Mind the gap! – on knowing and not – knowing in design
Or: there is nothing more theoretical than a good practice

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Abstract
The question of design foundations, or, "common ground" is open. Foundations are either "nothing" – the very beginning of cultural evolution, "Point Zero" (the stick and the stone), or "everything" – the history of what happened up to the present moment. From "Point Zero" to now we had an endless cycle / spiral / "history" of construction and destruction of artefacts and knowledge, or, of complexification (to avoid the overloaded word "learning"). And we have the moving "wavefront" of the present, where we experience the similarity of designing and "science in action". Both are acting in the hybrid swamp of artefacts, consciousnesses, communications and human bodies.

But knowledge has different meaning, status and use in science and design. Science is aiming at predictability, thus needs stable models, which deliver "the same". Science has to purify its models in order to transfer them from hypotheses into prediction machines. Bodies, consciousnesses, communications and artefacts can be neatly split. Scientific problems are solved, as long as the solution does not turn out to be false, which means of less explanatory power compared to a new one. Design is aiming at single phenomena that fit various unforeseeable conditions. Design has to intentionally create variations, differences, because the "fits" dissolve, fade away, get old-fashioned. Design environments change too fast to talk of true or false design knowledge / facts. The archive of design knowledge is like a memory, a growing reservoir of variation as well as restriction. Expertise in design is the art of dealing with scientific and non-scientific knowledge, with fuzzy knowledge, with outdated knowledge and with no knowledge at all in order to achieve these value-laden fits. In other words: the art of muddling through.

We are facing the paradox situation of increasing manipulative power through science and technology and, at the same time, decreasing prognostic control of its social consequences. Accepting these limits of project-oriented science suggests a new role for design: more modest and more arrogant.

My conceptual tools for understanding the mechanisms that produce and destroy design artefacts and knowledge comprise: (1) Sociological systems theory (Luhmann) with the concept of autopoiesis, including the shift from identity to difference, (2) evolution theory (Darwin, Luhmann), and (3) evolutionary epistemology (Campbell, Riedl) and the concept of action research.
Why Still Considering Design Foundations?

The discourse on design foundations is isolated and erratic. The industrious and breathless "scientific" research activities have to be backed up by a more coherent + flexible and less rigid theoretical framework (= “foundation”), in order to promote the autonomy and specific character of genuine design (research).

In two papers I tackle the issue of foundations (Jonas 1999, 2000). The first describes design theory as "a floating network of chunks of ideas", without fixed epistemological core, acting in the interface region between shifting reference spheres: the contextual and the artefactual. Some deliberately provocative consequences were put forward, for example: there is no progress in design, or: design is amoral, and has to be, in order to fulfil its function. The second paper describes the interface as the "swamp", which is a provisional metaphor for the hybrid mix of the natural, the human, the social, the divine, which cannot provide foundations but only entry points. Design has no foundations because design itself is the basic human activity. Foundations might be emerging transitory patterns. Science is also acting in the swamp (in their case called laboratory or field), but science is obliged to purify and de-contextualize the facts constructed there in order to protect its mythical image of being closer to the truth than other ways of knowledge production. And I asked whether design should follow this tempting but problematic program.

No doubt, design has reached considerable status and complexity:
- Dozens of professions are using the concept design. But what are their commonalities apart from transferring existing states into new (at best desired) ones?
- There is a growing sphere of design research. But what is the design-specific aspect in these activities, except that they might be useful in design tasks?
- Enormous canonical lists of apparently relevant knowledge fields and disciplines (almost *everything*) and well-established academic rules are piled up and promoted (Friedman 2001). But is this creating "common ground", or rather obscuring the lack of genuine foundations through quantity and eloquence?

One could go further, addressing communication styles:
- Conferences are nice social events, and conferences produce proceedings, which are, however, mostly not more than a collection of unconnected texts.
- Competition and rivalry ("I know better") is the prevailing style. There are fierce debates, yet mainly concerning details of the respective positions. Hardly anyone is looking for understanding or even connectivity and possible links between different approaches.
- Fresh (to avoid the hackneyed word "innovative") ideas are frequently marginalized as fringe positions or kicked out with reference to academic standards that are not our own.

I do not want to be a spoilsport (and I do not at all question the current efforts and achievements of design research in all its facets), but for these reasons the loud suggestion of foundations and progress sounds like magic spell. It may appear futile, or, even narrow-minded to stick to this point; but I am convinced, that, in order to develop a genuine design identity, it is necessary to keep the question of foundations open and alive. This comprises ontological, epistemological and methodological aspects:

1. Is there an essence of design / designing?
2. What is the overall function of design?
3. What is the specific nature of knowing in design?
4. What about the relation design / science?
5. How to improve the process of "problem-solving" through research?

One may object, that the very product of designing, the artefact, is missing. In my view artefacts are not central, they are necessary but contingent materializations in the never-ending process, which can, at best, be interpreted retrospectively (with benefits for further projects, of course).
After the "Common Ground" conference in September 2002 there was a short discussion of the observation, that, for some people, the event did not meet the expectations raised by the ambitious metaphor. The debate was cut off by the laconic answer of the organisers, that it was "a title, not a theme". This is not satisfactory, since theoretical contributions, explicitly addressing the issue of foundations, reveal a proper "carnival of opinions" (Jonas 2001-2003). We should mind the traps and deadlocks of this endeavour. Speaking of "common ground" claims the description of the whole of design from a position inside design. Normative fixations and quasi-religious formulae are frequent outcomes of such auto-logical situations of self-reference and paradox. They cover the necessary singularity and fluidity of all self-observations and entice us to take the map for the terrain.

