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# Design, Time and Not Knowing

**Wolfgang Jonas**

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This experimental sketch, with many dubious claims and open questions, tries to interrelate two main dimensions of my previous considerations on design: the systemic and the temporal.<sup>1</sup> Both are related to current German sociological systems theory.<sup>2</sup> Both dimensions emphasise *unpredictability* because of *causality gaps*. These occur between the different, separated autopoietic systems involved in any design activity, and between the separated sequential evolutionary phases of the design process. Because of these delicate conditions, design as a ‘whole’ cannot be conceived as a coherent subject of science, which always aims at generalisations and predictions regarding the behaviour of the subject matter or its elements. Therefore ‘design science’ is an impossible endeavour.<sup>3</sup>

Design activities change the world, without being able to predict anything, except, maybe, the correct functioning of an artefact in a very restricted manner. For example, cars as isolated artefacts are working ever more perfectly. But design activities always comprise and affect<sup>4</sup> ‘wholes’ consisting of non-causally connected components. Some

of them can be treated as systems of a different kind, but the 'wholes' cannot, at least not in proper correspondence with any existing serious non-metaphorical systems theory. The external boundaries of these 'wholes' are fuzzy, their internal relations cannot be defined in scientific terms,<sup>5</sup> their behaviours are unpredictable. Therefore design should be theoretically conceived as a *'practice of not-knowing'*.

Taking risky decisions under conditions of not-knowing is a trait of design and of modern society in general (in technology, politics, economy, etc.). Therefore it may be important to know more about not-knowing. Exploring the patterns of temporal change in design might *improve our capacity for good judgement with respect to design or design-like decisions*, which exert increasing impact on all aspects of the human condition. The findings may be patterns of change, not predictions of specific trajectories; the latter may be re-constructed afterwards. And the ultimate achievement might consist of the argumentative, or rhetorical function of providing justifications for founding that which cannot be founded.

After a brief introduction of my concept of time, the exploration of these temporal patterns will be done very formalistically in a matrix scheme. Tables 1 and 2 present a kind of map, which indicates the underlying theoretical positions and the conclusions drawn from applying them to each other. Observations and interpretations regarding design are described in boxes a – t. Propositions and hypotheses regarding possible changes in design are given in boxes u – x.

**Some Brief Remarks on Time<sup>6</sup>**

Time is normally considered as something existing. Therefore there can be true and false theories about time, for example: time as a distance, divided into segments, where 'something' is moving from the past towards the future. Or: time as the 4th dimension

Table 1: Map of the article

1 Introduction		3 Systems			
2 Some brief remarks on time		3.1 Communi- cations	3.2 Conscious- nesses	3.3 Bodies	3.4 Artefacts
4 Evolution - variation - selection - re-stabilisation	4.1 Archaic societies	a	b	c	d
	4.2 Hierarchic societies	e	f	g	h
	4.3 Modern society need	i	j	k	l
	4.4 Post – ... society?				
	need of need	m	n	o	p
	need of orientation	q	r	s	t
	need of what?	u	v	w	x
5 Attempt at a conclusion for design ...					

of space-time. Augustinus saw time emerging from the dark and disappearing into the dark again. But *is* time?

I decide to shift from this metaphysics of world-division to observation (= *distinction* + *indication*). Time is observed by an observer, who draws a distinction. This observation is an operation, which takes time and happens at a certain point in time.

Everything which happens, happens simultaneously. The observer, who is observing time, does this when he does it, and not, when he does not. Everything, which happens, happens in the moment, when the observer reflects on future, past, acceleration, present, urgency, or whatever, not before and not afterwards. What we have done is gone and cannot be changed or repeated any more. On the other hand, we have to take into account a future, in which neither we nor anyone else can act, plan, or arrange anything yet.

This leads to problems of synchronisation, which always require access to that which cannot be changed any more or which is still uncertain. Something, which is simultaneous, cannot be influenced or modified operationally, because usual concepts of causality require a temporal distance between cause and effect. For the same reason we cannot react to the environment, which is simultaneously real as well. These considerations raise fundamental questions regarding concepts of control and causality.

