The Third Industrial Revolution

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Sustainability is a word that has gained great currency over the last decade. However, in my experience, few people are aware of what it really means, or understand the challenges that we face. In the industrialised world, buildings and the activities within them consume almost half the energy we generate and are responsible for half the carbon dioxide emissions – the remainder being divided almost equally between transport and industry. Sustainability requires us to challenge this equation and to think holistically. The location and function of a building; its flexibility and life span; its orientation, form and structure; its heating and ventilation systems and the materials used; together impact upon the amount of energy required to build, maintain and use it, and travel to and from it.

These are issues that have concerned my practice from its earliest days. Thirty years ago we considered individual components which would contribute to energy savings. This soon progressed to entire systems at the scale of buildings. As we became more aware of the interconnectivity and unifying qualities of energy systems and the environment, so we began to tackle the issue at the scale of the community – looking at entire urban quarters. Finally, and most recently, we are now applying this thinking at a regional scale. I would like briefly to chart this development, citing a number of projects which have given us the opportunity to develop a sustainable methodology and to consider some of the present and future challenges we face as the world's urban populations proliferate and our cities are transformed.

While we were designing the Willis Faber & Dumas building (1971-1975), a conversation with the late Buckminster Fuller prompted the idea of wrapping the site in a free-form triangulated glass skin. The 'Climatroffice', as the project was known, suggested a new rapport between nature and the office, its garden setting creating a microclimate within an energy-conscious enclosure. In the 1970s we lacked the technological tools to realise it in the time available. But today we have sophisticated computer-modelling software that allows us to design and build complex structures in a fraction of the time it would have taken

then.

Moving forward in time, a number of projects in Germany have provided us with opportunities to push the boundaries of environmental design in many different contexts. With our transformation of the Reichstag in Berlin (1992-1999) as the new home of the German Parliament, we showed how sustainable strategies could work in the context of an old building – once a huge consumer of energy and a major source of pollution. Before the installation of new services, the building consumed enough energy annually to heat 5,000 homes. Raising the internal temperature by just one degree on a mid-winter's day required a burst of energy sufficient to heat ten houses for a year.

Today, the building burns clean, renewable bio-fuel – refined vegetable oil – in a cogenerator to produce electricity, a system that is far cleaner than burning fossil fuels. The result is a 94 per cent reduction in carbon dioxide emissions. Surplus heat is stored as hot water in an aquifer deep below ground and can be pumped up to heat the building or to drive an absorption cooling plant to produce chilled water. Significantly, the building's energy requirements are so modest that it produces more energy than it uses, allowing it to perform as a mini power station in the new government quarter. If a nineteenth-century building can be transformed from an energy-guzzler into a building so efficient that it is now a net energy provider, how much easier is it to design new buildings that make responsible use of precious resources?

A new Berlin building, the library for the Faculty of Philology at the Free University (1997-2005), realises many of the ideas latent in the Climatroffice. Its four floors are contained within a naturally ventilated, bubble-like enclosure, which is clad in aluminium and glazed panels and supported on steel frames with a radial geometry. The building's double skin acts both as air duct and thermal buffer, while the mass of the building is used for either heating or cooling via concrete tempering. Flaps on the outer skin can either be opened or closed depending on the temperature. The concrete tempering can also be controlled to provide heating or cooling depending on requirements. These and other temperature control systems are co-ordinated by an electronic building management system. As a result of such measures natural ventilation is used for 60 per cent of the year, and there is no requirement for full air-conditioning or humidity control. All of these elements combine to provide energy savings of 35 per cent compared to a modern conventionally constructed library.

The Commerzbank in Frankfurt (1991-1997), is a building that is symbolically and functionally 'green'. Although the climate is controlled, it uses natural ventilation for energy reduction, making it the world's first

ecological high-rise building. The tower has a distinctive presence on the Frankfurt skyline but is also anchored into the lower-scale urban fabric, through the restoration and sensitive rebuilding of the perimeter structures to reinforce the original scale of the city block. These buildings provide shops, apartments and a banking hall, and help to forge links between the Commerzbank and the broader community. At the heart of the scheme is a public galleria with restaurants, cafés and spaces for social and cultural events, which has become a popular pedestrian thoroughfare. The project is rooted in an understanding that sustainability requires us to think about more that just reducing a building's energy consumption: if we are to reverse the wasteful pattern of people commuting from the suburbs, we also have to create urban communities that are attractive places in which to live and work.

