MELTING THE CRYSTAL

A Design Intervention

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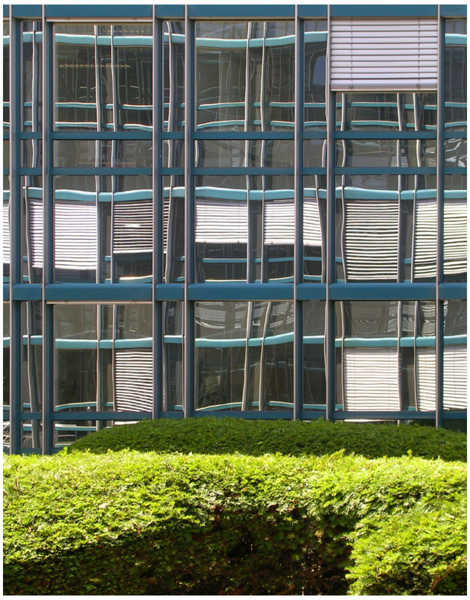

ABSTRACT

Title: Melting the Crystal: A Design Intervention

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Design interventions have an immanent relation to a design. They can precede the act of designing itself and contribute to discourses on contingency design and design futures.
The term *design*, so the study will argue, stands not only for design practices, but also for the production of knowledge. ***Melting the Crystal*** examines responsive systems, collaborative environments and interface design, works out structural-/procedural foundations, and delineates analytical contexts.

The paper is presented as a heterogeneous ensemble that divides into: (1) A cultural probe with experiments in plant electrophysiology, (2) *Semantic Fields* where the probe is brought into relation with design science, (3) A conceptual model to explore logical interactions, (4) A brief literature survey on digital collaboration, and (5) *The Production of Knowledge*.

The sensated plant at the heart of the study is meant to perceive state changes and to respond with climate change. The implications of this are touched upon in a closing discussion in terms of sustainable development and measurable ecological services.

Keywords: Collaborative Environments; Cultural Probe; Design Futures; Design Intervention; Design Knowledge; Design Science; Design Thinking; Interaction Design; Interface Design;

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PART 1

TECHNO-CULTURAL PROBE

1 RESPONSIVE SYSTEMS

The Inverter investigates relationships between humans and the natural environment. It was created as part of a research-based design project for the University of Technology Sydney (UTS).

The underlying principle of the project is *"information-driven interaction."* It thus differentiates between information used by humans to describe the world and "genuine information systems" based on universal mass-energy relations. (Roederer, 2005)

Information-driven interaction involves:

- An interaction mechanism, e.g. physical/chemical processes;
- Pattern-dependent operations (Ultimate purpose);
- Correspondence between sender and recipient [Resonance].

Information-based interaction allows the transmission of patterns contained in the source system to resonate and cause change in a recipient system. A successful interaction between the environment and an adaptive entity [evolutionary fit] may also stimulate the encoding of new instructions, eg. plasticity and natural selection. The patterns can be represented as functions, variables, and parameters.

1.1 Operationalisation

The designerly task of tracking and rendering such interactions, according to Diezmann and Gremmler (2003), should be based on *"the assumption that the essentials, the characteristic features of the behaviour of objects, people, animals, processes, etc., lie in their structure, and the aim is to extract these and transfer them to other media."*
In the project, sensor-data resulting from controlled interactions between a person and a green plant would be used to generate data visualisations, as well as changes in a physical responsive structure.

1.2 Sensated space

```
<components>
lab room; box; lamp; soil; water; plant;
sensors; interface;
</components>

<SensorList>
<ListItem name='light_sensor'>data</ListItem>
<ListItem name='soil_temp_sensor'></ListItem>
<ListItem name='water_sensor'>
<ListItem name='air_temp_sensor'>
<ListItem name='bioelectric_sensor_1'>
<ListItem name='bioelectric_sensor_2'>
</SensorList>
```

1.3 Comparing plant action potentials

Plant Electrophysiology refers to the *electrochemical interface* between plants and the environment ... nerve-like structures that enable the propagation of electrical signals in response to external stimuli such as light/dark transitions, temperature changes, or mechanical interference. These 'information transmissions' from plants [called action potentials] can be measured using bioelectric sensors and LabVIEW software. (Volkov and Brown, 2006)

1.4 Experiments and scenarios

The plant has been fitted with two surface contact electrodes [sensors] to determine differences in membrane potential [between the measurement electrode and a reference electrode] after a certain stimulus has been applied. This will allow the researcher to monitor plant action potentials and to graph or visualize the resulting sensor-data on a monitor.

