Social and Technical Systems - a possible Perspective to the Design and Development of a Car Plant

Keynote at Aedes Network Campus Berlin Inauguration Symposium, Berlin 19th of April 2009

Peter Claussen

Factories.
Developing a Social-Technical System.
One possible Perspective on the Design of a Car Plant.

Photograph © BMW AG

Ladies and Gentleman,
Thank you for inviting me to this symposium and giving me the possibility to add some perspectives from a different business to this fascinating project.

1. Systemic Approach

In my professional career I was continuously busy with questions around car production. Even as my academic background is one of engineering, it did not take long to become aware of the fact that technology - it is true - is a very important tool for people, but in the end people decide on the success or failure through the way in which they cooperate and form their environment and use technology.

I was often surprised that the working together in a team with people from very different backgrounds led us to new insights, great solutions or generated an unforeseeable effect, nobody had thought of before. More often it surprised me that my ideas, which of course I thought to be excellent, turned out to be ineffective. A while later I learned that these had only been my ideas and not theirs. The lesson was about being outside or part of a social system.

Over the time it became more and more interesting for me to understand the processes occurring in the interaction of people.
And more and more often I tried to develop a more holistic vie w while

Systems Theory - Holism.
Parts.

Photograph © BMW AG

working on the design of production processes and I began to understand

Systems Theory - Holism..
Whole.

The appearence of new properties when several elements form a whole is called emergence. Aristoteles: „The whole is more than the sum of ist parts"

Photograph © BMW AG

that the famous Aristotelian proposition in his Metaphysics 'The Whole is more than the sum of its parts' is the beginning of systems thinking in a holistic way where new phenomena emerge. Here illustrated that a pile of parts, when seen as a whole develops a new functionality which we see as a dashboard.
Others, like the mathematician N. Wiener or the biologist L. v. Bertalanffy extended thinking in the 1940th and formulated a theory of recursion and feedback between parts. It was called Cybernetics and today we take it as

a matter of course, that control theory is part of the world to solve problems.

If we take the same illustration and change the perspective to one looking onto the relations between the parts we will see a different system, where

Photograph © BMW AG

Photograph © BMW AG

the position of the car on the road or the temperature provided by air conditioning is controlled. The perspective from where we look at things thus appears to be quite important.
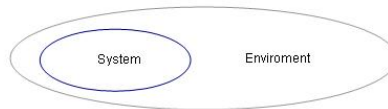

This finding is made use of, by the 'newer sociological systems theory' which defines a system first of all (following the mathematician Spencer-Brown) 'as a distinction we draw by arranging a boundary with separate

sides'. The one side is the environment the other is what we look at as 'the system'.
.

Relations in a System. Luhmanns Theory.
System as Distinction - Reentry.

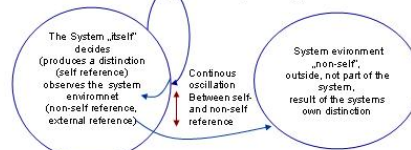A system is a distinction, we draw by arranging a boundary with separate sides'. The one side is the environment the other is what we look at as 'the system'. If there were no distinction between system and its environment, there would be no system. So the basic question in this theory is not to sustain a status but to observe and to sustain this distinction (Luhmann, N.: Einführung in die Systemtheorie, Heidelberg, 2006, S.75 ff, ders.: Organisation und Entscheidung, Wiesbaden, 2006, S.45 ff).

The system references recursively on itself (reentry):

The System "itself" decides (produces a distinction (self reference) observes the system environmet (non-self reference, external reference).

Continous oscillation Between self- and non-self reference

System evironment "non-self", outside, not part of the system, result of the systems own distinction

(cp. Luhmann, N., Die Gesellschaft der Gesellschaft, Frankfurt, 1997; ders., Organisation u- Entscheidung, Wiesbaden ,2006)

