Summary

The Change of the Rules
Mike Davies
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4000 years ago the Egyptians looked at the sky and wondered how it worked. And they developed a cosmology, they developed an understanding of the universe in which they suggested that the goddess Nut swallowed the sun in the evenings and gave birth to the sun in the mornings and that she had her body covered with diamonds. That system explained the universe - the day and night cycle and the stars. For thousands of years that concept had its way. It was gradually replaced by more scientific thought through the Greek eras and through the Middle Ages, and the universe began to be more precisely understood with the invention of precision scientific instruments. Some of the first of those instruments had the purpose to measure fairly accurately the positions of the stars in the sky and the movement of the planets. In doing so, those machines revealed that the simple ideas and the previous cosmologies were false, and so the comfortable concepts of earlier days were threatened.

Galileo Galilei invented the telescope. It was a change in the rules, it was a huge conceptual shift - a technological conceptual shift. It completely changed the nature and the way we understood the universe. It was a little telescope which had 4 cm aperture, and with it he saw the satellites of Jupiter. After doing so he realized that the Earth moved and he therefore produced a new cosmology- a cosmology where the sun was the center of our solar system and all the planets rotated around it. He was of course arrested, he was of course put in prison, as all people who have radical ideas are generally suppressed by the authorities of the day, because it is uncomfortable for the authorities and it changes the political power structure. Nevertheless that sun-centered cosmology become the new cosmology. There was a huge conceptual shift from one system to another.

In music, for hundreds of years we have been playing traditional instruments. In the Institute for Research and Coordination in Acoustics and Music in Paris, researchers began to study in the seventies what was popularly known at the time as computer music. And one of the things they did with computer music was to try and describe the nature of the sound of the instrument: Why does a violin sound like a violin and a trombone sound like a trombone? Researchers programmed the sounds into the machine, they tried to write programs which would then reproduce these sounds, and they got to the point where the computers could reproduce sounds which were pretty convincingly like an oboe, a violin or a drum. So the computers began to be able to produce the traditional noises. They also wrote programs comparing the violin and the trumpet and they wrote programs which would translate the sound from one into the sound of the other. So if the computer started by playing the sound of a trumpet and the computer would then transform the sound over time until the sound became the sound of a trombone. Researchers then realized that if you stopped that computer program halfway through, you heard sounds which had never ever been heard before. That was a huge conceptual jump. So commencing with instruments which we know - and we have three or four hundred instruments with very specific sorts of sounds - we are now in a situation where the computer has been able to fill in this enormous timbral spectrum which was previously largely blank, and it is able to produce the sound of instruments which do not exist. So by changing technology we have been able to move into a new realm.

Another example of a technological conceptual jump is the development of the sonic tape. The days of the tape measure are now over. We are now able to measure distance by ultra-sound. One can stand in a large space and measure its height, its width and its depth by sonic means without physically walking through the space. A completely different concept, a completely different technology doing a job that was previously done by more traditional means. It entailed a conceptual jump from one technology to another. Technology incorporated in such devices is changing our everyday life, changing our work methods, and of course, inevitably, such things will have an impact on building fabric in the future.(...)

So what has been happening in the building industry? Let us hop back in history and take a look at the window. For thousands of years we have been building traditional masonry constructions, from cliff dwellings of several thousands of years ago to the large medieval megabuildings. The great medieval fortresses are virtually without windows, and the windows there are, are very tiny openings in an otherwise immensely solid, thermally inert building. Basically the building was a cave, it was a protection device.

In the Gothic era the technology of building advanced very substantially structurally and in terms of glazing. We discovered glass and created great windows and great structures. Basically we built larger and larger structures, but they were not very high performance apart from their structural capability. The great cathedrals were built for the glory of God, not for the comforts of man.