Task 1: The researcher adds an amount of iced water to the base of the plant. The system `{soil_temp_sensor, etc.}` responds by increasing the lab room temperature from 20 degrees to 38 degrees Celsius and displays a message dialog box prompting the researcher to take further measures:

```
IF STATUS = ('PARAMETERS=>ready') THEN
Draw rectangle IN LABXYZ:{0,0,0}, Width:480,
Height:320   //open new window
AND Get sensor data
AND Display

AND Display [JOptionPane.showMessageDialog
(null, "Soil temperature now below acceptable
levels.
Lab room temperature has been increased.
Recommend application of plant growth
stimulant.")];

ELSE
Display Error Message
```

Task 2: The researcher applies a dose of plant growth stimulant. The system `{bioelectric_sensor, etc.}` responds by decreasing the lab room temperature to 25 degrees Celsius and displays a message dialog box indicating the current state of the system.

2 HYPOTHETICAL DESIGN, SEMANTIC FIELDS

Compared to the signal generation from animals or earth tremors, the electric excitation from the neural network of plants hitting the sensors is weak and thus requires sensitive equipment to collect, including biosensors and a Faraday cage. Nevertheless, the *Inverter* project could be implemented to ground the discourse of a futures study and it forms a significant part of this design intervention.

The following section attempts to outline a critical/analytical context by bringing the *Inverter* [as a cultural probe] into relation with design science.

2.1 Orientation, process model

The conscious practitioner 'oscillates' between doing and reflecting, between applying propositional knowledge and generating operative knowledge. The continuum behind *"research through design"* (Jonas and Münch) appropriately runs from 'pure praxis' to 'pure research', lending activities like design, design methods, or design research a qualitative as well as a quantitative nature.

>> The *Inverter* project could be located by relating it to Nelson and Stolterman's knowledge domains (2003). It could, moreover, be organised using a compatible design process model, eg. Hugentobler, Jonas, Rahe (2004). The design methods and tools there would indicate the need for a futures studies process - that is, micro processes associated with *Analysis* [true/rational] and *Projection* [ideal/speculative].

2.2 States of the system

A problem space allows client needs to be identified and linked with a prospective solution space by means of design iterations in order to develop interim solutions. In a state system, the design brief or requirements specification may already represent State A of the future product, and a specification of implementation might represent State B. As the connectivity between product states is also likely to be more dynamic, any designerly- and programmatic interactions would be subject to the reflexive relationship that occurs between emerging systems and a changing environment.

>> The systems of the lab room, the *Inverter* itself, and the researcher together form an effective state space. In order to explore new balances between the good earth and its human inhabitants, the powers of the plant have been augmented to surpass their natural dimensions. As the above scenario indicates, the sensated plant is able to communicate significant state changes and to respond with counter measures such as climate change.

2.3 Context, network

Designers act within a complex system, they are part of a *"dynamic morphology"* (Findeli, 2001) where creative change can propagate in various ways to affect not only future artefacts, but also their clients and users. The rhizomatic urge to form opportunistic, interconnected, non-hierarchical structures goes beyond technological- and social determinisms. Latour's actor-networks, moreover, 'recruit' human and non-human 'actors' to share resources and to solve common problems. Scientists, instruments, notepads and conversations are all embodiments- and generators of knowledge. This fluid system is elegantly echoed by distributed cognition (Hutchins and Klausen, 2002) where *"trajectories of information"* 'engage' representational media to reach our conscious awareness. None of these people or artefacts exist in stasis or isolation, but actively reflect/integrate inherent- and borrowed meaning during their passage through a socio-cultural space.

>> The *Inverter* was conceived as a microcosm and as a nested system comprising organic and artificial components. As a designerly intervention into evolutionary processes, it claims to turn a green plant into a kind of cybernetic organism, even to 'stimulate the encoding of new instructions' and forms (phenotypes).

Miller: Like it or not, this is the only oxygen for three billion kilometers. (Event Horizon, 1997)

>> Is this a race of the fittest that is lost when all free oxygen has gone? We can be certain that the current symbiotic relationship between plants and humans (who are capable of eradicating most life on earth) is completely artificial. Plants now need our protection to survive! This goes back to the emergence of nervous tissues, the cruelties of want and pain, and the fins, limbs, and wings to escape it. Without photosynthesis, only anaerobic organisms may survive next to our intelligent machines ...

2.4 Interface, perception, cognition

Interface boundaries between modular systems allow components to be easily coupled or decoupled and to form new configurations of machines (Haugeland, 1998, Grush, 2003). Desktops, 3D interfaces, VR, TUI, and AR, variously facilitate: (1) Recognition of their intended purpose, (2) Perception of linked artificial realities (Welterschliessung), (3) Access to world-making and co-creation (Poiesis), (4) Wayfinding in virtual spaces, (5) Instructions, directions for negotiation, and (6) Controls to select a course of action. *Trans-disciplinary interfaces* are able to support design-innovation in other disciplines, for example through 'Designtransfer' (Hammer, 2010), or to promote co-development between science studies and design science (Mareis, 2010).