Can there be foundations with axioms, laws and scientific methods? Or do we have to accept the concept of elegantly "muddling through"? Any attempt to fix foundations leads to the question: what is the foundation of these foundations? The "Münchhausen-trilemma" shows up (Münchhausen was the guy who pretended to have pulled himself and his horse out of the groundless swamp by his own pigtail, see Albert 1968), leaving the options of infinite regress, circularity, or dogmatic postulation. Love (2002) is looking for foundations on a very basic neuro-physiological level. His explanations based on biology will end up in infinite regress, I fear. Buchanan (2001) introduces "generative principles". Where do they come from? They are generated, but they reveal a nice circular aspect, as will be shown. Friedman (2001) defines some concepts and concludes: there are foundations, and basta! In my view, a mix of circularity + time (= "spirality") seems to be promising.

**Foundations by Definition and Deduction?**

We tend to stick to the inappropriate expectation of being able to tackle polymorphous phenomena (design, progress, foundations) by means of sharpened definitions and formal conclusions. Fuzzy concepts may better be grasped through illustrating the core of the term by means of analogies. This means a shift from a definitory (binary) towards a transitory (fuzzy) logic.

Friedman (2001) took a critical look at the papers mentioned (Jonas 1999, 2000). The following is a part of an imaginary dialogue (see also Jonas 2002), i.e. I reply to his critique, concentrating on the questions of overall style and the issues of progress and foundations. His main critique: "The arguments against the concept of foundations are intuitionist in nature."

**K.F.:** "... These papers outline problems and issues without defining them. Opening the problem space allows us to reflect. Closing the problem space through robust definitions allows us to begin the search for solutions."

**W.J.:** The basic problems mentioned cannot be defined in a manner you would accept; definitions are not available. The concept of interface clearly refers to Simon and Alexander and their notions of design as interface discipline. "Robust" definitions might kill the problem before the search for solutions has even started. The idea that the problem space has to be closed in order to proceed towards solutions is inappropriate. Since the early 1970s we could know that in ill-defined, wicked problem situations problems and solutions evolve in a parallel process. If at all, the problem can be stated when a solution is achieved. And then the solution is the problem! I am convinced that this is true for design problems as well as for design theory problems.

**K.F.:** "The growth of design knowledge, the steady history of improvements in design practice, the dramatic development of design research, and the gradual development of design teaching, all indicate progress. Progress is not uniform. Comprehensive progress is impossible. Nevertheless, there is relatively wide agreement in our field that we are meeting Bunge's (1999: 227) definition of progress as a 'process of improvement in some regard and to some degree' in all four areas of design. The state of physics in 1895 offers a good comparison for our field. Because we are a different
kind of field, we cannot hope to make the fundamental progress that physics has made over the past 100 years. Even so, we can hope to grow if we focus on a progressive research program.

... Progress in research and in practice depends on prior art. This is another way of stating that progress requires foundations. If there is progress – and there is – there must be foundation(s). There is progress in design. QED: design has foundations."

W.J.: There is an interesting rule, or axiom: "Progress requires foundations." And as we have progress, we have foundations. This is a nice circle, or syllogism / deduction, which fails immediately if one does not believe in your definition of progress and your postulation of progress in design. In my old-fashioned view progress comprises (1) an increase in scientific "truth" (there is progress e.g. in physics; but in design?), (2) an improvement of the human condition, the claim that Galilei and Bacon stated for science (there is progress in many fields; but through design?), and, (3) the utopian claim of enlightenment thinking: better human beings (no progress here!). But I do not accuse design for not showing much progress in this sense, because, as I argued, design is the agency of bridging the gap, the interface. There is no reference point for defining progress, but merely fit or non-fit. Is Mac OS X a design progress compared with OS 9, or just an increase in functional complexity?

Parallels with physics or even mathematics seem inappropriate. Maybe there are parallels to the situation of the Design Methods Movement (and the "design science decade") some 40 years ago: an exponential growth in rigidity ... and then a collapse with important insights: that there are designerly ways of knowing, that design problems are mostly ill-defined, embedded, situated, etc.

Today we are in a situation when other disciplines realize the fragile, fluid, historical character of their respective "grounds". We should beware of the "fallacy of misplaced concreteness" (A.N. Whitehead), which means that if we possess a word, to avoid the conclusion that there would be a thing indicated by this word. To put it quite simply: What are we talking about when we are talking about design and design research? I do not reject "systematic" inquiry. But this must not necessarily be the same as, e.g., in the social sciences. Refreshing and inspired designerly ways of inquiry are possible (Dunne and Raby 2001).

Foundations Through "Generative Principles"?

"Generative principles" are first of all generated principles. In order to come closer to foundations we have to look at the underlying evolutionary mechanisms, which are able to "generate principles".

Buchanan’s (2001: 67-84) "ecology of culture" could well be compared to my notorious "swamp". In stating, that "We tend to dismiss the way human beings have formed their beliefs in response to the natural and human environment" he explicitly introduces an evolutionary concept. In developing our paths of thinking, we depend upon the philosophical assumptions that stand behind our basic beliefs, the contingency of which is not made explicit, however. Mostly they rest in a pre-conscious state of mind. In order to render them more explicit Buchanan identifies, or invents, four "generative principles" as generators for the various, sometimes incompatible, patterns of design theorizing today. His scheme shows two dimensions: the phenomenal processes (A) and the ontic conditions (B), each with two typical faces, so that a nice cross-scheme is showing up, an example of theory as design:

A: Phenomenal.
The underlying assumption is "that design is best understood by our experience of it ..."

