Reinventing the Airport

Two global urban scenarios are rapidly unfolding. The first of these is the explosive growth of cities: by 2030 more than five billion of the planet's predicted eight billion inhabitants are expected to be living in cities. The second is the shift of balance of growth from the so-called 'developed' to 'developing' countries.

As an example of what this global shift means in comparative terms, in 1939 London was the highest populated city in the world. Ten years later it still shared the big-league with cities such as Paris, Milan and Moscow. However, at the turn of the new century a demographic map of the world reveals how the European cities have receded into a mini-league, while the concentrations of population elsewhere have enlarged and proliferated. This is particularly true on the Asian Pacific Rim.

One of the implications of this shift is migration around the globe on a very large scale. Airbus, for example, anticipates that by 2010 only twenty per cent of air travellers will be business passengers. A key indicator in this respect is the accelerated rate of investment in infrastructure in the Pacific Rim, particularly in airports, which are being built on a hitherto unparalleled scale.

A further shift can be discerned in the nature of such infrastructure projects. The edges between infrastructure and architecture are becoming more blurred. We can see this in structures concerned with information transmission — communication towers and platforms, for example. But we can also see it in structures for physical communication, such as the airport. Is the airport infrastructure or is it architecture? Or is it perhaps inhabited infrastructure? As these edges become less finite, the distinctions between the role of the architect, the engineer, and the other professions become similarly blurred. New infrastructure projects are typically becoming more publicly accessible, more multifunctional, less unidirectional. Together these trends have the potential to create a new kind of airport building.

The first generation of airports — such as Hong Kong's Kai Tak, Berlin's Tempelhof, or Le Bourget in Paris — were located close to the city centre. The combination of an earlier age of smaller aircraft and a predominantly low-rise building infrastructure was compatible with an embedded urban airport. However, the pattern with these and similar early developments is that the city, as it expanded, finally engulfed them. Kai Tak probably stretched this model to its logistical and technical limit. The dramatic approach path into the airport memorably wove in between the tower blocks that had grown up around it, giving rise to an 'urban myth' about Jumbo Jets landing with washing hanging from their wings, plucked from the balconies of nearby flats.

In London, the entrepreneurial vision that generated Heathrow's original Terminal One in the mid-1950s, and set the pattern for the first generation of large airports around the world, echoed the pioneering spirit of the London Underground in the 1930s. However, that impetus has been lost in the capital, and transportation projects habitually founder in the wake of an overdeveloped and stultifying bureaucracy.

London Heathrow, in terms of international passenger movements, is currently the world's largest airport, with some 40 million visitors per annum. It has evolved over the last 50 years from a military airfield and a cluster of canvas tents nestling amongst market gardens, into four major terminals on a site covering 1100 hectares. In European terms this rate of growth might be considered rapid, but in terms of contemporary Asia it is closer to a snail's pace.

Compare Heathrow with the pattern of Hong Kong's Chek Lap Kok, or Shanghai's Pudong. In one tenth of the time that it has taken London's airport to grow, Hong Kong has overtaken it by realising even more capacity in a single massive building. By 2040, the airport's planned passenger capacity, at 87 million passengers and 375,000 aircraft movements per annum, will be the equivalent of Heathrow and New York's JFK airports combined.

In 1972 the British Airport Authority had the opportunity to anticipate the huge demands that would eventually be placed on Heathrow, and the transport infrastructure that serves it, and make a bold leap into the future. They almost did it. They identified a site at Foulness, in the Thames Estuary, to the east of London. Foulness, a former army artillery range, offered almost unlimited space - 50 square miles - on which to build a brand new airport, far from the restrictions of the city.

It was the opportunity to scoop up all of the facilities then existing at Heathrow, together with those that would eventually be provided by the 'second' London airport at Gatwick and what was to become - after 40 years of negotiation and public inquiries - the 'third' London airport at Stansted. Foulness would have been to London as Chek Lap Kok is to Hong Kong, and involved similar travel distances. But the opportunity was lost. Construction began in 1973 and was abandoned in the face of entrenched opposition in 1974.

