UNIVERSITY OF NSW

HARRY SEIDLER UNSW TALK 3

CONSEQUENCE OF DESIGN AND DETAIL

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INTRODUCTION

[0.00] **Sydney architect, Harry Seidler, was appointed visiting professor in architecture at the University of New South Wales for the first semester of 1980. He was born in Vienna in 1923. After studies in England he graduated from the University of Manitoba in Canada. Later, he did post graduate work at Harvard University under the founder of the Bauhaus, Walter Gropius, and studied design under the painter, Josef Albers. In 1948 Seidler started to practice in Sydney and the many buildings he has completed since then have earned him an international reputation. Amongst his best known buildings is Sydney's Blues Point Tower, Australia Square and the MLC Centre and Canberra's Trade Group offices. A recent overseas work is the Australian Embassy in Paris. In this lecture Seidler deals with his experience in evolving a technical vocabulary from design concepts. He speaks of the consequence of design and detail.**

Architectural design essentially considers three things which must be brought into unison. The very act of designing a building involves a three way, simultaneous process which brings into a happy marriage considerations of planning, structure, construction and aesthetics. Now, we have dealt with matters of aesthetics by looking at the correlation that is evident between the forces that mould much of twentieth century art and that which has influenced much architecture. Today, I think it may be of importance to deal with the other considerations in this simultaneous design process which is how design results in the tangible, final result and that is the structure and the method of construction of the building. There are two things that must be basically considered and that is how much labour is to be exerted in achieving the task and what kind of and what method of material assembly should be used.

Now, in the past, architecture has been very labour *intensive* and that really is the *difference* between traditional architecture and the aims of the architecture of the twentieth century. Initially, tentative moves have been made to *innovate* and use new materials more efficiently to achieve the results in building and this has been brought to our time in the latter part of the twentieth century to the point where the balance between material and labour has to be a particularly delicate one because of the expense and unavailability of on-site labour and the development of quite sophisticated industrial devices to prefabricate, to premake and then assemble by mechanical means on the site elements of buildings.

Now, the level of appropriateness, of just when it will be reasonable to make something in a factory, bring it to the site, erect it by crane and when it will be more reasonable to simply use essentially traditional labour intensive operations, that balance and that degree of appropriateness is the very consequence that every design brings with it because no shape can be conceived unless it's the consequence of what it means in terms of physical implementation is at the same time and simultaneously considered. That would be a very different thing to build in countries such as India or Mexico, such as I have done in the past, or in places like the United States or Australia. In the first two there is ample labour very cheaply to do and perform almost any task on a site; labour that is not very spoilt, they will be willing to do quite dirty tasks, difficult tasks, whereas in the United States and Australia if one *demands* such tasks to be performed they will be extremely uneconomic, very, very expensive, whereas the techniques and technology that's available in those more developed countries bring into focus the opportunity to *use* industry to do much of the task. Now, whatever the balance one finds will inevitably depend on the *size* of the task because if we build a one-off, small structure or one-off *highly* specialised and *moulded* structure it will be labour intensive but that may *well* be the only way of achieving the result. Those who rather naively suggest we should now build *houses* by entirely industrial methods will find that it's unreasonable because unless you produce a hundred thousand virtually identical elements every year it would be uneconomic to set up mass production lines to produce such a commodity, whereas if there is a huge, repetitive building of substantial proportions needed it may be entirely reasonable to set up production line because of the alternative being economically quite unattractive.

There is one thing clear, I think, that in the twenty first century we will not readily find people who are willing to perform dirty tasks, labour intensive, heavy muscle work on top of scaffolds – in other words, to pour concrete in mid air, wearing gumboots and all the things that go with it – we will simply not have people willing or economically willing to perform such tasks and therefore the tendency is to get away from the handmade product and to bring it more and more within the realm of industry and technology. But whatever the balance we do find and the techniques that are appropriate at this time and in this place are in flux; they will vary, they will change with economic conditions, industrial development and labour relations.