It is significant that Germany's progressive environmental building regulations have provided us with our opportunities to range wider still and to explore sustainability at the scale of the city. We undertook a study for a 'Solar Quarter' on an extensive city site in Regensburg (1995), which grew out of a desire by the Renewable Energies in Architecture and Design Group (READ), chaired by myself and the European Commission, to address the potential of renewable energies, particularly solar technology, and their application in an urban context. Still ongoing, our work in the 'rust-belt' city of Duisburg has also become a paradigm for the practice, embodying a number of themes and concerns that are central to our search for sustainable solutions to life in the twenty-first-century city.

Our work there began twenty years ago with the Microelectronic Park. There we integrated buildings for new-technology companies within a dense residential district and in the process created a new linear park. Given the trend towards clean, quiet industries, it demonstrated the potential to create attractive, mixed-use neighbourhoods that combine places to live and work. The underlying themes of that project were reinforced by our masterplan for the physical and economic regeneration of Duisburg's Inner Harbour, where we combined new construction with selective refurbishment to forge connections between the waterfront and the city centre and to establish a new urban quarter with all the amenities of a modern city.

On a global scale, today two urban scenarios are unfolding; and together they have the potential to create a new kind of architecture. The first scenario is the explosive growth of cities: the future of the city is the future of society. 2008 is a landmark year, when for the first time, more people now live in cities than in the entire history of human civilization. By 2050, it is predicted that 70 per cent of the world's population will be urban. In many countries the pace of change is extraordinary. What took Europe 200 years is now taking twenty years in China and India. Urbanisation has accelerated by a factor of ten.

The second scenario is the shift of balance from the so-called 'developed' to 'developing' countries. London in 1939 was the world's most populous city with a population of 8.6 million. Ten years later it still stood in the big-league with cities such as Paris, Milan and Moscow. Today, the European cities have receded into a mini-league, overtaken by a number of mega-cities around the world, with populations in excess of 15 million. That raises several questions: what are the models for these new cities; and how do we adapt existing communities to accommodate rising populations?

The Masdar Initiative in Abu Dhabi has provided us with an extraordinary opportunity to create a new community and a model for future energy security within a wholly sustainable framework. Masdar has far reaching significance in global terms, in that it tackles the issue holistically. It is not specific in terms of individual buildings, important though they may be. Instead it looks at the bigger picture – it is rooted in the recognition that one cannot divorce the issue of energy consumption and carbon emissions from architecture and infrastructure.

If we look at what urbanisation really means, in an industrialised society, and look at energy consumption, you find that transport represents some 35 per cent of the total and buildings (construction and use) 44 per cent – the combination is therefore critical. If architecture addresses buildings, and infrastructure addresses urban planning, Masdar brings them together as its central thesis – and you can only do that at the level of community planning. That is what makes Masdar so critically important and progressive in a global context.

There is a crucial relationship in urban terms between energy consumption, carbon emissions and density. The lowest density cities, those that sprawl, are huge per-capita energy consumers. At the other end of the scale, very high-density cities have low levels of energy consumption. Somewhere in the middle there is an interesting balance – a city that is high density and economical. That city has a mixture of uses; it is socially diverse; people live and work in the same locality; it is well served by public transport and the pedestrian experience is enjoyable.

Traditionally, such cities – Zurich, Geneva, Copenhagen – have become destinations or tourist attractions. In any quality-of-life survey they still come out on top. What can we learn from these models? If you take a new-world city like Detroit and compare it with an old one like Copenhagen, you find that the old is twice the density of the new, and the difference in fuel consumption is a factor of ten. You also have to consider

the quality of life in terms of downtown Detroit and downtown Copenhagen. It is critical to learn lessons from the past while planning for the future.

To be sustainable, we must build for the long term. Flexibility is a key consideration. Masdar is being planned in 2008 and will be finished in 2018, so it will have the ability to respond to new technologies – products of the third industrial revolution, which we can only dream about now – that will have an impact on the way we live in the next ten years and beyond.

Crucially, in order to harness the creative energy needed to envision the 'Third Industrial Revolution' – and to establish a sustainable future – we have to believe that it will result in a better world. If Masdar – or any sustainable initiative – does not result in a great place to be, a more attractive place in which to live and work, if it isn't a city that you really want to visit, if it does not lift the spirits, if it not globally viable as well as locally compelling, then it is not fulfilling a central part of its function.

I recognise, however, that as architects, we are only as powerful as our advocacy. We rely on governments, policy-makers, clients, market forces, investment incentives and emerging technologies to enable us to plan and design the cities of the future. Global climate change is a concern that unifies the world and impacts upon the way we envision new, and adapt existing communities to become more sustainable. That is a goal that we can and must achieve, not just at the scale of individual buildings, but beyond that at the scale of communities and regions. It is a matter of survival.