Which distinctions are used for the observation of time?

There is the familiar distinction of *linear/cyclical*. Of course one can always find historical sources, which describe linear or cyclical concepts. But it seems inconceivable that a culture reduces its complete time-orientation to one or the other type.

There is the ancient occidental concept of *moving/not-moving*, or *variant/invariant*. Time perception requires a fixed background, which is provided by eternal essences and ideas. This allows us to conceive god as the unity of this distinction: the unmoving mover. For god all time is simultaneous, everything is present.

Finally we have the distinction of *past/future*,<sup>7</sup> based on the difference of *before/afterwards*, which gains importance in the transition to modernity. The concept does not necessarily require an explanation of the causal links between the events. It is just the sequences of before and afterwards, which create the infinite and shifting time horizons of the past or the future.

The most probable reason for describing time by means of this difference is the assumption that the future will look different than the past. The possibility of working with stability, with impossibility, with necessity, is considerably decreasing, even within the lifespan of an individual. Even human beings lose their essential stability.

The present thus shrinks to a point, where future and past are set into difference. This shrinking of time produces a *pressure of decision*. Decisions always happen in the present. The risk of taking wrong decisions grows, producing the danger of 'post-decisional

regret'. In this situation it is reasonable to fall back on *planning*. We have to plan our present as a past, which will be useful in the future. Looking back from the future, the present is a present with a different past and a different future than those, which we have today. The planning question is: Which past for which future present are we aiming at?

Futures are increasingly infiltrated with time limits and deadlines and suchlike. Certain things can only be done before a certain point in time, not after. Time perspectives push aside the factual and social importances and dominate the *value preferences*.

### Systems

Most systems theories are based on the unquestioned familiar distinction of 'whole' and 'parts', of unities consisting of interrelated elements. Niklas Luhmann states ironically, that '*ontology is very close to common-sense plausibilities – but nicer, more splendid, more thoughtful*'.<sup>8</sup> This thinking is appropriate for mechanistic systems and trivial machines, it is inappropriate for living/autonomous/non-trivial systems. And worse: it impedes design theory building. Following Luhmann I shift the emphasis from the ontological distinction whole/parts to the difference-theoretical distinction system/environment, and from allopoietic (externally controlled) towards autopoietic (self-produced and self-controlled) systems concepts.

Systems theories of the past, in design and in general, have been working with the 'humanistic' concept of 'man'. Societies were considered to be consisting of men as basic elements, equipped with (at least bounded<sup>9</sup>) rationality. But there is no useful systems concept available, which encompasses the generalised construct of 'man'. Therefore 'man' is here taken as the hybrid combination of a living, a mental, and diverse changing social systems. What 'man' is depends on who is observing and how and when. Society, according to this view, consists of communications and nothing else. Consciousnesses and bodies belong to the environment of society. Only the strict separation of these components is able to explain the differentiation and complexification – some are still using the concept of 'progress' – of life and of civilisation/culture as a process of co-evolution. Integrated 'wholes' have no need to adapt and thus to change/differentiate/evolve. The conclusion may appear cruel and inhuman and even paradoxical: *in order to improve our capability to explore and to serve human needs in their broad variety, it is important to split the nice, but naive concept of 'man'*.

The systemic dimension is based on the concept of *design as an interface discipline*.<sup>10</sup> In the most simplistic terms: design creates the interface between humans and artefacts. Following my previous assumptions, I will put it more generally: design is the agent/parasite/joker,<sup>11</sup> which creates temporary fits between the

co-evolving systems of cultural evolution, namely: communications, consciousnesses, bodies, as autopoietic systems, plus artefacts, as allopoietic systems. With respect to these autopoietic systems, *causality-gaps* have to be introduced, which are always present in different distinctness according to the specific design task.

