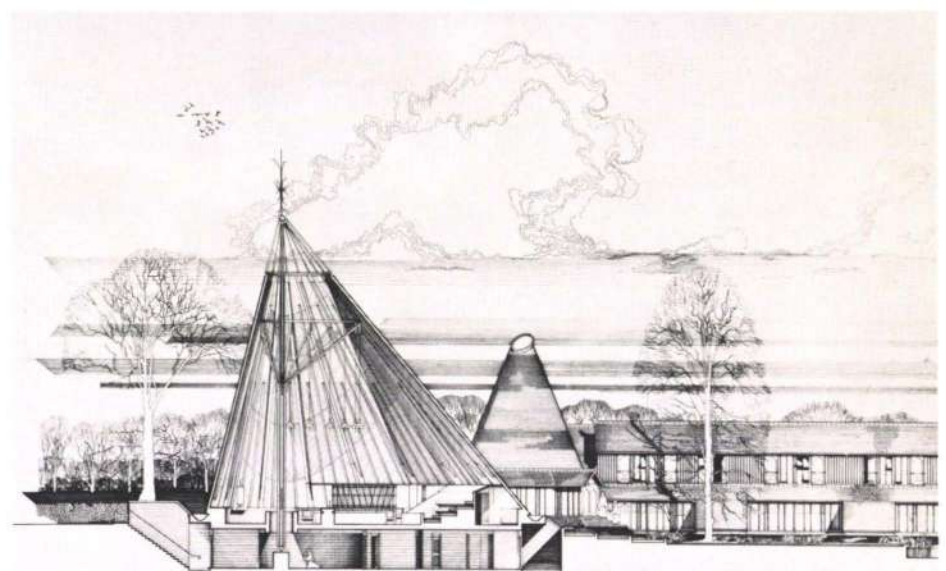


Fig. 2 Architects' drawing (Courtesy of Michael Blee Whittaker Partnership)



**Fig. 3**  
The fairfaced blockwork in the interior  
(Photo: Harry Sowden)



**Fig. 4**  
Detail of blockwork (Photo: Harry Sowden)

#### Geotechnics

The site investigation revealed a thick stratum of weald clay which is highly weathered near the surface, with the water table approximately 2m below the latter. The crosswall construction logically led to strip footings at a depth of 1.5 m, at an allowable bearing pressure of 150 kN/m<sup>2</sup>.

#### The superstructure

In keeping with the architectural concept it was decided to use fair-faced concrete blocks to form the main load-bearing walls, two storeys in height, and the final type chosen was an etched *Forticrete* block. To maintain the uninterrupted perimeter cloisters, fair-faced concrete corbels cantilever out from the ends of the crosswalls. Where the room lay-out did not permit the crosswall, this was replaced by a concrete column on grid and the corbel extended into a beam. The first floor slab is a conventional concrete slab with the fair-faced walls continuing up above it to support the roof.

The roof support system is almost completely exposed. Main, glued, laminated beams span between the crosswalls, with occasional vertical posts and sloping members giving stability and equalizing the load between the four main beams. This system enables all the beams to be of equal depth and fortunately the spans were such that the beam depths could be kept at a block height without producing unsightly beam widths. The torsional problems of beams curved in plan was solved by marginally increasing the beam width in the curved plan areas.

Most of the spans are approximately 3 m but these are increased in the open Narthex and the refectory. The solution here was to provide cruciform timber columns and larger beams propped by timber struts from the columns.

#### Church

The drawing of the original scheme shows the skew conoid church and the two smaller conoids of the chapter house and the oratory. The church solution was an ingenious system of main laminated ribs stabilized by four skins of tongue and groove boarding laid in alternate directions to provide adequate shear stiffness. Regrettably, this solution had to be abandoned on cost grounds and, although several attempts were made to devise steel/timber composite structures capable of achieving the shape needed for liturgical functions, none satisfied the financial restraints. A much simplified straight conoid was found to be the only economic solution. The final solution was to keep the timber ribs but replace the stressed skin with horizontal purlins framing into the ribs to provide the stiffness. Tapered timbers attached to the purlins create a circular exterior from the multi-faceted interior.

#### Services

The building is not air-conditioned nor mechanically ventilated. There is a central boiler house containing two oil-fired boilers for the central heating and hot water. Most of the trunking is accommodated in the in the false ceiling, passing from there down through the voids in the *Forticrete* block walls to serve the ground and first floor rooms. The blocks were carefully cut to take the junction boxes.



**Fig. 5**  
The curved laminated timber beams in the library (Photo: Harry Sowden)



**Fig. 6**  
The Priory from the Church (Photo: Harry Sowden)

**Fig. 7**  
The Priory from the new cemetery (Photo: Harry Sowden)



#### Progress

The structure of the monastic arc and the guest wing were completed this winter and the services installation and the finishing trades are under way. The final problems of the church design have now been overcome and its construction will start this summer.

#### Credits

*Architect:*  
Michael Blee Whittaker Partnership  
*Mechanical & electrical engineers:*  
Hamdon Electrical Ltd.  
*Main contractor:*  
W. C. Hilton and Sons

# Theatre Royal Nottingham

Peter Lock

In the spring of 1975, Renton Howard Wood Levin Partnership were approached by the Nottingham City Council to examine the implications of building a concert hall to hold 1500 people plus a 400-seat multi-purpose hall, within the area of Lace Market.

