LEARNING the UNLEARNED: Product Design for Sustainability

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Abstract:
Teaching and learning of Design for Sustainability (DfS) is not an easy undertaking within the well-established discipline of industrial design today. As **learning** of DfS emphasis on the **'unlearning'** of product-based approach, it involves the up-take of, if not contradictory, an entirely novel set of design skills, such as co-creation approach, consumption-alleviation thinking and solution-based design, which post challenge for most physical-liking design students. Because of these seemingly alienated natures of DfS, most design schools in China are having difficulty in promoting DfS teaching, or force to set it aside as a 'decorative' subject within industrial design discipline, which hinder its proper development in design education. In this paper, the authors argue that learning of DfS should best be begin from the **'unlearned'** practices of industrial design, and within a local, social setting. Supportive cases are also presented at the end of the paper to serve as reference of alternative teaching and learning of DfS in China and for China.

1. the Three Transitions
Since the mid 90's of the last Century, the world has been experiencing three macro transitions.

- A transition towards *digital connectivity*, from physical interaction and communication to virtual networking of people.
- A transition towards *service-based economy*, from the production of mass physical commodities to the production and delivery of highly customized product- services.
- A transition towards *sustainable culture*, the urge to improve the quality of life by means of drastic reduction in environmentally unfriendly consumption and of natural resources.

The convergence of these three transitions is resulting in a post-industrial economy and ecology that is based on *knowledge*, *information* and *service* **(Leong, 2004; Manzini & Leong, 2001).**

This change not only dramatically altering the practices of business and industries globally and locally, but also the perception of values [1] of everyday people. The rise of the so call 'conscience consumers', who look for well-being, togetherness, and sustainable living from around the world in early 2000 **(Ray & Anderson, 2001; Viewpoint, 2005)**, and recently in China [2] are clearly evidential **(Leong, 2010)**.

1. Values can be defined as *quantitative*, emphasising physiological and psychological needs (e.g. proper nourishment, safety, and affluence) and *qualitative*, emphasising spiritual needs and socio-psychological desires (e.g. intellectual cultivation, self-esteem, love, and solidarity).
2. According to a recent large scale research: 'Lifestyle China', over 90% of middle-class households in urban China opted for environment protection over economic development for their own cities.

2. The arise of DfS and its learning in China

2.1 The DfS Arise

In reaction to the change above, a systemic change, which aims to sustain economic growth, maintain people's well being while reducing the consumption of environmental resources has been proposed in the West around decade ago. Such change emphasis much on the education, promotion and practice of 'sustainable consumption' as a core strategy to achieving sustainable development in the long run.

At the same time, within the design arena, the idea of ***Design for Sustainability (DfS)*** ---an act of strategic design that aspire to conceive '*Sustainable Solution'* via product-services system to *satisfy* needs and quality of life of people while minimize the consumption of environmental resources --- has then been initiated to supplement the prevailed practice of ***Design for Environment (DfE)*** or eco-design for attaining swifter transition towards sustainability. **(Charter & Tischner, 2001; Leong & Manzini, 2006; Tukker & Tischner, 2006; Vezzoli, 2007)**

2.2 Brief review of DfS promotion in China

In collaboration with professor Ezio Manzini, professor Zhao J.H. [3] and professor Carlo Vezzoli in 2000 and 2003 respectively, the principle author of the paper has assisted and initiated the promotion of the concept of DfS, SPSS (Sustainable Product-Service System) and SpD (System-product Design) [4] via series of workshops and a few pilot projects at the key design universities in Hong Kong, Beijing, Hunan, Wuxi and Guangzhou of China. The idea of DfS has eventually landed on China.

2.3 Confrontation of the 'Old' and the 'New'

Though DfS was welcomed initially as a novel concept or idea, but it couldn't root properly at that particular period of time in China. Quite a number of student participants, who had taken part in the DfS or SpD workshops were doubtful about the practicality of solution-based approach of DfS for the industries of China **(Leong, 2008)**. In reviewing such feedback and experience, two fundamental reasons could be summarized.

2.3.1 Developmental Reality of China

The actual situation and the stage of economic development of China and the West were very much different at the early 2000. China's economy was still at the mounting stage of industrialization. For instance, China's manufacturing productivity shared 35.3% strong of the gross domestic product in the year 2003 **(Economy Watch, undated)**.

The whole industry environment was very much production and OEM (original equipment manufacturing) oriented then. It's obvious that China was still in its developmental phase of its ***product-based*** economy, while the West has been heading steadily towards a ***service-based*** alternative.

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3. Together with professor Ezio Manzini and the chief author of this paper (Benny D. Leong), professor Zhao J.H. from Hunan University has help to cofound the first DfS organization in China named '*the Chinese Network on Design for Sustainability'* in June 2001. Network members include Hong Kong Polytechnic University, Hunan University, Tsinghua University and Guangzhou Academy of Fine Arts.

4. SpD (System-Product Design) is "*a design approach and process which aims to identify, design and strategize needed products to be utilized within the Product-Service System (PSS) of a designated Sustainable Solution"* ***(Leong, 2002)***. A series of workshops had been conducted in Hong Kong, Guangzhou, Hunan and Wuxi by the chief author and Ms. Elaine Anne, Director of Kaizor Innovation Ltd. in 2003 for the promotion of the concepts of SpD and Design for Sustainability in China.

2.3.2 the Dilemma of 'Unlearning'

Under such economic reality, teaching and learning of industrial design within most design schools and universities in China were unsurprisingly ***production*** focused and ***product-based*** driven.

As a result, the promotion of Design for Sustainability (DfS) was not an easy undertaking, as learning of DfS emphasis first on the ***'unlearning'*** of product-based approach. It involves the up-take of, if not *contradictory*, an entirely alternative set of design skills, which post challenge for most physical-liking design students and conventionally trained faculties. Quite some of these ***contradictions*** could be experienced from the design inception to the finalization phases of typical industrial design project that can be enlisted in the following table:

phases of project	DfS learning	Industrial Design learning
research	- People-centered (real life context)	- User-centered (i-methodology [5] based)
analysis	- Socio-cultural driven	- Economic driven
ideation	- Co-creative (participatory)	- Expert mind set
design approach	- Strategic: service-based	- Operative: product-based
idea development	- integrated, system thinking	- linear, process thinking
design formation	- physical consumption alleviation	- materials production reinforcement
outputs	- dematerialised solution	- physical product

Because of the seemingly alienated nature of practice of DfS above, most leading design schools in China were having difficulty to align the teaching of DfS with existing design curriculum, or incline to set it aside as a 'decorative' pedagogic component of the mainstream syllabus within the industrial design discipline. As a result, teaching of DfS was unable to draw sufficient attention from students and the senior managements of design schools in China, and its promotion within design education arena had slowed down at around 2004 to 2007.

