URBAN MINE REDESIGN COURSE: RESEARCH AND TEACHING PRACTICE

Xin Liu
No. B464, Academy of Arts & Design, Tsinghua University, Beijing, China. xinl@tsinghua.edu.cn
Fang Zhong
No. B464, Academy of Arts & Design, Tsinghua University, Beijing, China. zhongfang@tsinghua.edu.cn

ABSTRACT

Garbage is a misplaced resource. With economic development, underground mineral resources are running out while enormous precious resources (minerals) have been turned into facilities and supplies in our daily life, which become the so-called “Urban Mine”. This paper will introduce the core idea, teaching method and student works with regard to the course Urban Mine Redesign offered by Academy of Arts & Design, Tsinghua University, explain how to guide students to incorporate social and environmental issues into design and explore solutions to future sustainable cities through design thinking.

Key Words: Urban Mine, Circular Economy, Sustainable Design, Course Research

1. BACKGROUND

With rapid economic growth and prevailing consumerism in recent years, urban garbage is experiencing a surge. Particularly, owing to the penetration of e-commerce, people depend increasingly on online shopping, bringing about an unprecedentedly prosperous express industry and causing disposable packaging waste to spawn. According to relevant data, the world produced 490 million tons of garbage in 1999, of which that from Chinese cities amounted to 130 million tons[1]; in 2016, 214 large and medium-sized cities in China generated approximately 188 million tons of domestic garbage (Ministry of Environmental Protection of China, 2017). China is the world's largest domestic garbage producer. As China lags far behind in municipal waste classification, plenty of valuable waste is burnt or buried, not only posing a huge pressure on environment, but also constituting a serious waste of valuable natural resources.

Futurist Toffler once forecast in his book The Third Wave that "another wave influencing the survival and development of human beings, following the agricultural, industrial and computer revolutions, will be the garbage revolution to appear at the turn of the century." In fact, mineral resources upon which industrialization depends have gradually been transferred from the natural world to the unnatural one. After 300 years of plunderous mining during the industrial revolution, over 80% of mineral resources available for industrialization in the world have been rendered aboveground and piled up around us in the form of "garbage", which totaled hundreds of billions of tons and increased at the rate of 10 billion tons a year (Qu, 2010)[2]. How to find treasure from the enormous urban garbage heap and turn waste into minerals has become an important issue attracting the attention of experts in various fields all over the world. This necessarily has posed a new challenge to the design discipline which makes it its mission to solve problems.

In this context, the course encourages students to consider design issues from the perspective of ecosystem, so as to turn urban garbage into mineral resources, probes into the collection, disposal and reuse of urban waste at present with design thinking and finally puts forward innovative solutions based on user needs. Learning of the principle, strategies and evaluation criteria of sustainable design will entail the course, from identifying problem to research and then to putting forward a design proposal, which means that design issues will be considered environmentally, socially and economically. The course aims at arousing students' environmental awareness and sense of social responsibility, so that they can participate in the process of social innovation to explore sustainable solutions.

2. CONTENT, PHILOSOPHY AND METHODOLOGY

2.1. Urban Mine

The concept of "Urban Mine" can be dated back to the 1980s in Japan, which initially described the recycling of rare metallic materials in waste home appliances. In 1988, Michio NANJO, a Japanese scholar, first gave a definition from the perspective of recycling of metal resources: industrial product resources piled up above the ground can be considered as renewable resources and called "Urban Mine"[3]. The concept did not widely spread in China until China's National Development and Reform Commission and Ministry of Finance issued the Notice on the Construction of Urban Mine Demonstration Bases in 2010. "Urban Mine" is a neat metaphor for scale development of waste resources recycling and specifically covers recyclable resources generated in the process of industrialization and urbanization and contained in waste mechanical and electric equipment, cables and cords, communication tools, cars, home appliances, electronics, metals, plastic packages and waste materials, such as steel, nonferrous metals, rare and precious metals, plastics and rubber.[4] Later, the extension of "Urban Mine" has been further expanded to gradually include all discarded but recyclable materials and energy resources in production and life.[5]