A1: Experience and environment. The focus lies "on the problems that human beings encounter in their environment. ... It seeks to identify and integrate multiple causes of design rather than reducing it to a single cause. ...". The four Aristotelian causes are showing up.
A2: Agent.
The focus lies on "the agent who performs an action. Design is shaped by the actions that human beings take in creating and projecting meaning into the world. ... This existential, operational approach is exemplary in its key features. It looks for successful examples of design practice in the past or present for models that may guide future ventures in designing. ..."

B: Ontic.
The underlying assumption is that there are "real and ultimate' conditions that determine design in human experience ...".

B1: Underlying forces.
The focus lies on "underlying natural forces and material reality. ... The paradigm of design is engineering, since engineering is closest to the natural conditions that are the 'real and ultimate' conditions of human life. ... This ... approach ... looks to the conditions that have shaped the past and seeks to project the trends of fundamental forces and movements into the future ...".

B2: Transcendent ideas.
The focus lies on "ideas and ideals that transcend the necessities and contingencies of physical or material culture and the limitations of individual, personal experience. ... This vision ... is always oriented toward an ideal of beauty, truth, or justice that transcends and permeates the world of human experience, giving structure to meaning and values. ...".

Thus an explanatory structure for the chaotic image of design theory building is offered. The scheme as a whole reveals a strong Platonic appearance, which Buchanan only attributes to principle B2. It seems to float in an eternal realm of ideas, producing the puzzling variety of the phenomenal world of design theories. But where does it come from? Can it be integrated into a more generative model of knowledge production? The answer is contained in the scheme itself. Buchanan - between the lines - seems to be in favour of principle A1: Experience and environment. Humans' experiences lead to personal attitudes, preferences, and styles. In consequence, theories of how the world (or design) works will come up, according to those preferences. Buchanan’s four principles are one of these emerging theories, which, in turn, through their dissemination (Design Issues is an effective replicator) influence personal attitudes, preferences, and styles in the community, and which shape the further conditions of our experiences. "Generative principles" are generated, before the evolutionary generative background of 2500 years of Western philosophy.

To sum up: Generative principle A1 seems to be a bit "more basic" than the rest, because it contains the other ones plus itself. This shows the fractal character and self-reference of design theory, and, this is important, allows, to integrate the "Buchanan meme" into the general process of knowledge generation.

A Foundation: Evolutionary Epistemology

*Evolutionary epistemology provides the most basic generative mechanism to explain learning in the living world, thus explaining the ongoing production and re-production of both artefacts and knowledge, finally of design and science as dynamic forms.*

This is the “essence” (à question 1).

There is no need for any specific nature of knowing in design (à question 3).

A Darwinian mechanism of (1) mutation – (2) selection – (3) re-stabilization – and so forth is showing up: (1) Jonas introduces a new concept, which might be called a mutation, creative act, intentional provocation, or whatever an observer might prefer. – (2) Friedman acts as a selective environment, contesting the proposition. – (3) The chunk of ideas survives in this "struggle for life", the interaction of the system (Jonas’ ideas) and the context (Friedman’s critique). The concept is re-stabilized. – (1) Buchanan’s new appealing chunk of ideas appears, which
Jonas tries to integrate. – (2') Someone might act as a selective mechanism, and so forth. In contrast to a genetic process in biology this is a memetic process. The “chunks of ideas” that are transferred might be considered as memes or memplexes (Dawkins 1976, Blackmore 1999). The essential observation up to now is, that learning cycles might emerge in design debates, if only there were debates.

The basis of our learning processes, which are the epistemological core of design, can be considered as biological, grounded in the need of organisms to survive in an environment. The aim cannot be true representation of some external reality, but (re-)construction for the purpose of appropriate (re-)action. Even Aristotle suspected, that the recognizability of the world must rely on the fact, that there is a kind of similarity between the “particles” of the world and those in our senses. The history of biological evolution indeed suggests similarities of the way the material world is structured and the way we think of the world. Evolutionary epistemologists (Campbell 1974) argue that the Kantian transcendental apriori has to be replaced by the assumption of an evolutionary fit between the objects and the subject of recognition.

The evolutionary model of knowledge production presents a spiral scheme with structural identity from the molecular up to the cognitive and cultural level (Riedl 2000). The basic structure reveals a circle of trial (expectation) and experience (success or failure, confirmation or refutation), of action and reflection. Starting with and driven by new cases, the circle consists of an inductive / heuristic semi-circle with purposeful learning from experience, leading to hypotheses and theories and prognoses about how the world works, and a deductive / logical semi-circle with the confirmation or refutation of theories. Depending on the purposes and desired outcomes we have design or science.

Only very recently in the cultural evolution this general scheme was split into the ratiomorphous (the term was coined by Konrad Lorenz) systems of recognition and the rational systems of explanation / understanding, with its most extreme form: the logical positivist dualism of “context of discovery” (acting) vs. “context of justification” (thinking).