2.4 The return of DfS in China

Ironically, as China emerges recently into the 'bottle neck' of its ***production-led*** economy, -- which due to the appreciation of Chinese yuan [6], the widening social disparity [7], and

5. 'I-methodology' is a primitive form of user-based design methodology, which is about designers design with themselves or their friends in mind. ***(Lindsay, 2003)***.

6. From the year 2003 to 2008 alone Chinese currency (Yuan) had appreciated 21%, and the cost of China's manufacturing is merely 5.5% (compare to the 22% in 2003) lower than that of the US. According to *the Ministry of Commerce of the People Republic of China*, a further 3% rise of value of Chinese yuan will possibly driving most labour intensive industries such as textile, clothing, toys, furniture and electrical appliances bankrupt in China ***(as cited from Forex Finance People, 2010)***.

7. Today, there are large income, social inequities between the rich and poor in China. According to the recent survey by the CASS (Chinese Academy of Social Sciences) in 2009, the top 10% of the highest income population control 40% of country's assets, while the poorest 10% possess just 2% ***(Hickey & Kawamoto, 2010, January).*** And the income disparity between these two groups of people is 65 times, according to Mr. Wang Xiaolu, deputy leader of the National Economic Research Institute, China Reform Foundation. ***("Diagnosing China", 2010, September)***. This lead to inequalities of educational opportunities and accessibility to healthcare too. As grievances of China's poor is growing, it is central government's will to address it swiftly before big trouble erupts.

its rapid deteriorating environment [8] --- China has to move up to the value chain of its industrial economy, whilst anticipate its environmental and social problems with alternative developmental strategy.
Starting from the last 11th and the recent 12th five year plans, the Chinese central government has demonstrated its determination to seek for major socio-economic transitions for the future development of China, which includes…..

- turning export-oriented industries towards ***domestic-focused*** one;
- replacing high-carbon economy with ***low-carbon*** alternative;
- switching national-focused development towards ***people-centered enrichment***. **(CPEIN, 2010, August 16)**

Under this particular context of sustainable transition, the strategic, solution-based DfS has made its return and has been placed under the 'spotlight' of design and particularly, design education in China once again [9].

3. The myth of 'T' shape design training

3.1 The cause of change

At the same time, since there was a need for China's industries to move up to the value chain for seeking further growth, ***'innovation'*** has became a buzz word in the worlds of business and design just at the dawn of 2000.
In fact, because of the rise of Japanese industrial might in the 1970-80's, then the emerging industrial tigers of Taiwan and Korea in the 1990's, and finally the rapid developing 'world factory' of China at the end of 20th century, the urge of ***innovation*** for remodeling industries has originated much earlier in the developed West then. The phrases '***value innovation'*** and '***strategic differentiation*** have been diffusing and deepening within the business arena after the publication of 'the Experience Economy' *(by Pine B.J. and Gilmore J.H.)* in 1999 and the 'Blue Ocean Strategy' *(by Kim W.C. and Mauborgne R.)* in 2005.

3.2 Up rise of 'design thinking'

For industrial design, because of the rapid shrinking of business in the United States at the beginning of 2000 **(McGetrick, 2006, March)**, design industry leader IDEO has taken lead to advertise the ***strategic*** and ***design thinking*** skills of designer via publishing books and articles (particularly led by David Kelly and Tim Brown, founder and CEO of the company).

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8. Today, over 40% surface water and 90% of water in aquifers of China is unusable; about 40% of its land is affected by soil erosion. Acid rain affects one-third of its agricultural land and diminishing agricultural outputs. China's air carries suspended-particulate-matter loads that are more than twice the highest level of 'reasonably safe' standard of the World Health Organization. 400,000 people die yearly as a result of air pollution. Economically, it had cost 8 to 15 percent of China's GDP in 2007 alone ***(Economist, 2007; Economy & Lieberthal, 2007).*** Socially, because of rapid environmental deterioration in China, there are over 50,000 environmental protests in year 2005 alone. The total sum of cases of environmental litigation in 2008 is equals to the total of previous decade. And just in 2009, environmental proceedings have increased 87% from 2008. Environmental issue has become the ninth major cause of social unrest in China ***(Yang, 2010, September)***.

9. Two particular Networks related to DfS established just recently in China. One is the LeNs (the Learning Network on Sustainability), initiated by Prof. Carlo Vezzoli from Milan Polytechnic in 2007. It has extended to China as ***LeNs-China*** at around mid 2009, which is coordinated by Academy of Art & Design, Tsinghua University and with members such as, School of Design, H.K. PolyU. and School of Design, Jiangnan University. Another one is the ***DESIS-China*** (Design for Social Innovation and Sustainability Network of China) established in March, 2009 (which was promoted by Prof. Ezio Manzini and has involved six key design schools in China: the College of Design & Innovation,Tongji University; School of Design, Jiangnan University; School of Design, H.K. PolyU; School of Design, Hunan University; Academy of Art & Design, Tsinghua University and Guangzhou Academy of Fine Arts). The Network is developed base on the former connection once established in 2001 (pls refer to footnote 3).

