

About how 'was' 'becomes': emergence of a sustainable spatial-energy system

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Abstract

In this paper the relationship between the complexity of a spatial system, sustainability and the type of design principles used is researched. In an analytical framework design projects are phased in timeframes and are placed in a complexity-sustainability field. The conclusion is that we are living in a timeframe in which complex systems are most common and that a new planning phenomenon might emerge based on the right impulse at the right time: swarm planning. The aim to reach a fundamental change in our spatial system, leading to a jump ahead in sustainability, is possible by adjusting our designs and planning system to the new laws of swarm. To find the right sustainable impulses to meet these laws an image of a backtracked landscape is useful. Not taking into account the complexity context we are in and not adjusting our planning system accordingly means heading for failure.

Keywords: planning and design, sustainability, complexity, swarm planning, energy.

1 Introduction

As the World population continues to grow as rapidly as it does nowadays and the growth of wealth in developing countries holds up with the standards of western countries we might need more natural resources then ever will be available on one earth. One side of the solution is that the depletion of resources by the rich communities should be diminished by a factor 20 as Ehrlich and



Ehrlich [1] and Van den Dobbelsteen [2] describe. In spatial planning this challenge is not yet on the agenda. And the spatial-energy system is not sustainable yet.

As the world becomes rapidly more complex the urge to find simple, one-dimensional, solutions is huge amongst designers. The focus on only one aspect of the whole neglects the complete picture. The effect of this way of looking at things is most likely a non-sustainable situation on other aspects involved. A complex world, a complex society and a complex system require multi-complex principles and solutions to reach a sustainable future.

The relationships between the kind of design principle, the complexity of the system and sustainability are the key issue of this paper.

2 Sustainability

The main aim of sustainability as described by Brundtland *et al.* [3] is to fulfil the demands of the current generation, without making it impossible for future generations to fulfil their demands. If there is a balance between the amount of people in a certain area and the availability of natural resources in that same region for now and in the future, one can speak of a sustainable situation. In an historical perspective a changing impact of sustainability in planning and design processes is described by Roggema *et al.* [4]: the 4 waves of sustainable planning. The solution in the fourth wave is that the design in itself is sustainable. Main characteristic of these design processes is that they do not focus especially or only on environmental issues, but show an integrated development towards a sustainable future. By taking care of the beauty of the site, the social and economic development and the living conditions for man and nature an entire new perspective for the area opens up: the system changes.

3 Complexity

Complexity theory is looking at the functioning of systems. Systems that are more or less complex. If there is minimal complexity we call it order, if there is (too) much complexity we call it chaos. A complex system, that is not chaotic, but at the edge of chaos, is adaptive and self-organising. Mitchell Waldrop [5] describes the characteristics of complex systems. Interesting aspect of this theory for sustainability and planning and design is that a complex system is able to change into a new order if very simple dynamic rules lead to extraordinary behaviour and the edge of chaos is reached.

Based on this it is logical that if a simple dynamic design principle is used at the edge of chaos, extraordinary behaviour takes place and the complex system can change at once: into a new sustainable complex system.

3.1 Typology of complex systems

Which kind of systems are the 'playground' for edges of chaos and the right design principles? To find that, a division in four types of systems might help.



Wolfram [6] distinguishes closed system, linear feed back systems, systems randomly open to assimilation and non-linear adaptive systems. De Roo [7] describes the characteristics of class I-III systems and class IV systems. Mitchell Waldrop [5] points out that behaviour in Class IV systems enables entities to maximise benefits of stability while retaining a capacity to change.

The question is which connection between design and complex systems is appropriate? Design projects contain a large number of interactions, in the design projects simple rules underpin complexity, adaptation, self-organisation and co-evolution is apparent, the design transforms and retains the project and design principles are characterized by robustness, emergence and fitness for purpose. The same characteristics de Roo [7] describes for class IV systems. Above that, the subject of design is often sensitive to impulses, tipping points.