<table>
<thead>
<tr>
<th>Recognition (Erkennen)</th>
<th>Explanation (Erklären / Verstehen)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- networks, many causes</td>
<td>- linear cause – effect relations</td>
</tr>
<tr>
<td>- simultaneous (simul hoc)</td>
<td>- sequential (propter hoc)</td>
</tr>
<tr>
<td>- 4 Aristotelian causes considered</td>
<td>- only causa efficiens considered</td>
</tr>
<tr>
<td>- only local validity, context is crucial</td>
<td>- global validity claimed, context excluded</td>
</tr>
<tr>
<td>- allows no experiments, mostly irreversible</td>
<td>- relies on experiments, mostly reversible</td>
</tr>
<tr>
<td>- prognosis is projection</td>
<td>- prognosis is forecasting</td>
</tr>
<tr>
<td>- correspondence of organism / artefact in a milieu</td>
<td>- coherence of elements inside a system</td>
</tr>
<tr>
<td>- reaches into high complexity</td>
<td>- reduces complexity</td>
</tr>
<tr>
<td>- fitness, “truth” means strong design</td>
<td>- “truth” means correct causal relations</td>
</tr>
<tr>
<td>- is labelled “pre-scientific”</td>
<td>- is labelled “scientific”</td>
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While the ratiomorphous process of recognition has a high potential in dealing with complex, evolving phenomena, it is not always useful for causal explanations, and vice versa. But this “dilemma” is not inherent in the nature of knowledge production, but rather a consequence of the dualistic concept, which we have imposed on it. The path from recognition to explanation is continuous and circular, sometimes with dead ends. Our language is too poor, or, too much locked in the “black&white” tradition of scientifically determined thinking, to express the beautiful transitory shades of “grey” between the poles.
The argument of naturalized epistemology appears in various forms and formulations. Another prominent representative is John Dewey (1986). In his view processes of circular action, driven by intentionality, are the essential core of knowledge generation. The separation of thinking as pure contemplation and acting as bodily intervention into the world becomes obsolete. Quite the reverse: Thinking depends on real world situations that have to be met, initiated by the necessity to choose appropriate means with regard to expected consequences. The projected active improvement of an unsatisfactory, problematic situation is the primary motivation for thinking, designing, and, finally - in a more refined, purified, quantitative manner - for scientific research and knowledge production. Knowing is a manner of acting and "truth" is exchanged by "warranted assertibility".

Schön’s (1983) epistemology of "reflective practice" can be regarded as the design-related description of these concepts. It is this unspecific pattern, which Cross (2001) characterizes as "designerly ways of knowing": "The underlying axiom of this discipline is that there are forms of knowledge special to the awareness and ability of a designer, independent of the different professional domains of design practice."

Another Foundation: Theory of Social Systems

Luhmann's theory of social systems provides the requisite complexity to split the nice but simplistic concept of the "whole" human being into autonomous subsystems. Design(ing) is the discipline of creating contingent fits / interfaces between bodies, consciousnesses and communications by means of artefacts (à question 2). The shift from identity to difference allows to handle the transitory nature of apparently fixed concepts.

Having accepted, or at least having taken note of the messy, swampy, hybrid situation as it is, we can continue to describe the function of design in society. According to the interface concept, introduced by Alexander and Simon, design acts in the region between the artefactual and the contextual, being responsible for the fit of objects and the contexts in which they have to operate (or survive, in plain Darwinian terms). In order to make this productive we have to overcome common sense notions and explicitly introduce coherent systemic and evolutionary concepts. Luhmann (1997) states ironically, that "ontology is very close to common-sense plausibilities - but nicer, more splendid, more thoughtful", and shifts the emphasis in systems thinking from the ontological distinction whole / parts to the difference-theoretical distinction system / environment which is necessarily depending on observation (= distinction + indication).

<table>
<thead>
<tr>
<th>identity</th>
<th>difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>An &quot;origin&quot; is posited by a privileged observer.</td>
<td><em>Draw a distinction!</em> as initial request</td>
</tr>
<tr>
<td>Existence / non-existence as fixed primary distinction (Sein / Nichtsein).</td>
<td>No rule regarding the initial distinction.</td>
</tr>
<tr>
<td>Subdivision of the existing whole into parts.</td>
<td>Marked / unmarked state, created through an observation (= distinction + indication).</td>
</tr>
<tr>
<td>System / elements.</td>
<td>System / environment.</td>
</tr>
<tr>
<td>Logical laws of - identity</td>
<td>The unity of the difference of marked and unmarked state is called &quot;the form of the distinction&quot;</td>
</tr>
<tr>
<td>- no contradiction</td>
<td>Crossing the distinction allows the negation and exchange of counter-terms.</td>
</tr>
<tr>
<td>- tertium non datur are valid</td>
<td>This introduces a kind of trivalent logic - tertium datur</td>
</tr>
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Table: The shift from identity to difference (Luhmann 1997).
Luhmann distinguishes (heteronomous) mechanical systems / artefacts and (autonomous) self-organizing systems. The latter comprise organisms, consciousesses, and communications as autopoietic systems. Organisms act in the medium of life, consciousesses and communications act in the medium of meaning. We should seriously take into account the operational closure of autopoietic systems and consider any temporal development as a co-evolution of isolated systems. This avoids the illusion of control (through design) in social situations, which always refer to all three domains, or, “to the whole of life”, as John Chris Jones would call it.

The consequences should not be considered as normative or “anti-humanistic” but as methodological: No analysis of consciousness will ever reveal anything about communication and vice versa, just as no analysis of mental processes will reveal anything about brain processes, which are the domain of living systems. Consciousesses cannot communicate, but only communication can communicate. Consciousesses and communication interact through language. They have a relation of interpenetration, they make use of each other but cannot control each other. Our bodies are external to our consciousesses and external to communication. There is no place (and no need) for the individual in the theory (“there are simply too many of them”). The simplistic and diffuse idea of “man” is avoided, as no super-system encompasses living, mental and social systems. What man is depends on who is observing and how.