For instance, in an article titled 'Strategy by Design' published by Fast Company in 2005, Brown stated that business strategy of large company *"often gets mired in abstraction"* **(Brown, 2005:2)**, while design and ***design thinking*** is inherently a prototyping process which is ideally to meet the needs of visualization and communication of strategy for business innovation.
In another article named **"Design Thinking"** within the world-renowned business journal—Harvard Business Review, Brown **(2008)** has further promoted *design thinking* and stated that:

> *"Design Thinking….is a methodology that imbues the full spectrum of innovation activities with a human-centered design ethos."* **(para. 1: 86)**
>
> *"as economies in the developed world shift from industrial manufacturing to knowledge work and service delivery, innovation's terrain is expanding. Its objectives are no longer just physical products; they are new sort of processes, services,…… ways of communicating and collaborating – exactly the kinds of human-centered activities in which design thinking can make a decisive difference."* **(para. 4: 86)**

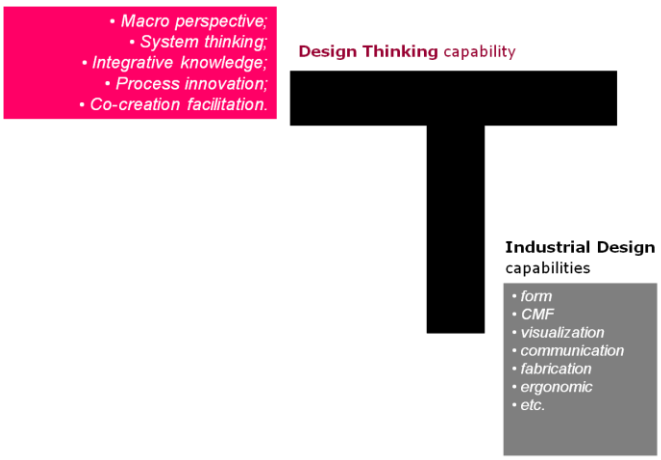
In other word, the *strategic* value for innovation of design thinking has also been pronounced.

3.3 The 'T' design thinkers

While affirming the strategic values of ***design thinking***, Brown also advocated the recruitment and promotion of the ***'T' shape people*** (or ***'design thinker'***) to enable innovation for business. In his view, the so-called 'T' shape people are people…..

> *"...have a principal skill that describes the vertical leg of the T—they're mechanical engineers or industrial designers. But they are so empathetic that they can branch out into other skills, such as anthropology, and do them as well."* **(Brown, 2005:3)**

As a matter of fact, Brown was not the only design leader who advocates the importance of the ***'horizontal'*** (design thinking) skill of the ***'T' shape designers*** within and outside the realm of design. Quite some leading design institutes such as Institute of Design, IIT and the d.school of Stanford in the States for instance, have long been pursuing the value of the *design thinking* training, which emphases the capabilities of macro (or big-picture/ strategic) perspective; system thinking; integrative knowledge (knowledge of related disciplines such as business, social science, marketing, etc.); process innovation; co-creation facilitation **(Fig.1)**.



(Fig. 1) the emphasis of 'Horizontal' capacities of the 'T' shape training of Industrial Design.

These design schools alleged that *design thinking* as methods can be applied to many real world problems such as *"catalyzing organizational transformation, defining new markets, designing new experiences and shaping corporate strategy."* **(Banerjee, 2008:20).**
In other words, once a designer possessed *design thinking* capabilities, he or she could take on various types of design works such as service design, system design, organizational design, business innovation, etc. and even social design.

4. The risks of blurring the 'old' discipline for DfS

4.1 A rush towards 'T' shape design training

Back to China, since two core developmental concerns of…..***(i) turning 'made in China' to 'create in China'*** and ***(ii) balancing 'environment' and 'development'*** have became top national agenda since 2000, industrial design education in China has been aiming ***massive*** and ***high***. With annual enrolment of over 14,000 students today (was about few hundred in the mid 1990's), and more and more shifting from ***vocational*** towards the ***'T' shape*** strategic, innovative training.

Such changes within some design schools have started even at the undergraduate or BA level. For example, in 1996, with the arrival of new head of school, the School of Design in Hong Kong Polytechnic University initiated a revolutionary BA program, which design teaching and learning was to be redefined. The whole curriculum was broad, multi plus inter-disciplinary based. Core subjects and projects were ***themes-based*** instead of discipline-specific. Students were encouraged to practice team work, multi-skill design, integrated, strategic thinking, while exploring deep in user-centered, socio-cultural issues **(Lo, 2003)**. Unfortunately, the whole ***'experiment'*** couldn't last long, while immediate feedbacks from the industry were not so positive that the ***'good-will'*** reform ceased in 2002 abruptly.

4.2 Queries of being design 'generalist'

Some of these trials of remodeling industrial design profession in design education couldn't simply be judged as either *right* or *wrong*, especially within a short timeframe. However, there are multi-perspectives to be contemplated while making similar attempts, particularly for teaching and learning of DfS in the context of China today. For instance….

- ***Economic perspective***

  No matter how much we (as a designer or design educator) would prefer to see a swifter removal of the title of **'world factory'** from China, we have to accept the fact that…
  [a] China's economy is still heavily rely on manufacturing today [10], and
  [b] even if it could evolved into a more sustainable economy with smaller quantity and scale of domestic trades, physical production and consumption would still be required. Not to mention a 'transition phase' towards possible sustainable economy is surely required. Within a report (which aimed to review the status of Hong Kong's economic development and offer strategic advice for its design education), Prof. Heskett **(2003)** has stated that…..

  > *"The future [of Hong Kong manufacturing industry] therefore cannot simply be viewed as a large scale transition away from OEM, and strategies to help this sector continue to be successful and competitive will also be required."* **(pp.20)**

10. In 2009 China's GDP share of manufacturing industry was still around 48.9%, while GDP sharing of the same sector in UK and the States was ¼ and 1/5 respectively **(Liu, 2010)**.

And therefore…..

> *"The design needs of OEM manufacturers need just as much attention as other forms of organization…."* **(pp 10)**

These remarks are worth for pondering about, as China's economy and manufacturing industry are anticipating similar experience of transition at the moment.

- ***Pedagogic perspective***

As design educator, we have advantages over our apprentices of early exposure of new design ideas [11], such as the concept of *design thinking* from the developed West. Additionally, with essential design skills learned at the early stage of our professional life, we've taken basic skills for granted. At the same time as we are likely to design syllabi from our own perspective, it's always tempting for us to plan in the ***'most advance'*** curriculum, and introduce the ***'latest'*** design theories to our students, forgoing level, or even nature of programme [12] that we are teaching. Needless to say, the 'T' shape design training is one of such ***'advance'*** and ***'hot'*** subjects that quite some design educators are much willing to promote in China these days.