On the detour via biological control and self-control mechanisms the social systems theory was finally developed. The detour was important to understand the limitation of human sensory abilities und the relevance of subjective construction of reality in the consciousness, the human psychic system.
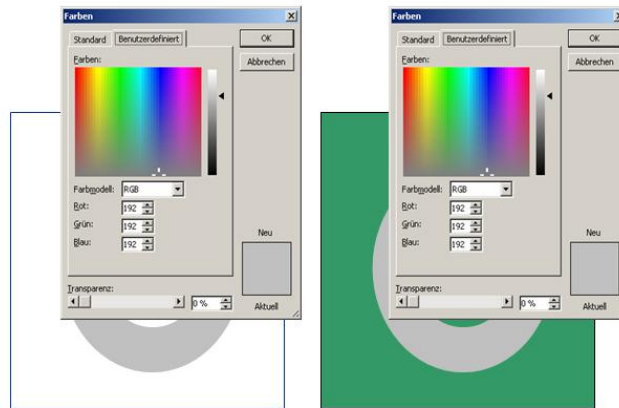Let us think about the well-known picture puzzles where different

Reality.
A Construction of Mind.
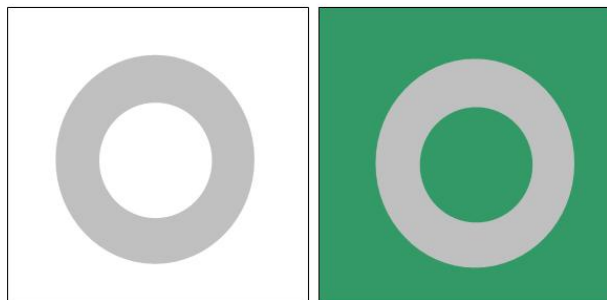
((GNU License wikisource))

perceptions are possible depending one's actual perspective and cognition. Or let us look at these grey rings, where the perceived colour tint of the ring differs depending on the surrounding colour.
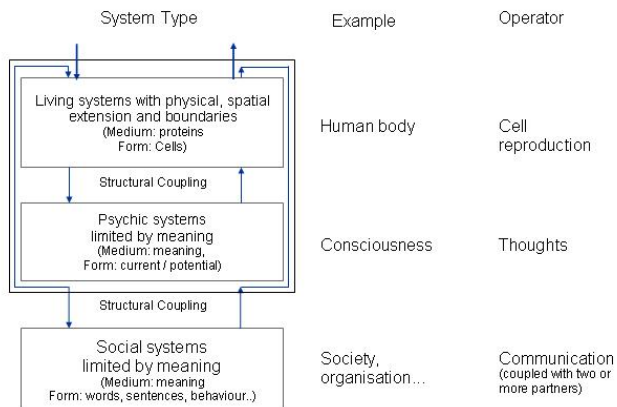
Reality.
A Construction of Mind.

We thus come to an explanation why people perceive their environment so differently: reality is a subjective construction of one's consciousness.

Body and psyche are two sub-systems constituting

System Relations n. Luhmann.
Living, Psychological and Social Systems.

System Type	Example	Operator
Living systems with physical, spatial extension and boundaries (Medium: proteins Form: Cells)	Human body	Cell reproduction
Structural Coupling		
Psychic systems limited by meaning (Medium: meaning, Form: current / potential)	Consciousness	Thoughts
Structural Coupling		
Social systems limited by meaning (Medium: meaning Form: words, sentences, behaviour..)	Society, organisation...	Communication (coupled with two or more partners)

Every system shown is operationally closed. However all systems are structurally coupled.

human beings and both are engaged when people get into contact and form relations which constitute social systems.

To form and maintain relations, we select information and pass them on to our counterpart. We observe if the counterpart selects the information which was passed on and take in turn the observed reaction as a message to ourselves. By this circular, recursive action communication evolves. And this type of communication is seen as the basic operation which constitutes social systems.

If communication is continuously carried forward and every message responds to the antecedent, patterns of perception and appraisal will evolve. P. Senge names this 'shared mental model', social systems theory calls it 'patterns of meaning' (Sinnstruktur). Meaning in a social system is a result of convergence in conviction and belief of its members and the convergent and reinforcing communication process creates a strong identity.

Technical systems – and the social systems theory regards space and form created by men as part of the technical system - are artefacts. They are conceived, designed and produced in social systems and they represent ideas and beliefs of their creators.

Photograph © BMW AG

Their impact solely evolves if they are perceived or used. In most cases their creators and the users are different entities. Therefore it is a good idea to assume that the meaning incorporated in the artefacts will not be perceived for sure in the same way by observers and users as it was thought by the creators.

And even more: social systems change their patterns of meaning over the

Photograph © BMW AG

time as they have to adapt dynamically to the changing environment in order to safeguard the existence of organisations in a tough competition. So from a systemic point of view sustainability is a target which is immanent to the idea of an organization and forces it to keep constantly balanced between economical, ecological and social effort.