The acquisition of this site would have meant a Compulsory Purchase Order followed by a Public Inquiry, which, at a time when this method of acquiring sites was falling from favour, might have proved difficult.

The Council did, however, own a block of land close to the City Centre that included the Theatre Royal, which was becoming difficult to operate, due to poor dressing room accommodation. The focus was switched to this new site and the brief was extended to include the refurbishment of the Theatre Royal and its incorporation into the scheme.

We were invited by the architects to join the team at the beginning of June 1975 along with Gleds as quantity surveyors, Edwards & Blackie as services consultants, Theatre Projects as electrical, lighting & theatre consultants and Hugh Creighton as acoustic consultant. We gratefully accepted and got down to work immediately.

Our brief was to report on the structural condition of the Theatre Royal and the adjoining properties, any restrictions on demolition and conversions of the properties,

and to make an assessment of the site for new buildings.

As always, our first move was to seek help from Geotechnics and Roger Thompson gave us a brief note on the problems we could expect in the centre of Nottingham. With this cheerful news we set off to see Nottingham.

The site lay  $\frac{1}{4}$  mile north of the Market Square on possibly the highest point in Nottingham and faced onto Parliament Street which is said to have been the northern perimeter of the walled city.

## History

The Theatre Royal was in the middle of the southern boundary, flanked on the west by the County Hotel and previously had been flanked on the east by a music hall, the Empire Theatre.

J. C. Phipps, probably the foremost theatre architect of the day, had designed and supervised the Theatre Royal which opened on 25 September 1865 with a production of *The School for Scandal*.

Since the opening night the theatre has undergone many alterations, the most extensive of which was carried out in 1897 by Frank Matcham. The theatre had changed hands and the new owners wanted to turn it into a music hall. Public outcry foiled this and Matcham, another well-known Victorian theatre architect, was instructed to refurbish the Theatre Royal and build a music hall next door with common foyer and dressing room accommodation.

As well as remodelling the interior of the auditorium, Matcham made major changes to the foyer and stage tower and reconstructed the balconies.

The last alterations were carried out to the design of Edwin Lawson for the Nottingham City Council in 1969. The now empty Empire was demolished to make way for a road widening scheme and the foyers were replanned once again to serve only the Theatre Royal. A new façade was built opening onto the corner of Parliament Street and the widened South Sherwood Street.

## The original structure

The auditorium of the Theatre Royal was built with solid brick walls supporting three levels of galleries and a timber roof structure and the elegant circular plaster ceiling was hung from handsome timber roof trusses which supported timber purlins with tongued and grooved boarding under a slate covering. The galleries were of typical cantilever construction having timber decking and secondary members on steel rakers which were built into the auditorium wall at the tail and which cantilevered over steel built-up girders acting as main beams that were in turn supported on circular cast iron stanchions. As this form of construction was not usually used in the 1860's it must be assumed that the gallery structure dates from the Matcham reconstruction.

There are remarkably few stanchions but the main beams were very deep and, in a few instances, restricted the headroom. The ugly plaster false ceiling to the underside of the galleries, although sound, added nothing to a very elegant and intimate auditorium.

The stage was of timber construction, sloping at 1:20 to a small orchestra pit. The stage floor was provided with the usual traps and the basement below had two storeys, the lower one being hewn out of the sandstone and left unfaced.

The stage grid and fly galleries were of substantial timber construction, suspended from heavy timber trusses similar to those used in the auditorium.

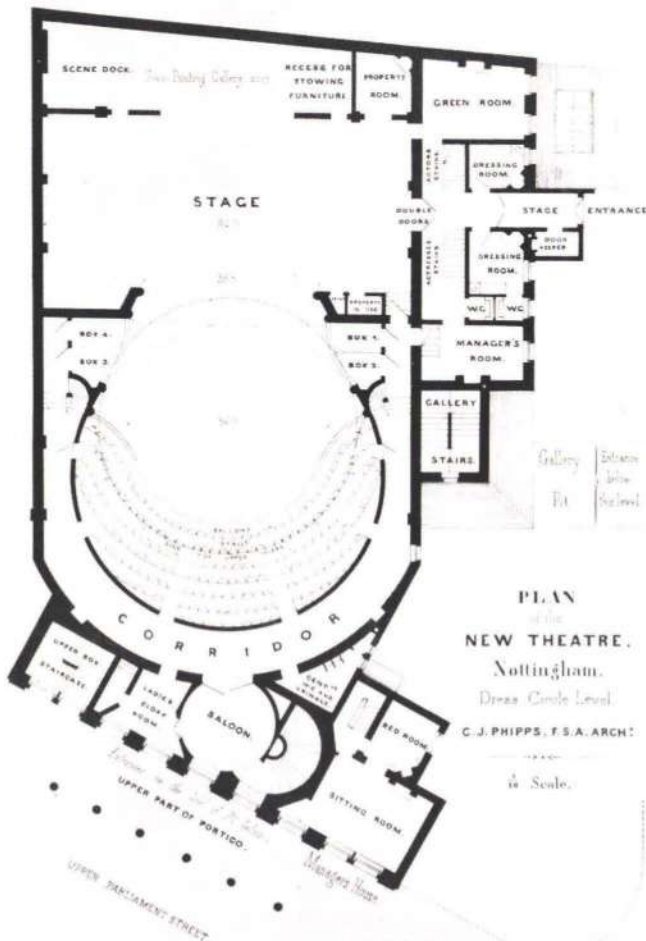
No major structural defects were found in the fabric of the theatre which would prohibit its re-use. The grid however was a little low and the headroom over it was very limited, especially at the outer edges, which meant that it would be impossible to install a fully counterweighted scenery flying system which is required nowadays, the skilled flying staff of 20-24 required for a theatre with a manual hemp rope flying system being impossible to obtain and prohibitively expensive to employ.