However, we might forget, are students suppose to be taught or told to be a 'T' shape designer, no matter are they prepared or interested? And are the extended horizontal design competences really preferable? Or is it appropriate for China?

- ***Disciplinary perspective***

At a recent DMI conference held in July 2010 in London, Geoff Mulgan, the director of Young Foundation (the world's leading centre for social innovation) explained how designers 'entered' the social entrepreneurs space but failed because of their **'naivete'**, lacking of domain knowledge[13], hence inability to make change. The idea of extending the ***horizontal*** capabilities of design or promotion of ***design thinking*** as new design skill has also been queried by renowned design scholar Don Norman and design practitioner Kevin McCullagh just recently. Norman **(2010)** simply disagreed the claim of either the uniqueness of *design thinking* or designer's right to hold monopoly on creativity. He argued that……

> *"what is being labeled as "design thinking" is what creative people in all disciplines have always done."* **(para. 3)**
>
> *"design thinking is a public relations term for good, old-fashioned creative thinking."* **(para. 5)**

While McCullagh **(2010)** queried that…..

> *"without a strong vertical stack of capabilities that are relevant to their chosen problem domain, designers stop being designers - and join the legions of free-floating generalists."* **(para. 8)**

As a matter of fact, since the whole notion of 'T' shape people was originated from

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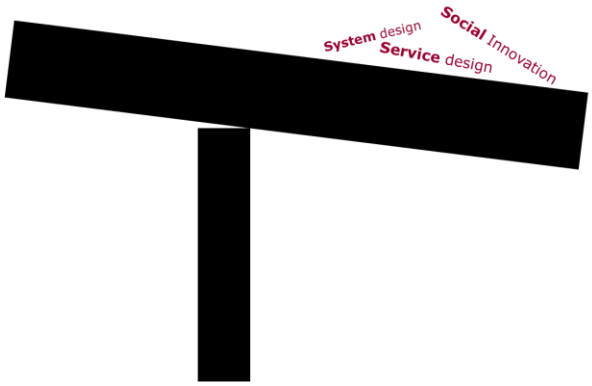
11. For instance, design educators have opportunities of attending international design conferences and or visiting leading design institutes abroad.
12. Industrial design programmes in China are traditionally developed from Arts and Engineering disciplines. 'Design' is yet a very new discipline to be developed in China. The notional graduate or undergraduate awards of BA, BEng, BSc, Mdes, MFA, MA, MEng, MSc or Mphil can be confusing for inexperience educators or newly established design institutions in China still today.
13. Designers who enter the field of social design are normally quite unaware of their new domain's background, who often came up with failed ideas that were tried decades ago according to Mulgan **(as cited in McCullagh, 2010).**

management consultants before IDEO popularized it in the noughties, there are reasons for cautious about its recent popularity in design.
In addition, not long after the publication of Brown's article of "Design Thinking" in HBR, another article titled "The Innovator's DNA" was publicized. It has released result of years of studies about ***creativity*** by a group of business management professors. And their proposed approach resembles much of the ***design thinker's profile*** which Brown or IDEO has been promoting these days[14] **(Dyer, Gregersen & Christensen, 2009).**
In fact plenty of intelligent people are as strong or stronger than designer in term of the so-called 'T' shape capability or even ***design thinking***.
Therefore, instead of trying to expand ***horizontal*** skills for reaching new or higher grounds for design, we should re-examine seriously the risk of over stretching of horizontal capability whilst diminishing our ***vertical*** stack of expertise **(Fig.2)**.



(Fig. 2) the risk of over stretching horizontal capability of 'T' shape design training.

5. Belief of learning the unlearned

5.1 revisiting design basics

In view of a rapid convergence of the three transitions (towards *[i]digital connectivity, [ii] service economy and [iii] sustainable culture*--- please refer to para. 1) at the turn of the last century, industrial design has seemingly became an ***odd*** and ***embarrassing*** discipline, or an approach better to be ***'unlearned'*** in favour of the promotion of the immaterial practice of DfS.
However, we believe that industrial design as a discipline should be ***revisited***, and its potential for green applications should be ***explored***.
In term of learning of DfS within industrial design, the basic value and the set of physical skills of the discipline should be ***revised*** and treated as new ***'essentials'*** for the promotion of DfS [15].
Our argument is based on the ***reality*** and a ***vision*** as follows:

The Reality— To transform the 'world factory' into a sustainable economy, a transitional period is required. During this period, creative, sustainable products are essential to enable a smoother transition of economies of today towards a better and preferable one.

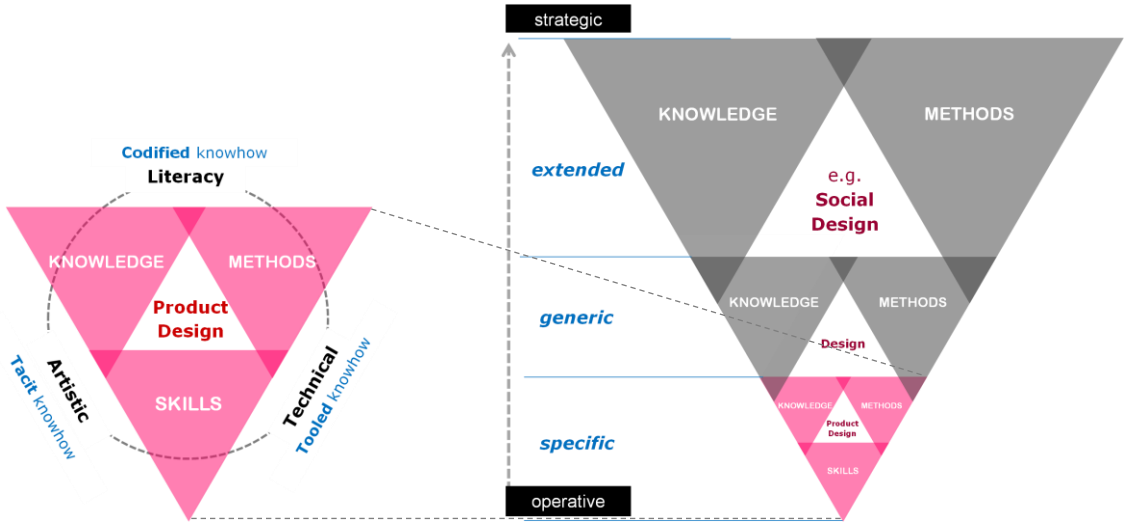
A Vision— A sustainable society that we would like to envision, will rely on large