Gradually technology moved on. By 1675 Europe was absolutely enflamed by the idea of navigation. We were discovering the world. People from all over the world were sailing all over the world. Europe had great fleets of ships which began to trade and began to discover. One of the problems of trading was, you had to know where you were, and you had to know the time. And you had to understand the shape of the world, otherwise you would drop off the edge of it, or arrive in the wrong place. In 1675 the observatory was built at Greenwich in London by Christopher Wren, and this is on the world's prime meridian - the zero zero meridian of the world runs through these buildings. And the reason for building it, was time and navigation - to understand where you were and to understand location. And in doing so navigators had to look at the stars, because the stars were what gave you time and location. This wonderful building is the only building I know where the top of the pediment comes off, it is chopped in half. It is a technological building built for technological reasons, it allowed trade around the world to begin to have some form of reference of time and place.

By 1780 the industrial revolution started. The greatest structure of the early industrial revolution was the iron bridge built at Coalbrookdale by Abraham Darby in 1779. It was the first great cast-iron structure in the world. It had a 30 meter span. It was a bridge which was based upon a new understanding of structure, tension and pressure, a conceptual shift were the discovery of cast iron began to open new ground and offer new potentials entirely different from masonry construction. (...)

By 1928 one had new explorations which combined a sophisticated understanding of the new materials, of steel, glass, and concrete. By the time Le Corbusier was operational, there was a very sophisticated use of concrete and the integration of steel, glass and concrete which is wonderfully displayed in his Villa Savoie in Poissy in France. One of the things that is interesting about the house is the incredible use of glass. The whole ground floor is really a great tale of glass, of light flooding through from outside to inside, and of transparency and of feeling of space. Here, instead of just modern spans over railway stations and windows in the edge of buildings, we begin to see the interplay of three materials as a true architectural symphony, where space and form and light were really quite spectacularly used. The window onto the terrace of the Villa Savoie was the largest piece of glass in domestic use in Europe at the time - 1929. Le Corbusier had a small frame at the edge to protect the corner of the glass, but it was the glass that took the load and it was a mobile piece of glass. He was trying to use a piece of glass as a non-wall, something which is an absence of wall. That piece of glass winds aside, so that it leaves the space flowing through. Whether it is there or not, the architectural intention is always the same - the space does flow through. (...) So we begin to play with glass in very active and conscious architectural ways. A wonderful building, but phenomenally cold in the winter, bloody hot in the summer. (...)

In the 30s, Mies came up with his absolutely extreme image of the modern skyscraper. The complete reversal of the mediaeval fortress, we have now moved from a solid masonry building with small windows to a skeletal frame entirely clothed in glass. The thesis was: all we have is a wonderfully expressed frame and to that frame we wrap this amazing transparent 'stone' that will last 500 years. And the expression of the architecture is as pure as it can be. It was a wonderfully clear idea and of course nobody ever built it, because you would have been able to fry an egg on the floor of the offices. There is an enormous problem of thermal loss and thermal gain and the enormous impact of the external environment on the interior and the huge thermal loss from the internal environment to the exterior.

An attempt to solve the problem of solar-gain has been the reflective glasses, glasses which actively reflect the solar gain. The Hyatt Hotel in Dallas, built in the early 80s, is a fine example of reflective glass technology in a warm climate. It is a very good example of what has happened to the American wrapper building. Here one is really putting mirrors all over the building. The building's transparency and the building's structural qualities have been totally lost in the attempt to deal with the solar problem. There is a quite interesting building structurally behind the façade, but it is gone. It is just a wrapper, it is just like a piece of Christo - brown paper all over the building. So you are paying penalties for defence against the sun, in terms of the other opportunities within the architecture of the building.

We - Richard Rogers Partnership - were trying to do other things at the same point in time. We wanted to keep the transparency, and we have always tried to avoid this problem of the great reflective package, where you cannot read the elements of the building. So at the Centre Pompidou we conciously avoided using reflective glass, and we tried to deal with the problem of solar gain by layering. There are seven layers of material between the glass and the outside of the building. There are pieces of circulation fabric, there are staircases, there is structure, there are walkways, their are lifts. In some ways it is a sort of brise-soleil building. And it has that great property of being able to reverse itself. So the building in daytime is totally different than the building at night. In the day, one reads the form and the structure and the people flowing through the circulation tubes from the piazza. And at night the building changes completely and you read the guts, you read the interior, you read transparency, you see people movement rather than building, and you see the great vertical piazza with light streaming out of it.