There were no separate footings but the walls corbelled out and sat directly on the local sandstone.

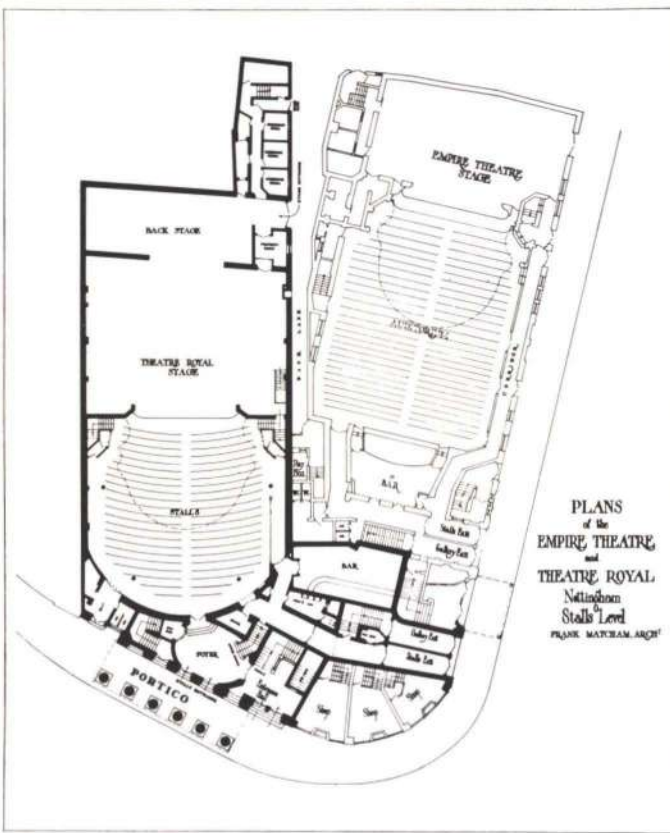
The adjacent County Hotel was a four storey Victorian building with a pleasing neo Georgian façade. This crescent-shaped building was of cellular construction with timber floors and load-bearing brick walls, both parallel to and radiating from the curved façade. It appeared to be structurally sound but would have required extensive structural modifications if its plan lay-out had to be changed in any way.

Roger Thompson reported that the site was directly underlain by the Bunter Pebble Beds which are coarse-grained brownish sandstone with rounded pebbles, varying in size from 5 to 20 mm in diameter. These beds form the high rock on which the Castle is built, and it is in them that the enormous system of rooms and passages which underlie much of the old town, were cut some centuries ago. These cavities form a major hazard for foundations in Nottingham and all bases in the centre of town have to be probed.

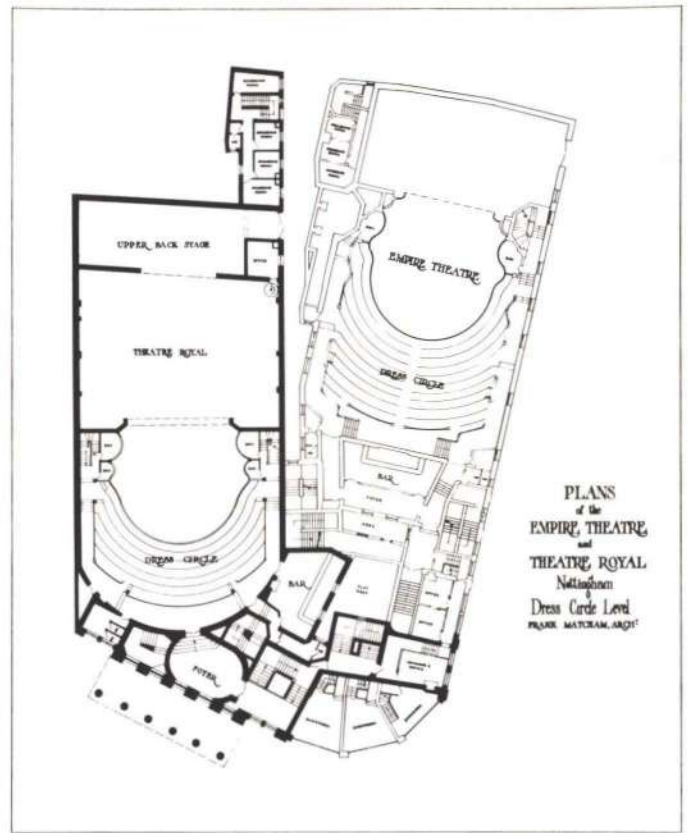
The stage basement showed that the sandstone was lightly cemented, easily cut with hand tools and had thin horizontal bands of marl. Tool marks from the original excavation were still plainly visible.