### **Communications**

Communications act in the medium of meaning. They produce and reproduce themselves as autopoietic systems by connecting communications to communications. Communication exists as long as communication is followed by communication. Meaning in communication is connectivity of communicating. Communication is a means of coordinated action, and thus one of the main drivers for what we can call 'learning'. Thus there is a close link between communication and social evolution, which do not cause, but 'mark' each other. On the other hand the fast development of human and cultural evolution seems to depend on the intensive mutual interrelation/irritation of consciousnesses and communications, without any exchange or transfer.<sup>12</sup> Both need each other, though they cannot control each other. Both are operationally closed systems.

With regard to communications we have the *fashion gap*, which indicates, that it is not a trivial task to generalise a variety of information gathered from individual consciousnesses and to transfer this into the shape of an artefact, for example to plan a new collection of household goods for the Turkish market.

### **Consciousnesses**

Consciousnesses act in the medium of meaning. They produce and reproduce themselves as autopoietic systems by connecting thoughts to thoughts. Meaning in consciousnesses is connectivity of thinking. Talking about contents of consciousnesses is, in principle, impossible, except concerning myself (introspection). Everything else is the invention of an observer, which means observations transferred into communicable 'facts', which have nothing to do with what really happens in the other's mind (which makes psychology a highly improbable endeavour). The autopoietic consciousnesses are of utmost importance for evolution, because of their dynamic interrelation with communications. Both co-evolve in a process of mutual irritation, and both have developed the highly improbable medium of verbal language, which, in turn, contributes to the accelerated development of thinking and communicating, making these processes ever more efficient.

Written language created efficient storage devices for knowledge and has contributed to the development of the 'generalised media' such as power, truth, and money.

With regard to consciousnesses we have the *taste gap*, which indicates, that it is not a trivial task, to coordinate individual

consciousnesses, for example to optimise a solution for the 80 million consumers of the German market. They are all different, and they cannot speak about their taste in clear and distinct manner.

### **Bodies**

Bodies or organisms act in the medium of life. They produce and reproduce themselves as autopoietic systems by connecting biological processes to biological processes. Life ends as soon as these processes stop. There is nothing substantial to be said about bodies in this context, except that human bodies are rather fragile and helpless and not very viable without the support of communications and consciousnesses.

With regard to organisms we have 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.

### **Artefacts**

Artefacts are intentionally made things, which may be conceived as allopoeitic systems. Thinking about possible artefacts and planning to make them may be called designing. By inserting artefacts into the world as it is, design activities intervene in the relations of the other co-evolving autopoietic systems ('man' – environments). One characteristic of design interventions is their claim to improve those relations; in any case they change them.

Artefacts as isolated artefacts are assumed to function; this is not the primary task of designing. The basic problem is neither lack of individual creativity nor insufficient planning, but the *uncontrollable* and *unpredictable* behaviour of bodies, consciousnesses and communications in the environment of the artefacts.

### **Evolution**

The temporal dimension, as introduced here, does not primarily consider historical time, but patterns of development in time. Nevertheless it is applicable to historical epochs, as will be shown in sections 4.1–4.4. The scheme is based on the generalised 3-step pattern of evolutionary change: variation – selection – re-stabilisation – variation – and so forth. This pattern is applicable to the development of society/communicative systems; here I will apply it to design. The three necessarily separate and independent components of the evolutionary process create further causality splits:

- *Variation* is aiming at the creation of alternatives. This is no problem in design, because consciousnesses and communications provide abundant 'creativity', which is essential for producing new potentialities, thus increasing the variety of selective options. This is the 'timeless' task of

- designing artefacts, separated from any social or cultural or commercial context.
- *Selection* is aiming at the fit of alternatives into existing communicative structures, which are expectations (of expectations). This is a problem indeed, because 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-stabilisation* is aiming at the integration of selected alternatives into the system, eventually by modifying structures or creating new ones. 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*.

