Abstract: In this presentation Robin will describe the winning entry in the international competition for the expansion of the city of Ningbo, China, for 350,000 people on a 4000ha site, and the urban design of its new Centre. The entry from HASSELL, with engineering consultants Hyder, was declared winner from a shortlist which included German, Japanese and Chinese entrants, in late 2002. The scheme blends traditional Chinese practices in sustainable farming, aquaculture and soil and water management, evolved over forty centuries; with 21st Century technologies; to create a sustainable city. The competition was organised in the context of the Chinese urbanisation program, planned to accommodate 500 million new urban dwellers by 2020. The new city concept embodies urban design qualities rarely found in contemporary Chinese cities, and complements a fine city building tradition which spans 4000 years, utilising the principles of the ‘magic square’ and the ‘field of nine divisions’.

ESD components of the city structure are woven throughout the fabric of the new city. The largest parks and waterbodies accommodate water treatment and storage for recycling, and sustainable energy generation from wind and wastes; the smaller urban canals and waterways provide drainage and water distribution into wetlands for cleaning. The ESD agenda for the new Ningbo will reduce externally supplied water and energy by half that of a conventional city, while providing a physical environment equivalent to the most advanced contemporary cities. The concept includes a comprehensive public transport system, which minimises incentives for growth of private vehicles, by providing an excellent standard of service, linking old and new centres and enhancing their functional and cultural integration.

HASSELL is continuing its involvement with detail design of the project through the Shanghai and Hong Kong offices of the firm.

Keywords: NINGBO – a model for sustainable 21st Century urbanism in China.
Introduction.

Ningbo is growing and evolving into what will be one of the great cities in China in the 21st century. Ningbo is already the No.2 port in China, with a major export trade in textiles, clothing and other manufactures, and is a major centre for high tech research and education, banking and finance.

The Ningbo Urban Planning Bureau requested competition entrants, to provide clear strategies to guide the future expansion of Ningbo beyond the boundaries of the old city, to encompass the New District of East Ningbo (NDEN). The Brief included a new business and commercial centre on 7km² and urban expansion by an extra 350,000 population over the total 38km² site.

The legacy and the future

The old city centre of Ningbo dates back to 700 AD. It has a unique character epitomised by the scale and design of its older areas, the river system; new parks, plazas and commercial complexes within the city and on the riverfront. This leads to a city which combines a thriving business and commercial sector, with an active street life, reminiscent of much larger Chinese cities, and containing a variety of housing styles and densities integrated within the old centre.

The vision for the NDEN is to reinforce the unique qualities of the old city and create a second centre for the metropolitan area. This will allow for central functions to be expanded within the new centre without destroying the unique qualities of the Old City. The express rapid underground transit system is proposed to link the two centres via a 5-
10 minute journey, thus allowing shared central functions to be practically realised between the two centres. The rich intellectual tradition of Ningbo is reinforced through the creation of the Knowledge Axis in the New City, while cultural facilities are located in the Urban Axis, which forms the major transport and green space link between the new and the old city centres.

The concept aims to achieve harmony and balance between the old city and the NDEN and to create a unified world city with two complementary centres.

**City size and density**

By 2020, the Ningbo Urban Planning Bureau estimates that the Three River Division of Ningbo (including the NDEN and the old town) will have 2.6 million people, on 146 km$^2$ of land. This is approximately the same density of population as Berlin, and some other European capitals have similar population densities.

**Creating a sustainable environment**

The project brief called for the new Ningbo to be a model environmental city. The HASSELL approach was to blend traditional Chinese sustainable practices in agriculture, with modern ESD practices and technologies specifically developed for large cities. These are described in more detail in section 10.

![Figure 2: New Urban District Site and Environs](image)
Making better use of the NDEN site

The site allocated for the eastern expansion of Ningbo, is 38km² of flat former agricultural land running from the Yong Jiang River in the north, to the regional freeway and hills to the southeast. The main characteristics of the site which have influenced the concept development are listed below.

Site elements and the planning and design process

Existing canals
To adapt, re-use and change from agricultural to an urban role performing a wider range of ESD functions. Re-use the best where appropriate and replace the worst where heavy metal or nutrient build up is excessive. Add complementary soft edged wetlands, which will provide storage for flood control and water re-use, as well as drainage and water treatment.