2.2. Teaching philosophy and methodology

That waste can be turned into minerals is a result of a combination of design strategies, technological means and organizational management in the principle of circular economy; otherwise waste is just waste and is either burnt or buried. By borrowing the Circular Economy System Diagram proposed by Ellen MacArthur Foundation and Cradle to Cradle, Figure 1 simply classifies the waste in our life into biological and technical nutrients from the perspective of "minerals". Most of the supplies of daily use are sold to us following raw materials mining and production. Once discarded, both technical and biological garbage can be re-mined and return to the chain of circular economy, so as to minimize incineration and landfill. Technical nutrients can be recy-

[1] TheMeetingMinutesoftheFirstSymposiumontheSituationofChina'sMunicipalSolidWasteandtheCountermeasures(2000),JournalofNaturalResources, 15(1).

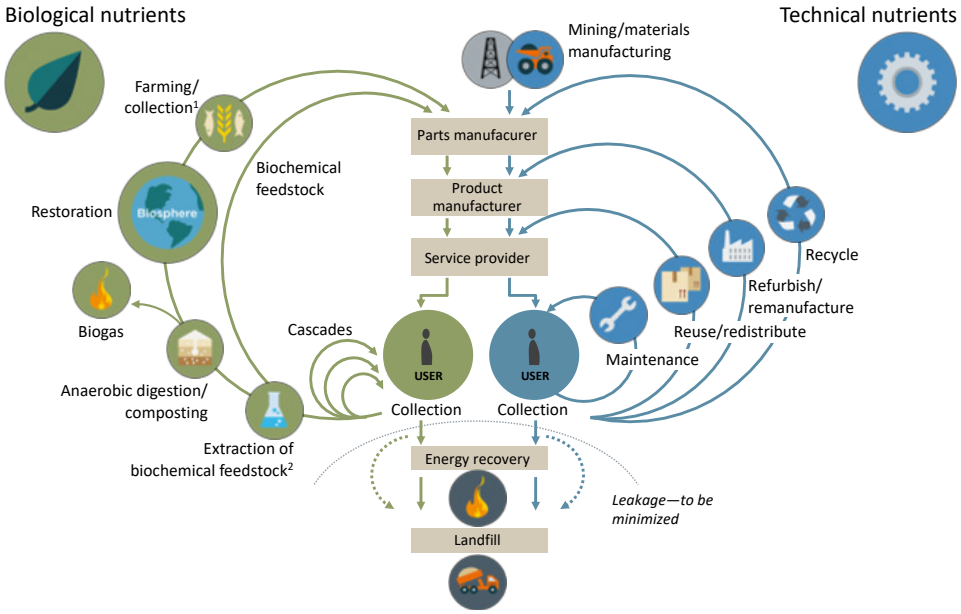
[2] Qu Y X (2010). Interpretation of the "Urban Mine", China Nonferrous Metals, 24, P30-31.

[3] Wang C, Xu J & Yao H L (2017). A Systematic Review of Urban Mining Theory, Resources Science, 08.

[4] National Development and Reform Commission, Ministry of Finance, Notice on the Construction of Urban Mine Demonstration Bases, retrieved from http://www.ahpc.gov.cn/upload/xxnr/100232012 2287780.pdf, 201005.

[5] Brunner P H (2011). Urban mining: A contribution to reindustrializing the city. Journal of Industrial Ecology, 15(3): 339-341.

cled through classification, maintenance, reuse/redistribution, remanufacturing/refurbishment and recycling; and biological nutrients can be recycled through classification, biomass extraction, fermentation/composting, preparation of biofuel, soil remediation and production of feed stuff.



[Figure 1] Circular Economy System Diagram, Source: Ellen MacArthur Foundation

In terms of garbage disposal, as the waste incineration technology becomes increasingly mature, harmful gas emissions have dramatically decreased in the disposal and the incineration efficiency has been greatly raised. Incineration is becoming a mainstream technique to dispose municipal waste worldwide and is expected to occupy a larger share in future. The share of garbage incineration in China is estimated to exceed 50% in 2020 (Liu, 2016). Despite a lot of controversies, garbage incineration, as an effective approach to energy recovery, is apparently advantageous over landfill.