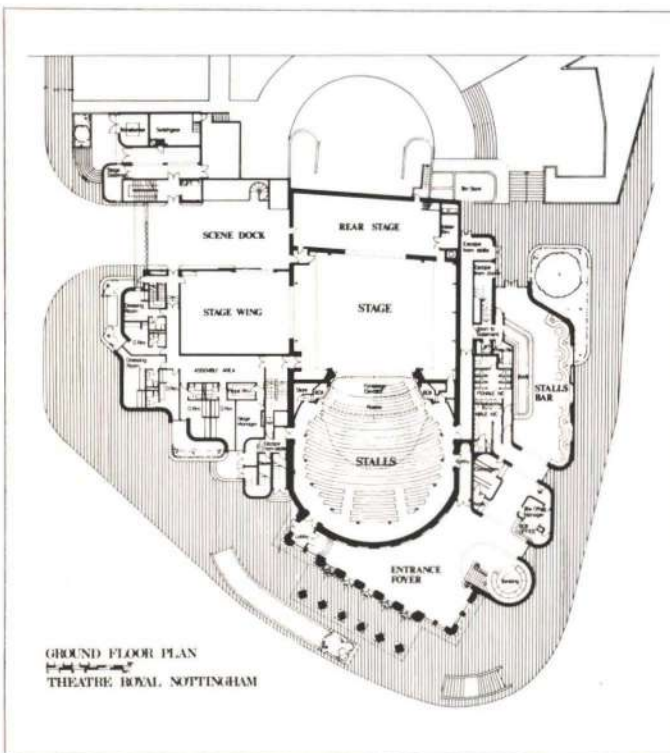
**Fig. 1**  
Dress circle plan of the new Theatre Royal Nottingham, by C. J. Phipps, 1865 (Courtesy of British Architects Library, RIBA)



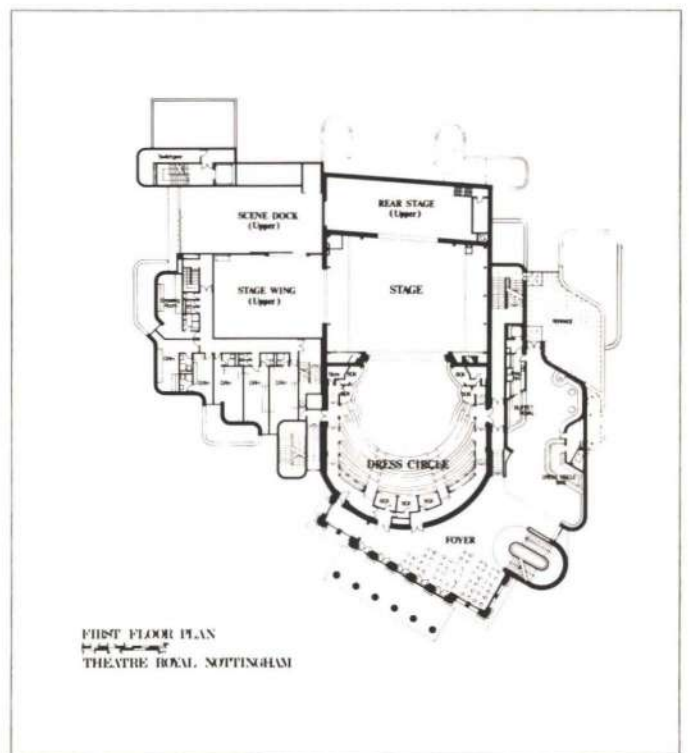
**Fig. 2**  
Stalls plan by Frank Matcham (Courtesy of Renton Howard Wood Levin Partnership)



**Fig. 3**  
Dress circle plan by Frank Matcham (Courtesy of Renton Howard Wood Levin Partnership)



**Fig. 4**  
Ground floor plan (Courtesy of Renton Howard Wood Levin Partnership)



**Fig. 5**  
First floor plan (Courtesy of Renton Howard Wood Levin Partnership)

**The first scheme**

The feasibility report was delivered to the Council in mid-July 1975 and made the following recommendations:

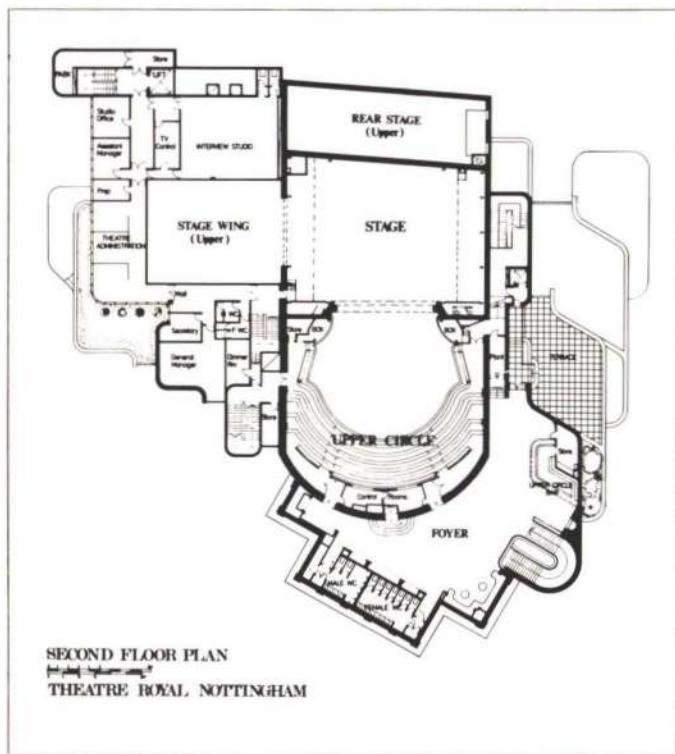
- (1) The Theatre Royal site should be used for the Festival Hall complex.
- (2) The Theatre Royal should become part of the complex with a new dressing room block, offices, foyers and a new steel stage tower with a fully counterweighted scenery flying system.