14. The proposed 'Five Discovery Skills' of Associating; Questioning; Observation; Experimenting; Networking by Dyer, Gregersen and Christensen **(2009)** in their article resemble very much the basic emphasis of design thinkers profile of Brown **(2008)**.
15. To reinforce the idea of lessening of mass production hence consumption, **Product Design** should be revised (from the tradition Industrial Design learning) as a new discipline which focus on green, batch and customised design and production. Design for Environment or Eco-design learning should also be modified and be taught as the core basic of this revised discipline.

variety of customized services, supported by specially designed products (mostly systemized to be shared) for serving people's daily needs. These products may not be mass produced anymore. Apparently basic knowledge and skills such as form semantics, prototyping skills, and knowhow of ergonomic, material and fabrication technique of industrial design today will likely be ***revised*** with new significance.

5.2 Shape 'V' instead of 'T'

With the ***vision*** and ***reality*** in mind, we would like to advocate the training of 'V' shape designer rather than the 'T' shape thinker that have been promoting today.
For a 'V' shape designer, the required design training start from (and very much found on) the bottom tip of the deep 'V' expertise. Acquiring relevant ***skills***, ***knowledge*** and ***methods*** **(pls refer to Fig.3)**, accumulated capabilities from ***specific***, ***generic*** to the ***extended*** levels and sharpen through years of training and practice **(see Table 1)**.



(Fig. 3) the core and initial framework of 'v' shape product-based design training.

	***Product Design** training* → → → → →		***Extended Design** training*
	SPECIFIC	**GENERIC**	**EXTENDED**
SKILLS *(tacit-based knowhow)*	- handling of surface geometry - 3D visualization/ drawing - empathy - model making - etc.	- creativity - visual sophistication - problem framing - communication skill - etc.	- leadership - opportunity framing - analytical thinking - collaboration, etc. **(+ extended design skills)**
KNOWLEDGE *(codified-based knowhow)*	- form aesthetics & semantics - 3D principles + related color theory - material properties - basic mechanic - fabrication process - drafting - ergonomic/ human factor - Eco-design (DfE), 4DfD, PDfS, etc. - etc.	- critical, creative thinking - representational drawings - visual literacy - computer literacy - user research / UCD - design theory & methodology - Art/ cultural appreciation - design history - DfS,	- design management - system/ strategic thinking - process innovation - cross-silo facilitation, etc. **(+ extended domain knowledge)**
METHODS *(tooled-based knowhow)*	- scale, proportion & orientation - color wheel - I-methodology - CAD/ CAID - Task analysis - LCA, MET, strategic wheel, etc. - etc.	- brainstorming, mind mapping, etc. - figure, objective, perspective drwgs. - Photoshop, AI, etc. - observation, contextual inquiry, etc. - story boarding, map/ matrix - etc.	- 5Cs analysis - strategic mapping/ frameworks - NPD, PCP, PIP, etc. - product development strategy - creative workshop, etc. - scenario, SOD, PSS, etc. **(+ extended domain methods)**

(Table 1) examples of capabilities required for the 'v' shape product-based design training.

The idea of such 'v' shape product design training focus much on the core expertise and yet provide a perceivable framework of learning --within a boundary of designated ***tacit*** (artistic), ***codified*** (literacy) and ***tooled*** (technical) knowhow [16]. So as to avoid probable drawbacks of 'T' shape design training of over-stretching the horizontal capabilities (without knowing where to start or stop), while weakening of vertical expertise and become free-floating generalists.

5.3 Product Design for Sustainability?

In favour of promoting the 'V' shape design training for enhancing DfS learning, we would like to focus on the 'product' led DfS (also named as ***Product Design for Sustainability***--PDfS) in this paper. Unlike the 'system' based DfS (or called ***System Design for Sustainability***--SDfS), PDfS focus on ***product-based*** solution and rely more on the operative, core (the bottom tip of the 'V' shape) competences of design training.

To summarize, the notional PDfS embraces the followings:

(1) Beliefs and Purposes

The basic beliefs and purposes of PDfS are….

- ***Subjective based*** (or i-methodology) user-centered design ideology as a starting point of design. Emphasis of the ethics of designing things for others as for oneself.
- ***Individuals*** is vital for enable collective change towards sustainability. Every seemingly tiny contribution of individuals count, and could stimulate, influence many more others.
- ***Product as a key*** to drive for (both behavioral and mentality) changes of individuals. Enable people to act and take responsibility of their daily consumption.
- ***Product as a vehicle*** to alter social perception and enable sustainable forms and/ or practices of production and consumption.

(2) Potentials

The practice of PDfS could be employed …..

- To promote sustainable lifestyle or way of living via creative product solution; or
- To design and strategize product(s) to be utilized within the Product-Service System (PSS) of a designated *sustainable solution* ***(pls. refer to footnote 4)***; or
- To revitalize indigenous crafts and skills or small scale fabrication for facilitateing knowledge and capital exchange among social strata of the marginalized and the affluent ***(pls. refer to the two specific cases presented below.)***.
  (Leong, 2002; 2009; Siu, Pan & Lee, 2009).

6. Sample cases of practice of PDfS

Based on the beliefs and purposes above, we would like to briefly present two sample cases of training and practice of Product Design for Sustainable (PDfS) at the School of Design, Hong Kong Polytechnic University (SD, HK PolyU) in China.

16. **Tacit** knowhow of design come from the combination of artistic skills and knowledge that could only be learned by doing and experiencing, while **codified** design knowhow consolidated from the fusion of literate knowledge and methods that can be encoded in various symbolic forms such as textual, audio, visual, and acquired by anyone who understand the code (e.g. visual and form language); **tooled** knowhow of design are accumulated from both technical skills and methods through years of training and practice. It can be embodied into forms of physical artefact (hard-tooled), programme, standard process or method (soft-tooled).