3.2 Swarm planning

The question is which planning approach can be useful if the future consists of mostly Class IV systems (problems, projects). The insights of organisation dynamics can be useful here. Homan [8] describes different types of conditions to improve the overall fitness of the system.

The common characteristic seen in the conditions described before is that they are divers, contain large numbers and have many interactions. There needs to be some kind of large pool of elements. Then, the chance that things interact is larger. Eventually processes like collective patterns, influence on large parts, auto catalytic processes, developing of new structures, etcetera emerge. So, some large pool of elements (there has to be a lot of something), leads to a certain process, which increases the overall fitness of the system.

What seems to be missing is a certain trigger, a focal point that enforces the pool of elements to interact and starts the process of changing the system. These points, the 'flutter the doves' kind of ones, make things happen. Every element in the system orientates itself at these points, and by doing so the system as a whole changes. Exactly this makes from a bunch of ideas an innovation. An impulse needs to be added to the scheme (figure 1).

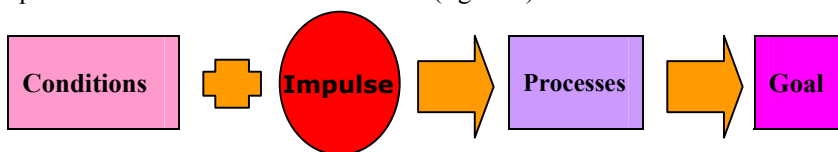


Figure 1: An impulse added.

Translated in planning design terms, the right design principle should be used to orientate all spatial, societal, political elements in such a way that the entire region or city is changing. This requires a new way of planning. Roggema [9] describes how spatial planning can use impulses that will shape the patterns in the future city: swarm planning. The role of spatial planning is to introduce small but essential impulses, hereby influencing the whole system, like a swarm of birds is reshaping itself constantly, depending on current impulses. Spatial

planning is no longer concerned about the whole picture, but needs to focus on those essential design interventions, that enforce the region to reshape itself. No Blueprint, but Acupuncture.

3.3 Tipping points

The tipping point is that magic moment when an idea, trend or social behaviour crosses a threshold, tips, and spreads like wildfire. The possibility of sudden change is at the centre of the idea of the tipping point. Big changes occurring as a result of small events. Gladwell [10] defines three rules of epidemics:

1. The law of the few, a small part of the whole is doing all the work (80/20)
2. Stickiness factor: the message makes an impact. It is impossible to forget.
3. Power of context: sensitivity to the environment. Influence of the surrounding.

If we try to transform these rules to planning and design, the question when a design becomes a success and enforces the required changes can be answered. First of all the law of the few tells us that a design needs to be originated by a small group of individuals. The design is not what the common people expect. To change things the design should be away-from-the average as Ridderstråle and Nordström [11] and Roggema [9] describe.

Secondly, the stickiness factor shows that a design should stick in ones heads. Once you saw the image of the design, you never forget it. A good example of this is the design for Almere Poort, the Wall by MVRDV [12].

Finally, the power of context in relation to design processes will tell us that the design should give the solution to a commonly felt problem. If a fundamental change is required, like the urge for a sustainable system is, the context better be in deep trouble. A sense of urgency is required to change fundamentally. A crisis could give the energy to jump to the new situation. Or as Geldof [13] shows us in a graph: if the existing system dissatisfies, a crisis is required to jump to the next level of complexity and the system is upgraded. These crises can also be seen as the tipping point in design processes.

To condense this: a design group has to come up with a sticky idea, which is/can be used as a tipping point in times of crisis. Or: a crisis has to be arranged to make the time right for a sticky idea, to be designed by a couple of designers.

This approach is not yet common, but the first evidence can be seen growing in the field of spatial planning and urban development. The way injections, like the Blauwe Stad, are planned in the poorer areas of the Groningen province [14], the impact the Öresund-bridge has on the popularity, economic welfare and image of Malmö and Copenhagen or the way Mendini [15] changed the entire inner city in Groningen with the Groninger Museum are early examples of swarm planning.