The Lloyd's Building incorporates a deliberate attempt to create some secondary interest in the glass itself. (...) We designed a particular pattern into the glass of the Lloyd's Building which made the glass alive, which made the glass more interesting visually than purely as a flat sheet. The wall glows in sunlight. Unlike a clear glass wall, it takes on luminous properties similar to those of the great Japanese screens of the past, but it also performs a technologically demanding job in the late 80s. It is a conscious attempt to add a new dimension to the glazing.

Another building which pushes the glass into slightly greater performance is the Billingsgate Market in London, which is used as a trading market for financial securities. The market is characterized by visual display units, television screens with their inevitable problems of reflection and glare, and so we were obliged to develop a glazing system which prevents the sun falling directly onto those screens, and also which keeps the luminosity down sufficiently that the glare in the room is not unbearable. We utilized a sophisticated triple layer glass system with particular properties to solve that particular problem. So we are making layers of glass and we are beginning to specify different properties in each layer to do a specific sort of job. We customed-designed a mix of layers here to try and achieve a particular task. In that idea there is a hint of things to come.

Another problem which affects the façade of a building is the client and his use of the building. The clients will come along to the building that you've designed and say, 'Thank you very much. A very beautiful building.' And then, when you next come back, he has put a new window in. And you go back to your office and you think: 'What a dreadful client.' But he's right! The client is right. It's us architects that are wrong. We call this in the office the "Reliance Control window syndrome". This building, called Reliance Control, was done in 1965, before I was involved in the practice, by Richard Rogers and Norman Foster who were then partners. It has been modified by the client. The client said 'I want some more offices, so - bang! - I'll get a saw and I'll cut along the façade and I will just put a window in.' Of course, he destroyed the visual balance of the building. But why shouldn't he be able to do that? Buildings change their uses over time. So our practice has been developing buildings which are less precious. We have been deliberately designing things which are more robust, buildings which have got a strong enough façade to survive an attack from the client. So when the client comes up with his commandos and he screws on the air conditioning unit and the fire escape, the building does not completely become an aesthetic wreck. The PA Technology building in Cambridge is a building (...), which gives great flexibility in terms of use. The façade of the building is really just a patchy set of panels. It is designed as a zipper façade so you can take the panels out and move them around. And they have moved the panels around the building to suit different uses. Aesthetically it is a little bit difficult to handle, but the client is quite happy because he tinkers with it and the architect doesn't come rushing up saying, hey, you can't do that. (...)

The Lloyd's Building, although essentially built from basic construction materials, attempts to become a dynamically modifyable building in that its skin, which is the triple-layer laminate which I referred to earlier, in fact incorporates the air conditioning of the building. Air is drawn from the interior space through the light fittings, where it picks up excess energy that we do not want to be introduced into the interior space, and this air is then drawn down through the façade itself, between the layers of the glass. The energy, the heat from the room is then rejected to the exterior -if you require- or taken away into the heart of the building, processed, and recycled. If it is hot, you can reject energy through the façade. If the building is cool, or a particular piece of the building is cool, you can absorb energy through that façade. In the south façade at Lloyd's you can collect energy in the air circulating in the façade and bring it back and put it somewhere else in the building. The skin is therefore a crude example of a dynamic control mechanism. One of the interesting aspects of the Lloyd's Building is that it incoporates an energy-management system which begins to build a network of awareness of the physical fabric of the building. A building energy-management system is essentially a central processing computer which is monitoring the condition of various parts of the building and its plant. The average airplane knows how much fuel there is in the tanks, what the pressure is at the ends of the wings, what the ailerons are doing, what the flaps are doing, what the various parts of the aircraft are doing. It is monitoring itself continuously thirty or forty times a second. So that aeroplane knows how it is feeling. I propose that the average building should know how it feels. Such an intelligent building basically is a building which is aware of itself, it is aware of the energy falling on its façade, it is aware of the energy coming through the façade, it is aware of the people inside the building and what their needs are. It is a building which is capable of responding to local energy control and transfer, local glare control and local user tuning in any particular piece of its overall environment. (...) And why shouldn't buildings in the future know if the next morning will be cold or warm and therefore prepare themselves and heat up or cool down? The necessary information is already there and needs only to be made available to the building. And if it is a brilliantly hot sunny day, the south façade of the building darkens down sufficiently to make it comfortable to live in. The concept of the intelligent building, of the intelligent environment, requires a reasonably sophisticated, adaptive, dynamically changeable building skin. We have attempted to integrate in Lloyd's the building skin as part of that system. So we are now beginning to talk about the concept of the skin of a building as part of its plant and servicing system.