Consciousesses, communications, organisms, and artefacts create the “swamp”, which is a provisional metaphor for the interaction / development of this mess. Design deals with this situation and sticks to the optimistic opinion that prognosis as to the success of design interventions is possible. And this (design’s ignorance of its ignorance) is what makes design so attractive to other disciplines, even to the sciences (Baecker 2000):

“Design as a practice of not-knowing will be readable with respect to various interfaces, but probably the interfaces between technology, body, psyche and communication will be dominant: as soon as these ‘worlds’, which, for themselves, are described by a more or less elaborate knowledge each, are set into difference to each other, this knowledge disappears and makes room to experiments, which are the experiments of design. ... Considering nothing as self-evident here any more, but discovering the potential of dissolution and recombination everywhere, becomes the playground of a design, which finally reaches into pedagogy, therapy, and medicine. ...”

This is the scandal of split causality, which systems theory makes explicit, and which design has always managed without knowing about it. There is closed causality: the system itself can be described as a causal system (based on knowing), and there is indeterminable causality: which implies, that in the environment of a system there may be further causes whose effects inside the system are indeterminate, because the system relies on its difference to the environment and its ability to cut chains of causality (based on not-knowing). It is these gaps, which provide the locations for models of creativity as well as for models of failure. We can still talk of causality, but have to keep in mind that it is nothing but the choice of an observer.

This view implies a change from a concept of design as a causal field with (still) some white spots into design as an - in principle unpredictable, non-causal - field with some unconnected islands of causality, mainly referring to isolated technical or scientific facts. It implies the renunciation of a scientific knowledge base in favour of a functional scheme. A knowledge base, due to the necessarily trans-disciplinary nature of design activities, would have to comprise *everything* (as Friedman’s canonical lists are impressively demonstrating) yet without being able to re-connect the islands. Finally it implies the renunciation of the concept of progress. While design is installing fits between dynamic systems (which may claim progress for themselves), there is no reasonable criterion of progress for design itself. Design is evolving.
To go a step further: Design is acting as a kind of, often useful, sometimes annoying, parasite (Serres 1987), creating interfaces, couplings, aids, prostheses, meaning, etc. Design is permanently observing the field for wishes, unsatisfied needs, potential links, seizing the opportunities that are showing up. Design observation is always second order observation (observation of observations). Causality, as soon as introduced by an observer, will be absorbed by uncontrollable deviations and interactions. If the parasite sounds too negative: others prefer the joker.

A Third Foundation: Theory of Socio-Cultural Evolution

The theory of socio-cultural evolution seems to be a useful framework to describe the unpredictability of design developments and project outcomes, thus the limits of causal explanations, in a scientific manner.

Simple feedback mechanisms produce the order and chaos of the natural and social life. The insights on evolution lead evolution theory to conceiving itself as a result of evolution, which immediately leads to evolutionary epistemology… and so forth. There is abundant evidence for implicit evolutionary concepts in design theory and methods, even in the most “rigid” approaches (see for example Roozenburg and Eekels 1991, fig. 5.12). There are even explicit evolutionary concepts. Hybs and Gero (1992) perceive artefacts as entities struggling for the survival of the fittest in the hostile environment of the market. In order to arrive at fresh descriptions, the generalized concept of evolution should be more rigorously applied to design. In the following I will refer to Luhmann again, whose theories are closely related to evolutionary epistemology. In his main oeuvre (1997) he has started to work out the concept of social evolution.

Firstly, evolution theory is based on the system / environment distinction. It is this difference, which enables evolution. Secondly, it does not distinguish historical epochs, but variation, selection, and re-stabilization. Re-stabilization is the essential condition for variation and selection being possible at all. Evolution theory serves for the unfolding of the paradox of the probability of the improbable, thus explaining the emergence of essential forms and substances from the accidental. It relieves the order of things of any bond to an origin or form-giving beginning by simply turning the terminological framework of world-description upside-down. Evolution theory is neither a theory of progress, nor does it deliver projections or interpretations of the future. The concept of autopoietic systems enforces a revision of the theory of “adaptation”, which is a condition, not the goal or outcome of evolution. On the basis of being adapted it is possible to produce more and more risky ways of non-adaptation - as long as autopoiesis continues.

The three separated processual components of evolution can be related to the components of society, conceived as a communicative system:

- Variation varies the elements of the systems, i.e. communications. Variation means deviating, unexpected, surprising communication. It may simply be questioning or rejecting expectations of meaning. Variation produces raw material and provides further communicative connections with wider varieties of meaning than before.

- Selection relates to the structures of the system. Structures determine the creation and use of expectations that determine communication processes. Positive selection means the choice of meaningful relations that promise a value for building or stabilizing structures. Selections serve as filters to control the diffusion of variations. Religion has been such a filter. Truth, money, power, as symbolically generalized media serve as filters in modern societies.

- Re-stabilization refers to the state of the evolving system after a positive / negative selection. It has to take care of the system-compatibility of the selection. Even negative selections have to be re-stabilized, because
they remain in the system’s memory. Today stability itself becomes a more and more dynamic concept, indirectly serving as a trigger for variation.

Variation, selection and re-stabilization can be related to the empirical reality of evolving systems, thus allowing the re-interpretation of historical reality in the light of evolution theory. For example:

- Early segmented societies (families, clans, …), where communication mainly happens as interaction between people present, hardly need the distinction of variation and selection, because every interaction is aiming at immediate acceptance or refusal.

- Stratified, hierarchical societies have problems to differentiate between selection and re-stabilization, because the main criterion for selection is stability.

- Modern, differentiated societies differentiate variation / selection as well as selection / re-stabilization, but have problems to distinguish re-stabilization and variation, because stability is of extremely dynamic character and provides the trigger of evolutionary variation. Here we may identify designing, the creation of variety, as a constituent of modernity.