4 Design principles

For designers and planners it is important to discover the working and effects of design principles. Design principles are general measures that can reach a certain



goal, which can be used by designers in most of the design projects, but is working differently in every situation, depending on the specific characteristics of the project.

Some of the principles are working straight forward on one or a small number of issues: single dimensional design principles. Other design principles are able to change a certain area completely: the multi-dimensional ones. The principle Mendini [15] used to create a good connection between station and city-centre not only aims to stimulate the traffic flow here, but makes a complete change of functional patterns in the area.

The change into a sustainable future, as described in the introduction, enhancing a reduction of the use of natural resources by a factor 20 [1,2], requires design principles that are able to initiate this change.

Which design principles are useful to meet this aim? Principles that:

- Are able to support the sustainability of a spatial design. Or: Using these principles in spatial designs create a desired sustainability.
- Have the power to enforce the change of the entire system (tipping points, change of colour)
- Have an impact on ecological, economic and social functions of the system.

Here 10 principles are (preliminary) selected to measure designs.

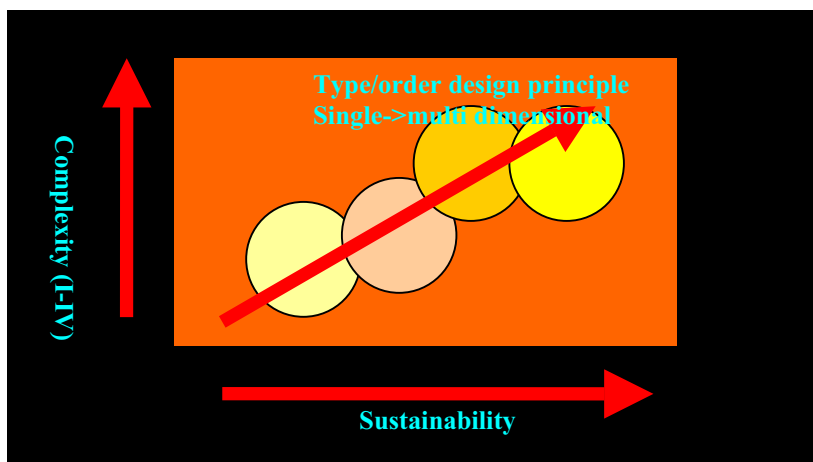


Figure 2: Sustainability, complexity and dimensionality of design projects.

5 Analytical framework

Based on the different analyses on sustainability, design and complexity it is now possible to give an insight in the relative sustainability of different design projects. The question what the sustainability of a certain design is and how several designs can be positioned can be answered by placing them in a graph. In the graph the axes are complexity and sustainability. If a project is complex (class IV) swarm planning can be used to make a sustainable design for it. In

swarm planning we are searching for those design principles that are able to enforce a breakthrough. These design principles are mostly the multidimensional ones. If in a design project more multidimensional design principles are used, these projects are highly complex and highly sustainable. Analysis of the design projects thus, tells us something about the sustainability of them.

6 Design analyses

Three design projects are deeply analyzed. How and if the 10 design principles are used in the different projects is assessed. Roggema *et al.* [16] describe the Grounds for Change project, Bing Yu [17] the Longhu project in Chongqing and the Jinze town project is described by Roggema and van den Dobbelsteen [18]. Beside these thorough analyses 13 detailed designs are roughly analyzed. They are also positioned in the graph.