The continuous adaptation causes intensive work in social systems. Individuals and organizations have good reasons to dislike abandoning patterns of meaning which proved their worth in the past. It is important to find a balance between sticking to these recipes of success and identity which are predominantly preserved in artefacts like space and form and an active adaptation to environmental changes.

2. Example: The Task

The requirements on benefit, safety, efficiency and minimized ecological impact make automobiles part of the technologically most challenging products in mass production. Tough competition and volatile markets cause – even without the turbulences of a global economic crisis- massive pressure on cost efficiency and permanent innovation. Globalised markets with massive differences in living standard, labour cost, level of education, infrastructure and technology lead to an international division of labour. Not every task can be performed efficiently everywhere.
Each company has to make up its decision to differentiate itself in the market and to define the optimal location to perform different tasks.
Wherever a factory finally will be located, it has to be seen as an element which has to be integrated in many different networks, like the supplier network, the production network, the regions citizens' network etc...

Factory Planning and - Development.
Premisses, Parameters, Requests.

The plant becomes an element of different networks which all have a
different behaviour, belief and identity:

- Corporate production network
- Supplier network for construction work, machinery and tools, services
- Network of parts supplier
- Regional network personnel development
- Regional economic network:.
- Regional socio-political network
- Network of Automotive Cluster
- .....
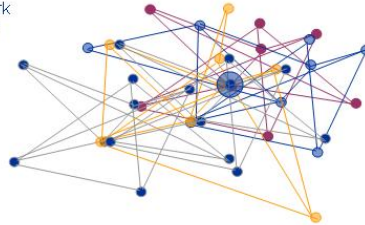
That means, the factory has to integrate itself in different systems of
meaning as well as into the communication of these systems. This
obviously creates a recursive impact on the factory's meaning- system
itself.

Factory Planning and - Development.
Premisses, Parameters, Requests.

1. Customised Production: one model – 10^{17} variants

2. Order freeze by customer five days before start of assembly

Photograph © BMW AG

Using the example of BMW, the company has decided to position itself in
the market as a supplier of customized cars. Customers have the
possibility to decide just five days before their individual car will be
assembled, what type and what options they finally want to choose.

There are about 10^{17} different sets of type, colour, engine, options etc.
which can be ordered. It is evident that this is a complex situation for a
factory. Everything one learned about material planning is obsolete when
one does not know until five days before start of assembly what parts will
be needed. Material planning then therefore has to be based on
probabilistic methods, but in fact: the probability that this calculation is right
is less than 100 %.
Besides this challenge the pressure on cost efficiency forces to lower
stocks. That means, that the production sequence has to be defined 4

days ahead of start of assembly and the parts will have to be delivered lineside exactly on time.

A similar challenge is created by the amazing number of variants. One never knows, what variant the customer is going to order, but it is impossible to have checked the producibility of 10^{17} different variants in advance. Even the fastest computers are not able to perform even the geometric simulation for this number of variants before start of production or during the life cycle of this model.

What can be done? It is evident, that the only chance is to fight problems as soon as they occur. Machines and computers can support this job, but finally only people succeed. And it is not one individual, but a team of experts with different skills and capabilities who can solve such complex problems. Thus again we come to the conclusion of communication as the crucial point of a car factory.

3. Development of a social system

The distinction of the reckoned system and its environment and the perception of groups of people as social systems with bound patterns of meaning are two of the basic figures of thought in the systemic development of organizations. Here you can see what we defined in the Leipzig project to be 'the system' and some of the environmental subsystems we regarded to be important.
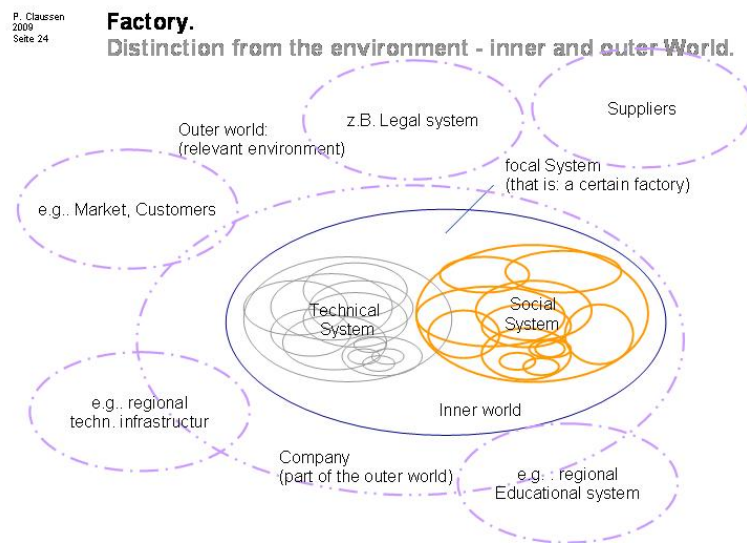
A successful development of a plant is based on the acceptance in the neighbourhood. Such an acceptance you solely obtain by integrating yourself in the communication processes of these environmental systems. Quite often there are high financial expectations put on the 'corporate citizen', he should donate nearly everything. But expectations towards a member of a social system are wider and members have many more

