

An artist's impression of Dongtan marina © Arup



CREATING AN ECO-CITY

Dongtan, the world's first sustainable eco-city, illustrates how sustainability can be a cornerstone of future cities and the business opportunities they represent. It is a city where the goal of cutting carbon emissions has shaped nearly every element of design. This visionary project, which is awaiting final planning permission, could be a major milestone in the evolution of urban living. Peter Head OBE FREng, leader of the project for Arup, outlines the principles, goals and objectives of the Dongtan engineering initiative.

The creation of Dongtan as a blueprint for urban developments is extremely important because it will not only point the way for future projects, but it will also provide knowledge about the potential for sustainable business opportunities. Sustainability is increasingly becoming an essential component of global economic activity and Dongtan will reveal where concern about sustainability represents

other latent business markets. In nature all waste generates new growth – this is the mantra by which the Dongtan project has been developed.

The site for the Dongtan development is currently a swathe of cultivated and flood-controlled agricultural land in the middle of the Yangtze Delta, called Chongming. Chongming is China's third largest island and the world's largest alluvial island, gradually

formed from silt which drifts down the great waterway. At 100km long, it is getting bigger every year as more mud washes up on its banks. Soil washed from areas thousands of miles upstream means the island has doubled in size since 1950.

SATELLITE CITY

Until now the island has been separated from the breakneck urbanisation of its neighbour

Shanghai, China's most economically advanced city, by a 30km stretch of water; however, the Chinese government has decided to urbanise Chongming as part of a wider scheme to develop the whole of the Yangtze estuary. Chongming will be connected to the mainland via a bridge and a tunnel directly into Shanghai's heart, the soaring Pudong district. Once connected, Chongming will be

separated from downtown Shanghai by only a 30 minute drive, and this rural backwater will gain a population of millions.

China, home to 1.3 billion people, already has 90 cities housing more than one million inhabitants. Around Shanghai alone, 10 satellite cities are now being built, of which four will have more than half a million residents. In the last decade many millions of rural Chinese have left the countryside for jobs in the cities, and in the next 20 years over 200 million more will do the same. This relentless march of urbanisation goes hand in hand with a vast increase in energy consumption and pollution.

China recently became the world's second largest consumer of energy, after the USA, and more than half of China's cities suffer the effects of acid rain. A third of its major cities face falling levels of water and the groundwater they do have is contaminated. In addition, more than 40% of Chinese cities fail

basic standards of air quality. The rush to the cities seems to be inevitable, but it also completely unsustainable. The current, energy-wasting, resource intensive way of city living cannot continue.

SELF-SUFFICIENT

It was this realisation that led China's third biggest developer, the Shanghai Industrial Investment Corporation (SIIC), to want to build a city that not only provided a healthy return on its investment, but also attempted to find a totally new paradigm for sustainable city living. SIIC asked Arup to use our international team of designers, planners, engineers and business consultants to help create a masterplan for Dongtan. The fruits of this will be the world's first sustainable city, with a population of up to half a million by 2050, but the innovations and lessons of Dongtan could, one day, become a blueprint for the way 21st century cities are designed.

Designed from scratch, Dongtan has been guided from the beginning by profound and ambitious environmental goals. Some of these goals have been achieved individually in small communities and pilot projects around the world before, but taken together, nothing on this scale has ever been attempted. The aggressive Chinese construction deadlines are also faster than anything attempted in the West. Dongtan's first stage, a 'demonstrator' city that will house up to 10,000 people, must be ready in time for the Shanghai Expo in 2010. The proposal for Dongtan was given outline planning permission in the summer of 2006 and building work will start at the beginning of 2007.

Arup was initially hired to do a small consultancy for the project. Once involved, we realised that for such an ambitious scheme to work, SIIC did not need piecemeal advice on planning, energy and waste issues. To be successful, it

DONGTAN'S SUSTAINABILITY GOALS

To preserve the wetland habitat

To create an integrated, vibrant and evolving community

To improve quality of life and create desirable lifestyles

To create an accessible city

To engrain contemporary Chinese culture into the city fabric

To manage the use of resources in an integrated manner

To work towards carbon neutrality

To use governance to achieve long term economic, social and environmental sustainability



China's third largest island, Chongming, will have Dongtan at its tip

needed a more holistic masterplan.