Now, what we'd like to look at now is going through a period of history, say during the last thirty years and just see what kind of balances can be brought about by this interchange between on-site labour in the traditional sense and using the products of technology in a certain varying degree of balance and cooperation in order to achieve very different type of results.

Now, here is a simple structure, depending purely on its support on a skeleton of minimal steel; only four columns support a platform which is relieved from its structural task by means of these hangers that relieve the load of these long, horizontal members. On both sides of a support a cantilever is relieved as well as a mid span is relieved. Now, this is minimising the amount of material but this material is obviously made in the factory, erected on the site and then filled in with a hand wrought, lightweight structure that completes the building. And this was done some thirty years ago. I think this kind of technique in its purest forms such as this is has not had much influence on building as a whole because people tend to dilute the clarity of a concept far too much and simply expediently use whatever comes to hand and it doesn't really depend so much on new materials as much as a frame of mind in how one attacks a problem.

[10.11] The problem in this case was the use of traditional materials, economic because they are lightweight, readily achievable timber frames but timber frames brought to a distant site in the mountains for a ski lodge, erected on the site by minimal technology and then filled in by hand labour to achieve the total result. Now, the frame is the *key* to it because the building got started very quickly by having these five vertical frames which help hold up the structure. Without them, the building would have been entirely hand made whereas by pre assembling, pre-computing the main structural elements and also make them help in the whole organisational pattern of the building because the floor levels are supported at different levels on this frame, so instead of corridors there in fact is only a staircase in the centre of the building, fusing all areas of it to each other and the frame becomes the dominant element of the whole concept, which is to be expressed, to be exposed, to be naturally visible, both on the outside as well as on the varying levels on the inside. So, here some benefit and some balance has been found between those diverse problems of pre-assembly, technologically made elements and hand labour. When the problem is to minimise the task even further, as in this case of a temporary building, it is inappropriate to use technology in the conventional way, to ask of it to create a structure, to assemble a structure that will be quite elaborate, resist bending moments but in favour of that the choice has been made here for a hyperboloid structure, which is a minimal surface, the most torsion resistant surface as being the appropriate one because it *lends* itself to the production by the assembly of straight line skin elements. Now, here is the hyperboloid. We can see the totality of it. Part of it is only used above the ground. The rest, of course, doesn't exist but this being the ground level a exhibition hall has been built which really is a half of a hyperboloid. Now, this hyperboloid will have the advantage of being able to be assembled, as I say, by in this case pipes and by devising a system that will allow us to assemble these pipes readily. We can then erect it in a minimum of time, take it down in as short a time, have the building *reusable* and *cover* it on the outside with a material that performs the task that is required, which is to stay there for a month or so, be waterproof and also allow light to be transmitted to the inside. So, you get a translucent kind of tent structure but what is evident is the form is related to the technique of achieving it and the technique is the use of pipes which are *squashed* at the ends, connected by a special patented element here - which we will see later in a bit more later – and that can be pushed together and brought about very quickly.

In long span buildings where the need is to have no columns inside a vast area covering some acres, this use of pipes in this case made into space frame structures, is an appropriate answer of industrial technology applied to this problem. Now, here we have a warehouse building which consists of the same kind of pipes erected to result in enormous spans and this is the way the pipes actually are produced by industry: the pipes are squashed at the end, they are serrated at their tips and these long surfaces produced by an industrial process, their length are computed automatically by a computer and these are then assembled either on the ground and lifted up or on minimal scaffolding on the ground, these central cylinders form the housing for these pipes to be slid into; a very rigid, a very ingenious method of using standard industrial components of varying thickness, depending on the *load* in each particular member - the thickness and the diameter of these pipes, of course, varies. But here we have technology, the design, directly related to the concept of the building; it's an outcome of it.

