Achieving the Success of Sustainability Systemic Design Through Data Visualization Approach

Ying Chuai[1] and Haiwei Yan[2(✉)]

[1] Liquid Studio of Accenture, 1687 ChangYang Road, 5F, Building C4, Shanghai, China
ying.chuai@accenture.com
[2] Beijing Institute of Technology, 5 South Zhongguancun Street, Haidian District, Beijing, China

Abstract. Under the SDG goals put forward by the United Nations, all things, races, universities, governments, institutions and organizations on the planet are working together for sustainable development. The blue economy, which goes beyond the Globalized and the Green Economy. This economic philosophy was first introduced in 1994 by Prof. Gunter Pauli when asked by the United Nations to reflect on the business models of the future in preparation for COP3 in Japan where the Kyoto Protocol was decided. Starting from economy, ecology and culture, it is increasingly clear that it is possible to generate more revenue, while generating more jobs and still compete on the global market. But in this way of sustainable design, we need a very professional economics, ecological background, and long-term research and observation, for designers, it is difficult to quickly capture an effective solution, so benefiting from data system is an inevitable necessity for company to direct the sustainability business operation.

This article introduces new ideas about sustainability system design with data and elaborates on how to collect data, which can be collected from computer modeling or real-world measurements; analyzes all inputs and outputs in the system; calculates carbon emissions and other impact; and presents all the data in a visualized way, so designers can choose the most appropriate solution.

Keywords: Sustainability · Systemic design · Data visualization · Supply chain

1 Introduction

1.1 Systems Thinking

"Systems Thinking is a context for seeing wholes. It is a framework for seeing interrelationships rather than things, for seeing patterns of change rather than static snapshots" [1].

Looking through a systems lens can be overwhelming. As a system theorist Donella Meadows said System Thinking needs to see all dynamic changes and potential changes brought about by it [2]. The major characteristics of this systemic thinking are as shown in Fig. 1.

Therefore, systematic thinking can help us see the problem in a macroscopic view. In the current complex environment, it is easier to find the root cause of the problem than linear thinking.

S. Trzcielinski et al. (Eds.): AHFE 2021, LNNS 274, pp. 215–222, 2021.
https://doi.org/10.1007/978-3-030-80462-6_27

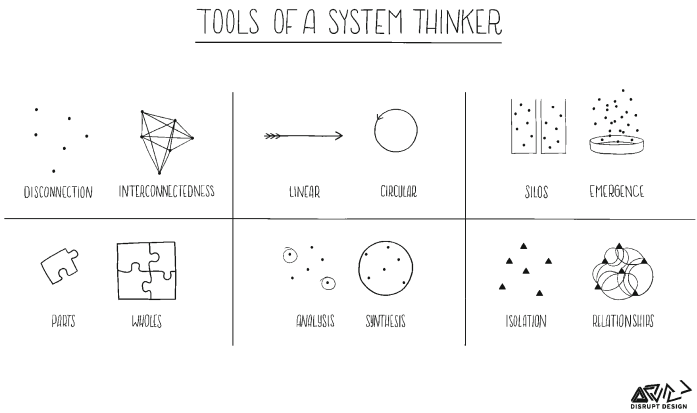

Fig. 1. Tools for systems thinkers: the 6 fundamental concepts of systems thinking (resource: Disrupt Design) [3].

1.2 Systemic Design

Systemic Design integrates systems thinking and human-centered design, with the intention of helping designers cope with complex design projects (also called Wicked Problems [4]).

Traditional design methods are inadequate to face the recent global challenges stemming from increased complexity as globalization, migration, and sustainability.

Systemic Designers need improved tools and methods to design responsibly while avoiding uninterested consequences/side-effects.

2 Systemic Design Methods and Tools

2.1 Systemic Design Methods

Since Karl Ludwig von Bertalanffy (1968) put forward the "general system theory" [5], system design has gradually been applied to artificial systems and management organizations. Treating productive organizations as complex adaptive systems allows a new management model to emerge in economical, social and environmental benefits (Pisek and Wilson, 2001 [6]). With the further improvement of society to the environment, systemic design has gradually produced theories such as industrial ecology (Frosh and Galopoulos, 1989 [7]) with multiple design dimensions. Therefore, systemic design requires strong interdisciplinary and cross-disciplinary design in the design stage. Disciplinary competence (Fuller, 1981 [8]). The systemic design initiative is addressing this problem by seeking new connections and relations between systems thinking and designerly ways of working. This is also the systemic design process and method that is more acceptable to designers.