- (3) The concert hall should be increased in size to 2,200 seats and the multi-purpose hall maintained at 400 seats.
- (4) The County Hotel should be demolished to make way for the new dressing room block, side stage and scenery entrance, the conversion of the existing building not being practical.

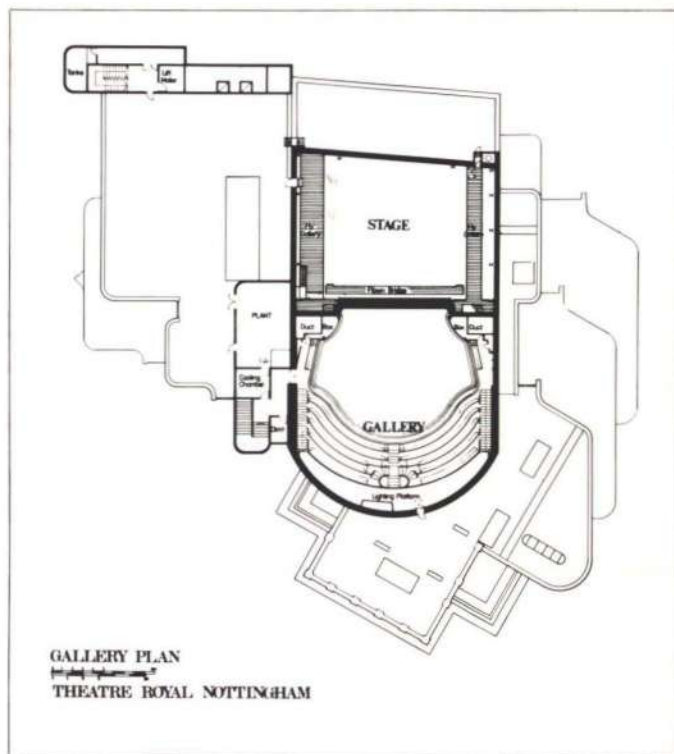
The Council accepted these recommendations and instructed the team to proceed with the design of the total complex.

A start was to be made on site before 1 April 1976 but the theatre was to be kept open until the end of the 1976 pantomime season, that is February 1977, and if possible re-open for the 1977 pantomime season which meant completion by mid-December 1977. This resulted in an extremely tight design programme with little time for a Bill of Quantities which would have been, at the best, very approximate.

A management contract seemed the ideal solution but, as this meant that there would



**Fig. 6**  
Second floor plan  
(Courtesy of Renton Howard Wood Levin Partnership)



**Fig. 7**  
Gallery plan  
(Courtesy of Renton Howard Wood Levin Partnership)

be no competitive element in the tender, it was unacceptable to the Council.

Gleeds suggested a target price contract where the tenderers are required to state their management fee, overhead charges and expected profit as a percentage of the contract sum.

The successful tenderer then prices a Bill of Quantities and, together with the quantity surveyor, agrees the estimated cost for the job. This figure becomes the target cost on which his management fee, overheads and profit are calculated.

During the contract the contractor and quantity surveyor keep a record of the actual costs which are monitored throughout the contract and compared on completion with the target cost.

If the final cost is lower than the target cost

the contractor keeps half of the difference, and if it is higher than the target cost the contractor pays half the difference.

This form of contract is competitive at tender stage when the contractor states his fee and the service he will provide for this, and during construction when the target cost is a spur to contractual efficiency.

The Council agreed to the target cost principle and instructed the team to proceed. As the contract was to be phased, the design was broken down into the following elements:

- Section 1: Dressing room, offices and theatre workshop
- Section 2: Theatre Royal – Stage House and auditorium
- Section 3: Theatre Royal – new foyer
- Section 4: Concert hall

Section 5: Multi-purpose hall.

Before the main contractor could be appointed the target cost for Section 1 and a budget cost for the remaining sections had to be agreed. This meant working drawings for Section 1 and scheme drawings for the remainder of the project by mid-November 1975.