The Asian experience is very different. In Hong Kong, when the time came to select the site for a new airport there was no available land. The site itself had to be created. But far from being an obstacle to development, it became instead the catalyst for the largest construction project of modern times.

In 1992, Chek Lap Kok was a compact mountain island rising out of the sea off the South China coast. In an ambitious reclamation programme that involved moving 200 million cubic metres of rock, mud and sand, the island's 100-metre-high peak was reduced to a flat seven metres above sea level and expanded to four times its original size. At 6 kilometres long and 3.5 kilometres wide, it is as large as the Kowloon peninsula.

From Chek Lap Kok, new road and rail links cross a causeway to Lantau to the south, and continue across two new bridges, including the typhoon-resistant Tsing Ma Bridge - the longest combined road and railway suspension bridge in the world - to reach Hong Kong itself. Thanks to the new railway line, three-lane highway, and Western Tunnel to Hong Kong Island, the entire journey between city and airport can be completed in approximately twenty minutes.

In Hong Kong brand new physical infrastructure is already in place to support the airport's expansion over the next 50 years. Central London, meanwhile, has only belatedly begun to enjoy dedicated transport links to Heathrow. But even the Heathrow Express has to share ageing Intercity and suburban rail track, and the airport's planned expansion, in the form of Terminal Five, is mired (perhaps indefinitely) in an official inquiry.

As London contemplates the nostalgia of its past and trades on a physical infrastructure largely inherited from the age of the horse and cart - long before the onslaught of the car - Hong Kong, which is already less than four hours' flying time from half of the world's population, plans strategically for the reality of global expansion and major shifts of population.

In this new world view, airports are the symbolic gateways to a city. In the past these might have been the portals in the castle walls, the harbour quayside or the train terminus. The need to create imposing and symbolically important structures to celebrate these points of arrival and departure would seem to be a constant over time, from antiquity to the present.

In the newest generation of airports the gateway has to be pushed well beyond the city limits and linked with an umbilical cord of rapid transit. The more remote location not only protects the environment of the core of higher density cities, but creates the opportunity for the airport to expand as a destination in its own right. The rapid transit system can be suppressed below ground and emerge into the heart of a city. Our expansion of the Kowloon Station to accommodate some 80 million passenger movements a year to and from China is also a gateway to Hong Kong and part of the wider network of ground transportation supporting the airport.

During this shift from centralisation to decentralisation in airport design we have witnessed a passing phase in which individual airlines have commanded their own customised terminals. But the almost universal model of an airport in the Western world is one of incremental, ad-hoc growth. Heathrow remains London's principal airport. And although facilities at Gatwick and Stansted are growing, Heathrow is still expected to expand on its original site by adding yet more terminal buildings.

I can recall the previous head of the British Airport Authority, Sir Norman Payne, reflecting on nearly twenty years experience of London's airports by saying that not once had any of the terminal buildings expanded in the way that their designers had planned. All their predictions had proved to be obsolete, rapidly overtaken by events. At Heathrow the end result is a non-finite architecture of individual structures, each in a state of continuous change and growth, with new ones being squeezed in wherever possible; the only limiting factors in this cycle being land and runway capacity. As a result, Heathrow is closer to the 'concrete jungle' of a 1960s' new town than to the planned development of Chek Lap Kok or Osaka's Kansai.
Perhaps the same tendencies will eventually overtake the thrusting Asian economies. Meanwhile the architectural rules are being rewritten by the sheer scale of these single-large-volume buildings, which have evolved from a combination of political will and the appetite to invest in a fresh start. At this size they pose unprecedented challenges and opportunities.

I can trace the lineage of our projects for the airports of Hong Kong, Shanghai and Bangkok back to our design for Stansted, which we began in 1981. But they are not simply bigger versions of the same concept: they are transformed by their mega-scale.

