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The strengths / limits of Systems Thinking denote the strengths / limits of Practice-Based Design Research

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„There is no purer myth than the notion of a science which has been purged of all myth."
Michel Serres

Overview

If we focus on Practice-Based Design Research (PBDR) in its various forms and terminologies one can consider Design Research as a process of *„generating the unknown from the known"* or of *„organizing the transition from knowns to unknowns"* (Hatchuel). It is thereby confronted with the fundamental problems of control (non-reducible complexity), of prediction (not-knowing of evolutionary emerging futures) and of incompatible domains of knowing. The problems show up in causal gaps between bodily, psychic and communicative systems and between the phases of evolutionary development. PBDR explores the possibilities of bridging these gaps in the medium of design projects and thereby creates new knowledge. This is necessarily done with scientific support, but in a situated, „designerly" mode, which means that the designer is part of the design / inquiring system. This is the epistemological characteristic. We argue for a strong coupling of PBDR and advanced Systems Thinking to face the problems mentioned above.

1 Introduction and framing

One of the myths that Serres (....) addresses says that modern Science has achieved a clear and proper separation of the human (society) and the non-human (nature). Bruno Latour deconstructs this myth and argues that we experience (Latour 1998):

„... the transition from the culture of `science´ to the culture of `research.´ Science is certainty; research is uncertainty. Science is supposed to be cold, straight, and detached; research is warm, involving, and risky. Science puts an end to the vagaries of human disputes; research creates controversies. Science produces objectivity by escaping as much as possible from the shackles of ideology, passions, and emotions; research feeds on all of those to render objects of inquiry familiar. ... Science and society cannot be separated, they depend on the same foundation. ..."

Latour introduces the *„paradoxical constitutional guarantees of modernity*:

1. Even when we construct nature, it is as if we did not.
2. Even when we do not construct society, it is as if we did.
3. Nature and society must remain absolutely separate ; the work of purification must therefore remain separate from the mediation work."

Design has – at least implicitly - always known this, or rather: has never built on these guarantees of modernity. The design of Design Research can build on this knowing.

2 Practice-Based Design Research (PBDR) as focus of interest

Design conceives complex life-world situations in future contexts. We consider design as a process of *„generating the unknown from the known"* or of *„organizing the transition from knowns to unknowns"* (Hatchuel). Design Research is aiming at exploration and innovation. It may be labelled a „Science of Uncertainty" (Dilnot 1998). Therefore, beside descriptive Analysis, the normative and practice-oriented phases of Projection and Synthesis are essential elements of Design Research processes Chow and Jonas 2008). Bruce Archer adheres to this idea and states (1995: 11): "*It is when research activity is carried out through the medium of practitioner activity that the case becomes interesting."* That means PBDR in its various forms and terminologies lies in the focus of interest.

We all know the controversies regarding the scientific validity of PBDR (Friedman 2003). The standard reaction consists in the adaptation to established scientific standards from other disciplines such us the Social Sciences. This ignores, for example, the exciting and promising developments in Science and Technology Studies, which indicate a convergence of „scientific" and „designerly" processes of inquiry. The strategy of escaping to the „high ground" may provide short-term relief, but impedes the longer-term learning processes and the appreciation of designerly modes of inquiry. And, hopefully, a new role for design.

3 Fundamental problems and causal gaps

Design and design research are confronted with the fundamental problems of control (non-reducible complexity), of prediction (not-knowing of evolutionary emerging futures) and of incompatible domains of knowing. The problems show up in causal gaps between bodily, psychic and communicative systems and between the phases of evolutionary development (Luhmann 1997). Schön (1983: 42) puts it pragmatically:

"The dilemma of "rigor or relevance" arises more acutely in some areas of practice than in others. In the varied topography of professional practice, there is a high, hard ground where practitioners can make effective use of research-based theory and technique, and there is a swampy lowland where situations are confusing "messes" incapable of technical solutions. The difficulty is that the problems of the high ground, however great their technical interest, are relatively unimportant to clients or to the larger society, while in the swamp are the problems of greatest human concern. ..."

