Design as Problem-Solving?

or:

Here is the Solution - What was the Problem?

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Design as problem-solving? Regarding the cognitive process, this seems appropriate, but in the context of society - and that is the area of interest here - it is misleading. Ideally (e.g. in mathematics), a solution makes a problem disappear and the unity of problem and solution is adopted as recognized stock in the fund of secured knowledge. A look at the dynamics of the market, with its new "solutions" for old "problems", with its invention of "problems" for new "solutions", raises doubts in regard to this understanding. This article attempts to "problematicize" and redefine the concept of "problem" on the basis of system-theoretical concepts using the positions of Operative Epistemology. It aims at a terminology that goes beyond the static linearity of the schema of problem --> solution and leads to a view of the circular, dynamic, mostly self-organizing unity of problem / solution.

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TRADITIONAL UNDERSTANDING

Designing objects to be industrially manufactured is generally attributed to the profession of designers. There are primarily technically-determined objects (e.g. gears), the purview of engineering designers, and primarily formally-determined objects (e.g. furniture), the concern of industrial designers. Usually, however, the products (from the coffee machine to the automobile) are determined by requirements from both spheres and there is intense cooperation with other disciplines involved. Here, I will treat both aspects of design together, not only because of the increasing reintegration of the product development process[1], but also because of my understanding of design (in the cognitive sense) as a process transforming a verbally-formulated "problem" situation into a detailed plan for a tangible[2], usable artifact, whether "designed" or not. I consider the separation between design in the engineering sense and design in the sense of styling, often emphasized by both sides, to be outmoded.

Common definitions avoid an understanding of *design as* mere *form-giving*. A clear line is drawn between it and the traditional image of the "decorator", in the neighbourhood of handicrafts, as well as the widespread image of the fashion-oriented "stylist". Seeger states: "The treatment of design up till now as part of a general history of art or style ... will not do justice particularly to its *social commitment* . ... It would be wrong to conti-

nue to understand industrial design merely as applied minimal aesthetics ("Ulm") or as "product-aesthetics" oriented solely toward sales. The education and qualifications of the industrial designer today contain the comprehensive recognition and definition of the practical and social criteria of use for a product as well as the development of constructive solutions for it."[3] Construction-oriented designers, on the other hand, traditionally have no difficulties in accepting themselves as pure engineers, translating a catalogue of primarily verbally-fixed demands into a concrete object while ignoring social and other marginal conditions. Only recently there is a significant shift of concepts even in "mainstream continental engineering design theory". Hubka and Schregenberger, apparently influenced by Ropohl[4], no longer refer to technical but to *sociotechnical* systems. In contrast to Ropohl however, whose concept comprises the context of generation as well as the context of use, they only mean the context of generation, i.e. the engineering design process in its psychological and social dimensions[5]. Widely accepted in industrial and engineering design (cf. Sudrow[6], Schregenberger[7]) is the rather general description of *design as "problem-solving"* .
The relation *design - science* is dealt with again and again, whereby an ambivalence is conspicuous: On the one hand, there is the usually quite cautious claim that design *is* "scientific". In this, the words Brecht put into Galileo's mouth, "...that the sole goal of science consists in easing the troublesomeness of human existence..."[8] always provide a good aid to argumentation. On the other hand, the differentiation is made between "discovering" in science and "inventing" in design, between "researching facts" and "creating facts", namely "better and more usable artifacts".[9] Since about the early eighties, there is a broad consensus that while design can be the object of scientific examinations, it cannot be seen or established as a science itself.[10] This statement is still accepted even since the traditional concept of science as an instrument superior to everyday awareness for gaining knowledge about the world "as it really is" has been called into question, particularly with the reception of the works of Kuhn and Popper. There seems to be something attractive -and confusing at the same time- about the idea of scientific character. This is not the place to pursue this question, the following must suffice: "Science is where those who are recognized as scientists work on research according to criteria generally recognized as scientific."[11] As a working hypothesis, I understand design as a service discipline, not a science. Design is an action process aiming at predetermined goals whereas science aims at creating knowledge about something. For illustration compare medicine and design: Medical practice is not science in my view though certainly based on science. Design practice is not science either, no matter whether based on theory or not. So the right question, which is open indeed, is whether design-*theory* should be considered a science or not.