However, in the lifecycle of garbage generation, the tremendous resources wasted in links including production, use, storage and transportation of products cannot be offset by incineration. As a result, from the perspective of circular economy, we must minimize the generation of garbage and promote garbage classification and recycling as far as possible, whereby the goal of completing a sustainable society can be achieved. This exactly is the basic idea and viewpoint of the course.

The course is an elective course for undergraduates from different majors and often carries out design research and practice through lectures, seminars, field research, concept design and prototype test. It is mainly offered through interdisciplinary research and in-depth communication and discussions between teachers and students. The course will contain a systematic introduction to concepts, theoretical development, core idea and evaluation criteria with regard to sustainable design; and invite experts in various fields to give lectures and have discussions with the theme of "Urban Mine", which will cover the theory of circular economy, the status quo of the environmental sanitation industry, policies and measures, design philosophy, environmental public services and commercial practices; later, students will conduct an intensive survey into the categories, disposal techniques and the possibility of recycling of waste resources, be inspired through case collection, sorting and analysis to reflect profoundly about the status quo and look forward to the design exploration about to begin. Finally, students will be required to put forward innovative product or service system solutions and evaluate the sustainability of their own solutions.

3. INTRODUCTION TO PRACTICE PROGRAMS

Over the past three years, the course has been taken by undergraduate students from different majors at Academy of Arts & Design, Tsinghua University, including Industrial Design, Fashion Design, Visual Communication Design, Ceramic Design, Animation Design and Environmental Art Design. The student research and redesign Urban Mine in combination with their design expertise and sustainable design criteria, which involves the application of multiple strategies, including design for reuse and recycle, product life cycle design, product-service system design, etc. The course design works will be described below.

3.1. Plastic bottle cap redesign

Students in this group studied common plastic bottle caps and made some interesting attempts given their features such as high material strength, orderliness and rich colors, and gave them a second life before there were smashed. After repeated experiments, students finally produced three arc grooves on each of the bottle caps through laser cutting and turned these colorful caps into splicing blocks for children, which were equipped with supporting maps to be "Lego"-like educational toys. Whilst meeting the entertainment needs of children (especially those with mental

retardation), they can also exercise the ability to create and the capability of 2D-3D thinking shift. Such a splicing mode offers a variety of possibilities for further toy development. More importantly, it makes a small contribution to garbage classification and recycling and popularization of knowledge of materials to prolong the service life of plastic bottle caps and guide users to actively separate bottle caps from bottle bodies.

[Figure 2] Plastic Bottle Cap Redesign: Shen Ruotong and Cai Miaoting

3.2. Textile upcycling design

According to the data from China Association of Resources Comprehensive Utilization (currently China Association of Circular Economy, CACE), China sees approximately 2,600 tons of clothes thrown into garbage cans every year, of which most are not recycled or safely disposed. Therefore, this group studied how to upcycle old or worn clothes and finally created a mysterious and staid material by mixing old or worn clothes with resin, and designed and produced a number of simple and fashionable household products with the material. Natural texture of textiles presents a unique and fantastic sense of beauty while the new material is hard and smooth and can be easily processed. With a customized service system, such design can not only meet individualized household needs, but also reduce waste and create new commercial value.