Now, when it comes to the one-off, unique, special building it would be inappropriate to use sophisticated industrial techniques but rather the use of modern *structural* technology is of course in order but the aim here is to build a concrete building which would be as least labour intensive as can *possibly* be devised and this is done by having the floor levels flat, no beams under it – this is easy to pour on scaffolding – and to create those elements that carry the weight as upstanding rails or walls to result in a *stiff* channel-like form which can perform the structural task asked of it. And the result of this is then evident in the way concrete is used to be formed and poured into wooden moulds that are easy, straightforward to produce and that is its essential aim.

Even a garage structure such as the one over here, by just using a hundred and fifty millimetre thick concrete walls but the way they are *shaped* into a box-like form gives the whole structure innate stiffness, which enables it to hang out this large distance from its support – great cantilever – which any *one* of these component elements would not be able to do but in unison it *can* perform the task. Now, here's the suspension of this enormous overhang of a garage made possible by the use of a slab, both horizontal and vertical concrete slab, joined together to form rigid boxes. When it comes to the vertical support I think the question is, "Now, is it reasonable to build such vertical supports of concrete also?" and the answer would be no, because if you were to form concrete support of these proportions of some one and a half metres or so, you could carry a twenty storey building with it. It would be inappropriate to use concrete for that purpose but instead something more easily and involving less hand labour was assembled by the combination of steel reinforcing and hollow concrete blocks. Now here are concrete blocks of a conventional variety with holes in them, with steel rods passing through them and more steel rods pass through them at the point where the major supporting task is to be done and in that way we get a vertical element, quite thin, holding up a poured in place concrete floor, which is the more useful material for that particular purpose.

[19.49] A lot of buildings are in the nature of repetitive floors or special floors to serve needs of occupation and the building is not really high enough to warrant building it of a frame – that is to have an internal, rigid skeleton on which the external walls are hung or the floors are supported – and for that reason such buildings are very often simply the layer cake of floors supported by traditionally laid and produced walls. These walls may be a rough, split concrete block in themselves, also produced by technology, or they can be conventional brickwork but the same thing applies, in that the whole supporting surface of the wall carries then layers of the floor which are poured in place concrete clearly visible on the outside.

And the same can also apply to multistorey buildings because even if there is a frame that holds the building there still is the need to clad the building externally and such cladding may be produced entirely by industrial methods, such as hanging panels of concrete on the outside of the building but where they vary too much, you have too many different types and therefore it becomes uneconomic and the conventional material is resorted to such as brick but the brick here again is carried by ledges of the floors brought to the outside, be it the staircase – these are landings of a fire stair repetitively and this behind here are lift shaft, so the code and regulations say every second or third floor has to be tied and brickwork is supported in between. But the *directness* is important, to build a frame and directly give *full* support to the infill material. The repetition of even a poured in place concrete structure is important and will have a *direct* consequence from its design and that design says "There shall be columns to serve the purpose of particular width of units" – these are maybe four metres apart or so – and the formwork that produces the beams, that produces the columns, that produces floor slab edges or beams, as the case may be, are of a unified, repeated use form. So, you make one or you make five, pour concrete into them, disassemble them and reuse them progressively vertically in the building. Often, the task, of course, is to produce the almost impossible in terms of minimal labour application and the right kind of balance being found to use technology to best advantage to produce the absolute minimum cost multistorey structure.

Public housing has often asked these questions: “What can be done to build hundreds of flats needed urgently?” and the answer in this case is by means of partly industrialised, partly on-site devices that builds two parallel buildings. But because we don’t want to interrupt the *system* that is developed for these buildings, the interruptions, the inevitable interruptions such as lift wells and to some extent stairs are placed in between them and not made part of the repetitive, labour saving process that’s developed and the *minimal* size structure that can be conceived, really, in concrete is a single span slab, a slab that has continuous support on two sides and spans a short distance, something like four or five metres across between walls.