Design principle	Elucidation Grounds for Change	
1. Backtracking	Historic sustainable functioning was the base for the design for the future.	+
2. Multi energy & LowExergy	In every area of the region several energy sources were combined and used. LowExergy principle is used in appropriate area.	+
3. Multifunction & densification	Combination of energy-functions and urban functions was introduced. Densification was not specifically done (point for further elaboration).	+/ -
4. Acupuncture, nodes	Choice of specific projects in the region to catalyse developments was done.	+
5. Landscape a living machine	The capacity of the natural system is a limiting condition for developments. Natural system delivers the energy typology.	+
6. Chaos aesthetics	Regional differentiation is based on energy and landscape typology. Climatic conditions (of the future) are part of the design.	+
7. Visualisation of processes	Process of LowExergy and cycles like tides are made visible (could be extended).	+/ -
8. Niche planning	Unexpected chances for specific places (Grolloo, Hoogezand, Lauwerslake, Leeuwarden North, Peat colony) emerge in the design.	+
9. Habitat approach	Dominance of sustainable energy and climate change, effects on social-economic and living conditions.	+/ -
10. Symbiosis city-landscape	City and landscape strengthen each other. The city is networked in the landscape and the landscape steers urban developments.	+

Figure 3: The use of different design principles in Grounds for Change.

6.1 Grounds for Change

In the Grounds for Change project a design approach for the Northern Netherlands is undertaken, where-in energy-potentials in the region steer the spatial differences [16].

To find the different energy typologies a new method was developed. The usual negligence of local strengths – climate, landscape, nature, cultural-



technical elements – in regional and urban planning, especially with regard to the potential for local self-provision of energy triggered the emergence of this method. The paper 'Using the Full Potential' by van den Dobbelsteen *et al* [19] describes the Grounds for Change project more extensively.

6.2 Design principles used

In the project the functioning of the natural system was taken as a starting point. Sustainable functioning in history, with tidal influence, natural flows of water, living on the higher grounds, was taken as the base for up to date and futuristic designs. Doing so, future developments have a sustainable base as well.

The conclusion on the Grounds for Change project is that most of the multi dimensional design principles were used. Energy is here the trigger that steers the design and gives the whole system, including sub-designs, a reason for change into a sustainable energy region.

6.3 Chongqing - Longhu

The Longhu project, in the outskirts of Chongqing, China, is one of the many urban developments around the city. In the existing proposal for the site the urban design restructures the whole area. Existing height-differences were diminished, the functioning of the water-system was re-ordered and natural energy-principles were neglected (ventilation, orientation). In the design-method used to review the design, the natural qualities of the site were the base for the redesign [17]. An integrated model was presented in which the different driving forces were combined with each other and with traffic structure, building typologies and parking solutions.

6.4 Design principles used

The redesign for the Longhu project pays a lot attention to the natural dynamics of the site, the landscape and the climate. Most of the multidimensional design principles were used in the redesign. Water is the trigger that steers the possible redevelopment of the design. Using the principles and rules of water direct the development in a complete different direction than planned: The way the water is treated in this project, functions as the tipping point for the change. The same kind of table can be developed for Longhu as shown earlier for Grounds for Change.

6.5 Jinze town

Jinze Town is a small historic village at the edge of Shanghai province. The enormous developments in the metropolis will have their impact on the future developments in Jinze. A regular Chinese approach would diminish existing culture, landscape and qualities. In the design for the Jinze area the historic fundaments were used to create a new future. The region once was part of the delta of the Jangze river. Living on islands, producing just enough food to feed



everyone and transporting people and goods over the water, the area was in a natural balance. This balance is transformed into a modern and future sound design. Large parts of the area, in use as fish ponds are transformed into wetlands or open water, to clean polluted water: the clean machine. Through traffic is abandoned to the outer parts of the area and around it and water transportation takes the most important place in the traffic system again. Existing resources are used to produce energy; wind, solar and biomass supply most of the demand.

New houses are build in an ecological way and eco-tourism becomes the main economic driver in the region. Several new tourist routes are proposed through the area, over the lakes and besides the historic cultural centre of town and the newly introduced shipyard and ecovillage.