A ‘design cycle’ comprises the complete evolutionary sequence of variation, selection and re-stabilisation. Someone has found out, that present design evolution has an extinction rate of 85 percent.<sup>13</sup> This refers to products, which have already passed the selection stage/entered the market. With respect to the whole cycle, including all variations, the extinction rate should be close to 100 percent. This means, almost all new product ideas fail. One might conclude, that planning only works during the re-stabilisation phase of the evolutionary cycle, i.e. for incremental changes of existing product trajectories.<sup>14</sup>

In the following historical sequence there is an overlay of structures: new ones cover and enrich the older ones, they do not replace them. So design will never be a systematic, but rather a historic discipline with some systematic components. The older structures remain intact, but sink under the visible surface in a kind of sedimentation process. Even the most archaic patterns are still there (family life as a new old need...).

Variation, selection, and re-stabilisation can be related to the empirical reality of evolving social systems, or, historical epochs, thus allowing their re-interpretation in the light of evolution theory. For a synoptic view of the systemic aspects see table 2.

### **Archaic Societies**

Early segmented societies (families, clans, ...) were exclusively based on oral communication, which happens as interaction among people present. Their boundaries are where concrete interaction in direct contact becomes improbable. ‘Man’ is located completely within one social system, parents tell children how to fit in. Being outside means the end of existence. There is no ‘history’, but just ‘myth’.



In evolutionary terms, archaic societies hardly need the distinction of variation and selection, because every interaction is aiming at and is followed by immediate acceptance or refusal.

### **Hierarchical Societies**

The development of written communication and of more structured societies proceed in parallel. The order of this world is aligned along centre/periphery, or top/down distinctions. The world is the unity of all things, in an eternal, perfect order. The world is the same world for all observers, and thus it is recognisable from one single privileged position. Codified rules tell people how to behave. There is the risk of 'falling out' of the social order, which means not necessarily death, but loss of any communicative support.

In evolutionary terms, stratified, hierarchical societies have no need, or: have to avoid differentiating between selection and re-stabilisation, because the main criterion for selection is the stability of social order.

### **Modern Society/The World Society**

Together with the development of global transportation and communication, the hierarchical differentiation is gradually replaced by functional differentiation. The functional subsystems of society (politics, law, science, art, education, ...) develop their own, highly specialised, media. There are no superior observation positions any more. *Observation of observation reveals the contingencies of any observation* (= distinction + indication). Every observation provides the initial points for the next, which dissolves the stable cosmos of essences and the moral codes of former times.

In principle, everybody can participate in every communication. *Inclusion/exclusion* in the social order is no longer determined by fate or descent, but becomes an active, risky task, which is more and more related to the availability of/access to designed artefacts.

In this condition, spatial relations loose significance. Thinking, feeling, acting, and communicating proceed increasingly under the primate of the time dimension: under time pressure. Society moves towards a state, which does not yet exist. *Perfection* as an existing state is exchanged by *perfectibility* as a state to be achieved. We have a sharp cut between past and present. There is an unavoidable gap between the present futures (as the realm of probabilities and potentialities) and the future presents, which will always be exactly as they will be, and not different.

Scientific planning and methodology are developed under the conditions of economic pressure and accelerated technological innovations. *Unselfconscious design* is replaced by *self-conscious design*, which becomes a profession.<sup>15</sup> At the same time we experience an increasing separation from natural ecological conditions and rhythms of time. Design activities are now bound

to the time-structures of economy, science, politics. Design has no 'Eigen-time', its scattered structures evolve 'in-between'.

In evolutionary terms, the modern, differentiated society differentiates variation/selection as well as selection/re-stabilisation, but has problems distinguishing between re-stabilisation and variation, because stability is of an extremely dynamic character and provides the trigger for evolutionary variation. Here we may identify *designing, the creation of variety, as a constituent of modernity*. Design today has to produce variations in order to provide new starting points for variations, without ever being sure about their viability.