Now, how does one produce the walls? And the walls if poured vertically would be very labour intensive to produce, so the device here used is to pour them on the ground and by mechanical jacks to slowly lift them up into a vertical position so that they may act as the continuous support for the absolutely minimal cost horizontal slab between them. And this is the device used on these Housing Commission flats in Roseberry. One can see the vertical walls stood up, the horizontal slabs poured in place and *then* the cladding is provided by industry, flat slabs of concrete bolted to this frame made in the factory and these external galleries, L-shaped units produced by industrial methods also.

Now, the interruption to the system would have been lift shafts and they are, as was pointed out, actually placed outside the buildings. Here, we have the run of the mass produced building as it were, a building produced by some sequence of operation, whereas this structure that provides the support for the elevator and the bridges leading to the building is in fact a hand wrought, conventionally built, poured in place concrete structure. And here the hangers to minimise the specially needed supports of a lift shaft is very rigid in itself, a box vertically, almost like the garage we saw used horizontally and from it it is quite capable of supporting hangers that can emanate from it and give support to these access bridges which would otherwise need special vertical support.

Now, when the scope of the object is much broader – and that is the scope of repetitive, a huge building housing some three and a half thousand office workers in open landscaped offices – the opportunities for production of such a building brings it much *closer* into the sphere of technology because if the task is to build repetitive office space of this nature some sixteen metres across without any columns and a long span between the supports, all the office part can be produced by technology, whereas the specialised access cores, both access for people, lifts, services such as toilets and air conditioning shafts, that is a specialised, ideally then hand made product. So, you get the mix between that which can be readily mass produced in the way of the long span structure, fully repetitive so it is *warranted* to go to *quite* a level of sophistication to produce it, whereas in the cores are then essentially hand made, although clad in this case with external prefabricated panels. Now, the system of construction is such that it brings into unison only three industrially produce components, which is a column, a long span beam and a floor plank and they are connected by prestressing wires to produce the unity. Here is the three elements in a triad situation, a prototype which was tested in an attempt to assess the structural viability of each member; they performed very successfully. So, mass production and sophisticated lifting, hoisting equipment was resorted to which is an outcome, of course, of the choice of such devices to assemble the building in a minimum of time. Once you have a production line going making these three elements you can assemble them fairly quickly but it does, of course, take and it is proven to be economic when the scope is large enough to even go to the expense of such moving gantries as these are in the erection of the units. Now, the units themselves are *attuned* to the structural task asked of them. Here, the sixteen metre long floor planks are shaped to reflect what is the structural need, which is to have a T-configuration in the centre of the span and for that T to merge into a rectangle more and more toward the support to resist sheer. This would be a very difficult thing to produce by conventional means. And here it is actually exposed in the building; on the undercroft of the structure you can actually see these elements freely and the upswept shape of them - which is a structural logically arrived at thing – allows services to run longitudinally in the gap that is left at their upswept ends, which is most useful for integration of mechanical services.

[29.53] Now, how does one produce such elements? Obviously in premade moulds. In this case there are four moulds in order to keep up with the need of the rate at which these elements are needed. A steel mould here is empty, ready to receive the steel harness, the reinforcing, which is then put in, concrete poured, and here you see an element finished after steam curing overnight being lifted out. And by having several of these moulds, once can make a specialised production procedure which produces these elements which as they are completed are stockpiled and then the crane comes, picks them up, and puts the whole thing together almost like a meccano set. But each individual unit is really not *enough*. What makes the structure viable is the way in which these units are connected and they are connected by means of prestressing wires, both vertically and horizontally. The side elements are tied into the floor elements and one can see the actual stressing points on the exterior of these long span beams. Here is a detail showing that each floor plank is prestressed and has its anchorage at the end – there is a floor plank – and where it is joined into the main façade beam its stressing is continued through the web of the façade beam and anchored on the exterior and made fireproof with a steel cap over it.