This means we need:
- a notion of complexity appropriate for messy real-world situations (Mikulecky no year),
- ways of dealing with future uncertainty, which points to scenario approaches,
- an epistemological framework, which integrates thinking and making as well as teleological/normative, causal and evolutionary ways of knowing, and
- an instrument and terminology for reflecting user / stakeholder / observer / designer involvement, which might be 2nd order cybernetics.

4 Unresolvable blind spots

Blind spots in Design Research comprise:
- Unconsciously defined and intransparent value systems, mainly based on today´s zeitgeisty beliefs, and the mixing of facts and values.
- Implicit driving forces based on the optimistic or pessimistic views of an assumed future from subjective perspectives and motivations.
- Biased, selective pasts, which means that trajectories of the past are continued. The pasts outside the observer‘s perspective are neither integrated in the present nor the future image.
- Pseudo-objective scenario-techniques, which convey the illusion of an ideal, value-free observer. Scenarios are normative in any case. Observers are either unaware of their involvement or they are consciously concealing their role.

Blind spots are the necessary condition of every observation, but we can reflect and use them productively in managing complexity. The suggestion would be to use as many incoherent perspectives as possible. Mikulecky (no year):

"Complexity is the property of a real world system that is manifest in the inability of any one formalism being adequate to capture all its properties. It requires that we find distinctly different ways of interacting with systems. Distinctly different in the sense that when we make successful models, the formal systems needed to describe each distinct aspect are NOT derivable from each other."

5 Paradox and oxymoron

The problem of control (describing and managing systemic complexity) and the problem of prediction (dealing with future uncertainty and evolution) are essential and they are related to each other. Even simple deterministic feedback systems produce bifurcation patterns and chaos. The considerations can be expanded in various ways:

Rittel (1972) argues that rationality means the attempt / claim to predict the consequences of intended actions. But he shows that:
- one cannot start to be rational, since one should have always started one step earlier,
- one cannot stop to be rational because one should draw the consequence of every consequence,
- the uncertainty of factors grows, the further we look into the future of a causal chain, and finally,
- the causal model of the phenomena to be designed would have to include itself as central part.

The consequence is Rittel´s description of planning as an argument, a cognitive and social process of creating, exploring and reducing variety, supported – for example - by Issue-Based Information Systems.

Krippendorff (2007) still sharpens the argument and describes Design Research as an "oxymoron", a contradiction in itself, since it is impossible to do research about something that does not yet exist. He characterizes Design (Research) as the social construction of meaning through language by stakeholders.

Rorty (1989) suggests narrative, speculative, poetic methods. The potential of this approach is still unexplored.

6 Research Through Design (RTD) as an implementation of PBDR – C1

We consider Design and Design Research as a cybernetic process of experiential learning, which follows evolutionary patterns (Kolb 1984). There are various 4-step models (ID Chicago) and models with 5 or more steps. Yet 3-step models as shown in table 1 reveal the underlying logic most clearly: induction – abduction – deduction, with abduction as the central designerly phase.

My own model or theoretical framework of Research Through Design (RTD) with the phases of Analysis – Projection – Synthesis is chosen as one possible realization of PBDR. Projection represents the abductive step. Please note the analogy to the terminology of Transdisciplinarity Studies.

Authors	**phases / components / domains of knowing in design research**		
Jones (1970)	divergence	transformation	convergence
Archer (1981)	science	design	arts
Simon (1969) Weick (1969)	intelligence	design	choice
Nelson and Stolterman (2003)	the true	the ideal	the real
Jonas (2007) RTD	Analysis	Projection	Synthesis
Fallman (2008)	Design Studies	Design Exploration	Design Practice
Brown (2009)	Inspiration	Ideation	Implementation
Nicolescu (2002) Transdisciplinarity Studies	System knowledge	Target knowledge	Transformation knowledge

Table 1: Triadic concepts of experiential learning processes in Design Research, especially providing the framework for Research Through Design and Transdisciplinarity Studies.