6.1 A Case of PDfS Training

The first case is about the teaching and learning of PDfS. There is a subject named ***Sustainable Product Design-SPD*** for the final year students of Industrial and Product Design at SD, HK PolyU. The subject aims to reinforce students' learned design skills, knowledge and methods, while introducing them the ideas of Design for Environment (DfE), system design thinking and most importantly learn to develop products from a broader social and ecological context based on the notional DfS. Every year new project(s) will be designed base on the outlined course syllabus. In the year 2009, students were asked to take up **three particular design challenges** during the course.

(1) 'Mini' project

The 'mini' project of the **SPD** subject was a short, warm-up design exercise at the initial stage of the subject. Students were required to make use of the discarded PET (Polyethylene Terephthalate) bottles and come up with a simple design, which explore the quality of the original material and can be reproduced with simple hand tools at home. In addition to the seminars that course tutors had provided, students were encouraged to conduct…..

[i] field and desktop research for locating where discarded PET bottles could be collected within Hong Kong (logistic issue) and

[ii] tests to find out the physical and structural possibilities of PET bottle.

Hand-on design experience was the key of emphasis of this small project **(Fig. 4)**.

(Fig. 4) the 'mini' project emphases on *hand-on* testing, mock-ups making and prototyping.

(2) PDfS project (phase I)

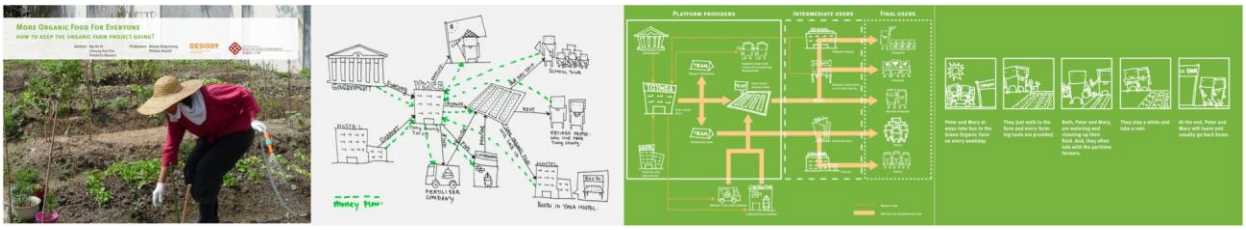
The second challenge for the students is another short design undertaking is the phase I of a two stages project named PDfS. The design undertaking aimed to introduce students the basic concept and tools of system design particularly related to sustainability, and as a preparation for them to anticipate the phase II of the project.

At this phase, students were asked to work in groups and…….

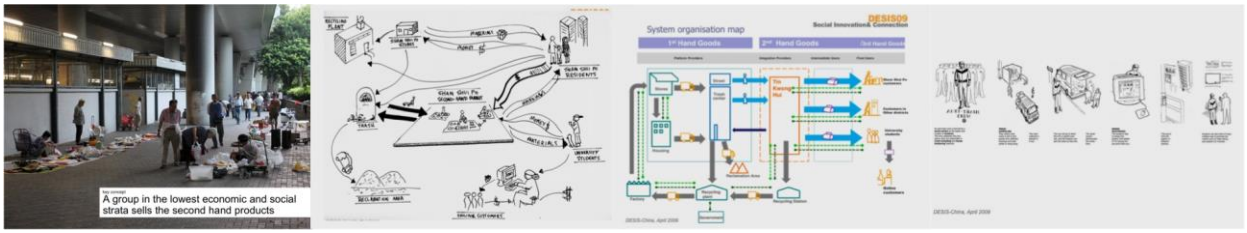
- to conduct ***field research*** to obtain deeper understanding and insights of a given promising case.
- to ***visualize*** and ***communicate*** the case with selective photos, images and text.
- to ***analyse*** the documented case (focus on weak spots and links of the usability, desirability, socio-cultural and socio-environmental quality of the case), and
- to ***redesign*** and improve the case.

Throughout this design undertaking, tutorials, reference seminars, samples of tool (such as *mental model*, *system map* and *story boarding*) were provided. Here under are two selective design outcomes (the *"Sustaining the green organic farm"* project **(Fig. 5)** and

the *"A second life for second-hand market project"* **(Fig. 6)**) of the exercise, which demonstrated students had initially managed the basic skill of system thinking and design.



(Fig. 5) the design outcomes of project "Sustaining the green organic farm".



(Fig. 6) final design and visualization of project "A second life for second-hand market".

(3) PDfS project (phase II)

The phase II of the PDfS project is the core of the whole subject.

At this specific stage, students were expected to design a new product together with the women sewing workers from the Hong Kong Women Workers Association (HKWWA) [17], and based on discarded banner materials and marketing advice provided by the ECOLS shop (a company which trades recycled furniture, household products and bags out of used materials.). With this particular project setting, students were expected to anticipate three major tasks below:

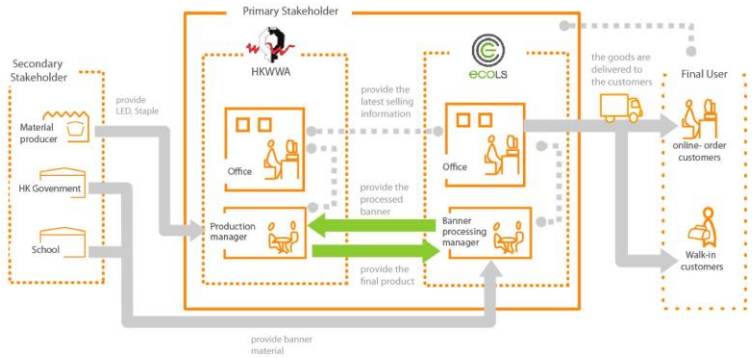
[i] Design research --- study and analyze of sewing skill of the workers; properties and construction possibilities of the banner materials; organizational and operational characteristics of HKWWA, and potential product competitions in the market.

[ii] Product design --- make use of the used banner materials and come up with a competitive design.

[iii] Solution visualization --- visualize initial idea of services flow for the operation, production and marketing of the new design.