They are also rooted in the thirteen-year collaboration we enjoyed with Buckminster Fuller before his death, in 1983, which influenced our projects during that time and beyond. This is true not only of those projects that were recognisably geodesic in form, such as the Knoxville Energy Expo and the Climatroffice, but also of the deep-plan office projects, such as the Willis Faber & Dumas Headquarters in Ipswich. Aside from an intrinsic concern for the relationship of mass and volume to the building's energy equation, Bucky's influence liberated our attitudes to scale, size and repetition.

The Climatroffice project, dating from 1971, points to a direction where the architecture is determined by a world of 'interiorised' buildings, which live within an envelope so diaphanous that its presence is perceived as being closer to the sky or clouds than to any conventional structure. The form of this minimal envelope is a manipulation of Bucky's optimum sphere, which can envelop the maximum volume within the minimum surface area. It is the sheer scale of the single volume membrane that reverses the traditional hierarchies. The mechanisms for creating order, orientation and routes through the interior space are independent of the enclosure, which from inside and out is anonymous and without scale, except for that of its surroundings which are reflected on its skin.

The vast new airport terminals have some characteristics in common with these Fuller-influenced visions. The form of an airport terminal is of necessity extruded to provide linear frontage and although the exteriors are closer to a traditional building, the interior is increasingly determined by an architecture of individual buildings housed beneath the protective umbrella of a vast lightweight roof. This is an approach that we pioneered with the design of Stansted, which has subsequently become a model for airport terminals worldwide.

When we planned Stansted, we questioned, at the most fundamental level, the nature of a terminal building. Before Stansted, every large terminal essentially followed the same model: the structure would carry huge amounts of ductwork at roof and ceiling level to move large volumes of conditioned air; and there would be a reliance on artificial lighting, which generated a great deal of heat, and in turn required more cooling, with increasingly large ducts and more and more refrigeration plant. Furthermore, all that equipment had to be supported at roof level, and so the structure had to be enormous. The whole arrangement was incredibly wasteful of energy and other resources.

Stansted represents a departure point, one that was achieved by demonstrating that the old order of the 'serviced shed' could literally be turned on its head. At Stansted, the heavy engineering of mechanical plant rooms, metal ducts and supporting structure that made up the traditional roof are all relocated in an undercroft below the concourse level.

The undercroft is really the engine room of the building. It contains all the baggage-handling and environmental engineering plant and runs beneath the entire floor of the concourse, where it can easily be accessed via a service road. The heating, ventilating, air-conditioning and artificial lighting distribution systems that would in the old days have run through the roof space are all contained within the 'trunks' of the buildings tree-like structural columns as they rise up through the floor. The result is a lightweight membrane roof, which is freed simply to let in natural light and keep out the weather.

Flexibility for change is a vital consideration in such a volatile and expanding industry. This is another reason for the services undercroft. It is analogous to the void beneath a highly serviced office floor, which enables you to reconfigure the cabling to suit different layouts and changing technology. The headquarters building we designed for Willis Faber & Dumas, in Ipswich, in the early 1970s, was the first in Britain to be equipped with a raised 'aircraft floor'. Before Willis Faber it was only computer rooms that had a void below the floor for cabling; and Willis Faber is the only British insurance company not to have been forced to move into a new building in the 1980s in order to accommodate new communications technology.

The difference between these two examples is simply one of scale. Instead of cables, in the services undercroft one is presented with the possibility of moving or replacing the hardware of baggage handling systems, electrical generators and heating and ventilating plant. As an example of how far this principle can be stretched, at Stansted it was possible to insert a mainline railway station in the undercroft (for a direct link to the city) without disruption, even after the building had started on site.

A terminal building is in some ways also analogous to the aircraft it serves. The investment in a modern aircraft is so great that prolonged downtime for maintenance or upgrading is simply unaffordable. This has design implications. The engines, for example, have a relatively short design life when compared with the airframe, and will be replaced many times in the lifetime of an airliner. So in a modern aircraft, such as a Boeing 747, they are located in separate pods under the wing for ease of access and maintenance. This is in contrast to an earlier generation of aircraft, such as the Comet, where the engines were embedded into the airframe itself making them very difficult to access.