Now, this thinking of combining or developing *components* that can do structurally remarkable tasks given a large volume of production leads one to the investigation of just how appropriate the shape can be to serve a particular task and here there is really no limit within economic viability, no limit to the *span* that one can produce almost with such elements. And here is one, even if the last one spanned something like twenty four metres, this one spans something like thirty five metres, an enormous length, conventionally quite unachievable but with prestressed concrete quite possible as long as the form of the element is attuned to its task and the task is to resist bending as a simple beam, which means a maximum of concrete at the top in the middle for compressive resistance and in other words the *flange* of this beam widens at the top where as conversely the bottom of the beam isn't needed at all from a compressive point of view; all the tension takes place there, the prestressing cables go past there so it is thin, it is narrowed from the support and at the support the element is solid to resist sheer and form the anchorage points for the prestressing tendons. And such elements would normally be considered unachievable if one had to build conventional formwork but when you repeat it as in a multistorey building such as this plan for Hong Kong it is possible to make one mould, plan the production far enough ahead to result in a very beautifully shaped element, almost baroque in form but achievable only by quite sophisticated, one mould only, but once that mould exists I think there is no limit to how many one can go ahead and in fact make.

In the case of a long span beam being of advantage to a design, the consequence is to come to the realisation it would be unfeasible to make a mould of the sophisticated type just seen. So, when you only want one or two of such things but they are still demanded or ideal for a design, then their shape has to be devised so as to be achievable by more handicraft *methods* of making the formwork. As in this case it's a single, not a multiple curve, not a compound curve but a single moulded shape that changes this element from an I section in the middle to a solid one over the support, it being a pin joined structure resisting substantial spans and moments. So, the form is a direct *consequence* of the means of production that are considered economic in any particular instance. The integration of such structures with the mechanical installations are in their *infancy*, I think, in architectural thinking. Very often or too often we find it that however sophisticated the structure, however economically it is produced, the remainder of the services that are needed in the building, such as air conditioning ducts, are simply considered an afterthought and done as it were almost any old how, fitted in by highly labouring intensive means. Here is an example of a building that attempts to systematise and bring into the industrial processes the means of mechanical services and they happen in between the strength of these prestressed units in the centre between units, this being the core of the structurally carrying concrete elements, such as we have seen in between them, run the mechanical services, taking advantage of the fact that longitudinal supply ducts can run under their upswept ends. The prerequisite for this is for a building to be fully sun protected and that makes mechanical sense, so as not to attract substantial heat loads as are so usual in so many recent buildings that are all covered with glass but here the lighting, the air conditioning run in between the webs of the structure and the structure itself is in fact moulded into a light fitting, using the structure to reflect the light that is thrown up onto it to give diffused daylight, artificial light throughout the interior and it then, the mechanical services are as industrially produced as the structural components. It doesn't mean, of course, that once one accepts the viability of such industrially produced components that special things, a stair, a bridge, are then also in need of being made in a factory, they would be inappropriate; there's only one of those, so they are simply produced by poured in place, conventional techniques. But here we have the intertwining of a supply duct and cross ducts with the lighting fitted above them in, for instance, a library, where this is very appropriate, clear open space to arrange book stacks and whatever the interior demands are and the hand in glove relationship between structure and mechanical services.

A very different consideration applies when we build high rise buildings as against any lower structure, because the great demand in a high rise building such as this circular tower at Australia Square is for it to be produced quickly and its very concept of design is that of repetitious elements that can be made not so much entirely industrialised but by techniques that involve a *serial* production, even if performed on the site. And this building has two floors particularly of which the demand is to carry heavy loads, these first two; the others are repetitive floors and have *radial* beams. All the columns are the same but the technique of building the building itself brings the industry to it by making the exterior forms of the columns in the factory, filling the columns with concrete on the site, and in that way getting a structure that is not in need of any scaffolding. You can see the hollow forms made in the factory here filled with concrete but just to show how these interlocking ribs which are derived at by the development of isostatic structural forced lines – just how does one achieve such a thing in reality? - and here a simple method of production was used to achieve the tangible result.