Beyond that, the function of design-objects as a "contribution to the quality of life of all of us" is emphasized: "The meaning of life is seen in the possession of products".[12] In the context of "problem-solving", my interest is directed particularly toward the "recognition and definition of the practical and social criteria of use" claimed above and toward the "better and more usable artifacts" that supposedly result.

CRITIQUE OF PRAXIS

Designers realize that design does not provide the solution of existential problems but is rather itself a part of them. Sudrow sees a contradiction between the traditional concept of progress and the quality of life. Thus, "basic research" in design is necessary, particularly in the form of the analysis of need.[13] Seeger sees the current task in sensibly reducing the number of products, not least for ecological reasons, and additionally, in involving the human-product relationship in the development and design of products more precisely than up till now.[14]

Van den Boom[15] laments designers' hesitant acceptance of the new electronic aids in the face of the dawning "information society", a "society in which we no longer primarily produce and consume goods, but rather information ... Information is ... neither matter nor energy; I conclude from this that information is extremely environmentally sound and nevertheless fun. To produce information, one needs practically no raw materials, no new arable land, and there is no increased energy demand." His "visionary definition of design" sees it as a "form-giving processing of information so that it can be consumed by people." The question as to the cognitive nature of the design process is eliminated in passing: "That design can be supported by the computer implies, in the end, that designing is simply a kind of data-processing."

Theoreticians of cultural studies[16] lament a general predicament, a discrepancy between "the life needs and ... an instrumental rationality that abstains from the reflection of its cultural effects and its location in cultural history and which gives itself a nature-like façade behind the slogan of unavoidability". In professional training, a "reduction of the profile of the profession to a designer of forms, originating in the early industrial division of labor of the second half of the 19th century ..." is discovered and the demand is made that "the course of study must not be reduced to the perspective of an industrial corporation, for its perspectives are different from those of the society or - overstated - from those of humanity's hopes for survival." Finally, the approach of a solution, which he calls the "ecologization of the industrial society": "...a discourse of the committed about the cultural preconditions of our thinking ... This (ecologization) can, however, succeed only if *highly competent elites* from the areas of design, technology, and business work on the common goal." The consequences for professional training: to

convey the ability "to recognize the network of relationships in the development of the industrial culture, to *see through* longer-term cultural and social-historical developments, to *decipher* connections in the histories of art and of design ."

Conspicuous is, on the one hand, the clear view of the problem of mass production, and on the other hand, the unreflected use of terminology adopted from everyday speech. In this way, the problem is immediately covered up again with supposed "solutions" from the respective specialized areas. In sum, two aspects:
1) The claim to a position as an external observer. But external to what? I see no social unit distinguishable from the speakers that could be observed in this way. In emphasizing social commitment, it is apparently overlooked, or at least not dealt with, that designers are part of the society and that their function and identity derive precisely from this embeddedness. Where should a superior insight into "needs" come from?
2) The claim to an objective truth recognizable by "deciphering" and "seeing through" the phenomena. Ruppert claims to have recognized the problem and the solution; there is merely no one willing to concern himself with it. Terms like "need", "quality of life", and "meaning" are used just as unreflectedly as by practicing designers.
I dread these self-appointed "highly competent elites". It can't simply be a question of another new (but *this* time absolutely certainly correct!) interpretation of history as the basis for recipes for the future. Nor is the view of the computerization of design a very convincing panacea. For me, it is first of all rather a question of developing a theoretical instrumentarium for adequately *describing* the situation. If suggestions relevant to activity can be derived from this, so much the better.