Modern society can be further differentiated in its dynamics<sup>16</sup>:

- We had (still have) the situation of *need* (linearity), with products that can be called 'solutions' to 'problems' such as washing clothes, preparing food, heating homes, transporting people, fitting into communicative situations, etc.,
- we had (still have) the situation of *need of need* (circularity), with products promising to give status, meaning, happiness, etc. and – even more important – serving as drivers for the production-consumption-cycle,
- and we are facing the situation of *need of orientation* (complexity), with contexts/environments that make sense or do not. Products in a traditional sense are secondary for this kind of need.

This is the ultimate stage of the modern release of bound individuality and subjectivity, but, at the same time, the very *endpoint of individuality* and the *startpoint of dividuality*.

### **Post – ... Societies, or: Need of What?**

How to label the time to come? Maybe 'post-human'. 'Post-modern' seems to be inadequate, as all achievements of modernity are sustained; only their consequences are showing up in unprecedented clarity: the causality gaps can no longer be denied and the evolutionary pattern is fully exposed. Today, for the first time in history, we are able to recognise the evolutionary character of design. Complete design cycles (variation: the use of a scientific or technical principle for designing artefacts, selection: the choice of one for further development, and re-stabilisation: the establishment and incremental development in mass-markets) are observable within one generation (computing), within a decade (personal computing), or even within 2 or 3 years (mobile communication).

The accelerated processing of the functional subsystems is driven by decisions. Decisions of any kind always happen in the present. The density of decision-making increases; the available knowledge cannot keep up with these requirements; the situation of deciding in situations of not-knowing becomes normal. That means

*risk is the central category of the present society.* Risky are only those decisions, which we would regret in the case of damage.

Need of what? Need of responsible handling of unlimited potentials in the face of unpredictable futures.

### **Attempt at a Conclusion for Design ...**

Design articles tend to end up with strong ethical propositions. I will do this briefly, because the main emphasis lies in the approach, which may turn out to have potential, not in the conclusions. One should avoid moral judgements as long as possible in the process, because good solutions can turn out to be bad or irrelevant, bad solutions can turn out to be good or irrelevant, irrelevant solutions can turn out to be good or bad.<sup>17</sup> *Amorality* is my ethical attitude towards designing, because otherwise we reduce the variety of choices and might miss the best solutions. Design should inform the stakeholders in the process, it should not try to direct them. Design has no privileged position.

So back to the crucial question: how to avoid 'post-decisional regret'?

- 1) By letting things happen and submit to the inevitability of evolutionary developments (uncertainty through uncertainty).
- 2) By planning as usual, which provides post-decisional justifications, even if decisions turn out to be wrong (uncertainty through certainty).
- 3) By preferring decisions, which do not limit, but increase the variety of further choices.<sup>18</sup> This may mean small, local, failure-friendly approaches. This may also mean shifting from impossible *adaptation* (to unknown futures) to *exaptation*, which means: creating stocks of possible future options, that are still useless in the present, but immediately available, if necessary (certainty through uncertainty).
- 4) By *accepting dividuality* and trying to explore the options of this way of thinking. My hypothesis is that this might contribute to make design interventions more precise, to reduce side-effects (certainty through certainty).

What does that mean? Dividuality means conceiving '*human life*' as a set of *modules*, which are deliberately put together, thus designing the 'wholes'. This is a shift from authentic artificiality to artificial authenticity. Points of intervention have to be selected with respect to the desired effect:

### **– Communication**

Without adhering to conspiracy theories, I do not consider it effective to intervene into communication on the scale of mass-media. This is much too imprecise and may end in catastrophes, so forget traditional communication design, except for purposes of orientation and navigation.

But: Social competencies should be strengthened by emphasising communication and action among people present, by exercising language through verbal communication. The emphasis on small communities (as families were in the past) may support the temporal re-integration of dividuality. They might serve as training-centres for strong self-confidences under the condition of dividuality, as laboratories for new forms of communication, thus limiting the dulling impact of mass-media. Only personal interaction, producing competence on trust, credibility, and empathy, can guarantee sustain-ability.