possibilities of helping to form the patterns of meaning in a social system. A 'corporate citizen' is able to bring in a wide range of abilities and will thereby legitimate himself to influence a region's development.

In our case this caused quite a few interesting projects: from creating an initiative to develop the complete automobile supplier branch in East Germany in order to increase the economic and financial potential and the scope of action for the region and its cities   to social initiatives, consulting cultural institutions in the fields of economics, marketing and strategy, creating networks between universities and cultural institutions, working with others on long term targets and a strategy for the development of the city of Leipzig etc.

If you want for your plant to develop organizational structures following the ideas of subsidiarity it requests intensive work in the social system to understand and contribute to the whole at the same time maintaining an own identity and responsibility for the part.

In an ideal case everyone should be part of this communication.

Photograph © BMW AG

But usually in a bigger organisation this is impossible. Then you have to cope with delegates and afterwards the discussion must be held in all teams. It is more time consuming but essential.

Independent from the cultural background of the system's members some methodical steps have proven to be useful. To begin with we should clarify the different ideas about an attractive future. Logically further questions will follow: how to proceed from the status quo to the realisation of this attractive future, what processes will be needed, what roles must be created, how should they be assigned, what are the expectations on the one, taking a part, in which way do we want to behave etc.

In such a discussion and its intense communication process the social system and its members get clarity about their shared convictions and beliefs.

In such a process you should never hurry. Continuous reflection of the inner situation and the external development is necessary, must never end and might cause corrections of earlier decisions.

On the other hand this process creates energy, understanding and innovation in an unbelievable extent.
The starting point in this process is always a change of the own perspective:
we have to be part of the system in order to have a direct impact on the patterns of meaning and the actions of a social system.

4. Configuration of the factory layout

If we consider communication to be the most important operation in a factory and adaptation as a result of its social system, then the factory layout has to make this its focal point of design.
Obviously there are quite a number of technological requirements which have to be met as well. Furthermore a plant design developed in a systemic way has to be adaptable to the development of the social and the technical subsystem. New forms of cooperation should be supported just as well as new product concepts or new technological processes. The plant has to be expandable in its capacity if the demand increases and it should be possible to implement every change in just a few days.
Nearly all car plants are designed by putting the buildings for the different
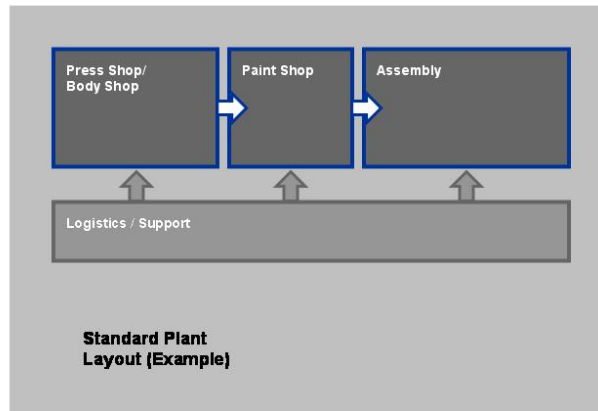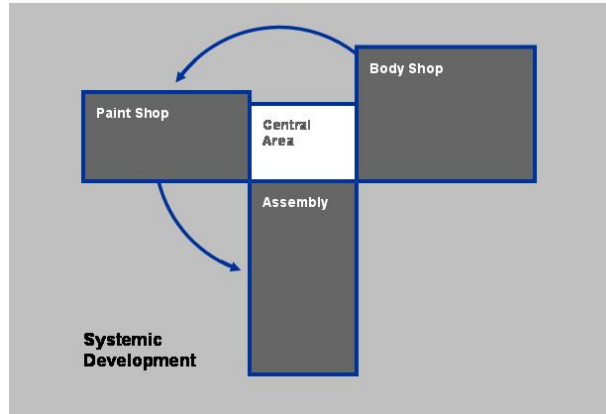