2.2 Systemic Design Tools

One of the well-known tools is the system design toolkit (as shown in Fig. 2). Built by Namah in collaboration with shiftN, MaRS and SDA, the Systemic Design Toolkit

is a methodology and a library of tools based on academic research and human-center design expertise [9].

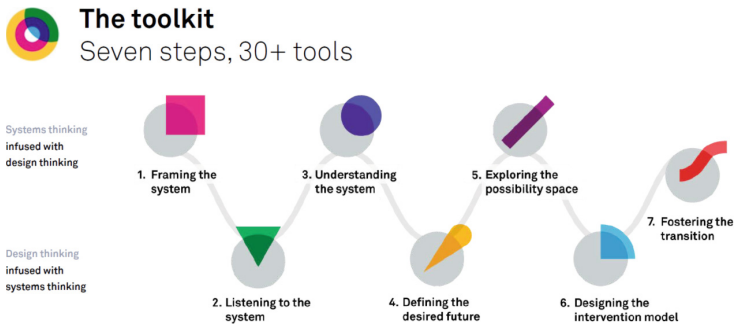

Fig. 2. The structure of the Systemic Design Toolkit (resource: Massimo Curatella. https://curatella.com/systemic-design-toolkit-virtual-design-thinking-barcamp).

It's based on the principle that Systems Change should be co-designed and co-created within the system and with the actor of the system, preferably, with the stakeholders in the same room. And provides tools to foster dialogue between the parts without requiring participants to master its inner working and principles.

The Systemic Design Toolkit is composed by seven steps: Framing the system (Systems Thinking); Listening to the system (Design Thinking); Understanding the system (Systems Thinking); Defining the desired future (Design Thinking); Exploring the possibility space (Systems Thinking); Designing the intervention model (Design Thinking); Fostering the transition.

2.3 Challenges

Among them, the first, third, fifth, and seventh steps require systems thinking. However, for designers and even corporate decision makers, the current systemic design has several difficulties that are difficult to be widely used:

- System thinking is very abstract and the cost of learning is high;
- Current system design theories and tools are biased towards manual drawing and analysis, which is less efficient;
- A research is only for one complex system, it is difficult to examine the relationship between multiple systems from a higher dimension, and it is difficult to produce a multi-system cooperation scheme;

Therefore, this paper proposes a systemic design visualization model. Using data sharing and visualization methods. Firstly, quantify the key factors in each system, digitize abstract thinking, and lower the threshold of use; Secondly, data can be automatically analyzed by the platform to efficiently generate valuable information, and by adjusting the data to achieve rapid comparison; Third, through the sharing of part of the system

data by enterprises, a matching network can be built together to achieve a more local, low-cost, and recyclable economic cooperation forum.

3 Systemic Design Visualization Model

3.1 System Unit

In order to visualize the core content of the system, this research first clarifies the core elements of the system. System theorist Donella Meadows [2] proposed "A system is not just any old collection of things, a system is an interconnected set of elements that is coherently organized in a way that achieves something", and he concluded a system must consist of three kinds of things: elements, interconnections, and a function or purpose (as shown in Fig. 3).

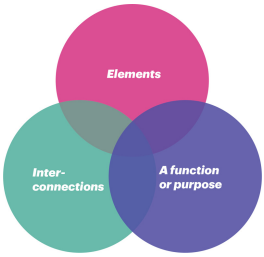

Fig. 3. Three kinds of things in a system.

Therefore, based on this, this paper establishes a systemic design visualization model. From the three necessary components of the system, the system unit in the system is deduced. Through the system unit, the data input dimension is clarified, and the visualization chart is displayed by obtaining the corresponding data (as shown in Fig. 4).