This introduces an elementary ethics, aiming at preventing humiliation. Learning to recognise the other as someone, who can be humiliated, seems to be the essential and ultimate ethical maxim, in my view.<sup>19</sup>

### **– Consciousnesses**

Emotional and cognitive strength reduces the manipulability of consciousnesses through communication. Thinking, as the linguistically structured processing of thoughts, may contribute to deceleration and reduced manipulation.

Emotional and cognitive design may contribute to better communication. But the points of intervention should be much more precise, i.e. turn to the body. Present 'emotional design' might proceed in this direction.

### **– Bodies**

Bodies will become the main subjects of design interventions in the future, if we like it or not: for functional purposes, for aesthetic purposes, and for emotional and cognitive purposes. Basic emotional qualities, which are today mainly evoked by means of product- or communication- or event design (as for example bungee-jumping), will be produced through immediate bodily interventions.

### **– Artefacts**

Artefacts can be precise regarding functionality in a restricted sense. Social and symbolic and emotional qualities of artefacts should be much more separated from their 'mechanical' functions as before, in order to optimise their material intensity per unit of service.

A shift in our semantics of time, i.e. in our observation (= distinction + indication) of time might be helpful. I have no new suggestion, but the Old-Egyptian difference of 'resultativity'/'virtuality'<sup>20</sup> seems promising. But such a shift is a matter of evolution...

Full stop.

Table 2: Cross-impact scheme of temporal phases and systemic components of design.

	Communications	Consciousnesses	Bodies	Artefacts
Archaic societies	a) Communication enables coordinated action and creates a spiritual frame, which is essential for survival of this highly endangered species. There is spoken language, maybe 'written' symbols.	b) Consciousnesses are necessary for communication and vice versa. We do not know much about designing consciousnesses in this time...	c) The human body is the material, organic basis. Bodies determine fate. Survival is depending on a strong and healthy body, as never again in later stages of human civilisation.	d) Artefacts are the characteristic of the 'tool-making animal'. Artefacts (functional and symbolic ones) are insufficient, but necessary for survival. They do not change within a human lifespan.
Hierarchic societies	e) Communication is the means to enforce/ensure stability. Written language supports the exertion of secular and spiritual power. Communication starts to differentiate (law, science, ...) creating generalised media.	f) Consciousnesses are brought into line according to the communicative regimes. On the other hand they are free to vary within certain limits, as the communities provide a rather secure space for surviving.	g) Bodies become the subject of pre-scientific repair. A poor man will meet a quack, a nobleman will consult a medical doctor from Salamanca.	h) Artefacts increase in number and perfection. Normally they still do not change within a lifespan. The 'new' comes from different geographical places. Some types of artefacts (ships, architecture) become subjects of scientific thinking.
Modern societies/need	i) Communication dissolves stability and creates future-orientation. The narrative of 'progress' replaces stable harmony. Fashion, as a communicative phenomenon, becomes a universal experience.	j) Consciousnesses develop individuality. Humans are subjects now, striving for personal happiness and success. Designing is shifting from an 'unconscious' towards a 'conscious' endeavour.	k) Body repair is perfected. A perfect body takes a high rank in the self-awareness of an individual.	l) Artefacts satisfy 'real' needs. They become cheap and differentiate into various new species. Technological change, mass markets, high complexity, etc. makes production a science-based endeavour.
Modern societies/need of need	m) Communication, driven by economy, creates accelerated sequences/cycles of changing fashion. Needs are thus designed. Fashion becomes risky, see the 'fashion gap'.	n) Consciousnesses seem to be easy to manipulate. On the other hand consumers experience the option of choice, they become unpredictable, see the 'taste gap'.	o) Bodies become elements and means of the fashion- and taste game.	p) Artefacts are of good functionality. They satisfy more and more symbolic needs, which should not be labelled 'superficial'.
Modern societies/need of orientation	q) Communications show increasing diversity and complexity. Design helps to produce and re-produce them, and, at the same time, begins to find out, how to improve orientation in this situation.	r) 'Individual' consciousnesses have to adapt to different communications. This may be fun, but also negative stress. People feel split, helpless, loosing control. The ability to choose becomes important.	s) Bodies become media for the orientation of self and others. Bodies are subject to medical and aesthetic design.	t) Artefacts are increasingly hybrid, 'individual' compositions of objects, services, symbols. They are perfect in pure functionality. Nevertheless the 'function gap' remains.
Post-... societies/need of ?	u) Communication/interaction creates 'wholeness' as a temporal, changing design product.	v) Consciousnesses accept their being 'dividuals' and become the subjects of personal design via bodily interventions.	w) <b>Bodies are subjects and media of design, just as products and services were in the past.</b>	x) Artefacts are built/grown according to 'dividual' needs. Their lifespan is programmable: from very short to eternal.