For the first time, you have got a switchable façade. In our office in Tokyo we have a conference room which is enclosed in clear glass. You go into the conference room, and if you want to have privacy, you touch the button and the glass goes white. So you don't pull any blinds, you just press the button and it changes. It is powered by 7 volts electric current, using very, very little electricity. It is using solid state electrochromic materials. The switchable conference room could change the way we think about buildings. With the introduction of an electrochromic panel, you can obtain a true intelligent façade. For the first time, you have a variable control skin for a building. Here is a device which allow you to adapt the four surfaces of your buildings - the north, south, east and west - differently. You would expect to find the east façade looking different than the south façade and the west façade. And you would expect it to be continuously changing. So you have a clear to black building façade. We begin to have our blinds or shutters integrated into the skin of the building.

Another thing that is happening which is fascinating is holography. We are involved at the present moment in a program of holographic research to deal with the notion of what we can do with holography in the skin of buildings. Can you use the glass façade in combination with holographic information in the façade? There are many interesting uses which are only just emerging. It is interesting that everybody who sees a holographic glass sees something different because they are not all in the same position. So as you move, you see a different image, and information can be transmitted to people, technical readouts may happen. The building may change continously as you move past it. The building skin is an adaptive 3-dimensional information screen.

The solar collector of the sixties used to cost £ 15,000 a square inch. It was build into satellites and used to fly around the world and power Gemini spacecraft. Technology began to explore ways of bringing down that cost. We now have solar panels which cost virtually nothing. So we can get energy off the façade. We have an energy source here which might be used in cladding the building.

We can now engineer our future. For the first time, you can specify the sort of façade you want. You can actually choose the building skin. You can custom design it's properties. You can choose the colour, you can let certain frequencies pass through and reflect other frequencies. You can begin to engineer your piece of glass in a much more sophisticated way than before. For the first time you can actually now design the skin of the building like you design everything else. You can specify the properties you want in it, and science is actually capable of developing it. The switchable glass, the electrochromic glass and holographic materials all exist today, and the cost of all those is dropping towards levels which the building industry can use.

And so I see the façade of the future building as this: All wiring and all cabling and all your plumbing and mechanical engineering is in the façade. And the façade of the building also has in it all the logic - it has the monitoring logic, it has the information transfer, it has the decision making capacity. The amount of logic required in the average building is incredibly little, amazingly little. So there is no reason why we cannot build the logic, the monitoring devices, the awareness and maybe the response directly into the skin of the building. I want a building skin that I can change the transparency of, where I can dial the insulative properties, where I can change the thermal mass - the technologies are around to do it. A building which has a façade which is programmable, adaptive. It can be multicoloured, it can transmit you information, it can process solar energy in, it can process solar energy out, it can play tunes for the occupants.

I have talked about the first industrial revolution - that which made Europe what it is today, which has put people on the moon, which is saving lives in far-off places with very straightforward and simple medical technology. What has happened in the last ten years is at least as significant as the revolution of a hundred years ago. We are in the middle of a second industrial revolution at this moment. We have moved from the valve to the computer. We have moved from the mechanical age to that of the solid state. The world of the 21st century is the solid state world. An enormous revolution has happened which has changed the world and its potential. Our built environment will be affected by this revolution and we must be prepared to take positive advantage of the new technologies for the improvements of our buildings, our environment and our lifestyle.