Back to design: The present does not at all mark the wavefront of progress, but merely consists of what has remained from the past. And so it happens that we do not live in the best of all possible worlds. Harmony, if at all, is “post-stabilized” harmony, which we are creating in our narratives. The study of failed innovations (“floppology”) might be a promising approach to improve designing. The “dark side” of the field is probably richer than the “best practice” view.

**Mind the gaps! Control and Prediction limited**

*There are two basic problems related to systemic knowledge gaps:*

1. The gaps between autopoietic systems involved in designing. This fundamental systemic "obstinacy" is labelled or covered with the nice and common but fuzzy terms "creativity", "subjectivity", "values", "trends", …

2. The gaps between the evolutionary mechanisms involved in designing. Variation, selection, and re-stabilization have to be causally de-coupled in order to enable the "creative" generation of the new.

**Fig.:** The scandal of split causality: 4 autopoietic systems + design.
The previous findings allow us to summarize as follows: Designing consists of dealing with interacting / co-evolving autopoietic systems and artefacts. Random mutations as well as deliberate decisions and connections in social life initiate open-ended processes of self-organization. Positive and negative feedback interact to produce changing patterns that may at some point assume relatively stable forms, called fashions or trends, for example. This kind of mutual causality implies, that it is impossible to exert unilateral control over any set of variables. Interventions are likely to reverberate throughout the whole. Though it is often possible to spot an initial "kick" that sets a system moving in a particular direction, it is important to realize that such kicks are not really the cause of the end result. They merely trigger transformations embedded in the logic of the system or the systems involved. We can identify two problem areas: (1) control, due to the system / environment distinction, and (2) prediction, due to the variation / selection / re-stabilization distinction.

(1) The problem of control:
Luhmann’s systems theory provides a map of the possible gaps related to these interventions, called design activities. Which are the locations, where the gaps are manifest? We have the following combinations:
- artefacts / organisms
- artefacts / consciousnesses
- artefacts / communications
- artefacts / organisms / communications
- artefacts / consciousnesses / communications
- artefacts / organisms / consciousnesses, and
- artefacts / organisms / consciousnesses / communications.

Artefacts as artefacts are assumed to function; this is not the primary task of designing. With respect to the autopoietic systems, I introduce the following gaps, which are always occurring in interaction with different shares according to the specific design task:

- *organisms à the function gap*, which indicates, that it is not a trivial (…) task to adapt an artefact to an organism, for example, because bodies cannot speak…

- *consciousnesses à the taste gap*, which indicates, that it is not a trivial (…) task, to coordinate individual consciousnesses, for example to optimise a solution for 80 million consumers in the German market. They are all different, and they cannot speak about their taste in clear and distinct manner…

- *communications à the fashion gap*, which indicates, that it is not a trivial (…) task to generalize a variety of ambiguous information gathered from individual consciousnesses and to transfer this into the shape of artefacts, for example to plan a new collection of household goods for the Turkish market…

(2) The problem of prediction:
The three separate and independent components of evolution create further causality splits:
- *Variation* is aiming at alternatives. This is no problem, because consciousnesses provide abundant "creativity", which is essential for increasing the variety of choice. This is the "timeless" task of designing artefacts…

- *Selection* is aiming at the fit of alternatives into structures. This is a problem indeed, because communicative structures are detectable, but not their future stability. To a certain degree, at least, design research can examine existing structures…

Single aspects can be tackled by isolated approaches: organism - artefact gaps by means of ergonomics, consciousness - artefact gaps by means of cognitive ergonomics, communication - artefact gaps by means of market research, etc.
- **Re-stabilization** is aiming at the integration of selected alternatives into the system. There is hardly any predictability, because this is a question of long-term viability within communicative systems. Futures studies and scenario planning are dealing with evolving systems…

Design activities intervene into the relations of co-evolving autopoietic systems by means of creating artefacts that pretend to improve those relations. The basic problem is neither lacking individual creativity nor insufficient planning, but the uncontrollable and unpredictable behaviour of consciousness and communication in the environment of the artefacts. Design activities are bound to the time-structures of other systems as economy, science, politics. Design has no "Eigen-time". Its scattered structures evolve "in-between". The most developed, almost universal, instrument for bridging this kind of gaps is language, which enables communication. Functioning communication is highly improbable, as we know. Functioning design is even more improbable…

**Changes in Society and Knowledge Production**

*Science, just because of its success, faces a shift towards more project-oriented forms of scientific practice. The inability to deal with consequences due to the knowledge gaps leads to a "crisis of knowledge": there is no longer pure "theoretical" knowledge, but rather practical knowledge in dealing with theory. A "socialization of science" is occurring: science becomes more visible, is observed, and under growing public "control".*

The argument developed so far is supported by changes in society and knowledge production. High modernity believed in planning, predictability, progress, and in the inexorable "scientization of society". The third quarter of the 20th century saw the peak of professionalization and its deficiencies (e.g. Schön 1983). Since the 1970s we experience severe transformations in society and in the patterns of knowledge production, characterized, in a positive notion, as "knowledge society" (Bell 1973), or, more negative, as "risk society" (Beck 1986). In order to avoid the inappropriate concept of post-modernity we can state that modernity becomes reflexive. Design has been highly sensitive regarding this development, as the radical change in the Design Methods Movement around 1970 indicates.