The modern terminal is locked into a complex international network of flights and connections and is even more sensitive to downtime. It is a 365-days-a-year, 24-hours-a-day operation. The roof of the old style terminal with its short-life elements such as mechanical equipment and light tubes sandwiched between structure and suspended ceiling was a maintenance nightmare. It was also a serious safety hazard, as the tragic fire at Dusseldorf airport, in April 1996, demonstrated. In that instance, a fire began in a flower kiosk and spread rapidly through the ceiling void of the arrivals hall, quickly engulfing the terminal. The advent of the undercroft solves all these problems.

There is no doubt that the quality of light and views in a terminal building contribute towards making it more friendly and spiritually uplifting. Added to that, this arrangement also uses much less energy, which is good news both for the environmentalists and the accountants.

At Stansted's natural light floods into the concourse through the glazed perimeter and apertures in the roof vaults. Suspended beneath the vaults are daylight reflectors, which shield the apertures and bounce light upwards onto the ceiling so that it is reflected indirectly at floor level. There is no 'black hole' effect at night. At dusk, as outside lighting levels diminish, artificial lighting hidden at the base of the 'trees' is projected onto the underside of the reflector so that the whole surface glows.

The principle of a single lightweight roof flowing freely over a multitude of different activities makes a quantum leap in the new generation of airports that we have designed for Hong Kong, Shanghai and Bangkok.

The essence of these new large terminals, following the Stansted pattern, is a single roof, flowing freely over a fertile ground plane, on which fully-serviced instant buildings can grow within a tempered climate of unbroken space. The possibilities opened up by this evolutionary response to the realities of mass air travel can be grasped as a civic opportunity, or merely exploited for their commercial potential. In the tradition of the great nineteenth-century railway stations these new terminals are the noble halls of our age, evoking a sense of occasion and bringing a new thrill to air travel.

For many people, however, air travel has become a stressful and confusing experience. In recognition of that fact, the terminal buildings at Stansted and Chek Lap Kok, are designed to make the traveller's experience as calm and pleasant as possible. Knowing that one can find one's way contributes greatly to this sense of wellbeing. The guiding principle was to ensure that the concourse would be a clear logical zone, and that movement through the building, from landside to airside, or vice-versa, would be as far as possible in a straight line, and at a constant level.

At Stansted, for example, you proceed in one fluid movement from the set-down point, to the check-in area, security and immigration controls to the departure lounges, from where you can see the planes standing on the tarmac. From there you are taken via an automatic tracked transit system to the pavilion-like satellite buildings from where you board your aircraft.

In the process you experience two architectural orders. The primary order is the lattice-shelled roof, which is supported on the outstretched branches of the 'trees'. The smaller, secondary, order is the flexible system of free-standing enclosures such as shops, banks, and bars which inhabit the space. There are none of the infuriating changes of direction and level that disfigure most major airports.

In Hong Kong, the airport's natural setting is spectacular. To the south is the backdrop of the Landau mountains, while to the north, across the water, are the New Territories, also with mountains in the distance. Wherever passengers are within the building, they can enjoy unimpeded views out. The glass sides of the terminal are purposely left clear up to a minimum height of four metres, and clutter throughout is eliminated so that sight-lines are never blocked. The design accentuates natural orientation far beyond the airport itself: you can see the land, the water, and glimpses of the road and rail bridges in the distance, from the terminal; and you can see the aircraft. You know whether your plane is waiting on the 'land side' or the 'water side' and can orient yourself accordingly. This elemental approach, quite different from the claustrophobic boxes and tunnels that characterise so many airports, brings a sense of pleasure and drama back to flying.

The lessons of Stansted and Chek Lap Kok are that unimpeded views of the airside and landside, together with the natural order provided by a clear structure, can dramatically reduce the need for complicated signage systems or colour codes. In that sense they are 'analog' rather than 'digital' buildings, in so far as, like a traditional watch-face one can read them instinctively at a glance: there is no awkward conversion process from sign to route. Instead of a seemingly life-threatening maze the experience can be friendly, direct and reassuring. Of course, the ultimate clarity of direct movement will always be modified by the inevitable barriers of customs, immigration, security and a degree of retailing. But these buildings are still very much open in spirit.