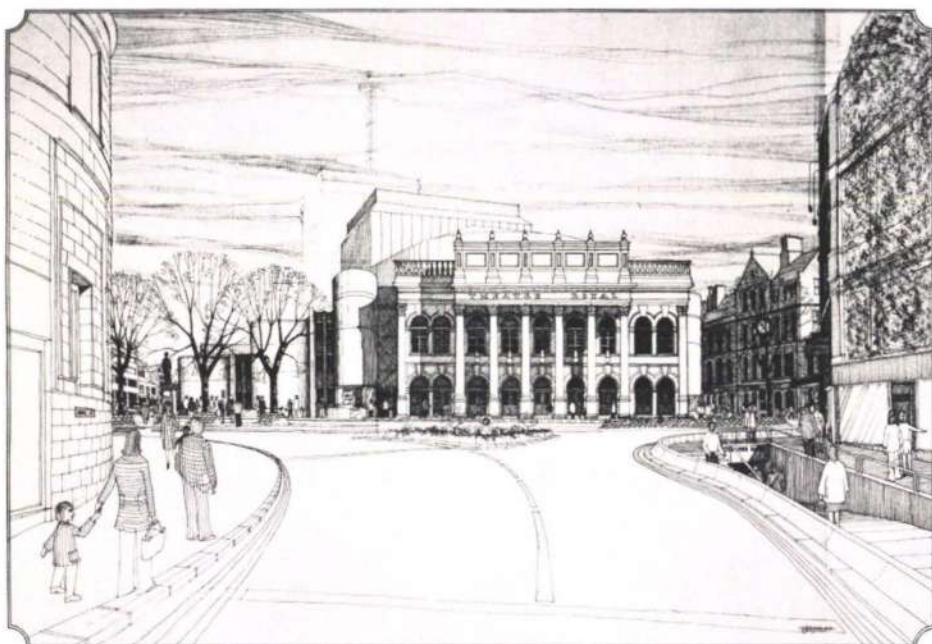
One further complication was that the County Hotel had to be demolished prior to the main contract which meant a separate demolition contract for which we prepared the specification and supervised the work.

Six major contractors were invited to tender for the construction of the Festival Hall and given a set of scheme drawings, very approximate quantities and a detailed specification. They were interviewed at the Council House in early December by a panel of the Council and members of the design team. The management fee was discussed, the contractor's team described how they saw the job being built and were asked to state what special talents they could bring to the contract.

After a very interesting three days, Bovis were chosen as the prospective main contractor and a letter of intent was given by the Council.

By March 1976, the Bill of Quantities for Section 1 had been prepared and the target cost agreed, the County Hotel demolished and Bovis started Section 1 with Brian Hogg of the Sheffield Office as resident engineer for the ground works. In the office the design work was divided with David Revill being responsible for Section 1 and 3, and Chris Barber looking after Section 2. Chris unfortunately was soon to go out on site on another job at which stage Ted Mann took over Section 2 with the help of Tony Broomhead who checked the existing balcony steelwork.

Section 1 which was of in situ concrete, framed construction with a woodwool deck, steel-framed roof proceeded without drama except for two caves and a well which were found by the probes, the biggest problem being noise which was severely restricted at all times and prohibited during rehearsals and matinee shows.



**Fig. 8**  
Architect's perspective  
(Courtesy of Renton Howard Wood Levin Partnership)

During this period we were carrying out a detailed survey of the theatre and pre-ordering the long lead items, such as the steelwork for the stage tower and the light-weight roofs of Sections 1 and 3.

**The revised scheme**

After the 1976 Council Elections the incoming Council reviewed its financial commitments and shelved a number of its building projects; among those postponed were the concert hall and the multi-purpose hall. This was a major blow and meant a certain amount of re-design so that the Theatre Royal and its new foyer could operate as a separate unit. Section 1 was too far advanced to alter to any degree so for the present stage of the

overall development the dressing room and office accommodation is overgenerous.

By Christmas 1976 the structure of Section 1 was complete, the hurried re-design of Sections 2 and 3 had been agreed by all parties and Bovis was starting work on the small Section 3 basement which meant underpinning the flank wall at the rear stage basement.

All members of the team, both on the design and construction sides, were bracing themselves for the coming 10 months when the theatre would be gutted, the existing foyers and changing rooms demolished and then the whole lot rebuilt and refurbished in time for the Christmas 1977 pantomime season.



**Fig. 9**  
The original steelwork  
(Photo: Tony Broomhead)

**Fig. 10**  
Existing stage timber with new stage tower steelwork going in  
(Photo: Ted Mann)

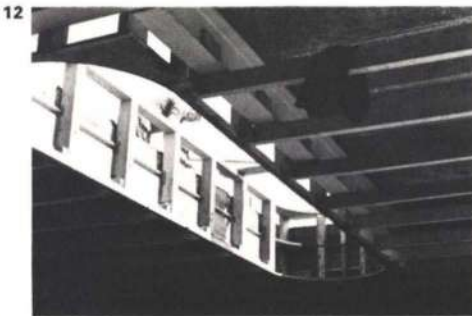
**Fig. 11**  
The old stage basement  
(Photo: Tony Broomhead)

**Fig. 12**  
Roof light over main stair section 3  
(Photo: Tony Broomhead)

**Fig. 13**  
Apse roof with resident engineer  
(Photo Ted Mann)

**Fig. 14**  
First floor section 3: new foyers  
(Photo: David Revell)

**Fig. 15**  
Stage tower blockwork being erected prior to cladding going in  
(Photo: Tony Broomhead)



**Fig. 16**  
Foyer from main staircase  
(Photo: John Donat)

**Fig. 17**  
Main staircase  
(Photo: John Donat)

**Fig. 18**  
Stalls foyer and booking office  
(Photo: John Donat)

**Fig. 19**  
Upper circle foyer  
(Photo: Courtesy of Renton Howard Wood Levin Partnership)

We hoped we had found and solved all the major problems and included them in the overall programme.

On 26 February the last performance of *Cinderella* came to a close and the curtain fell for the last time on Frank Matcham's auditorium. Work started the following morning stripping out the theatre, saving what was required for the new auditorium and selling off surplus equipment.