The key to making the city sustainable lay in understanding how planning for transport, housing, energy and all other factors fit together and influence each other. Each individual aspect of the Dongtan plan was quantitatively modelled to understand resource implications and optimise the design. It soon became clear that these individual models had to be linked together. A small change in the plan for food production could prompt a large shift in what was needed from the transport network, and that in turn could have a knock-on effect on the city's energy needs. All the models had to be brought into an integrated resource model, so that it was clear how the different aspects fitted together and affected each other. It is this holistic, sustainable way of planning that will not only be the key to the project's success, but is also likely to be one of its most lasting legacies.

DESIGNING THE MASTERPLAN

Dongtan will be a low-rise and high density waterfront that will eventually spread over an area of 84 square kilometres, although the city will cover no more than one third of the land mass.

Starting from the site of the demonstrator city on the southern coast of the island, facing Shanghai, approximately 6km east of where the new tunnel and bridge join the island, the city will grow northward across the island to the opposite coast, forming a ribbon 2km wide and 16km long.

Though Dongtan will be a large city most of the land area will not be built up. There will be three distinct but linked 'towns' set amid parkland and farmland which will be compact urban areas of living, bound together by a shared city centre that acts as a reference point for the whole development. It is in this city centre that larger facilities such as hospitals, universities and theatres will be found.

This pattern of compact, urbanised towns plays a critical role in making the city sustainable. Housing will be mixed with shops, post offices, schools, nurseries and healthcare facilities, meaning that facilities and energy provision can be local and centralised, reducing each resident's ecological footprint. Population densities within these compact centres will be similar to those in London. A compact, medium sized high-density design will also foster a village-like sense of community and identity in

Dongtan – a social goal just as important as the environmental ones.

GOING FOR GREEN

The highest priority in the Dongtan development was to protect the island's precious wetland habitat. Chongming is a crucial stop-over point for wildfowl on the migration routes running across China, so it was not enough just to try and minimise the effect of building a city on the delicate ecosystem – the plan had to try to improve the prospects of the wildlife living there. The wildlife reserve at Chongming's extreme eastern tip will remain untouched and will be buffered from Dongtan by a band of eco-farming and controlled wetland. As more silt washes up on Chongming, extending the island, the natural reserve will become larger.

Contact with green spaces will be an everyday feature of life in Dongtan and nowhere will be more than a few minutes from a park. The condensed, pedestrianised centres will have easy access to farmland and parkland that will open out the city. Buildings will have green roofs, a small difference that will have a positive impact on biodiversity and local climate conditions. This continuous network of green spaces will also create corridors for wildlife



An artist's impression of the first phase of Dongtan marina © Arup

to move through the city. The waterways and ponds that define Chongming will continue to play a defining role in the character of the city. Dongtan will be the gateway to the whole of Chongming's canal network – canals are a traditional feature of Shanghai developments and a bustling web, carrying freight, passengers and tourists, will serve Dongtan.

Another key sustainability goal is to ensure Dongtan produces as much of its own food as possible. Traditionally cities swallow farmland and grow at the expense of agriculture. In Dongtan food will be grown in fields around the city and at high density using new technology in the city's food centre. Though unlikely to be totally self-sufficient for food, Dongtan will produce as much food when it is built as the land did before. The agricultural industries that already exist on

Chongming will remain, and will be integrated into the way the city is run as a whole.

AIMING HIGH

Our aim is that the whole city should run on renewable energy. All the energy needed to keep Dongtan going will be created in Dongtan, and transport is no exception. Further to this, a key element of Dongtan's design must be to cut the use of cars. By placing people and facilities close to each other, it will allow residents to walk or bike to work, school or to the local shops. Cycle paths and walkways will crisscross the city, meandering through parks and alongside canals and ponds.

Neighbourhoods will be accessible to pedestrians and cyclists, but will prevent through motor traffic. Visitors from the mainland will be encouraged to leave their vehicles at the edge of the city and continue by zero

emission public transport. Buses and trams will be hydrogen or battery powered, as will the city's fleet of freight and delivery vehicles. Supplies from outside Dongtan will be delivered to a central depot and then distributed by clean vehicles.