TRADITIONS OF THOUGHT

Starting from the claim of improving the "quality of life" through design, the connection to techniques and technology is immediately given. The concept has not been subjected to academic reflection in design, one adheres more or less critically to the everyday understanding of the term: all realizations of "improvements" are of a material nature and manifest themselves in products. "Improvement" leads to the concept of "progress" as essential concept of bourgeois society's consciousness. With the emergence of "historical consciousness", "progress" takes the place of the Christian theology of history. Modern history formulates its idea of the future under this label. It means a linear quantitative and qualitative growth of theoretical knowledge and its technical employment, occuring in ever-shorter intervals of time. During the Enlightenment, the term was still based on the assumption that the free development of the intellect and an increase of knowledge, particularly in the natural sciences, would

lead of itself to a humanization of society; progress was thus equated with enlightenment as a historical process.Today´s pragmatic view equating progress with *technical* progress is relatively new. Only with the emerging industrial society of the 19th century did the belief in progress push the social-emancipatory aspects into the background and restrict itself to the material results of expanding technical knowledge. The increase in the "standard of living" achieved by the strength of this knowledge became the gauge for progress.

In regard to perception and knowledge, "metaphysical realism"[17] has dominated since the Pre-Socratic philosophers: Knowledge is seen as a picture of a world that exists before a consciousness experiences it. Traditional theories of the senses' access to reality include Realism (direct access), Representationalism (indirect access), and Phenomenalism (sense impressions are the primary or only access)[18]. The representation theory still dominates, interpreting perception as the reception, and thus language and communication as the transmission of information. Implications are:

- the separation of subject and object, and with it the assumption of a reality that exists independently of consciousness and which, in principle, is accessible, and
- the assumption of the existence of an objective, independent "final" observer as referent for awarding the label "true".

Criticism of this has a long tradition: With the development of the natural sciences, the ontological question as to *What* receded into the background. Man, increasingly with the attitude of Discoverer of the World, asks the question as to the conditions, the *How* of true knowledge. Scepticism questions the qualities of the things, and Kant formulates doubt as to "thing-ness" itself: how does a world of experience not being a mirroring of reality receive a stable structure? His answer: the processing of the raw material of the senses occurs through the automatic functioning of the "ideas" and the "categories" of our thought (space, time, God, etc.). These are independent of experience (a priori), they form a kind of description of an organism capable of experiencing. The questions as to *How* and *Why* remain bracketed off; we are left with the "mystery of self-organization", the resort to teleology, and God standing in the background. Vico, earlier than Kant, goes further: "Just as God's Truth is that which God recognizes by putting it together and creating it, human truth is that which Man recognizes by creating it and forming it in his *activity*. Thus science is knowledge of the emergence, of the way in which things are produced. What has been made determines what else can be made. The method of constructing reality is determined by the history of the construction." Even more clearly: "Science (is) nothing other than putting things in a beautiful relationship to each other."[19]

The natural sciences developed their own methods of cognition, oriented by the empirical practice of their research work. More and more, philosophy became one of

the humanities. Although of great interest for the physics' pressing problem of the relationship between perception and reality, the phenomenological approaches of the 20th century (Husserl, Heidegger, Merleau-Ponty) gained little importance. Merleau-Ponty[20] sees sense perception as the basic access to the world, in which we are located with our entire corporeality. It is not an ability but rather Man's fundamental stance toward the world, and activity and knowledge are reconstructable only through it ("the world is that which we perceive"). Dealing with the tension between the immediacy of perception and corporeality and the cultural context of mediation (language and history), he attempts to describe the structures of the world of living, of our "being-in-the-world", prior to any scientific and metaphysical access.
A rapprochment between philosophy and the natural sciences can be made out in the context of theories of science by Quine, Popper, and Kuhn, among others. Recently an interest in hermeneutic and phenomenological approaches can be observed in design-theory.[21] The wide reception of the work of Winograd/Flores[22], a critical consideration of the basic assumptions of the cognitive sciences, particularly of symbolic artificial intelligence, and, resulting from this, considerations in designing future computer systems, appears to have been a trigger for this. The approach introduced here emphasizes another strand of theory, also mentioned there: Maturana's and Varela's biological theory of cognition. Together with further approaches, an epistemological mode of thought has recently been developing from this. It strengthens the hermeneutic and phenomenological considerations of philosophy and - also due to the more familiar scientific terminology - makes them more attractive for work in design theory than are purely philosophical trains of thought.