[40.03] First you make a mould, a mould out of bricks, then you plaster that mould, then you make a master mould in it, you turn the master mould upside down and then you mass produce the pans that are finally used as permanent formwork on that floor. So, the steps then in physical terms are the production of a mould made initially out of rough brick, then it is plastered on the outside. It is then used as the base of a master mould, that master mould is turned upside down and on it is placed steel reinforcing which in turn forms the basis of producing every one of these types which are reused *all* the way around the circle of the building and then placed on minimal formwork, concrete poured on the top of them so as to result in this *visible* form on the ceiling, on the soffit of the lower floor.

When the task is to build a really exceptionally high building with as least time lag between the production of one floor and another – in other words, the greatest rapidity which in commercial building or in almost any building, really, means economics that are quite substantial – in other words, how long does it take to build a floor? Here a cycle of four days per completed floor was achieved in such a multistory building, sixty eight floors of it, supported by eight very substantial columns which attract a lot of the load for greater *lateral* stability and these columns change from bottom to top of the building. One is wider at the base, the column's wider at the base and gets narrower at the top and here are these industrially produced components being lifted by crane and assembled to result in these heavy supports for the structure. The long spanned beams similarly, the external mould of them – not the whole beam but only the external form of it made by industrial techniques embedded on the outside with the appropriate finishing material – in this case white quartz – and these are then assembled by this technique of spreading the workforce vertically, by having only the reinforcing of each major beam act as the support for subsidiary beams and the space between these little subsidiary beams, really the reinforcing for ribs, is then spanned by small plastic pans which can be removed and thereby the production changes rapidly from bottom to top and the workforce is spread over something like four or five floors and that *speeds* the whole method of production which is unique to the problem of building high rise buildings. Here the assembly of the column components and the end result, of course, shows the components quite freely; the joints are simply allowed to be visible.

The theatre which is attached to this large tower in a circular configuration was produced by similar means to the heavily loaded floors at Australia Square with this intertwining ribs far more critically dimensioned in order to resist the bending, which requires great depth of a section as against the wider but shallower width of these same ribs at the support, so the structure actually bends downward as well as consisting of these interlocking ribs. Again, the pans were mass produced, placed on formwork, concrete poured above them once steel is placed into these interlocking ribs and the totality then takes on this form, rather beautifully reflecting the structural demands of a circular form heavily loaded above and deriving *continuous* support from a drum-shaped wall and reflecting the needs of maximum bending, deep and narrow, as against sheer, wide and shallow in terms of the cross-section and these considerations, one a direction outcome of the other being the design as against the consequence, what it means to implement this in a construction in economic terms.

Rather unique systems were devised by French contractors with us for the construction of the Australian Embassy in Paris. The complex consists of two buildings: an office structure using long span beams, which we have seen before, and an apartment building. They're both curved for good reasons, in order to achieve good outward views in one particular direction, but let us just dwell on the means which were employed to implement and support this building. There are two such structures orientated and curved, one convex, the other concave, in order to see the Eiffel Tower and beautiful views held from the building. Now, the office structure consists of fully viable structural façade units; that is these boxes on the outside in fact carry all the weight of the exterior of the building. There are no columns as such but the precast elements carry the whole load. Where it is considered appropriate and desirable from the internal design of a building to *interrupt* the regularity of these supports, because the supports were undesirable for instance where is the need for an ambassador's balcony - he is to be given somewhat more consideration than all the others in the building and at the top of the building – hand wrought, special poured in place reinforced concrete is substituted for the mass produced industrial component that forms the rest; there's a clear differentiation in colour and texture. And here these structurally produced components are seen being lifted up – you can see one standing there – and the floor elements from it are deriving their support on its inner edge. Here the façade element's propped up temporarily on the façade and waiting to receive another layer of the floor structure. Now, the floor structure is systematised. It's designed as a curved building and one would think very difficult to mass produce but not so because each component when made wedge-shaped, narrower here, wider there, you put them all together and you get a curved building. So, no penalty paid for having a curved building and the façade elements are so small that they are all straight anyway. So, here's a way in which these were assembled. Here we have the structural façade and these units that span across, configurated the same way as we have seen used before, and lifted up by very sophisticated cranes that are available in France. Unfortunately, in our country, in Australia, it is very often a matter of being *afraid* to use such devices. We could use cranes of this nature but our industrial relations as such that is a hazardous procedure to bank on. In other words, the minute all the crane drivers go on strike, everything stops and that is something that makes the use of these elements less frequent here than it is in other parts of the world. The advantage, of course, of these long span units is a complete *freedom* for internal subdivision, this being a typical floor in the embassy which is then used for various office purposes.