Other than backed by the professional expertise from the ECOLS, HKWWA and the SD faculties, the students were expected to made use of the learned knowledge from both the 'mini' project and the first phase of PDfS undertaking (for e.g. the tool of *system map* **(Fig. 7)**.

17. The HKWWA is an NGO which has been established (in 1989) to assist low income, marginalized women workers in Hong Kong. For example, the sewing workers who became unemployed after the garment factories moved to mainland China at around 1980s. HKWWA has also initiated a few recycling programmes and Eco-friendly community services (e.g. soap making out of used oil, second-hand shop, green cleaning services, etc.) at around years 2005 to 2008.

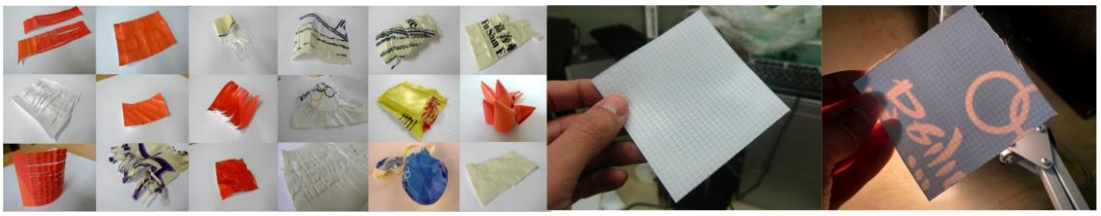


(Fig. 7) A sample of system map employed by a student group during the 2nd phase of the PDfS project.

At the end of the subject, two projects were selected by ECOLS, the HKWWA and the teaching team for further development. Eventually, one of these two projects has been further developed and commercialized by our SDWork (an unique platform established within the School of Design to encourage entrepreneurship via commercializing items designed by talented students.) just recently. The project has been named *'Living Pixels'* by the students who created them **(Fig. 8)**.

(Fig. 8) The *'Living Pixels'* series and the three design students (Match, Catherine, Kay) who created them.

'Living Pixels' is a series of colorful lightings which are mainly made of used banner (as light diffuser) and discarded lamp stands. The originality of the design came from the translucent property of the PVC banner material (usually printed with semi-solvent or solvent ink at one side while remains white at the other.), which the students have discovered after rounds of material tests, **(see Fig. 9)** structural experiments and thorough process of discussion prototyping



(Fig. 9) the process of material testing has helped to reveal the translucency property of the banner material.

together with the skillful sewing masters from the HKWWA **(Fig. 10)**. These wonderful series

(Fig. 10) The process of realization of the final collection of 'Living Pixels'.

of creative lightings can be designed and made flexibly, differently every time, since it's constructed mainly by many standard pieces of square-formatted banner 'pixels' and discard lamp stands collected from garbage stations and second-hand shops.

Through the 'Living Pixels' design series, the forgotten sewing skill of the women workers (and their professional pride) has been revived. With the 'Living Pixels' collection is now on sale online by the SDWorks, we are able to witness an alternative format of small-scale production and consumption practice spawn locally in Hong Kong.

6.2 Reviving Indigenous Craftsmanship via Product Design

The second case is about an actual yet experimental project of employing product design skill for social innovation and sustainability in Hong Kong. The project named ***'transforming wooden cart'***, was one of the undertakings within a larger design research initiative started at mid 2007 [18]. This project was about reviving traditional ***wooden cart*** making (a declining craftsmanship) into new design and alternative form of production and consumption practice.

6.2.1 background of project

The ***'transforming wooden cart'*** project is led and coordinated by Mr. Brian Lee, the second author of this paper and an experienced furniture and product designer. The project focus on a trolley shop named 'Yau Kee' (locate at one of the poorest district, Sham Shui Po of Hong Kong), owned by an old couple Mr. and Mrs Li who have been specialized in wooden trolley **(Fig. 11)** production for over 50 years. The practice of wooden cart fabrication by Yau Kee has been socially viable and environmentally sound all these years. For instance, the construction materials are discarded bed planks and used tires, while the finished products are mainly made and sold for the construction workers and street cleaners as handy collection tool within the same district **(CMP, 2007)**.

18. The design research initiative was named "In Search of Marginalized Wisdom" initiated by Mr. Siu King Chung from the SD, HK PolyU and sponsored by Sham Shui Po District Council of Hong Kong.

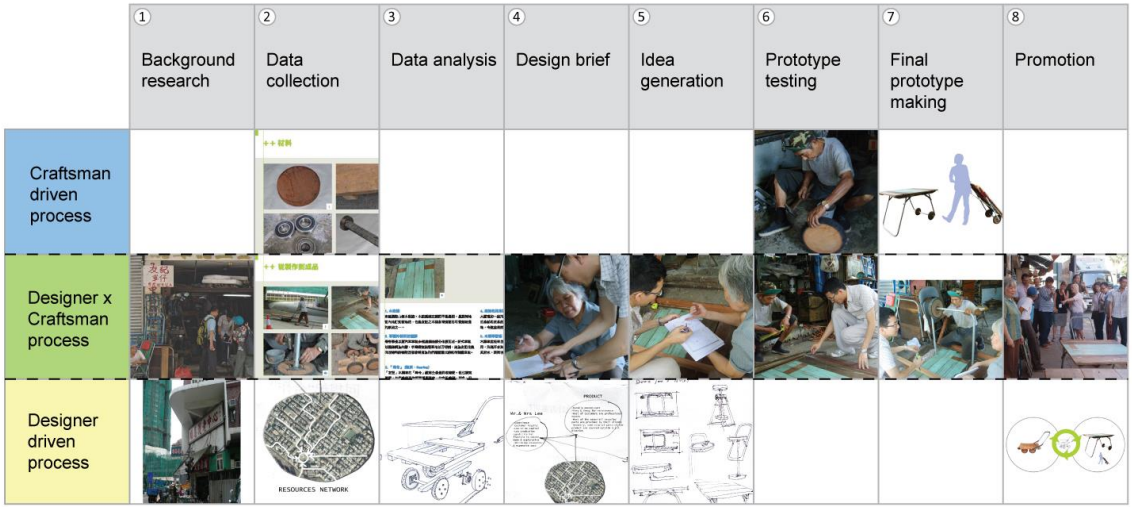
Yau Kee trolley shop is a typical handicraft's workshop which operates in a unique, small and local scale, highly connected with proximate business partners and clients within a urban district. It is also a craft based business which carries the DNA of local culture and conserves of indigenous values of the community of Sham Shui Po.
However, as mass produced metal carts became more popular and prevailing, Yau Kee's craft based business model and skill might soon be eliminated through keen competition.