INNOVATIONS IN THOUGHT

"*Operative Epistemology*" [23], better known in Germany as "*Radical Constructivism*" [24], means a way of thinking, not a collection of facts. Its origins lie in the biological theory of cognition, particularly the theory of autopoiesis (Maturana / Varela)[25], in the theory of knowledge construction (v. Foerster, McCulloch, v. Glasersfeld, building from Piaget's developmental psychology), as well as cybernetics (Wiener) and general systems theory (v. Bertalanffy). Epistemologically new compared to other empirical approaches is the "viewing (of perception) from the perspective of the brain" (instead of from the perspective of the sense organs, as e.g. in Lorenz´ and Poppers´ Evolutionary Epistemology).[26,27] The excitation of neurons occurring in the sense organs and transmitted to the brain is unspecific, the sense organs translate the variety of the world into the "unified language" of bioelectrical nerve potentials. The construction of the sense organs determines which environmental events can influence the brain at all. This

"unified language" is the foundation of the integrating work of the nervous system and the brain. The site in the brain where the excitation of neurons is processed determines the modality (hearing, seeing, smelling...) and the quality (color, taste...) of the sense impressions, and the frequency of impulse determines the intensity of feeling. The topological criteria are partly present at birth, partly ontogenetically gained. This means: the brain is a cognitively closed system dealing only with its own states. It is not in a position to picture or represent reality as such. Interior and exterior, space and time exist only within the closed cognitive world. Perception is thus interpretation, the attribution of significance to the incoming neutral signals. In Luhmann's very concise words: "Consciousness interprets body processes as the world."[28] Essential concepts of *autopoiesis* [29] include the *structural determination* and *operational closure* of biological systems, i.e. they can be perturbed from outside but not instructed. *Structural coupling* with other systems or with the environment is the precondition for *communication*. The system's ability to interact with its own internal states, due to the existence of a nervous system, makes the *concept of observer* possible: the system can cognitively create descriptions of itself and its environment. In an analogous manner, hierarchies of description are possible (observations of observations of...). These are of a purely verbal nature and do not mean higher levels of objectivity. Science, as the highly formalized way of observing observations, thus attains its power not on the basis of a quality of perception principally higher than that of everyday observations, but only as a consequence of the theoretical and methodological complexity of its conceptually differentiated disciplines.
Von Glaserfeld, following Piaget (and Vico), emphasizes the aspect of *activity* .[30] Perception and knowledge result from a subject´s activities. The construction of a relatively durable, regular world from the stream of experience is not defined from the outside, but internally on the basis of comparative operations. Thus, knowledge consists of cognitive structures that are constantly subjected to the world of experience and that either stand up to it or don't. This knowledge offers *one* tractable path but in no way a statement about the ontological world. Knowledge is "true", as long as it enables successful activity.