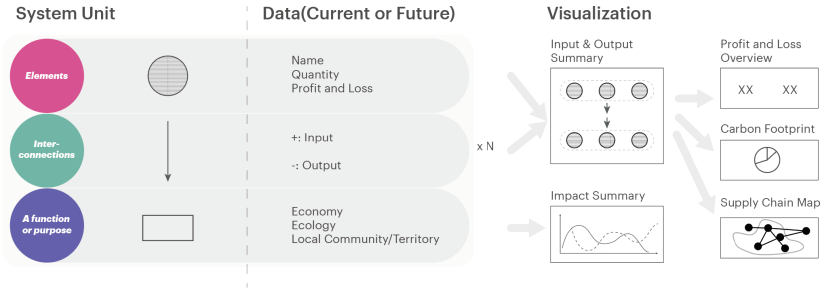

Fig. 4. Systemic design visualization model.

3.2 Data

Elements. In order to be able to calculate the scale of the elements and the corresponding benefits and costs, each element needs to have a clear name, quantity, and profit or loss per unit quantity.

Interconnections. The interconnections developed within the system generate the open system itself, and in the Systemic Design: the outputs (wastes) of a system become the inputs (resources) of another one [10]. Therefore, in order to be able to perform subsequent input and output calculations and supply chain network analysis, interconnections need to be marked as "+" (input) and "−" (output).

A function or Purpose. Since in the systemic design, the design integrates the three perspectives of economy, humanities, and engineering, this model defines the function or purpose of each system unit as whether there are three aspects of influence, namely economy, ecology, and local community/territory is shown in Fig. 5 [11].

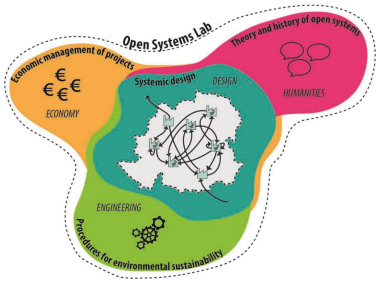

Fig. 5. Relationships between the four courses of the lab [11].

3.3 Visualization

Through data collection and corresponding calculation formulas, the following data visualization charts can be generated:

Input and Output Summary. Through the calculation of all the elements, quantities and interconnections (input/output) in the system unit, the corresponding total chart can be obtained. Through this chart, the designer can clearly distinguish the total input and the total situation of certain companies from the system.

Impact Summary. By judging the purpose or function of each transition in the system unit, the impact of each type of system design in the full life cycle of the production process can be restored, and the designer can adjust the plan according to the specific alternative.

Profit and Loss Overview. In order to monitor the economic impact of the system solution on the enterprise in real time, through all the elements, quantity and direction (input/output) in the system unit plus the calculation of its profit and loss, the most simplified profit and loss overview can be obtained. The designer checks this table in real time to ensure the profitability of the company.

Carbon Footprint. In order to ensure that the design plan can have a sustainable impact on the environment, the carbon footprint of the plan can be viewed in real time by inputting and outputting summary data, plus the local Carbon emission calculation formula.

Supply Chain Diagram. By inputting and outputting summary data, combined with each company's own information and local location, the system can automatically calculate supply chain costs and environmental impact, and finally recommend a suitable supply chain network map.

Therefore, this model can convert steps 1, 3, and 5 of the 7-step process in the above-mentioned System Design Toolkit into a data visualization method to analyze the current system, and directly explore possibilities by adjusting the data to achieve systemic design is easier to understand and apply.

4 Enterprise Systemic Design Co-creation Platform

This platform could have transformed the first, third, and fifth steps of the 7-step process in the aforementioned Systemic Design Toolkit into a data visualization method, making the system design easier to understand and apply. Therefore, the 7-step process for using the platform is:

Step1: Framing the system (Systems Data). Complete the platform registration and enter the basic information of the company, including name, headquarters, number of employees, fixed assets, etc.
Step2: Listening to the system (Design Thinking). Designers or decision makers need to disassemble the system to minimize the production steps (i.e. system unit) according to the industrial process of the enterprise, and put the elements involved in each step according to name, quantity, profit and loss, whether it is input or output, the target or function classification is input into the platform.
Step3: Understanding the system (Systems Thinking). The platform will analyze according to the corresponding data and calculation relationship. The designer can place the auxiliary understanding system according to the following icons. Take a Chinese animal husbandry company as an example is shown in Fig. 6.
Step4: Defining the desired future (Design Thinking). Based on the above-mentioned visualization plan, alternatives can be adopted to make stakeholders consistent in value. By imagining how we can improve the future environment of individuals, organizations and society, together we design an ideal future.