More with Less
Norman Foster and David Nelson
in conversation with Nikolaus Kuhnert
and Philipp Oswalt
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You have often said that a building is like a tool and that you try to achieve 'more with less,' as Buckminster Fuller put it. Is it fair to say then that your approach to architecture is dominated by the idea of performance rather than aesthetics?

Norman Foster: I think there is quite a lot of misunderstanding in all this. The driving force for any project in this office is very much about people and the idea that the building should be a good experience. For example, I could describe Stansted Airport in terms of energy efficiency, and I am very excited about the idea that the building doesn't need any electricity to light it, and therefore the cooling loads are less. You could demonstrate that that building would be very comfortable without the air conditioning working. In that sense, there is a tendency, a direction in our work towards buildings which are ecologically more self-sufficient. But having said that, the real motivation here was the idea of creating a space which is about the drama of travel, a place that would have a more poetic dimension by virtue of that natural light. Actually, the passion which drove all the explorations concerning the lighting, deflecting the light up on the ceiling, letting a shaft of sunlight in and so forth, was totally about a romance with the nature of that space, how it would feel, the experience of it. It is more about the quality, or it's as much about the quality, as the quantity. You can measure light, and any engineer can quantify and produce enough light with which to brighten a passage or by which to read a book. But in the end, lighting and the quality of light is something far more subjective. Natural light has a poetic dimension, for example the changing nature of an overcast sky, the discovery of shade, the brightness of a patch of sunlight.

Has this idea of modelling a space with natural light been there from the beginning of your work?

Norman Foster: It's a long-standing tradition. In the best historical buildings, the best buildings from the past that one admires, as well as the more recent architects that one admires, in the end it's the ability to create spaces, the relationship between those spaces and the feel of those spaces, the way that views are exposed or suppressed, the way that light is used, whether that is natural light or artificial light. As one grows older, one becomes even more interested in traditional architecture and in the work of more recent architects like, say, Kahn and Aalto, because they're closer to that mainstream tradition.

When did you first develop a concern for the theme of energy and the integration of services?

Norman Foster: This theme of energy has always been there, in all the projects. Reliance Control was important because it pioneered the integration of structure, fabric and service. Whenever possible, elements would be doing double or even triple duty - for example the metal roof profile was also acting as a lighting reflector for recessed fluorescent tubes as well as acting structurally as a stiff diaphragm.

The integration of services, structure and flexibility of use was further developed in the concept of sandwich space for the Newport scheme.

Norman Foster: What was fascinating and really interesting about Newport was that it was very much about natural lighting. The daylight was actually coming in because the whole of the ceiling was a glass ceiling. So you had this sandwich with all the ducts and wires and so on. But this was rough-cast glass. It was a total glass ceiling which would also work acoustically. In addition, there was the idea that all the surfaces - the walls and the ceiling - were flush. So the structure was inside. That meant that you could put a wall anywhere, even on the diagonal. But it was totally about natural light.

A further step in environmental control was the Sainsbury Centre. The double-skin of that building can change its properties and modulate the natural and artifical light.

Norman Foster: The Sainsbury Centre was a building which used the natural elements, whether that's light or the movement of air. The concept of a double-layered wall and roof is achieved through a total integration of structure, skin, lighting and engineering services - each element is interdependent. There are three types of exterior panels for roof and walls - glass, solid and grilled - which are interchangeable by merely undoing six bolts, so that for the first time in a building any part of the roof or walls can be easily changed in about five minutes from solid to glass or vice versa. In addition, the foamfilled sandwich panel has an exceptionally high insulation value which is an important part of the scheme's low energy concept, as is the highly reflective exterior finish which reflects heat and helps to keep the interior cool. The inner skin consists of adjustable louvres. These, combined with the interchangeable external panels and a highly flexible system of electrical display lighting, produces an infinitely tuneable light control. The search for low energy solutions coupled with higher performance led to the lateral transfer of materials and techniques from the aerospace to the building industry. The concept that high technology can equate with low energy was particularly relevant at that point in time.