7 Systems Thinking constitutes RTD processes

PBDR explores the possibilities of bridging the above mentioned gaps in the medium of design projects and thereby creates new knowledge. Systems Thinking and systemic methods allows for the modelling of complex design / inquiring systems and thus provide a means of communicating *about* them. Matrix representations provide means for representing complexity (cross-impact analysis) or for discussing future uncertainty (cross-consistency analysis). Cross-impact matrices – for example - provide an instrument for identifying and locating required scientific contributions (each field of the matrix represents a potential scientific or designerly research problem). Furthermore Systems Thinking and systemic methods allow for the reflection of observer modes and conditions of involvement in the systems of inquiry and thus provide a means of communicating *within* design / inquiring systems.

The very broad scope of subject matters (general human ecology) and the stance of the researcher (situated, aiming at change) characterize and determine the epistemological status of Design Research (Findeli 2008). Both aspects suggest that a purely scientific approach is unsuitable. The differentiation between Design and PBDR is fuzzy, the transition is continuous. Design Research is necessarily done with scientific support and in a situated, „designerly“

mode, which means that the design process provides the structure and that the designer is part of the design / inquiring system.

8 Reflecting observer modes – RTD requires the shift from C1 to C2

The cybernetic concepts of 1st and 2nd order observation are helpful for the distinction between classical detached inquiry and situated inquiry. My notorious diagram, inspired by Ranulph Glanville, is an attempt to substantiate the concepts of research FOR / ABOUT / THROUGH design as introduced by Archer (1995) and Frayling (1993). It relates observer positions (inside or outside the design / inquiring system) and observer perspectives (looking at the design / inquiring system or looking at some external point of interest). It provides a fourth category, which I have tentatively called research AS design. It may be interpreted as the (inaccessible?) location of abductive knowledge production...

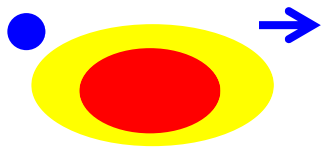
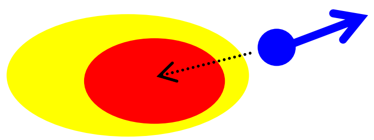
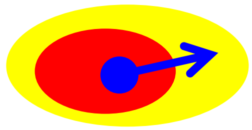
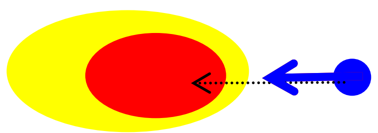
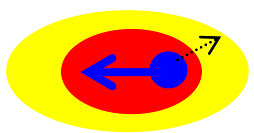
Observer position and perspective relative to the design / inquiring system and the life-world	**1st order cybernetics**	**2nd order cybernetics**
	Observer is situated outside the design / inquiring system producing facts	Observer is situated inside the design / inquiring system producing (arte)facts based on values
	research FOR design	**research THROUGH design**
Observer looking outwards		
	research ABOUT design	**research AS design (?)**
Observer looking inwards		

Table 2: The concepts of research FOR, ABOUT, THROUGH design, related to observer positions and perspectives. A fourth category is emerging: Research AS Design (Glanville 1997).

The notion of 2nd order observation might raise the question if there is a relation between Bateson´s (1979) five levels of learning to the orders of observation used here. Bateson – as I understand him – suggests deeper and more far-reaching insights the higher the level of learning. My notion is just formal, that means it does not make sense to speak of 3rd or 4th order observation. Higher orders are not superior to lower orders. They can be generative in positive and negative respects, both liberating and limiting. Observing observation provides / generates new options and new blind spots at the same time, but does not provide better knowledge. It contributes to managing complexity by introducing new perspectives (Mikulecky no year).

9 Zooming in: RTD and (Critical) Systems Thinking

The RTD model, as derived above and shown in table 2, can be further interpreted in a systemic perspective. It comprises three core systemic dimensions:
(1) the wider context of a design situation or the relevant environment,
(2) the design / inquiring system, which may be a designer / scientist, a group, a company, a community, etc. and
(3) the driving force, which is determined by the value base, the motivation and the goal of the inquiry.

All three of these systems are not „given“, but have to be negotiated by stakeholders, designers, the wider public. Critical Systems Thinking (CST) as developped by Werner Ulrich seems to be the most comprehensive systemic approach, able to deal appropriately with systemic real-world Design Research situations.