We have quantified the emissions from a detailed energy model of the city including an analysis of the energy generation systems. This model is part of the fully integrated resource management model of the new city. The transport figures, for example, have been assessed from detailed models which compare the eco-city approach with a conventional (grid connected) development. Our predicted reductions of 350,000 tonnes of carbon per year and 400,000 tonnes of carbon reduction per year from transport, based on a city with 80,000 population and 51,000 jobs, come from these detailed models.

UNSUSTAINABLE ENERGY USE IN CITIES

75% of the world's energy is used in cities and for their benefit. London requires the equivalent of two supertankers a week for its own energy use. It consumes as much energy as a country the size of Greece or Portugal, and London would need to be the size of three planets for this kind of consumption to be sustainable. 73% of London's carbon emissions come from heating, lighting and electrical energy, while in some American cities over 40% of emissions come from air conditioning alone. If the use of energy in cities can be made sustainable, then its contribution to climate change can begin to be addressed.

Herbert Girardet,
Sustainability Adviser, Dongtan Eco-City

WASTE AND WATER

All waste should be reused or recycled, and there will be as little landfill as possible. As well as improving the current water supply, water will be collected from rainfall and then recycled and managed. Conventional cities of this scale currently consume an average of 29,000 tonnes of water per day, and discharge the same amount. It is estimated that Dongtan will consume an average of 16,500 tonnes per day, but will discharge only 3,500 tonnes – a great leap in the recycling of water and reducing nitrate pollution of the wetland.

The goal of low carbon emissions extends to all other energy used by the city. Energy will be renewable and created in the city – houses will be designed for low energy use and will be fitted with solar panels and wind farms will rise from open land in the city. Biofuels are another foundation of the energy strategy. Rice husks, a byproduct of rice agriculture in China, are produced in vast quantities on Chongming. The husks are usually rejected as waste after milling, but in Dongtan they will fuel a city. Barges will carry tons of the husks from all over Chongming and the Yangtze Delta to the city's energy plant. Organic waste from the city and from its inhabitants will generate bio-gas which will in turn be burnt to generate more electricity.

Dongtan is predicted to be around 2.8 hectares, less than half of that produced by a current resident of modern Shanghai. Dongtan will grow and evolve over the coming decades, but as it grows it will continue to be guided by the goals of sustainability.

Dongtan is not a rigid blueprint of a city for the future. The masterplan for its development grew from the unique environment and situation of Chongming and other such projects would be similarly guided by the individual site. Not only will this innovative and holistic approach to sustainable planning be used in building other sustainable cities but it will also provide knowledge on how existing cities can be retrofitted. Such an approach with an existing city would take time and will be less cost effective than taking a sustainable approach from scratch; however, it is possible to change the ecological direction of a city in this way.

In Barcelona, for example, all new buildings must now use solar energy to run hot water systems. Dongtan will demonstrate that green roofs, renewable energy, LED street and traffic lighting and smart meters that tell you what it means to boil a kettle are small innovations that can be adopted anywhere, to great and lasting effect.

BIG IMPACT

All of this technology is currently available. The great innovation in Dongtan lies in bringing it all together and designing the city with sustainability as an all-encompassing guiding principle. The results so far have been impressive. The ecological footprint – that is the area of productive land and sea needed to supply food, energy and resources while accommodating waste – of someone living in

Further reference

See www.arup.com/eastasia/project.cfm?pageid=7047 or www.dongtan.biz

A plan of the Dongtan site showing the different phases of the eco-city's development © Arup



The Dongtan site as it looks now © Sally Quigg



The entrance to the canal network that will form part of the Dongtan marina © Sally Quigg

BIOGRAPHY – Peter Head OBE FREng

Peter is a civil and structural engineer who has become a recognised world leader in major bridges, advanced composite technology, consulting management and now in sustainable development in cities. He has won many awards for his work including the Award of Merit of IABSE.

Peter joined Arup in 2004 to lead their planning and integrated urbanism team. He was appointed in 2002 by the Mayor of London as an independent Commissioner on the London Sustainable Development Commission and leads the planning and development sub-group of the Commission. He is also Chairman of the Steel Construction Institute.