(Fig. 11) The old couple and owners of Yau Kee, and their environmental-friendly wooden cart.

6.2.2 Transformation of Declining Handicraft

From the perspective of the second author of this paper – Mr. Brian Lee, the urban typed handicraft's industries residing in the old communities are full of vitality and social relevance. This model of handicraft and fabrication could be learned, revived or even replicated for those resembled social contexts of Hong Kong.
Lee also believed, product design as a physical-based discipline could be employed to help to regenerate traditional designs while preserving the essential techniques, processes and values of those fading craftsmanship like *wooden cart making* in Hong Kong.

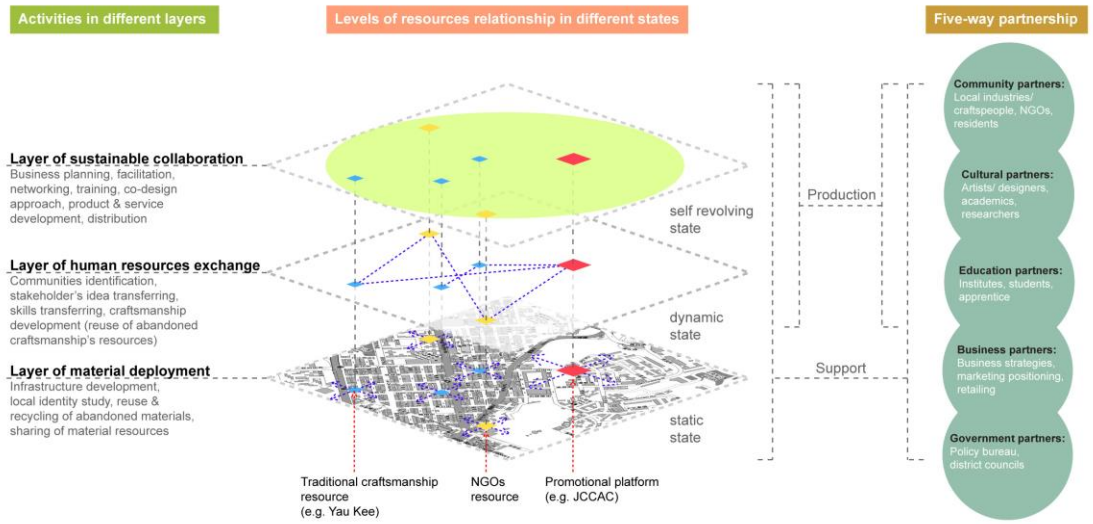
In order to attain this, three concurrent product co-design process *([i] the craftsman driven process, [ii] designer plus craftsman process and [iii] the designer driven process* **Fig. 12** *)*have been planned for the transforming the wooden cart making skill into a new design and product solution **(Siu, Pan & Lee, 2009)**.



(Fig. 12) The three concurrent processes of transforming wooden cart making skill into a new design.

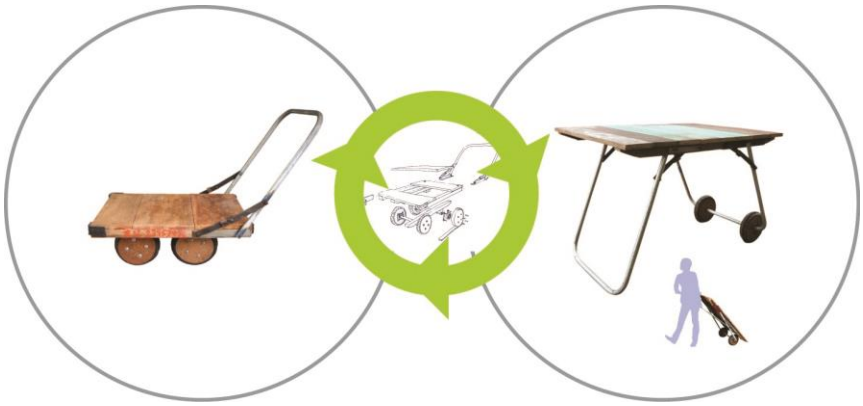
Which was also backed by an ***operation model of design for social concern*** **(see Fig. 13)** that outlined the relationships of activities involving the exchange of materials and human

resources, and the ways of partnership proposed by Siu, Pan and Lee **(2009)**.



(Fig. 13) The Operation Model of Design for Social Concern.

In the end of the application of the co-design process above, a simple yet innovative design (with some simple rearrangement and reuse of materials and skills, the old wooden cart has been transformed into an entirely different design) -- a table has been developed **(Fig. 14)**. Later the year, together with Yau Kee, Lee has developed further the wooden cart furniture series into the categories of stool and rack too.



(Fig. 14) The old wooden cart has been transformed into a new design --- a transportable table.

7. Conclusion

When most design professionals reckon that ***product design*** might become out-mode and irrelevant due to the rapid transitions towards a service-based sustainable economy, both the ***'transforming wooden cart'*** and the ***'Living Pixels'*** projects presented above have demonstrated just the opposite-- solid product design competences are invaluable. Not only the learning and training of DfS could begin with….

- ***design skill*** (in preference to strategic *design thinking*);
- ***physical products*** (instead of the *immaterial solution*); and
- ***emotion empathy*** (rather than mere systemic, *rational analysis*)…..

but also product design skills could be employed for preserving indigenous crafts and material cultures while addressing social issue and promoting sustainable forms of business practice for a better future.

Therefore, before we blindly mimicking the 'high flying' *design thinking* training from the West, and believe that the *'T' shape* mind-set will help to transform design from the world of ***form*** and ***style*** to that of ***system*** and ***strategy***, we need to pounder twice about this conception again.
After all, ***"strategy without form is an empty container these days"*** **(Klinker, 2008:30)**, and that we believe, it's time to relearn the ***'unlearned'*** core of design for better promotion of DfS in China and for China.

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