Hard Systems Thinking (HST)	**Soft Systems Thinking (SST)**	**Critical Systems Thinking (CST)**
systematic	systemic	critical to ideas of reason
mechanistic paradigm	evolutionary paradigm	normative paradigm
instrumental	strategic	communicative
efficiency emphasised	effectiveness emphasised	ethics emphasised
Management of scarceness	management of complexity	management of conflict

Table 3: Characteristics of systems thinking levels (Hutchinson 1997, after Ulrich 1988).

This is the fundamental difference to Science, where:
- the wider context is excluded as far as possible,
- the design / inquiring system is considered as disembodied, detached, objective, Cartesian observer, and
- the driving force remains implicit or mythic.

Simon´s (1969) famous description:

„An artifact can be thought of as a meeting point – an "interface" in today's terms – between an "inner" environment, the substance and organization of the artifact itself, and an "outer" environment, the surroundings in which it operates. If the inner environment is appropriate to the outer environment, or vice versa, the artifact will serve its intended purpose."

contains these 3 systems. Yet he does not reflect the role of the observer appropriately. Or even worse: He considers too much observer involvement as dangerous.

10 Relating RTD to a generic scenario model CFU

The future aspect is still missing. The PROJECTION part of RTD (the problem of prediction, dealing with future uncertainty) requires methodical support. Scenario approaches operate with a number of key variables of high impact and high uncertainty. Comprehensive scenario techniques require enormous effort and mathematical support (e.g. cluster analysis).

„Quattro stagioni“ / „otto stagioni“ approaches provide simplified methods with 2 / 3 key variables and 2 alternative projections each. The „Cube of Future Uncertainty“ (CFU) builds on these simplified scenario techniques. It is a generalized designerly framework for scenario approaches, defined by the three above mentioned systemic dimensions of RTD: the wider context, the design / inquiring system, and the driving force and thus establishes the systems-based connection between ANALYSIS and SYNTHESIS by means of PROJECTION.

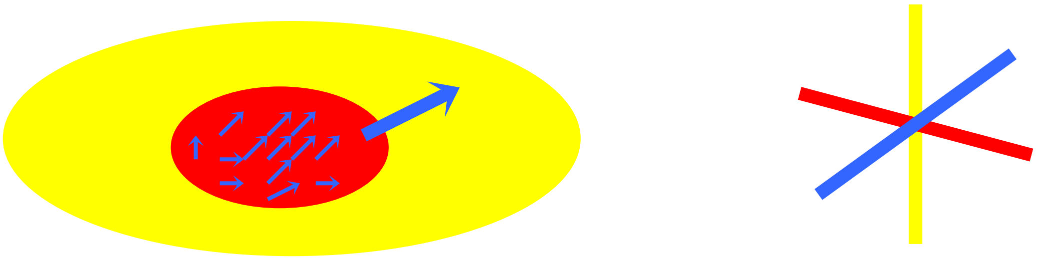


Figure 1: The wider context, the design / inquiring system (established by the involved actors) and the resulting driving force (left). The Cube of Future Uncertainty (right) is a scenario framework built from these three systemic dimensions. A situation of Research Through Design.

11 So what? Turning deficits and threats into strengths and opportunities

These seeming deficits of PBDR / RTD should be turned into the strengths of a new paradigm of inquiry, which comprises:

- Systems Thinking and the positive acceptance of multi-perspectivity. Mikulecky (no year) proposes to develop *“distinctly different ways of interacting with systems … in the sense that when we make successful models, the formal systems needed to describe each distinct aspect are NOT derivable from each other.”*

- The conscious adoption of generative, designerly approaches like scenario thinking as „playgrounds“ for explorations.

- The explicit integration of facts and values into our systems of inquiry.

Ulrich´s Critical Systems Thinking (2000) can be regarded as an approach towards integration and transparency of this kind. CST comprises the reflection and determination of system boundaries and driving forces as well as questions of legitimacy. Even if Ulrich mainly refers to Churchman, there are various influences such as Issue-Based Information Systems as dialogic instruments (Rittel and Kunz 1970), the notion of the Sciences of the Artificial and the reflections on designing the evolving artefact (Simon 1969), or dialogic approaches to systemic modelling, mixed causation problems, sensitivity modelling (Vester 1999).