Our activities become more projective and powerful, and at the same time we realize our inability to predict their consequences. We have to combine reliable scientific and technological knowledge about interventions with pure ignorance (not-knowing) of their psychological, social, economic, environmental consequences into completely new models of acting. Short-term determinacy changes into long-term uncertainty. The "crisis of knowledge" (Willke 2002) indicates our inability to manage not-knowing. Earlier societies had their appropriate mechanisms: traditional societies in the function of religion or industrial nation states in the function of free entrepreneurship based on power. If we refer to the concept of form (exposing the difference underlying our observations, see chapter 5), we can realize that the corresponding forms of knowledge are knowing / believing and knowing / power. Both forms of knowledge process their decisions not in the field of knowing but in the field of not-knowing. In highly complex secular societies we have to face the cruelty of a concept of knowledge, which finds its other side neither in faith nor in making or power but in not-knowing itself. We are no longer able to shift the burden of not-knowing to the distance of transcendental symbolizations or the immediacy of enforced making.

This shift of concepts may appear as an academic exercise, but it reveals the possibility and necessity to escape from cognitive deadlocks by means of tackling problems from the other side of the distinction. Pragmatically spoken: the acquisition of competence in dealing with uncertainty means that we have to make the right mistakes faster than others.
Nowotny et.al. (2001) characterize the same development as a shift from “Mode-1” to “Mode-2 society”. The interfaces between state, markets, culture are increasingly blurred. The relatively autonomous spaces these systems occupied, were products of the modern differentiation, as was science. The scheme of functional differentiation is dissolving in parts. The new program of the French CNRS reveals this shift from traditional disciplines to interdisciplinary problem fields. Moreover, the CNRS introduces the institution of “citizens’ conferences” (Frankfurter Allgemeine Zeitung 26.03.2002). In Mode-2 society a new relation of society and science is showing up which might be labelled the “socialization of science”, or, the shift from Mode-1 to Mode-2 knowledge production. Science and society become transgressive, i.e. not only that science can speak to society (it always could), but rather that society speaks back to science. Innovation is the centrepiece of a new contract between science and society. Science moves into the agora (Nowotny et. al. 2001: 201): “Science is no longer outside, either as a cognitive or quasi-religious authority or as an autonomous entity with its special access to the reality of nature.”.

It is just because of its success, that science has come under more pressure to deliver effective solutions to a wide range of increasingly complex problems. Thus science is being drawn into the production of contextualized knowledge. Contextualization happens through the shift from a "segregation" to an "integration" model (from a discipline focus to a problem focus, or, from subject-oriented science to project-oriented research), through the increase in uncertainty and the related “Darwinian” mechanisms of variation and selective retention, and through greater awareness of the place of “people” (actively involved in the production, conceptualised as either objects of research and / or as addressees of ensuing policies).

Mode-2 knowledge production implies, that
- the separation of basic and applied research is blurred (e.g. quantum computers),
- the separation of natural and artificial, of science (what is) and design (what could be) becomes fuzzy (e.g. genetic design),
- the distinction of facts and values becomes a problem,
- the context of application is extended towards a context of implication,
- the focus changes from reliable to socially robust knowledge,
- the concept of "context of discovery" vs. "context of justification" becomes obsolete,
- …

Seen from this perspective there is no longer any "theoretical" knowledge, but rather practical knowledge in dealing with theory. There is no "abstract" knowledge, but rather practical knowledge in dealing with abstractions.

The “hard” epistemic core of autonomous self-referential science, which scientists have struggled to articulate and to defend, is weakening. It is not empty but crowded and heterogeneous. This is not some sudden paradigm-shift from science to non-science, or from universal standards of objectivity to locally determined relativism, but the latest stage in a process of adjustment to an increasingly complex reality. Maybe the situation can be characterized as an uncoupling of modernization from modernity. The processes of innovation are separated from the values on which they were once assumed to rely.

Design as a Non-Modern Discipline - Science Approaches Design

*Design, in a smaller scale, has always been the expert discipline of dealing with not-knowing. Both design and science are based on circular processes of inquiry. They (still) differ in their purposes and outputs and in the criteria of evaluating these outputs. Nevertheless science becomes more "design-like".*
Therefore design is requested to sharpen its, in main parts, non-modern profile instead of striving at adaptation to a traditional and weakening concept of science (à questions 2, 4).

Basically humans are "universal dilettantes". The functional differentiation of societies de-valuated this trans-competence. Design, as a product of modernity, comes into being as a mediating interface between the making and the use of artefacts. Design professionalizes the competence of "universal dilettantism"; the human poietic drive is compensated by Do-It-Yourself industries. Functional differentiation of societies is the paradox foundation of design, paradox, because, at the same time, design, as a cheeky "un-discipline", rejects this separation, permanently meddling in everything. In this sense, because it is orthogonal to the operational closure of autopoietic systems, it is orthogonal to the traditional strategies of modernisation. Design has never really been modern. And therefore it may serve as a model for dealing with the conflicts of modernity.

On the other hand there is increasing evidence that scientific research practice resembles designerly ways of acting and reasoning. A "third way", a more nuanced and sociologically sensitive epistemology is needed which incorporates the "soft" individual, social and cultural visions as well as the "hard" body of its knowledge. Recently I formulated three theses regarding design (Jonas 2001), which can be related to science and the concepts of Mode-2 society and Mode-2 knowledge production.

(1) Design must fit – and so must science.
This refers to the interface concept of design. The growing contextualization of scientific practice shifts the emphasis from internal coherence of its findings towards fitness with respect to its contexts.