Our new site engineer, John Morgan, took up residence in Nottingham for the remainder of the contract.

The possible problem areas were within the walls of the existing theatre: in the auditorium where our survey of the existing balconies had been restricted by the need to keep the theatre in operation and the back stage area where, to avoid major temporary strutting, Bovis were required to install the major elements of the new steel stage tower and bolt these to the existing perimeter walls before removing the timber trusses of the old grid.

The slate covered roof to the auditorium was to remain with a new covering and a re-shaped south end where the awkward junction of the pitched roof and curved rear wall of the auditorium when seen behind the classic portico, was unacceptable to the architect.

To form the apse roof entailed removing the last auditorium truss and replacing it with steel rakers which were supported on the

top of a curved wall that was reduced to eaves level and the second timber truss which needed to be suitably strengthened.

The total roof space, over both the auditorium and new stage tower, was lined out with 100 mm thick woodwool slabs to improve the sound insulation. In the auditorium this was placed at bottom chord level immediately above the ceiling which provided a working platform and in the stage tower it was used as the structural roof deck.

Stripping the plaster ceiling from the balconies revealed few surprises but a check on the steel sub-frame showed that, although the Victorian engineers had done a good job on the design, we felt that they had been a little mean with some of the connections. These, plus a few connections which had suffered due to inaccuracies during construction, needed to be strengthened. All works connections had been rivetted and black bolts used for those made on site. Where rivets required replacing, high strength friction grip bolts were used and high yield bolts were generally used where the original black bolts were insufficient.

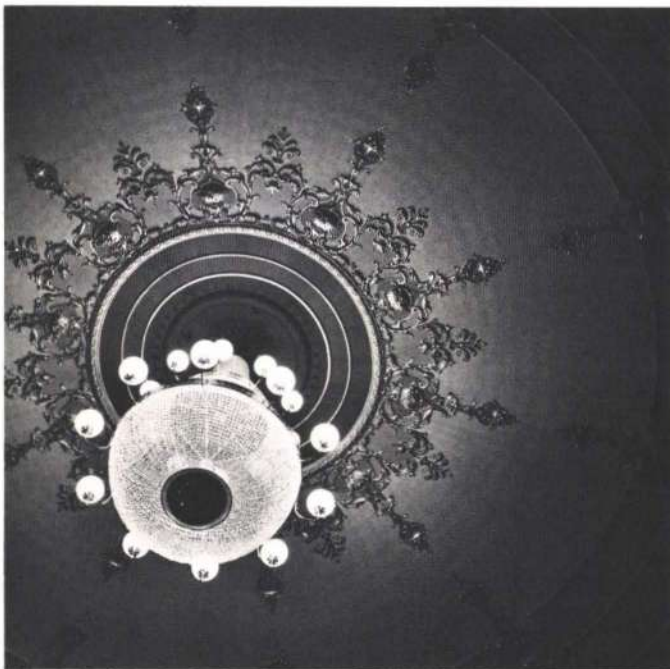
The cantilever rakers were shallower than we would have liked. The stresses were commensurate with the material used but the structure was lively under certain live load conditions. The delicate plaster balcony fronts had survived over 100 years without damage so we assumed that the movement was not excessive.

The timber decking to the balconies was modified and strengthened where necessary, the major changes being in the upper circle where the original seating had been sub-standard. In the Gods you were left with no illusions as to the cost of your seat. The capacity of the balcony was reduced and comfortable seating installed.

The stage and stage basement timbers were removed ready for the installation of the foundations for the new stage tower. The sub-basement, which was going to form the sprinkler tank, had been filled with ash from the coke-fired boiler and the removal of this was a dirty and lengthy business.

No underground voids were found when the stagehouse bases were probed, the concrete was placed and the tower steelwork dropped through the old timber frame. This operation went fairly smoothly and as soon as the main frame was in position a working platform was hung just under grid level. This allowed the construction of the new concrete stage and orchestra pit to proceed in safety whilst the steel erections carried on with the smaller detailed items such as the fly galleries, staircases and lighting platforms.

A second steel erection gang was working on the apse roof which took longer than anticipated due to problems of surveying the existing structure; this led to difficulties with some of the connections which needed to be modified on site. Everybody heaved a sigh of relief when the pre-felted woodwool slabs