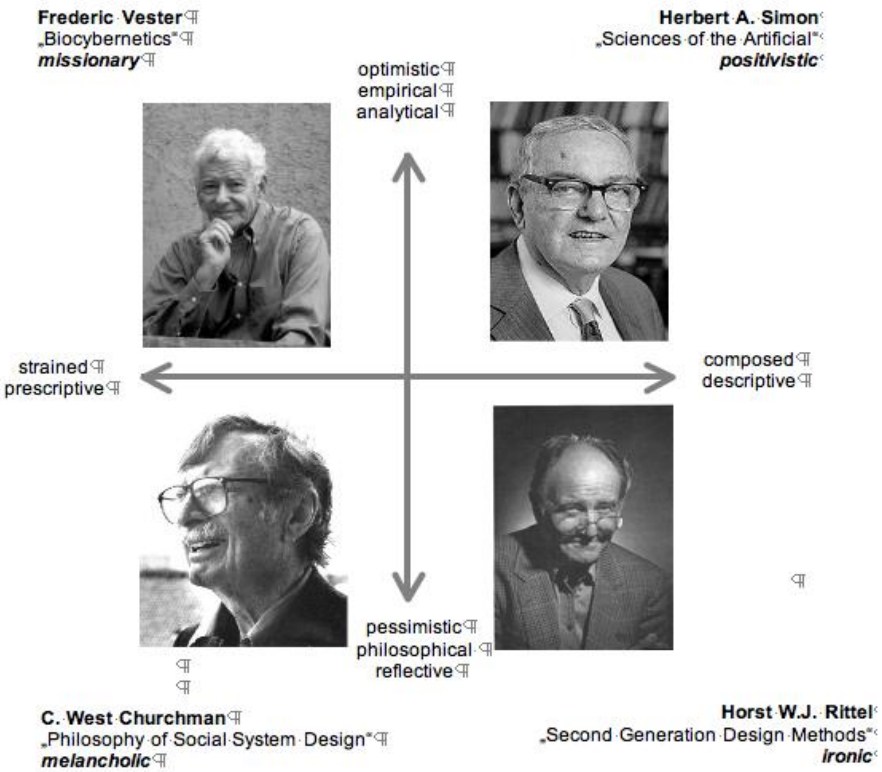


Figure 2: The diagram of the four „heroes“ demonstrate the richness of seemingly controversial positions and attitudes. There is no „progress“, but options for richer design considerations. It may be used as a map and navigation aid for reflecting our own positions.

12 Perspectives: Design as the new model for Transdisciplinary Science

The further development of this pro-active position means that Design might be the new model for Science, as has been suggested by Glanville (1980), who describes Science as a specific sub-category of Design. The concept of Mode-2 science (Nowotny et.al. 2001) with its emphasis on socially robust instead of true knowledge might be a strong theoretical support, as well as the emerging framework of transdisciplinarity. Radical transdisciplinarity explicitly addresses all the indecent issues of designerly inquiry as described above and takes them as the basis for a new kind of science. Nicolescu (2008), for example, suggests three *Axioms of Transdisciplinarity*, which explicitly address the knowledge gaps between the different levels of reality and the perceiving subject:

- The *ontological axiom*: in nature and society, as well as in our perception of and knowledge about them, there are *different levels of reality* for the subject, which correspond to different levels of the object.

- The *logical axiom*: the transition from one level of reality to another is vouchsafed by the *logic of the included third*.

- The *epistemological axiom*: the structure of the totality of all levels of reality is *complex*; each level is determined by the simultaneous existence of all other levels.

Various perspectives are showing up:

- There is the relation to De Zeeuw´s (1996, 2010) „third phase science". He distinguished First phase science, dealing with non-constructed objects, Second phase science, dealing with constructed objects, and Third phase science, dealing with self-constructing objects (2010: 19): *„´Second phase´ science aims to resolve the ´overload´ that derives from using the Cartesian form to study the ´in there´, as if it is the ´out there´. It is the range of forms of transfer which it studies. [...] ´Third phase´ science aims to consider alternative selections of forms of transfer. It may be interpreted as improving on collective learning through ´texts´. ..."*

- Epistemic democracy (Dewey)

- Design and Science - approaching each other (Jonas, Chow and Grand 2013).

- ...

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