[Figure 3] Textile Upcycling: Zou Dianzhe and Yan Zeteng

3.3. Shared Refrigerator

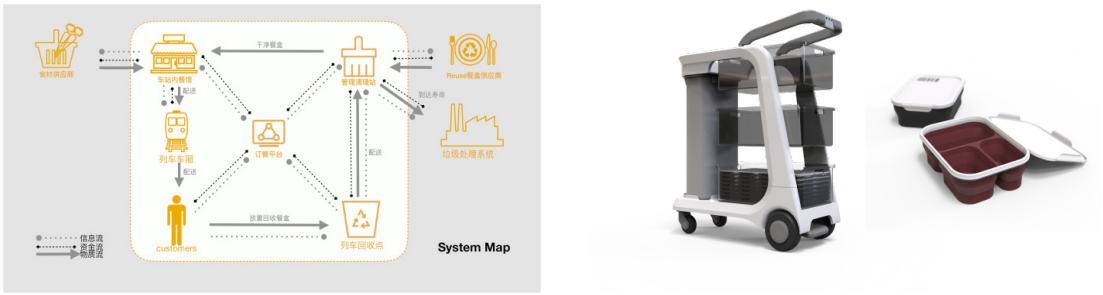
Two students majoring Visual Communication proposed a “food sharing”-based product-service system design against the waste of food near the end of shelf life by combining ideas such as charity, environmental protection and sharing. The system targets hardworking and busy couriers and low-income groups in cities. Equipped with technologies such as identity verification and magnetic stripe scanning, it guarantees the convenience, safety and efficiency for both merchants and users. The system encourages enterprise donations by means of public-benefit publicity and brand planning, and safeguards food safety, thus ultimately achieving the practical and public value of “Shared Refrigerator”. Apart from designing the products and interface of Shared Refrigerator, students also designed a complete brand image and service procedures.

[Figure 4] Shared Refrigerator – Zhang Qingxi and Liu Shuhao

3.4. CRH fast food box reuse system design

Fast food waste occupies an increasing share in urban waste year after year, which also has an astonishing yield on CRH. As Chinese food contains much oil and sauce, classification and recycling of fast food boxes cost high and are

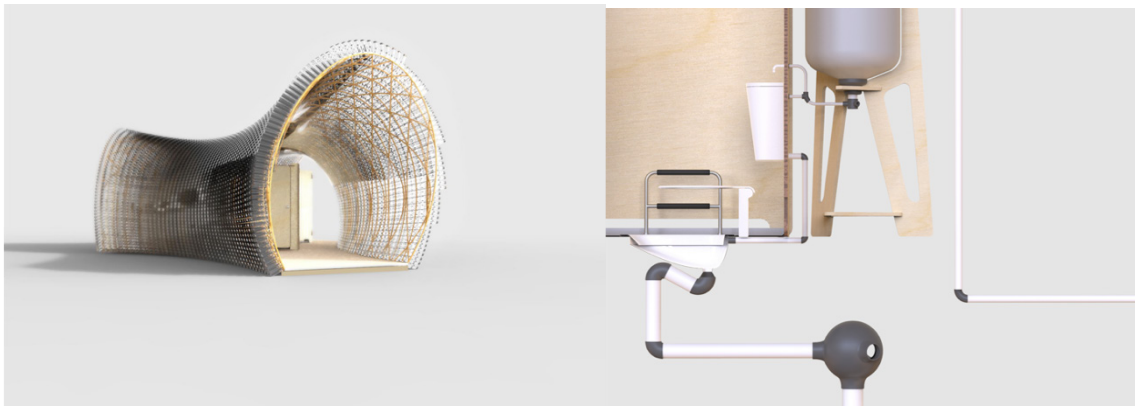
therefore often neglected. Targeting China's high-speed railway system, the student attempted to realize the reuse of fast food boxes within a controllable range and designed a viable service system. The student had catering facilities at CRH stations offer standard catering services, set up old box recycling devices and cleaning service sites along different lines and designed dedicated in-train transfer trolleys.



[Figure 5] CRH Fast Food Box Reuse System Design: Hu Kaizhou

3.5. Bio-toilet design

The bio-toilet design based on human waste recycling is a part of the reflection about Urban Mine. The student carried out basic research on technologies such as humanized toilet facilities, rain water collection and biogas system, with toilet design not only meeting functional needs, but also presenting a unique and simple style; more excitingly, the student built the toilet with waste plastic bottles through modularization & parametrization, guaranteeing effective lighting and shelter needs and creating an elegant and distinct building form whilst advocating waste recycling and environmental protection. Design for Urban Mine must and ought to be a part of our beautiful life.