The theme of the service skin was then developed further in the design for the Indoor Athletic Stadium at Frankfurt.

Norman Foster: Yes. there is a progression from the Sainsbury Centre to the Frankfurt Stadium. The roof is spanning much further; it is a very skinny curved membrane which again integrates structure, services and natural and artifical lighting.

In Stansted, finally, the roof is released from any service. It is just a light roof membrane, an umbrella, which enables natural lighting and ventilation. The interesting thing with the lighting is that the roof is in fact a huge light fitting. So you integrated several performances and utilized the available resources of the building and of nature.

Norman Foster: That's an interesting point. I've never thought of it that way before. It is indeed like designing an artificial light fitting. At night, when the individual dome which has the rooflight on the top is lit from below, it becomes a big reflector. But it is also designed as a daylight fitting, so that during the day, when the sunlight comes in, you are reflecting light onto the ceiling and you get the daylight in a diffused way. But at the same time - and this was very very carefully modelled with endless calculations - a shaft of sunlight can penetrate to produce a highlight on the floor. To get this fitted was truly a battle. We made painstaking lighting studies and large-scale models. It was quite heroic, to achieve that. The other thing is that at night, when you look up, it also is bright, because the daylight reflectors below the rooflights would avoid the experience of a black hole. And also it is only letting some of the heat through. But the other thing is that it's a piece of sculpture. It is doing all these jobs of work, and they're about things that you can quantify, but they're also about things that are totally of the mind. It's a matter of visual judgment, and so you're modelling it - it's like making a piece of sculpture.

We have only discussed flat single-storey buildings so far. But how do you deal with these kind of problems in a skyscraper like the Hong Kong Bank?

Norman Foster: The usual anonymous mediocre office tower seems to be totally unaffected by the context of climate and site. For the Hong Kong Bank we developed external sunshades which reduce the energy load, provide maintenance access and are an integral part of the wind engineering concept. More interesting still from the energy point of view is the the heating and cooling supply. The Bank uses Kowloon Bay with the seawater tunnel, so that the bay is part of the ecology system for the building. And it curiously uses the ferry itself. The seawater tunnel of the Hong Kong Bank comes out at the Star Ferry Terminal. And the Star Ferry, the boat itself, churns and mixes the water, so that in summer it dumps heat, and in winter it becomes a thermal source. That in turn is quite interesting, because what it does is that it liberates the top of the building for people rather than for heavy cooling towers.

In the project for the Commerzbank in Frankfurt you have developed a skin which can change its properties very easily so you can control the heat transmission, the light transmission, and the air flow without any complicated technology. You are actually reducing the services, instead using more passive elements.

Norman Foster: Yes, we're using the fabric of the building much more actively. We're using the ability of a cold ceiling or a warm ceiling. And you can open the window and have natural ventilation. We just had the most remarkable windtunnel tests. What is interesting is that because those gardens go around, you are always able to catch a wind, so as the direction of the wind moves, even if it is not a prevailing wind, it's working particularly well in terms of wind studies, for natural ventilation.

The interesting about Frankfurt is that it is a kind of new building concept for a skyscraper which is only possible with new planning tools because you are now able to predict the behavior of the building - to simulate it - and without that you wouldn't be able to design it.

Norman Foster: Yes, we also did some extraordinarily sophisticated windtunnel testing around the 800 meter high Millennium Tower to test the structure. The Frankfurt building has a form which is incredibly effective in the way it reduces the load and enables you to open up parts of the building, for gardens and so on.

But such tests are not only about things that you can quantify - we are also talking qualitative issues. In other words, does the end product look right? Does it feel good? Does it give some joy? Does it achieve those architectural aims of breaking down the scale? Providing a filigree of detail? Creating a building which is more human and enjoyable both inside and out? If the answer to these questions is no, then those other so-called scientific tests are almost of academic importance.

