

Investment is key to planning rail transit, whose high cost is one of its greatest challenges. Tongji researchers, leaning on rail transit financing experience from home and abroad, proposed a solution to return development benefits, and built a basic calculation model for value appreciation of nearby houses under the influence of urban rail transit.

They have also developed a tunnel boring approach to construct underground high speed railway beneath existing buildings with minimal disturbance to the surrounding ground, solving a key engineering problem in the sustainable development of rail transit construction.

High-density urban roads

Urban traffic congestion is one of the major challenges in urban expansion and development. High-density urban road networks boost urbanization and socio-economic development, but in the meantime, road congestion constrains urban socio-economic activities, and results in extra energy consumption and pollution.

With state funding support, Tongji

transportation scholars introduced a way to identify high-density urban road network traffic congestion; created a theory of analysing such traffic congestion; built a comprehensive transportation design, control and coordination technology system for relieving traffic congestion; came up with improvement measures targeting multiple subjects in complicated mixed-use road network; and developed an analysis platform and design support system for the high-density urban road network congestion. These enabled integration of transportation planning, engineering construction, and transportation management.

Tongji scholars published some of China's earliest transportation technology standards, works and textbooks, which drove the emergence of China's transportation design industry.

Vehicle infrastructure integration: smart transportation

Technologies linking road vehicles and roadside infrastructure to improve road safety and

efficiency are essential for the development of sustainable and intelligent transportation systems. Work by Tongji researchers has advanced technologies for vehicle infrastructure integration.

Aimed to resolve major issues in information and control of modern transportation, Tongji researchers built a precise analytic model for complicated urban multi-modal transportation systems, and developed an active transportation control approach that enables vehicle infrastructure integration.

Applying the research results, the team took charge of China's largest intelligent transport system planning — intelligent comprehensive transportation planning for the Suzhou Industrial Park.

They also built the intelligent monitoring system for transportation in Shanghai, Ningbo, Zhuhai and Foshan. The Shanghai Intelligent and Connected Vehicle project they designed was among 46 pilot demonstration projects in the Made in China 2025 scheme, for which up to 20,000 connected vehicles will be produced in 2019. ■



Made of a bamboo-aluminium composite, DuXing is much lighter than normal bicycles.

DESIGN AND INNOVATION

Reinventing the wheel

The Tongji University College of Design and Innovation has a reputation as one of China's leading design education institutions. It seeks to address global challenges by cultivating future leaders in sustainable design and innovation, who can contribute to social development while pursuing academic excellence. The college's vision is to establish an international benchmark for design education and research, which is grounded in China's socioeconomic context, while applicable to the design community worldwide.

The college focuses on improving smart, sustainable ways of living through product, service and system design. This idea is

upheld by the college's various research teams: the SustainX Design Research Centre, Centre for Digital Innovation, Inclusive Design Research Centre, Design for Social Innovation and Sustainability (DESIS) Research Centre, Biomimetic Design Lab, Behaviour & Cognition Lab, Digital and Parametric Design Lab, Interaction Design Research Lab, and Intelligent Big Data Visualization Lab. This allows an expansive repertoire of techniques, tools, software, assembly and evaluation methods, and perspectives that can be invaluable when for problem solving. The college offers a competitive environment, opportunities, facilities and foresight to fulfil its transformation to an institution dedicated to sustainability.

Sustainable product design

By investigating how to apply the principles and methods of sustainable design, every aspect of design and production is evaluated. This encompasses materials, technology and arts of making, analysis of product life cycle, labour and decision-making. Design strategies

are directed by either decreasing resource consumption or developing innovative products that tackle specific environmental issues.

Case 1: A sustainable bicycle

DuXing is a bicycle whose frame is made of a bamboo-aluminium composite that maximises strength and resilience, but also shock absorbance. Designed by Tongji professor, Yang Wenqing for Forever, China's traditional bicycle brand, DuXing is 30-40% lighter than current bicycle models and has already been awarded two innovation patents and three design patents. Innovative products like DuXing and others have helped to revitalize the old brand.

Sustainable service design

Since 2007, the Tongji University College of Design and Innovation has partnered with the Politecnico di Milano to establish the double-degree master's programme of 'Product-Service and System Design' (PSSD), the first of its kind in China. The core of PSSD is to provide quality service based on user experience, so as to achieve a "less

consumption, better life" way of production and living. In the years since its founding, PSSD has been applied in the areas of transport, food distribution, health care, urban agriculture and education.

Case 2: Urban public transport design collaborated with VOLVO

Volvo and Tongji College of Design and Innovation collaborated to explore designs for public transport in the urban ecosystem. National policies to promote clean energy have brought a radical change to the public transport landscape, and new stakeholders are emerging. Employing the methodology of service design, the collaborative project studied the interactions, touch points, stakeholders and business models of public transportation systems. This has led to proposed strategies and solutions to the re-design of vehicles, infrastructure, service and system.