Photograph © BMW AG

operations in the sequence of the material flow. Support functions are put in a separate building or added as a front section to the workshops. This causes long distances between the first and the final operations. Communication of problems last longer and tasks are more or less seen in a local point of view. To get a holistic understanding of the processes proves to be difficult.

Archetypes.
Centred, circular configuration.

Photograph © BMW AG

It is evident that a centred figuration of the workshops does not only shorten the distances between the different operations but also provides insight into the complete set of processes and their relations. Therefore our plant design arranges the three main workshops body in white, paint

Central Building.
**Central Support Functions.**

Photograph © BMW AG

and assembly around a central building where all the information from the markets and R&D arrive, are checked and then distributed. We also located all central support functions such as laboratories, metrology etc. and service areas for our associates in the centre of the factory. Here people meet by chance and solve problems before they cause more difficulties and everyone sees the flow of vehicles while the bodies are conveyed above the desks from one shop to the next.

This configuration of space can easily be decrypted as a message about the importance of communication. But there are more messages about the patterns of meaning in the plants social system fixed in other artefacts.

The relevance of transparency is as present as the importance and denotation of quality, which is expresses by putting the meeting point right in the centre of the plant where products out of the daily production and

P. Claussen
2009
Seite 72

Transparency.
Flow of Information and Flow of Bodies in the Central Building.

Meeting point for scheduling discussions

R&D data check and data distribution
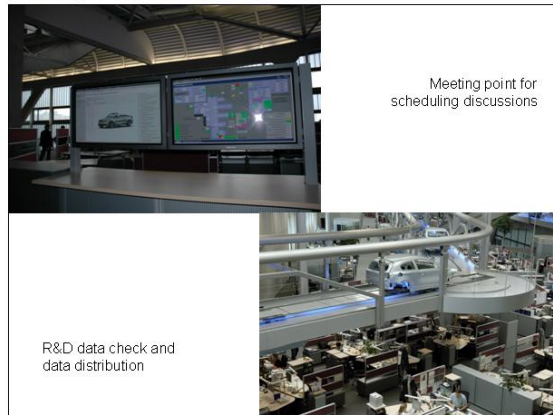
Photograph © BMW AG

quality reports are displayed

A similar message about the value of quality relates to the quality of the construction work, the workplaces, machinery and tools.

The unity of materials used without any distinction throughout the plant tells that everyone beyond any discussion of function and status is valued and respected in the same way.

Forms of Zaha Hadid's Central Building bind together all the different halls and functions and even details like information signs or workwear are statements of the plant's identity.

P. Claussen
2009
Seite 68

Meaning, Identity, Alignment.
Symbols: Unity of Function and Form.

a   b   c   d   e   f

Photograph: a-d © moniteurs Berlin, e-f © BMW AG

In contrast to direct communication between people artefacts are static, materialised messages. We have developed all those artefacts, which we thought to be relevant messages of our patterns of meaning for our project, in a joint process. We can call them eigenvalues of the system (in analogy to the mathematical meaning) that is to say they are stabile results of a long, recursive and convergent process of communication and represent the shared mental model of the social system. A change of these artefacts has great symbolic impact on the system.

Current empirical research shows, that the artefacts and the incorporated messages are well perceived and intuitively understood. The studies show a significant difference to other plants which are based on a different design perspective. The economical results tell the same.
It was the result we wanted to achieve: the design of the social-technical system stimulates the disputation in the social system and with its environment. It thereby supports the 'organizational capability' for a sustainable development.

The systemic approach is obviously only one of many possible ways, but it proves to be very useful in social-technical systems. As planners we should be aware of the fact that patterns of meaning materialise with the realisation of our projects and that we are responsible for the contained messages. These could last for a long time. In a systemic approach we will always ask ourselves if we are 'part of the solution or part of the problem'. And that might be a question to be discussed in the workshops of Aedes Campus Berlin in the future.