You now have new planning tools which give you the freedom to develop new building concepts. I think the Hammersmith project marked the first time in the work of your office that you made an advance calculation of the temperature inside the building, to see how it works, because you developed a new building concept and there was no similar building where you could see if that would work. So you had to find another way to prove it.

David Nelson: Yes, that's right. The Hammersmith project for us was one of the first very large projects that we had to look at. The question was: If we cover the huge inner court, would there be any advantage? And when we studied these things, we found that there seemed to be an advantage in covering. For example the air-conditioning loads of the offices are reduced because the sun doesn't shine directly onto the glass. The fabric roof reduces solar gain and at the same time allows the heat to escape at night.

In order to develop such a concept you have to work closely together with all the engineers involved - structural, services and even industrial engineers. This kind of design approach is rarely found in Germany. It seems to be a more pragmatic English design philosophy to bring all these people together at one table and discuss with them what the brief is and what needs to be done.

Norman Foster: I think that this office is quite unusual in the way that it harnesses and derives the energies, the inspiration, the cross-fertilization between very diverse skills. And that is very very different from design by committee. It is in a way trying to search for a deeper basis for design decisions. I may describe a building like Stansted primarily in terms of the spirit, but I can demonstrate that it is rooted in a whole series of interactive decisions.

David Nelson: The basic principle is that we start at the beginning with architect, structural engineer, mechanical engineer and cost person. Ideally right at the beginning. And we listen, we get client input, site input, general background input from the office here, and we start to put all those together and the beginnings of an idea start to come. Ideas bounce around, and things start to emerge. Then, if you have to prove something, you have to try and seek the best advice, you have to look for the best person to consult about this. Quite often it might be a consultant in America, it might be in Japan, it might be in Germany. Quite often in Germany, curiously. A lot more skills to do with environmental design, the techniques of it, lie in Germany than anywhere else. So you find that and get that piece of information slightly more firmed up. But it's always a balance. In the end, you're trying to achieve a building that actually makes sense as a complete entity. So it's a balance between the various factors.

Norman Foster: I cannot separate how a building works from how it looks or how it is made. All these things interact and inform each other. All the variables - for example massing, materials, inside, outside, structure, heating, cooling, lighting, cost, time - are entirely interactive. You cannot change one without affecting some or all of the others. To be able to pose the vital questions and assess the consequences requires a team of specialists who can come together and who are, each in their own way, able to share a vision. Anyone has to be able to challenge anything and everything - nothing is too sacred. It is the opposite of much that has been academically taught. The architect is not handing down from above, passing the parcel to the specialists who wait in line to be told what to do. Each individual has the potential for creative input. In this way, paradoxically, the architect comes much closer to the heart of the project because he is integrated into the 'how and why' of the making of the building.

Your design approach seems to involve a new understanding of the architectural profession. You seem to be destroying the barriers which architects usually have and to question everything that affects the process of building.

Norman Foster: No, I don't agree. I think it has brought it right back to its roots. The real break in the tradition is the division between people who design and people who make - and that is relatively recent.

It dates back to comes the nineteenth century.

Norman Foster: What we're talking about here is something very traditional: it's about function in a global sense - function being as much about the ability of a building to move the heart, to move the spirit, as well as keeping the water out. The real problem is that both of these aspects of function have been thrown out. So breaking this divorce between designing and making is really very much about rediscovering those roots, those traditions.

But the problem is how to introduce new technologies into this tradition.
The architect has to ask for the new technologies and to develop new technologies. That seems to be what you do here in the office - to try and get more advanced technology and to lead, as an architect, in the development of new building elements.

David Nelson: But where development comes, you have to first of all explore all of the technologies that do exist. And quite a lot of the things that are around now exist, but in different places. There is an idea here that works, there is an idea there that works. And it is a very - curiously an English thing to try and find a way of bringing those together and making sense. Quite often you don't have to invent; quite often it's a question of finding. It may exist in another industry, it may exist somewhere else (...).