(2) Design never ends – and so does science.
This refers to design as a projective discipline, trying to transfer existing situations into preferred ones. Once the problem is solved, the solution becomes the nucleus of a new problem. The new scientific criterion of social robustness requires permanent feedback with its context in the agora. Contextualized scientific problems are never solved either (Carroll 1996: 151, 152):

"…'Now! Now!' cried the Queen. 'Faster! Faster!' And they went so fast that at last they seemed to skim through the air, hardly touching the ground with their feet, till suddenly, just as Alice was getting quite exhausted, they stopped, and she found herself sitting on the ground, breathless and giddy.
The Queen propped her up against a tree, and said kindly, 'You may rest a little, now.' Alice looked round her in great surprise. 'Why, I do believe we've been under this tree the whole time! Everything's just as it was!'
'Of course it is', said the Queen. 'What would you have it?'
'Well, in our country', said Alice, still panting a little, 'you'd generally get somewhere else – if you ran very fast for a long time as we've been doing.'
'A slow sort of country!' said the Queen. 'Now, here, you see, it takes all the running you can do, to keep in the same place. If you want to get somewhere else, you must run at least twice as fast as that! …""

(3) Design is a special art – and so is science.
Design does not have to be ashamed of its pre-rational relics. There are mysterious aspects in designing, whatever we name them: intuition, creativity, insights, or chance, as I would prefer. Heisenberg, comparing mental images with their final mathematical models, suggests a complementary view of knowledge production, even in the "very hard" sciences (Miller 1996: 319, 320):

"... And, of course, then you try to give this picture some definite form in words or in mathematical formula. Then what frequently happens later on is that the mathematical
formulation of the ‘picture’ or the formulation of the ‘picture’ in words, turns out to be rather wrong. Still the experimental guesses are rather right, that is, the actual ‘picture’ which you had in mind was much better than the rationalization which you tried to put down in the publication. That is, of course, a quite normal situation, because the rationalization, as everyone knows, is always a later stage and not the first stage. ...

Design has never been strictly modern in a Mode-1 sense, and the discipline should not struggle for modernity in a situation when science and society and other “Sciences of the Artificial” (BJM 2001) are leaving important aspects of modernity behind. Design might be conceptualised as an agency of modernization (innovation), uncoupled from the ideals of modernity, situated between the established scientific and professional spaces and expert disciplines. And this is its very strength. Wiener (1948) argued that the promising fields for the flourishing of science are those, which have been neglected between the accepted disciplines. Cybernetics was a product of concrete design problems. Further disciplines may emerge from those fertile nowhere-lands. But design itself will remain in the swamp, or, more precisely, design will remain the evolutionary swamp, where the potential paths of meaning can grow and materialize; or the not-yet-wired brain, where the axons search their connections: hypothetical, explorative, speculative …

Don’t believe in foundations - Design as an Ironic Discipline

The more "true" and thus normative design foundations claim to be, the more counter-productive they are. Systemic irony is the optimal strategy against soporific truths and fixed standards. The temporal circularity (= "spirality") of making, observing, theorizing, planning, making, ... with its indicated consequences as to consequences seems to be the ultimate foundation.

In design research we cannot but follow Feyerabend (à question 5). Feierabend! (That's it for today!)

To sum up: We are facing the paradox situation of increasing manipulative power through science and technology, even concerning natural evolution itself, and – at the same time – decreasing prognostic control. Design is acting evolutionary, regarding its function (design processes) as well as regarding the creation of own improbable order as a discipline (disciplinary structures and theoretical foundations). Design theory has to create a fit between itself (as an artefact) and its environment, which consists of social conditions, fashionable theories, values, etc. There is self-similarity of the processes of designing and the processes of disciplinary development. Maybe temporal circularity (as in action research) is the only useful process model in design practice as well as in design theory building.

I am suggesting a U-turn in perspective, a "paradigm shift", if you like. The primary learning effect after 40 years of design research might be to reduce the claim of explanation and justification as well as completeness and coherence of theoretical models. Functional equivalents, which describe the dynamics of design processes on multiple levels, seem to be more promising than normative stocks of knowledge and rules. The gain in interpretative potential will compensate for the loss of explanatory power. Instead of expanding the islands of apparent scientific rationality (which frequently turn out to be unsafe), we cross the border from knowing to not-knowing. And on this side of the border we can determine (with scientific underpinning!) the areas of safe non-predictability.

Accepting the limits of scientific foundations in the creation of the new, requires a new self-concept for design indeed. Broadbent (2002) proposes a “guidance system” for socio-cultural evolution, which sounds rather ambitious, even arrogant. I would suggest, to be a bit more modest. But of course we should stick to the
sympathetic and presumptuous (and a bit naïve) professional claim to increase the quality of life. This means that our theory must acquire traits of an **ironic theory**, for only irony is able to combine modesty and arrogance.

- We know Socratic irony (I know that I do not know) as the core of the maieutic approach, which has always been an element of good planning.
- We know romantic irony, as the elegant play of genius. Applied to one’s own capability this kind of irony deconstructs and confirms the own superiority at the same time.
- We know Rorty’s (1989) irony concept with its permanent sceptic regarding closed and finite vocabularies.
- And we have “systemic irony”, which claims to be a competence of reflective dealing with fundamental uncertainty. The latter means that it cannot be dissolved through patient reflection, but rather extends in the course of reflecting it, because every observation opens up new fields of not (yet) observed phenomena. The other side of systemic irony is not certainty, but nothing else than the unavoidable paradox of knowing. Exactly in this sense Schlegel stated (quoted from Willke 2002): "Ironie ist die Form der Paradoxie. " Es ist "klares Bewußtsein ... des unendlich vollen Chaos."
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