**Fig. 20**  
Auditorium ceiling drum and chandelier  
(Photo: John Donat)



**Fig. 22**  
The safety curtain  
(Photo: John Donat)

**Fig. 21**  
The auditorium on opening night  
(Photo: Courtesy of Renton Howard Wood Levin Partnership)

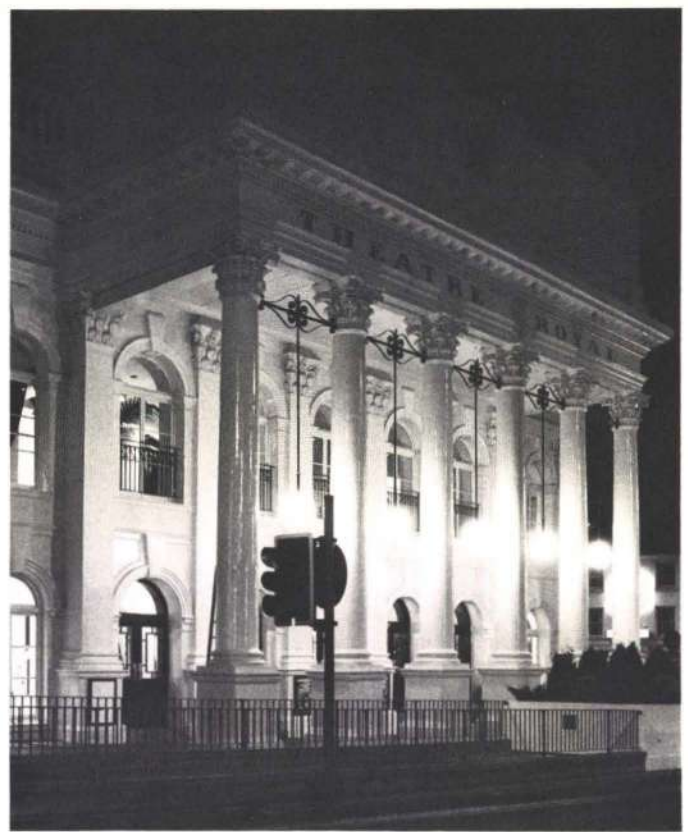


**Fig. 23**  
Exterior view showing new dressing rooms and existing portico  
(Photo: Courtesy of Renton Howard Wood Levin Partnership)





**Fig. 24**  
Detail of box  
(Photo: John Donat)



**Fig. 26**  
Exterior view of theatre  
(Photo: John Donat)



**Fig. 25**  
Exterior view showing new dressing rooms  
(Photo: Courtesy of Renton Howard Wood Levin Partnership)

were fitted to the apse steelwork and the auditorium was once again watertight.

Whilst this frantic activity was going on in the theatre, the old foyer had been demolished leaving a void between the portico and curved back wall of the auditorium. Once more the new bases were probed and fortunately only one old cave was found. It was reputed to have been part of an old brewery that had been on the site; nothing of any interest was found and the void was filled in with weak concrete.

As the architect required large column-free areas, the upper floors of the foyer were 375 mm deep, Omnia Atlas, through slabs which span up to 10 m onto 600 mm deep in situ beams sitting on reinforced concrete walls or columns in the outer wall. Work on these upper floors was pushed ahead, leaving out the ground floor slab so that the drainage could follow on later. As it turned out, this ground slab was one of the last sections to be cast.

No major problems occurred and Section 3

rose rapidly. Once again the roof was of light-weight construction; 75 mm channel reinforced woodwool slabs on Stratford joist purlins and UB main beams, the Stratford joists being chosen to allow services to pass through the ceiling void.

Meanwhile the auditorium was being transformed by the plasterers who were using acres of fibrous plaster to form the complex, curved, false ceiling to the balconies and intricate cast plaster mouldings to form new fronts to the private balconies and a new proscenium arch. The architects had found one of the few firms capable of executing this type of work. The firm still had moulds that dated back before the construction of the theatre to form almost any shape or style of decoration desired by the architect. It was a delight to watch these craftsmen form beautiful shapes without effort and take such pride in the finished work.

The crisp, white auditorium looked so good it seemed a pity to decorate it. So it was with mixed feelings that we saw the once cosy red and gold auditorium turning green before our eyes and it was much later, when the auditorium was complete and furnished, before we could appreciate the overall decor with the many subtle shades of green used on the plasterwork picked out with the restored gilding.

The repair work to, and painting of, the ceiling, balcony fronts and the proscenium arch required a scaffold tower which filled the auditorium with its top deck immediately below the ceiling. As well as being a working platform this tower was used for temporary circulation as the auditorium staircases had disappeared with the demolition of the foyers.

#### Conclusion

The theatre was topped out in November by the Sheriff of Nottingham and a sumptuous buffet lunch was held on the new stage which was structurally complete but in the throes of fitting out by the stage equipment sub-contractors. At this gathering it was officially announced by the client that they had decided

against staging a pantomime for the 1977 season and that the theatre would open in February at the end of the normal contract period, not in mid-December which had been the original completion date on the accelerated programme. This caused the sense of urgency on site to evaporate and the output dropped dramatically.

The fitting out continued at a more leisurely pace with the fore-stage elevator being fitted into the orchestra pit, the rigging of the counterweight fly system and the installation of the 1001 items that make up a theatre.

In the last fortnight before opening there seemed, as usual, 10 weeks work to pack into as many working days. The auditorium looked magnificent, the scafflod was down, the painted facing to the safety curtain fixed and most of the seating fitted. The foyer looked more like a battlefield with all the trades working in a very confined area; however Bovis planners had the situation under control.

A tremendous effort by all concerned enabled the Theatre Royal to reopen on Tuesday 7 February with the Ken Dodd Christmas Show imported for a three week season from Manchester.

The theatre and the show were a resounding success, Ken Dodd playing to a packed house for the three weeks he was in Nottingham.

A varied programme of shows and appearances has been billed for the coming year and there is every indication that the theatre will be a financial success for the Council, which we hope will encourage them to build the next stages of the Festival Hall complex; the concert hall and the multi-purpose hall.

#### Credits:

##### Architects:

Renton Howard Wood Levin Partnership

##### Main contractors:

Bovis Ltd.

##### Quantity surveyors:

Gleeds.

##### Mechanical & electrical engineers:

Edwards & Blackie.