It is difficult to comprehend the scale of these buildings. Hong Kong's new terminal is so large that - like the Great Wall of China - its distinctive Y-shaped plan-form is clearly visible on satellite photographs. At 1.27 km long, and with an area of 516,000 square metres, the terminal building is the largest enclosed public space ever made. Its roof covers 18-hectares - approximately the same area as London's Soho district. Within that, the baggage hall is large enough to contain five Boeing 747s wing tip to wing tip; you could drop Wembley or Yankee stadiums into it and still have room to spare. And the terminal's plant room alone, at 62,000 square metres, is large enough to contain Stansted's concourse twice over.

But although Chek Lap Kok is a huge building, in reality it can be thought of as quite compact, because it covers a very small footprint compared with the equivalent four terminals at Heathrow, while providing about 48 per cent extra space.

Nonetheless, the logistics behind the management of design and construction at this scale are awesome. To give just a few examples: the detailed design of the superstructure, including the roof, generated a print run of 125,000 drawings — in excess of 100,000 square metres of paper; at the peak of construction, there was a workforce of 21,000 on site; and the sheer size of this temporary community, and its isolation from the mainland, led to the creation of a 'smart card' cash-less society, based in a sizeable settlement of instant short-life hotels, offices and restaurants which sprang up on the island.

It is rare to encompass such extremes of scale and diversity in a single project. Moreover, all this was achieved at staggering speed. A total design that coordinated all the details of the airport's functioning, from aircraft parking to air conditioning, from security to shopping, was completed in just 21 months. Then, despite its heroic scale, and the fact that all building supplies had to be ferried to the island by boat, the building's superstructure took only 36 months to complete.

But perhaps the ultimate example of thinking big in Asian terms is the move from the old airport to the new. For a time they ran the two in parallel, while they tested the new airport's technical systems. Once they were satisfied, they changed from one to the other overnight. The whole operation was achieved within six hours. The logistics of that, in terms of moving people and equipment, are truly staggering.

The airport on this new scale assumes many of the properties of an urban settlement, which raises further questions of social responsibilities. Are the prime public spaces the equivalent of a city's main square? Are they to be protected, or squandered like so many places that become saturated with billboards and retailing? Should this inside world be subject to controls and restrictions similar to those that have evolved to cope with urbanisation in the world outside? Or is the terminal to be regarded as a cross between a department store and a theme park? Will the fake, half-timbered 'ye olde pub' that unfortunately graces one London airport ultimately find its equivalent inside an Asian terminal: perhaps a Chinese restaurant in the guise of a plastic junk afloat in space?

Significantly, the British Airports Authority presently makes as much money from retailing as it does from its airport business. Gatwick, for example, attracts half a million visitors a year: many more than go there to take a plane. These are not people going to meet somebody, or to say goodbye – they are just going to the airport to shop. Together, the BAA terminals contain more than 60, 000 square metres of retail space. Equally significantly, Chek Lap Kok's shopping centre — which covers an area the size of the original airport at Kai Tak — is the only one in Hong Kong with one hundred per cent occupancy.

Does the terminal in this scenario finally become a market with airline travel as a by-product: a shopping mall which feeds off the captive audiences that follow the new trade routes of industry and leisure? Is it an incentive to proliferate the retail maze to bolster the airport's profits? And, as hotels and the leisure industry investigate the potential of these new catchment areas, does the airport evolve into a settlement in its own right to attract people who are not even thinking about flying somewhere?

As cities grow and airports respond to the new centres of population it is worth sounding a cautionary note by recalling how one writer commented on the occasion of the fiftieth anniversary of London's Heathrow: 'Every human settlement is an organism. But this one, fuelled by the virtually unconstrained power of the market, is a monster out of science fiction, swallowing land and hamlets, continuously recreating itself, permanently ravenous. It can never get enough: enough land, money, noise, dirt, adrenaline, electricity, organisations, car parks, retail outlets, hotels, people. In this respect it is the image of us, and of our civilisation.'[1]

Norman Foster

1996