[Figure 6] System Design and Reuse Device Design: Zhou Rui

4. CONCLUSION

Mass production, consumption and abandonment represent the basic development mode of an industrialized society, which are followed by exhausted underground mineral resources. These precious resources are turned into facilities and supplies in our daily life and ultimately into massive urban waste. With garbage siege, design is playing active role while change in concepts lies at the core of design. From a new perspective, a city is a mine with infinite possibilities and urban garbage becomes valuable mineral resources.

Urban mine redesign is a systematic issue involving reflections on garbage production, classification, collection, storage, transportation, recycling or disposal and stakeholder relations. A systematic view is the essential ideological basis for design research. Redesign or beautification of single waste might be shallow and will often fall into the vicious cycle of turning a kind of garbage into another.

Additionally, single product design can hardly be an effective solution, but product-service system (PSS) design can facilitate the formation of a sustainable business model and may stimulate and guide community residents to perceive and participate in circular economy and green lifestyles, so it is an effective way to explore system solutions.

Designers' understanding and application of technologies are vital. However, they should not worship technologies and even be deceived by the same. Although specific technological breakthroughs are of great significance, whether such breakthroughs in any subsequent links will weaken our previous thinking and attention is worth discussing from the perspective of full product life cycle. No mines are inexhaustible.

Rather than garbage disposal alone, at the core of the garbage problem is to reduce garbage from the source, which on a deeper level concerns human's consumption views and values. If we remain advocating luxury, unrealistic comparison and unrestrained spending, any solution might be a daydream or idealistic words. Therefore, designers—quite influential in consumption despite no power—have to assume the heavy responsibility of leading social changes and pioneer a sus-

tainable lifestyle in their own capacity. Definitely, first of all we have to change our own concepts.[6]

The course effectively translates social and environmental issues into design issues, which are open-ended and require constant exploration and experiment. These design works are far from perfect, but the students have realized the problems and began to seek solutions with design thinking. The course is also open to the public: seminars and oral defenses gathered participators in different fields and the course had thousands of views on WeChat. Apparently, explorations into Urban Mine design and sustainable lifestyles are not confined to campus, but are increasingly concerned by the public.

Funding:
Major Science and Technology Project of Beijing: "Research and Demonstration of Integrated Sanitation System Service Design", Z171100005017005; Major Project Funded by the National Social Science Fund of China: Research on Design Morphology (Project No.17ZDA019); Tsinghua University Initiative Scientific Research Program (Grant No. 2015THZWZD08).

BIBLIOGRAPHY

1. Alvin T. Translated by Zhu Zhiyan and Pan Qi (1983), *The Third Wave,* Shanghai Joint Publishing Press.
2. Brunner P H (2011). *Urban mining: A contribution to reindustrializing the city*. Journal of Industrial Ecology.
3. Ministry of Environmental Protection of the People's Republic of China (November 2017), 2017 Annual Report on Prevention and Control of Environmental Pollution by Solid Waste in Large and Medium-sized Cities. http://www.gepresearch.com/uploads/soft/171211/9_1636273051.pdf
4. Liu J G (2016). *Analysis to Several Issues about Municipal Solid Waste Treatment in China* [J]. Environmental Sanitation Engineering.
5. Wang C, Xu J & Yao H L (2014). *A Systematic Review of Urban Mining Theory*. Resources Science.
6. National Development and Reform Commission, Ministry of Finance(2010). The Notice on the Construction of Urban Mine Demonstration Bases, http://www.ahpc.gov.cn/upload/xxnr/100232012 2287780.pdf
7. Ellen MacArthur Foundation, Circular Economy System Diagram, https://www.ellenmacarthurfoundation.org/circular-economy/infographic
8. Qu Y X (2010). *Interpretation of the Urban Mine*, China Nonferrous Metals.
9. Liu X & Xia N (2013). *From End to the Origin: Trash Tracking and Product Service System Design*, ZHUANGSHI.

[6] Liu X & Xia N (2013). From End to the Origin: Trash Tracking and Product Service System Design, ZHUANGSHI, 201306, P22-25.