## Notes

1. Wolfgang Jonas 'Mind the gap! – on knowing and not – knowing in design, or: there is nothing more theoretical than a good practice', in *Proceedings of EAD5* (European Academy of Design) Barcelona, April 2003.
2. Niklas Luhmann *Die Gesellschaft der Gesellschaft* Frankfurt/M: Suhrkamp, 1997, or, as an English introduction, Niklas Luhmann *Social Systems* Stanford, California: Stanford University Press, 1995.
3. Here I refer to Nigel Cross' categories of scientific design /design science/science of design: Nigel Cross 'Designerly Ways of Knowing: Design Discipline Versus Design Science' *Design Issues* Vol 17, No 3, Summer 2001, 49–55.
4. Here I refer to both the production and the reception side of design.
5. See for example Michel Serres 'Das Kommunikationsnetz: Penelope' in *Hermes I: Kommunikation*, Berlin 1991: 9–23 (original 1964), or Bruno Latour *Wir sind nie modern gewesen – Versuch einer symmetrischen Anthropologie* Frankfurt/M: Fischer, 1998 (original 1991).
6. This section is mainly based on Niklas Luhmann *Einführung in die Systemtheorie* Heidelberg: Carl-Auer-Systeme Verlag, 2002, 195–220.
7. Jan Assmann introduces the rather modern Old-Egyptian duality of 'Resultativität/Virtualität', which distinguishes that which has come to reality as a result from the past and that which is still possible in the future, see Jan Assmann *Stein und Zeit: Mensch und Gesellschaft im Alten Ägypten* München: Fink Verlag, 1991, 2. Aufl. 1995, 32–58.
8. See endnote 2.
9. For the concept of bounded rationality see Herbert Simon *Administrative Behavior: A study of decision-making processes in administrative organisations* New York: The Free Press, fourth edition 1997.
10. See Christopher Alexander *Notes on the Synthesis of Form* Cambridge, Mass: Harvard University Press, 1964; or Herbert Simon *The Sciences of the Artificial* Cambridge, Mass: MIT Press, 1969, 1981, 1996; or Gui Bonsiepe *Interface: Design neu begreifen* Mannheim: Bollmann, 1996.
11. See for example Michel Serres *Der Parasit* Frankfurt/M: Suhrkamp, 1987.
12. Luhmann describes this as 'interpenetration', which is based on Maturana's biological concept of 'structural coupling'.
13. See Product Development and Management Association (PDMA) 1996.
14. This is what Buckminster Fuller calls 'class-two evolution': the imperfect attempt of imperfect humans to plan their future. In contrast, 'class-one evolution', which is the unplanned an

unhindered and thus reasonable process of scientific progress and its technological application, will lead mankind into a golden future, see Richard Buckminster Fuller *Critical Path* New York: St Martin's Press, 1981, 229–251.

15. See endnote 10.
16. Wolfgang Jonas 'Viable Structures and Generative Tools: an approach towards 'designing designing'', in: *Proceedings of EAD2* Stockholm, 23–25 April 1997.
17. An allusion to the conference *good/bad/irrelevant* UIAH, Helsinki, Finland, 3–5 September 2003.
18. Heinz von Foerster *Observing Systems* Seaside, Cal. 1981.
19. Rorty, Richard *Contingency, Irony, and Solidarity*, Cambridge University Press, 1989.
20. See endnote 7.