Existing development
New areas and buildings to be retained where possible, and the gradual replacement of poor quality environments. Careful study and retention of areas of the best of traditional development, such as the town of Quiga which include canals, streets, and buildings of cultural significance.

Retain new roads and canals, bridges and parks and ensure incubator buildings have a prominent location in the new plan, as symbols of a high tech city.

Hospitals, schools and convention centres
Retain where possible, and integrate within urban design. Incorporate in centre, allow for new hotels, business park adjacent as complementary uses and locate main public transport routes and tourist water transport to service these facilities.

Soils
Incorporate soil conservation and reuse program from development sites, in allotments and open spaces; urban forestry opportunities; new open spaces and wetlands

Existing roads
Connect new grid of roads to existing grid to the west and proposed new roads surrounding the site. To incorporate bicycled and public transport routes for staged development, from bus light rail and main transit.

Yong Jiang river
Create a new park system, open up views to the river and recognise the significance of the river by the diagonal axis within the centre. To locate a boat harbour and neighbourhood centre on the riverfront.

Hills Surrounding to the East
Celebrate the hills to the southeast of the site by creation of a diagonal axis within the core area. To allow views down the main canal to frame the hills, as a backdrop to the urban areas

**Vegetation**
Wherever possible to conserve the few trees which remain, and to schedule major planting programs in boulevards and parks; and the microphyte, establishment programme, for urban waterways.

**Existing rail system**
Allow for planned expansion of urban and regional function. Incorporate into regional and local public transport system within the greater Ningbo metropolitan area.

**Water Transport**

The Three River District and Old Ningbo in particular, traditionally relied on water transport for much of its trade and prosperity. City development from 700AD onwards was always closely reliant on trade goods brought by water transport from the region and other parts of China, and then transferred for shipment by sea to other Chinese ports and beyond.

As with many port cities based on rivers, the Yong Jiang River is no longer able to provide the port function for the scale of shipping now generated by Ningbo. Nonetheless, the layout of the old port city has survived 1200 years almost unchanged. Although the main port has moved down river to the open sea due to size of vessels and cargo handling requirements, the legacy of water orientation of the city is a major area of potential interest to visitors to Ningbo. The HASSELL / Hyder concept for NDEN seeks to extend and enhance the experience of water for transport in and around the city.

The main potential water transport routes utilises two east west canals connecting the NDEN site to the old city, and with the addition of some locks, the Yong Jiang River also can become a potential route between the NDEN and the Old Ningbo centre. The new centre plans show the routes between main destinations and docking facilities next to major new cultural attractions on the Urban Axis. As much of the navigable canal routes are in newly constructed waterways, there is an opportunity to ensure depths are sufficient for navigation, and new bridges are designed with sufficient clearance for river craft. Existing canals to be developed as navigable waterways will require dredging to allow appropriate boat clearances at maximum storage levels required for the water recycling system. Dredging will also remove nutrient rich silts from existing canal floors, minimising risk of algal blooms in the new water system.
Drainage

The existing canal system which is largely retained for drainage and flood control, has been re designed to perform the following additional functions:

- Drainage and flood control for future urban, rather than current rural runoff
- A transportation network capable of being used by watercraft
- Improved water quality by installing litter and oil traps, to remove pollutants associated with stormwater runoff, prior to entering waterways
- Provision for storage of stormwater for:
  - Removal of nutrients and bacteria in wetlands
  - Re-use as a substitute for reticulated town water (non potable) use

Planting of aquatic vegetation will improve the aesthetics of the canals, as well as removing suspended solids and nutrients, which will result in water quality improvements throughout the water system.

Open water areas will provide for ultra violet treatment of water bodies to kill pathogens

Smaller canals will distribute urban stormwater to wetland treatment areas, distributed around the system.

Sewerage treatment

A reticulated sewerage system to the New District of East Ningbo will be provided to collect waste effluent from all forms of development.

Wastewater will be treated to a high level of quality in few existing plants. It will be suitable for recycling back into the NDEN for use on local garden and landscape watering, non-potable domestic use; and industrial water-cooling; or for discharge into the Yong Jiang River.

Recycling of solid waste (sludge) from the treatment plants will be possible for urban forestry, parks, allotment uses, and other purposes both on and off site.