This marks a considerable change in the way of dealing with the paradox of the scientific practice of the observation of observations. The resolution is no longer done statically, by resorting to final principles and first causes (the transcendental a priori of reason, or Popper's "World 3") but proceeds dynamically as a recursive process in the act of observing observations. By temporalizing the sequence of operation in the verbal schema of "problem" and "problem-solution", relatively stable states (verbal forms, objects, knowledge) arise in the historical and social context. Accepting the principle of

observing observations (second order cybernetics) means an important step toward the re-empirization of epistemology. "An operative epistemology does not overlook or repress that it is itself a product of human cognition, which it claims to explain. It must thus be worked out in such a way that it explains itself."[31]
Traditionally knowledge was attributed either to individual subjects or to material knowledge bases, whereas Winograd / Flores indicate knowledge as "a pattern of interaction within a common social frame of reference. Being human means belonging to a species that can create mutual obligations by speaking and listening."[32] Searle's theory of speech acts[33] and Habermas' theory of interaction[34] deal with this aspect. Emphasis here is in the communication of two individual consciousnesses. Luhmann criticizes this "unscathed intersubjectivity" and states that "... knowledge, whatever the corresponding state of consciousness may be, is a structure contributing to the enabling of the autopoiesis of communication."[35] He also designates the statements of Operative Epistemology[36] as insufficient and - controversially - applies the theory of autopoietic systems to social systems.[37,38] Communication now is seen as an autopoietic, structurally determined system, and the attribution of knowledge is done within the reference of communication. Thus, according to Luhmann, three separate, structurally connected autopoietic systems arise (organism, consciousness, communication). The view of consciousness and communication as separate systems appears fundamental for the description of design in a social context.

THE PROBLEM WITH THE "PROBLEM"

The concept of progress as an increasing improvement of human knowledge has stood in the foreground of theories of science since Popper's "Logik der Forschung" (1935): progress can only be postulated if there are general methodological criteria of scientific cognition; mainly the degree of usability (cf. Critical Rationalism). Kuhn's thesis of the methodological incommensurability of paradigms[39] fundamentally questioned the possibility of general criteria. In his view progress, if at all, can only be determined paradigm-internally. Feyerabend[40] regards methodological principles as being fundamentally hostile to progress (cf. Epistemological Anarchism). The discourse is characterized to this day by the use of terminology from the theory of evolution that traces back to Darwin's "On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life" (1859). This influences two areas: first, the question of the adaptation of the brain and the perceptual apparatus to the "structure of reality" in the process of biological evolution (cf. Evolutionary Epistemology), and second, the formulation of theories of scientific progress.
According to Toulmin, Popper's two maxims of the "scientific method" - the freedom

of design and the strictness of criticism - make sense directly within the theory of evolution: increasing the available pool of theory-variants and increasing the selective pressure[41]. The concept of evolution as a model for optimal solution of technical and scientific problems is spreading on the basis of an often greatly oversimplified understanding of Darwin's theory. The terminology of "struggle for life" or "survival of the fittest" leads as far as fascist ideologies of race. Von Glasersfeld[42] emphasizes that Darwin's "fit" means "what fits in" and not "what matches". "Natural selection" by the environment does not occur positively (i.e. what is "best", "strongest", "truest", etc. survives) but negatively (what doesn't fit in dies). Adaptation is the active recovery of an organism's viability, not an optimization in relation to a goal criterion. Bateson describes evolution as based on the cybernetic principle of limitation, not on the principle of cause and effect.[43] It is a tautology: the survivor is, at least presently, permissible, nothing more. Survival is the only criterion for success or failure. The analogy can be made (at least metaphorically) between organic structures viable in their environment and cognitive structures usable within their world of experience (science, culture, everyday life). Usability means the ability to explain, predict, and control, and the ability to guide experience. Winograd/Flores refer concretely to design (of artifacts, structures of organization, computer systems, etc.). They emphasize that, in today's practice, the nature of human cognition and language are misinterpreted. Computer use is based on this misunderstanding and gives a welcome model for tasks in other fields. The standard access is through the schema "problem -> solution" with the tendency to grant the questionable "problems" a kind of "objective existence".[44] The model for optimal "problem-solving" is, in turn, the everyday understanding of biological evolution described above. [45] It needs a "problem" (objective -> *existence*), a criterion of "solution" (optimal -> *truth*), and a formal algorithm for finding it. This approach, firmly within the rationalistic tradition of thought, is also characteristic for design practice, with the exception that in design there is usually no algorithm for finding a "solution".