Sustainable system design

Extending product life cycle to reduce resource consumption is a cornerstone of sustainable

ENVIRONMENTAL SCIENCE

Leading the way in clean and safe solutions

Environmentally sustainable development requires knowledge and innovation brought by basic research, cutting-edge technology and major engineering applications. The College of Environmental Science and Engineering at Tongji University strives to conduct research on environment and sustainable development while providing a high education standard for students. It owns important technologies with proprietary intellectual property rights

concerning wastewater treatment, solid waste treatment, and materials and environmental remediation. These technologies have been applied to some major national projects, such as those designed to control pollution of the Taihu Lake and the Chaohu Lake. The college is also cooperating with the World Wildlife Fund (WWF) on low-carbon city and ecological protection in the Yangtze River basin.

Moreover, the college has developed technologies that can be used to optimize drainage systems; control pollution caused by run-off in cities in the Chaohu Lake basin; upgrade the processes of urban sewage treatment works; and build land-lake eco-zones to intercept pollutants in rivers flowing through cities. With expertise in a range of key technologies such as aquatic biological-ecological remediation, pre-oxidation and biological pretreatment, as well as ozone-activated carbon-UF membrane treatment, the college has effectively used the technologies to control the pollution in

design. Too often products are bound for the rubbish heap shortly after they are manufactured. Therefore, we need a breakthrough that will allow maximum use of all resources with minimal environmental impact. The Tongji University College of Design and Innovation has established the 'Sustainable System Design' master's course. Its research initiative on 'Design for Circular Economy' was supported by the Ellen MacArthur Foundation.

In 2014, the college co-launched an initiative called 'DesignX', which focuses on a new, evidence-based design approach to address complex problems rising from socio-technical systems.

Case 3: China's first sustainable primary school
Xinjindai Primary School was damaged by the 2008 Wenchuan earthquake in Sichuan, and through the work of Tongji professor, Lou Yongqi, the school has been transformed into China's first sustainable primary school. The original hilly terrain was preserved, along with the 3,000 mu (around 494 acres) of agricultural fields, minimising disruption

to the natural environment. A water recycling system was embedded and building locations were chosen to make best use of natural sunlight and reduce the dependency on electricity. Construction materials from the pre-fabricated houses built for temporary accommodation were repurposed as wall foundations for the new school. In addition, the school was designed not only to be an education institution, but also as a social hub for local people to strengthen interactions and improve the sense of community.

Design for social innovation


Social innovation supports the transformation into a sustainable way of living and production, and can be a powerful driver towards sustainability. Driving the processes of social innovation requires great visions, strategies and co-design tools to transform original ideas to mature solutions and viable programmes. Tongji University believes that design schools should play a crucial role in supporting and accelerating the processes.

In 2009, Tongji University established the

Design for Social Innovation and Sustainability (DESI) Research Centre and initiated a series of important design and research projects on social innovation. In 2015, the college entered the European Network of Living Labs and started experimenting innovative, sustainable strategies and solutions with local communities through close collaboration with them.

Case 4: Designing the community-in-place

In 2015, the Tongji University College of Design and Innovation initiated 'Open Your Space', a community-based project aimed to revitalise the old community of Si-Ping. With over 60 design interventions, the project transformed the community environment—from public facilities to retail stores. In collaboration with local stakeholders, the college has created vibrant cultural hotspots for the community, which led to the emergence of new economic and social relationships. The community has become a design laboratory where new ideas are generated, new tools are defined and tested, and new projects are initiated and supported. ■



rivers, treat sewage in urban areas, protect the safety of drinking water and improve rural environments. Treating underground and wastewater with nano zerovalent iron (nZVI) is at the frontier of research in ecological and environmental sciences.

The college has been an active player representing China in global environmental affairs. Since 2012, as the expert group leader on the China-UN-Africa Water Action programme, the college has been looking at problems facing the Nile, Lake Tanganyika and the Sahara. More than 100 teachers and students have gone to Africa to undertake projects to protect and improve drinking water in countries including Kenya, Ethiopia and Zimbabwe. They have built the Tongji University-Nairobi Lab for Safe Water Supply and provided training to more than 100 water treatment technicians in Africa.

In 2015, the college jointly released a white paper with the United Nations Environment Programme (UNEP). The paper, *UNEP-China-Africa Cooperation Programme: Enhancing the role of ecosystem management in climate change adaptation*, not only increases the college's

influence, but helps China establish the trust of African countries, boosting cooperation significantly.

In 2013, the college's Professor Li Fengting was honoured with a UN prize in recognition of special contribution to South-South cooperation. At a variety of global events, including the United Nations Conference on Environment and Development, the college has been the only university representative from China. It attended the side meeting of the 21st Conference of the Parties (COP21) and delivered a report, highlighting the role of Chinese universities on the world environmental scene.

Initiated by Tongji University and the UNEP, the Global University Partnership on Environment and Sustainability (GUPES) was established in 2012. Every year for World Environment Day (June 5), Tongji invites more than 300 people from more than 30 countries to attend the International Student Conference on Environment and Sustainability, at which participants discuss environmental protection and sustainable development, expanding the impact of Chinese universities in the academic world. ■