Landscape and open space

Planning of the landscape and open space system responds to the site in a manner that assists in the achievement of the overall goals. The landscape and open space system aims to achieve the following:

Respect the importance of water in the history of the development of Ningbo, celebrating water in all its forms and reinforce the city’s unique identity
Assist in the achievement of establishing Ningbo as a model environmental city and reinforce the ESD Agenda by providing sites for energy generation, waste recycling, water treatment and storage for recycling.

**The axes**
The creation of the axes are both symbolic and functional. They trace the relationship of the site to the river and the mountains. They accommodate a diverse system of complex and diverse water bodies. Which provide an even distribution of water based ESD initiatives throughout the whole site; and creates landscapes of functionality and delight, ranging from wetlands, lakes and canals, to formal plazas and the public realm of the urban areas. They also provide the setting for major public sporting and cultural facilities for the new city centre.

**The linear parks**
The park system has been designed to provide a number of functions, including: acting as a buffer and screen to freeways and roads, and providing opportunities to facilitate aquaculture, urban forestry, garden allotments and an extension to water treatment methods.

The riverside parkland marks the importance of the river in the history of Ningbo, and its frontage to the site. Redressing practices of the recent past, in which the river has become visually and physically inaccessible, so great has been the pressure of commerce and industry in the last decade of development of Ningbo.
The canal system
A system of smaller linear parks is proposed along the canals, which distribute water from development into the main water bodies for treatment and storage. These will be augmented by a still smaller system of canals, developed within each super lot, i.e. land bounded by major roads in housing projects. The canals will be incorporated in the neighbourhood open space of each housing development, and be the responsibility of the building developer, rather than part of public infrastructure provision in the first instance. The penetration of the waterways into every part of the city will encourage its stewardship of the system by the whole population in the way that it was in traditional cities on the coastal plain in China.

Recreation facilities
Main sporting facilities will be provided as part of the major facilities programme. Other facilities such as walking and cycle tracks, playgrounds, pavilions and picnic areas, will be incorporated into smaller parks, and small sporting venues within neighbourhood centres at nodal points.

ESD Strategy - Preliminary Performance Assessment
The following project initiatives were suggested with performance indications:

Figure 7: Ningbo – ESD Framework
Green power
50% of all electrical energy used in the new city town is proposed to be green power harvested on site. Wind, solar and tidal energy sources, are considered and located on the ESD plan.

Wind
For wind power, up to 500 ‘prayer wheel’ type, wind turbines are proposed, located in:
A. The Knowledge axis
B. Within the eastern freeway buffer zone
Each wind turbine is rated at 800kw. Hyder calculate that the power produced will be approximately 1,752,000 Mega watt hours/year. New technologies in compact, cylindrical wind turbines have demonstrated high efficiencies with lower wind speeds, and are more suitable for use in urban areas due to compact size, appearance, lower noise levels and space requirements.

Solar power
Solar Power is proposed for hot water and electricity generating in building developments

Energy recovery from municipal wastewater
Two anaerobic egg digestors are to be installed as part of each existing wastewater treatment facility in order to produce power from biogas (predominantly methane).

Energy generated will provide power requirements for the wastewater treatment facility, with excess power being fed into Ningbo’s electricity grid. A total of four Eggs are proposed as noted on the ESD plan.

Brown power: cogeneration
50% of the power is to be generated through a number of high efficiency gas fired cogeneration plants. Waste heat will be recycled for industrial heating and the heating of residential buildings.
Urban stormwater management

Figure 5: New Urban Waterways

When all initiatives are complete, water usage from external sources in NDEN, will fall by 50% of existing levels in other areas of Ningbo.

The catchment volume of rain for the development area will be approximately 40,000,000 m$^3$ of water per year.

The volume of stormwater that can be stored within the canal system is 2.5 million m$^3$. This is 3.8% of the total volume available. More water can be stored during the dry season when flood protection requirements are reduced. Approximately 50% of the total rainfall volume can then be recycled for urban use, depending on the detailed design and operation of the system.

The existing 373ha of canals are to be reformed, with a proposed water area of 367ha that will include canals and wetlands.

Approximately half of the water area will be in the form of soft edged water bodies, with peripheral emergent macrophyte plants; and submerged macrophytes in deeper areas.