It seems evident now that human problem-solving has to be remodelled. The characteristics of the world and of problems are created in activity. Understanding is the circular process of activity and cognition. Knowledge cannot be separated from the fact that we live in a world that is inseparable from our body, our language, the history of our society. Knowledge cannot be represented as a set of assumptions and rules. Subject and object, perceiver and perceived condition and determine each other. Instead of an optimizing "problem-solving", one should assume a "poking around" in a field of possibilities. "Solutions" are viable in their environment, but say nothing about a reality independent of it nor about their own approach to this reality. An example of this thesis requiring no further explanation is pharmacological research ("drug design").

Thus, the terminology of "problem-solving" is a usable schema for structuring a design project, but it does not explain the social dynamic, the "anarchy" as it sometimes appears from "outside". It seems more appropriate to describe *the finding and solving of "problems" as a dynamic cyclically self-sustaining process*. The main purpose appears to be the creation of *connection points for continuation of the process* . Our "problems" are verbal (the decrease of a sales figure, the reduction of a probability of failure, etc.) and can thus be influenced to a large degree. We don't wait for the "real problems" (disturbances of action, "collapses" in Heidegger's sense). The "real" world reveals itself exclusively where our constructions fail. In our civilization, however, "collapses" take the form of catastrophes. Our methods of dealing with them are unproductive, because we can't use them creatively to define our needs. This recognition, again philosophical in origin, is increasingly discussed in failure-research. One speaks of the accident as being a system's most revealing case.[46]
One consequence is the struggle about the definition of the "problem". There are "important" and "unimportant" ones, "merely apparent" ones, "basic ones", "problems of mankind", etc. But are we free in the definition of "problems"? Is it even autonomous individual consciousnesses that do this? There are so many of them. And then there are "subjects" as "economy", "market", or "consumers". It looks like a dead end. Isn't it rather the case that the "solutions" present in society determine what is viable as a "problem"?

DESIGN AS ...

What should be clear by now: talk about design and design-theory is all bound up in the traditional paradigm of scientific thought, and so is mine. Nevertheless, instead, I follow Luhmann's extension of Maturana's theory, taking communication as a separate self-organizing system. It is dependent upon consciousnesses, but cannot be instructed, merely perturbed. The course of communication runs in accordance with its immanent structure. The decisive step is now to regard material and immaterial (design-) objects as elements temporarily emerging in this process: "Technology as externalized communication"[47], "Objects: Tokens for (Eigen) Behaviours".[48] Here communication must not be taken in the technical sense as directed transmission of information (here a meaning between producer and consumer) through a medium (here the product). Advertizing and some branches of "product semantics" are used to think in this terminology. Medium and meaning (message) are inseparable in design ("the medium is the message"). The concept of medium should be defined more generally as the developmental, productive, and distributional technology of the society so that it is distinguishable from its content , i.e. the concrete meaningful product. The whole

design cycle, not only the product, is thus a component in the society's process of communication and reproduction. With this concept, the description of design in the sense of a verbal phenomena is possible. Language, too, does not primarily designate objects and facts, but rather is concerned with the viability of social communication. Its most important goal is the securing of the continuability of this process, the *maintenance of autopoiesis*. Existing "solutions" are the most important starting points, "problems" are defined in a way that enables the result to deliver optimum continuability for the following "problem" definitions. A true *solution* would end the process, would break off the communication and would have substantial negative effects on other structurally connected systems of society (esp. economy).