6.6 Design principles used

Instead of just another fast growing neighbourhood of Shanghai this becomes an ecological and water-rich recreational and restful space in the region. The principle of the delta functions as the trigger to change. By putting specific new functions at exact locations (shipyard, eco-village) developments are catalyzed. The spatial system can be turned into a system which stays close to its origins, uses the natural potentials, lives in balance with their surroundings and develops a different kind of prosperity. For the Jinze project the same kind of table van also be developed as shown for the Grounds for Change project.

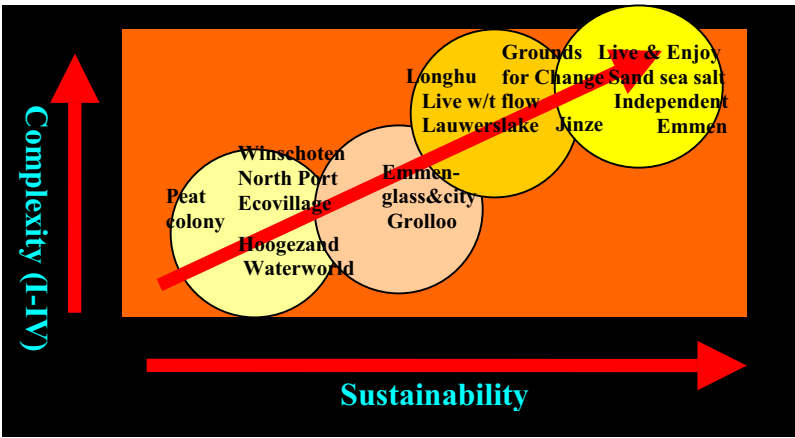


Figure 4: The designs placed in the complexity-sustainability field.

6.7 The designs placed

Figure 4 shows that designs with certain characteristics are found in the top right corner. They all have a base in the natural functioning of the landscape. Secondly, they all show an integrated approach. And the last factor they have in



common is that there is a specific trigger that is able to change the entire system. These acupuncture markers, all multi-dimensional, are all letting the system 'flip' to a next phase in history, reaching a higher level of sustainability. They prove that giving at the right time it is possible to let the swarm adjust to a new situation: swarm planning can be a successful approach.

7 About deltas, energy-mixes and slope-casting

Bringing together theories of sustainability, design and complexity offers a serious chance to influence the spatial(-energy) system of a region, a landscape, an area.

- There is a linkage between the use of multidimensional design principles, the purpose of their usage and the context they are used in. The chance at reaching sustainability in a complex context is higher with multi dimensional design principles.
- Influencing the context to some form of crisis can be useful to enforce the desired changes of the system.
- Multi dimensional design principles can become tipping points if the timing is right (i.e. the system urges for change, in times of crisis).
- If the conditions are right, an impulse is at hand and a process starts unfolding, the system increases its overall fitness (becomes more sustainable).

Finally: What do the three design projects (Grounds for Change, Longhu and Jinze) have in common? They all picked something out of the natural characteristics of the region and upgraded it to a steering principle. By doing so the rest of the spatial system is orienting itself to these principles. So, if we pick the right characteristic, aiming to create a sustainable future, it must be possible to enhance the emergence of a fundamentally more sustainable spatial-energetic system. They all gave the area their reason to exist, separate them from their surroundings and create new and richer spatial typologies. Last but not least they took care of the desired increase of sustainability in the region.

This leads to the following principles of swarm planning:

1. Sufficient conditioning forces (networks, elements, people) have to be available or need to be organised
2. The right impulse has to be picked. This is a multidimensional design principle originated in the natural landscape. Using the backtracking principle these principles can be discovered.
3. A crisis needs to be present, enforced or stimulated. Only then it is the right time to come up with an impulse.
4. Let the process emerge. The system will find its new structures, it will urge for interventions, newly developed areas or retrofits.

The result will be a much fitter and better-adapted system than before so that we are prepared for the future.



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