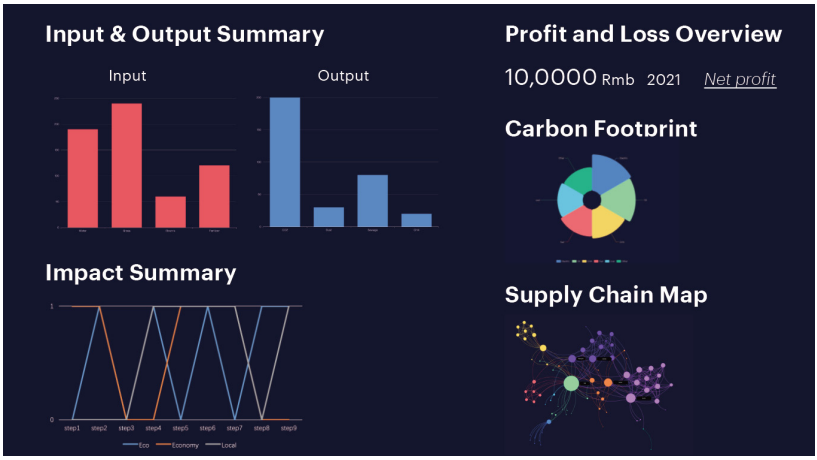

Fig. 6. Systemic data visualization of a Chinese animal husbandry company.

Step5: Exploring the possibility space (Systems Thinking). In order to make the whole process reasonable, designers need to explore various types of possible interventions to ensure that they cover the conditions that occurred in the initial research activities. Through brainstorming, designers can try to adjust the quantity, type, manpower or transportation cost of each raw material on the platform, and see the corresponding visual chart changes in real time.

Step6: Designing the intervention model (Design Thinking). Based on the above exploration, clearly improve the innovative plan, and find a suitable supply chain partner according to the supply chain map.

Step7: Fostering the transition. Plan the transition towards the desired goal by moving from the Minimum Viable Product (maybe the Minimum Viable Solution in this case) to the full implementation of the intervention model.

5 Discussion and Conclusions

In response to the current complex environment and social progress, this article introduces the use of data visualization to improve system design methods and promote new ideas for system design to be widely used. It explains in detail the visualization model of the system design, including how to divide the data dimensions, how to use the data to analyze the input and output of the system, calculate carbon emissions, and visualize better supply chain methods. However, due to the lack of practice in real companies, this theory needs further exploration and iteration in application. The design of the data dimension is only a preliminary stage, and it needs to be verified and supplemented by practice.

References

1. Senge, P.M.: The Fifth Discipline: The Art & Practice of a Learning Organisation. Random House, London (1990)

2. Meadows, D.H.: Thinking in systems: a primer. Earthscan (2010)
3. Acaroglu, L.: Tools for systems thinkers: the 6 fundamental concepts of Systems Thinking. Medium, Disruptive Design (2017)
4. Buchanan, R.: Wicked problems in design thinking. Des. Issues **8**(2), 5–21 (1992)
5. Von Bertalanffy, L.: General System Theory. George Braziller Inc., New York (1968)
6. Plsek, P.E., Wilson, T.: Complexity, leadership, and management in healthcare organisations. BMJ **323**(7315), 746–749 (2001)
7. Frosch, R.A., Gallopoulos, N.E.: Strategies for manufacturing. Sci. Am. **261**(3), 144–153 (1989)
8. Kuromiya, K., Fuller, R.B.: Critical Path, p. 331 (1981)
9. Curatella, M.: Systemic design toolkit by Kristel van Ael of Namahn | Massimo Curatella. Massimo Curatella (2020). https://curatella.com/systemic-design-toolkit-virtual-design-thinking-barcamp
10. Barbero, S., Agnese, P.: Systemic design and policy making: the case of the Retrace project. FormAkademisk-forskningstidsskrift for design og designdidaktikk **11**(4) (2018)
11. Battistoni, C., Barbero, S.: Systemic design, from the content to the structure of education: new educational model. Des. J. **20**(sup1), S1336–S1354 (2017)