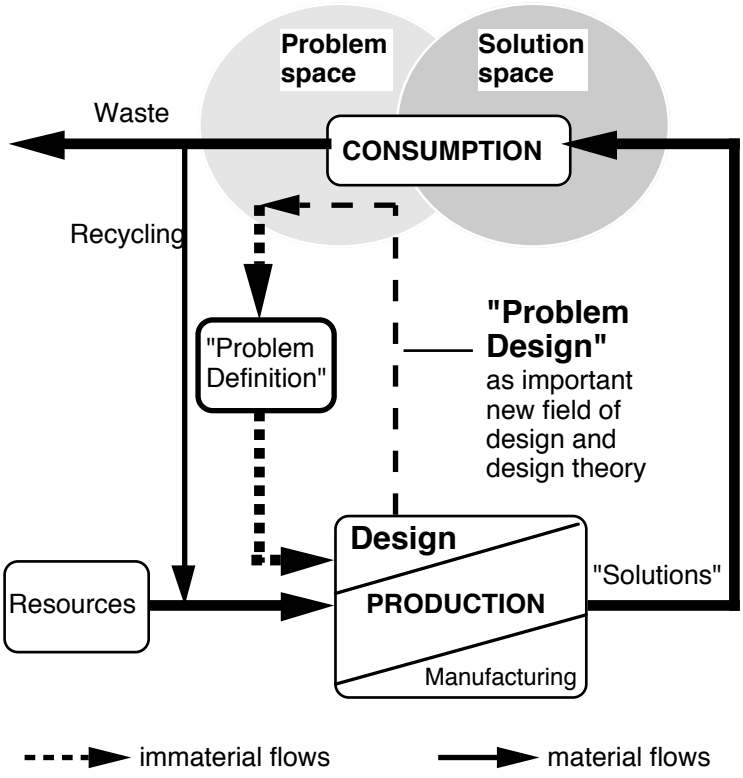

Figure: A Model of the Dynamic Cycle of Product-Communication

Comments:
- Design is a kind of language production, whose elements are material or immaterial objects. Social communication increasingly operates in this language. The utility value recedes in importance compared to the communication value. The functioning of essential social sub-systems is decisively dependent upon the smooth course of this communication.

- Social communication with and without artifacts creates spaces of viable solutions and problems. There is not a simple causal relation between existing solutions and emerging problems. The problem-space is the resource for "problem-definition".
- "Problem-definition", the fixing of solvable "problems", is not done by designers but mainly by marketing experts under economic considerations.
- "Problem-definition" is the key determinator and main impetus of the cycle. Other involved disciplines influence the process but do not determine it.
- Design has a considerable influence on the solution-space by furnishing its material components. Design has only little influence on the problem-space, mainly by means of designers being involved in everyday-communication.
- The cycle is a rather convergent process, limiting the range of possible solutions and impeding alternatives.
- The problem-space as resource for potential "solutions" cannot be determined as it is a self-organizing process. But it can be influenced by material and immaterial means.

Thus, if design really claims responsibility for "quality of life", the discipline has to be extended towards analyzing the problem-space, e.g. the mechanisms how "problems" emerge from the problem-space. I call it problem definition competence, leading to "problem-design". A means to this, in theory and training, is to emphasize the recursive character of the concept of problem and to show the very temporary event character of the "problems" usually solved in design practice. An extended design methodology aims at influencing the problem-fixing process into a more flexible, more divergent direction. This in turn influences the solution-space and could create a positive feedback in reducing the pressures inherent in the situation. It needs a theoretical basis and methodological tools. My own "neomechanistic" approach based on nonlinear systems dynamics, using computer-simulation techniques, aims at modelling and understanding the complex inter-relations of material and immaterial flows in design ("systems-thinking").[49] Brock characterizes "*creativity (as) the ability to problematicize*, that is, to create problems and to increase awareness, though always this side of emergencies".[50] In this sense, as a "problem simulator" beside its use as a "problem solver", the computer could indeed play an important role in design.

EXAMPLE AND ATTEMPT AT A SUMMARY

The automobile industry does not produce solutions, but rather artifacts which just secure competitiveness among the co-suppliers (in my terminology: stimulating the process of communication, instead of endangering it with too strong an irritation).