[49.59] The façade is interrupted - we cannot see this terribly well in this picture but there is a large, *special* support placed under the building. This is the height of the building and there is a specialised support produced to create the main entrance of the building. Here we can see it better. It is a support that will *pick* up the building above and all the floors that rest on it and take the load and bring it inward into a small point of support in the centre so as to allow cars to drive in and drive out again, forming a covered entrance. Now, how does one *shape* such an element, obviously it is not something to be produced by industrial means but the demands of structural design are paramount in the forming of such an element and the most rigid transitional forms and structures are inevitably hyperboloid or surfaces that join and produce quite diverse areas such as a curve from above with a rectangle down below by means of straight lines. And the straight line formwork is something that is quite visible on the outside of the end result: that is straight timber forms tapered to produce rather beautifully twisted surfaces into which concrete is poured.

The techniques of making such elements requires, obviously, a substantial amount of hand work but this hand work is minimised again if there is a little bit of repetition, as in the case of this apartment building which has its own structural exterior above, carrying floors, but here at least there are six elements used to pick up this entire building because it was desirable for it to be more open at ground level to give access than would have been the case had this structural façade been brought right down to the ground. So, the formwork was produced to pour into it six of such elements straight, balancing the curved load that comes into it from above and ending up in a circular caisson support against the ground. And giving expression to laws of statics produces some quite beautiful forms but the form is only as viable as the method that can be devised to achieve it, which is straight timber boards. And here is the mould that was actually used and used repeatedly to form these supports; not unreasonable in economic terms to make one such thing out of straight boards that are tapered each in order to achieve that result. Here it is when seen from the side how the quite sinuous curve of these elements reflect the structural task that they have to perform.

But finally, the most ingenious technique used on that building by the French is an invention that is entirely French and it's called predale. Normally, for a curved building of this kind which would involve quite labour intensive operations to produce formwork on every floor which would vary, be wedge-shaped elements and so on, to produce a curved building. But the French went about it by separating the flat slab floors into two layers: one that is precast on the ground and the remainder that is poured up in the building. On a steel platform on the ground, the shape required is made by simply having edge moulds going around the piece that is needed. It is only about seven centimetres thick – that is very, very thin – and one would think in large panels of this nature impossible to lift up but by this ingenious device that uses pipes and pulley carried cradle, such a very thin slab – this one is fifty square metres, a whole apartment – is picked up with cables and pulleys. Now, the effect of the pulleys is to equalise the load in each one of these points that it is picked up all over its surface, which means that one can pick up very thin slab without breaking it, able to lift it up and deposit it on minimal scaffold on the building and lower it down and, of course, do away with entirely all conventional labour intensive formwork. And the top surface of this slab is left rough so that steel is placed on it when in position, the rest of the slab is poured and the building proceeds at quite an exceptionally fast rate. The underside of these slabs, of course, can simply be painted and are complete.

Now, to sum up, I think what should be clear is that architectural design, any concept is only as viable as the techniques that are envisaged and proven to be economically possible for its implementation. Without it, I think we only plan castles in the air.