The improved water area will provide:

1. Storage for urban stormwater for cleansing within the wetlands, using ultra violet light from the sun, and absorption of nutrients by macrophyte plants established therein
2. Supply of treated stormwater to supplement irrigation requirements for nearby parklands and other non potable uses throughout the new city area
3. Navigable water bodies which will connect the Old City Centre to the NDEN Centre and environs
4. Use of parts of the water bodies for an aquaculture in adaptation from traditional Chinese practices, for the production of ducks, fish and water plants and encourage a fish population to predate mosquitoes

Provision of a third pipe was proposed to be added to urban infrastructure to supply recycled water to all water consumers, with on-site ancillary treatment of recycled stormwater using UV and high rate filtration, after withdrawal from the wetland system.
Additional uses of recycled stormwater will include fire fighting, wash down, industrial use and toilet flushing.

**Topsoil conservation**

The aim is to minimise waste and misuse of topsoil, which has been gradually improved over several thousand years of traditional Chinese agriculture in the Ningbo agricultural area.

Conservation measures:
1. Strip and store for reuse prior to construction or landfills
2. Avoid mixing topsoil with subsoil or other contaminants
3. Reuse outside the site for agriculture
4. Reuse on site in parks, wetlands, urban forestry, and productive allotments, as well as development of open spaces in residential areas

**Land allotment for market gardens**

Land allotments maximise the opportunities for residents to produce food on site and will be provided in some residential areas, especially along freeway buffer zones. Reuse of topsoil, composted sewage structure and other organic wastes and recycled water will be practiced.

**Urban forestry**

Urban forestry will be incorporated to provide the following benefits:
1. Buffer zones along freeways
2. For disposal of composted sewage and other wastes
3. Reuse of topsoil and recycled water
4. Noise absorption, air purification and visual screening. Harvesting of forests may be considered on a periodic basis

**Transport modes**

Ningbo presently scores highly in using high levels of cycling (60%) and walking (20%) for journey to work, by comparison with most major cities outside China.

1. Car usage in western countries is far higher in China in general, in particular Ningbo,
2. As community living standards improve in China, private car use is increasing
3. New systems for Ningbo will minimize the increase in private car use,

As more mechanical transport is demanded, utilisation of public transport will be encouraged by bus and light rail routes in main road reservations; and in the underground rail line along the Urban axis linking the two centres. Fast and efficient local and city wide public transport is aimed to minimise the growth of private car use in the new city.

**ESD building design**

A detailed schedule of ESD initiatives to be incorporated in individual developments was developed to compliment citywide ESD planning and infrastructure set out above. These include solar electricity and water heating, stormwater and grey water reuse insulation standard and orientation.
Concluding Remarks:

Modern sustainable systems for cities relate strongly to Chinese tradition and culture. The speed and quantum of China’s urbanization is unparalleled. The pattern of future growth of China’s new cities, and the degree to which they can be made sustainable will affect all our futures.

I have been asked about the "relationship of the paper to theory". To this I can only respond with the simple rejoinder enshrined in Aristotelian logic. THE CONCLUSION OF A PRACTICAL SYLLOGISM IS AN ACTION. To me it seems obvious, in fact platitudinous, to make the observation that urban design is a practical discipline and that design for sustainability must likewise issue in practical outcomes for our very survival. On pain of flying in the face of any theoretical prescriptions or proscriptions that the vagaries of fashion might occasionally dictate, on this issue I cannot be a fashion victim. I must side with Aristotle and begin at the start of the practical syllogism, as all original work must, and hope that it issues in appropriate action.

It was also suggested that the paper might discuss what the plan "might not actually achieve and why". Considering this, my response was that given the plan's implementation period of 20 or so years, as well as the political, economic and social changes which could be operative in China during this period, there are any number of particular reasons why things may not go according to plan. Trying to foreshadow what may and may not happen in the future of the Ningbo urbanisation program would be the subject of an entirely different paper, which might be best presented by others.

This different paper is not the one I offer today. In fact, on the issue of fully implemented sustainable urban design, I feel we need to dig into the past again to be reminded by the Chinese poet Lao Tsu, that 'The journey of a thousand miles begins with a single step'.

In this paper I am describing that first single step, not the rest of the journey.

In the context of the largest and fastest urbanisation program in history, which is currently in place in China and its potential impact on local and world environment. I hope that the people of Ningbo and their government will see that the journey continues.

References