Developmental steps going beyond that (I avoid the term "progress") are saved up for later cycles of "problem definition" and "problem solving". Automobiles are related to:
a) functional goals: fast, convenient, economic and secure transport from A to B.
b) communicative (semantic) goals: prestige, self-esteem and pleasure for the owner.
The average quality of solutions with a) is decreasing, especially compared to alternative transportation systems. The situation with b) is more complex, but the question has to be posed if the increasing cost/benefit ratio can be tolerated in the long term. The crucial factor seems to be self-esteem which has to be supported as a main prerequisite for facilitating a "shift of solutions", i.e. a flexibilisation and enlargement of the potential of viable solutions. A Mercedes-Benz TV-Spot makes a step into this direction, I call it the "virtualization" of design: A man opens his garage, a big Daimler standing inside. The camera surrounds it, showing all its splendour and the speaker tells about the ecological benefits of the vehicle. Finally the man leaves the garage ... on an old squeaking bike.
To develop this idea: It is desirable to *de-materialize the elements of the language design* without negatively affecting their undoubted contribution to the "quality of life" and their creation of "meaning". The goal are economically viable strategies for a reduction of the side-effects (production, use, waste disposal) while maintaining the utility value and the communication value. A beginning could be: One still has a car in front of one's home but its use is limited more and more by appealing alternatives and financial restrictions. Pleasure is gained in special autodromes, self-esteem and reputation is supported by communicating that one owns a car but rarely uses it. The next step: One does not buy a car but contributes to alternative projects securing economy (public transportation, ecological and third world projects, etc.). Pleasure and self-esteem are acquired as above.
A long range goal might be that qualities as pleasure and self-esteem are detached from things and reattached to communicative and widely immaterial processes. Sounds utopic? Maybe, but if so it only show our partiality. I don't claim that this partiality is the "cause" of, e.g., the environmental crisis. One could just as well say that the environmental crisis (or the "crisis of Modernism") has stimulated the development and spread of innovations in thought. The question is whether the present turmoil of activity and thought can carry us past the great catastrophe or not.

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[19] **von Glasersfeld, Ernst**, see ref. 17 p26
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[27] **Roth Gerhard** "Autopoiese und Kognition: Die Theorie H.R. Maturanas und die Notwendigkeit ihrer Weiterentwicklung" in Schmidt, Siegfried J. (ed.), see ref. 24 pp 256-286

[28] **Luhmann, Niklas** *Die Wissenschaft der Gesellschaft* Suhrkamp, Frankfurt / M. (1990) p 43
[29] Autopoiesis characterizes a system whose components work in a permanent circular process of self-production and self-organization. More precise (but not always corresponding) definitions in Maturana (ref. 25), Roth (refs. 26,27), Luhmann (refs. 28,37) and others.
[30] **von Glasersfeld, Ernst**, see ref. 17 p 30ff
[31] **von Foerster, Heinz**, see ref. 23 rear cover
[32] **Winograd, Terry; Flores, Fernando**, see ref. 22 p 130
[33] **Searle, John R.** *Sprechakte-Ein sprachphilosophischer Essay* Suhrkamp, Frankfurt/M. (1971)
[34] **Habermas, Jürgen** *Theorie des kommunikativen Handelns* Suhrkamp, Frankfurt/M. (1981)
[35] **Luhmann, Niklas**, see ref. 28 p 134
[36] Construction of the other person in analogy with the self-construction, verbal and non-verbal communication between single subjects, no acceptation of technical communication theories.
[37] **Luhmann, Niklas** *Soziale Systeme: Grundriss einer allgemeinen Theorie* Suhrkamp, Frankfurt/M. (1984)
[38] Concerning this terminology cf. Roth (ref. 27): He denotes communication (different from Luhmann) and cognition/consciousness (different from Maturana) not as autopoietic but as self-referential systems.
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[48] **von Foerster, Heinz** "Gegenstände: greifbare Symbole für (Eigen-) Verhalten" in von Foerster, Heinz, see ref. 23 pp207-216
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