>> The project intends to explore interdisciplinary collaborations between design, plant electrophysiology and cognitive neuroscience. To achieve this, a number of interface layers were structured around the central *electrochemical interface* of the plant itself, including a sensor system, a LabVIEW interface, data visualisations and the responsive systems of the lab, as well as the cognitive system of the researcher [perception, memory, decision making].

2.5 Interaction, adaptation

Desired artefacts are interacted with by desired humans, they become 'proxy-objects' of, or gateways to, a semantic space ... 'un certain regard', promises of wellbeing, 'Lebensgefühl' and so forth. The designing act itself, especially through reflection-in-action (Schön, 1983), intrinsically generates operative design knowledge. Interaction design needs to consider: (a) the realisation of future states, (b) scenarios, usability, interactivity, (c) encoding[1] desirable courses of action and, (d) assimilation of artefacts into an effective socio-economic space. The visual configuration of virtual objects may be performed by users themselves, based on interactive modeling environments with easy functions and parameters, a digital base model, and the means to order or output a [physical] instantiation. Concurrent design systems facilitate distributed simultaneous design activities.

>> Design Computing brings together design, computing science, and cognitive science. Design(science) is cybernetic (Jonas, 2010). An interesting question arises with respect to the

1 The reference is to: Hensel, M and Menges, A [eds.]: 2006, Morpho-Ecologies, Architectural Association.

intensity of interaction (Simon, 1969) [which refers to causal interactions between a system's components]: In the *Inverter's* loop of influence[2], both green plant and researcher may control the room temperature of the lab. By assuming a constructivist stance toward human perception -- and by laterally linking synaptic plasticity to Heisenberg's uncertainty principle -- how might an observer of the system exit the intrinsic 'race conditions' [regress] caused by *"the close reciprocal relationship between synthesis and analysis"* (Liestol, 2003) when required to locate the principal seat of control? Deckard seems to answer this in the film Blade Runner (1982) when he says: *"How can it not know what it is?"*

2.6 Preferable futures

"User needs, aspirations and abilities are the starting point and focus of design activities." Design links creativity with innovation. The role of designers is thus extended to improve overall perception of, and access to, more humane and socially just states of being. Design may become a strategic activity based on consensual and participatory processes, as well as ideational concepting associated with social contexts, market forces and business models. It is agreed that good design must be *"socially responsible and environmentally sustainable."* (Commission of the European Communities, 2009)

3 CONCLUDING REMARKS

Cultural Probes need to be open-ended, even speculative and unpredictable, to affect people's perceptions, generate feedback and to enable new insights, thoughts and ideas. The purpose of the *Inverter*[3] is thus to produce a design intervention and to become the basis for a research tool.

1) How could raw information from a cultural probe be evaluated? Both *Grounded Theory* (Glaser & Strauss, 1967) and *Frames* (Minsky, 1974) suggest ways to organise contingent data, to interpret a new situation based on interactive processes, and to build up concepts. Frames represent interrelated data structures [with levels ranging from 'one/generally-true/fixed' to 'many/specifically-true/interchangeable'] and can be linked with other frames to form a system. Minsky distinguishes between syntactic-, semantic-, thematic-, and narrative frames and, like Grounded Theory methodology, allows the formulation of queries [agency, context, conditions, consequences] to develop emerging information interactively, and to determine present reality.

2) Since the various interface boundaries dividing the *Inverter's* loop of influence are likely to 'shift' during its operation - thereby blurring relationships between the organic and non-organic, between feedback, symbol manipulation, and real understanding - who or what will actually control the responsive systems of the lab room, and why? Clearly, the *Inverter's* microcosm involves more than a thermostat and simple feedback. One approach to locating important control points, might be to determine the exact state of the system at any given moment by 'splitting' action-reaction pairs at each interface layer - something like tracking switched packets on the internet. Another way would b e to focus on *consistent patterns of behaviour* by considering not only the system's problem solving abilities, its internal representations, heuristic search mechanism, or production rules [which may deceive us by mimicking thought], but also the system's *intentionality*. If however *"intentionality is a biological phenomenon"* (Searle, 1980), the system could be complicated by natural evolutionary processes. One might expect a green plant to adapt to its new role as a 'cybernetic organism' and thus to reveal traces of plasticity and modified behaviour. It must nonetheless be assumed that, while able to act as part of an intelligent system, the plant itself has no real *understanding* of this [in our terms], in which case the seat of control resides within the cognitive system of the researcher. Even if it were possible, then, to replicate all the biological materials [using nanotechnology on an atomic scale] that constitute a real human being, there would probably still be 'nobody home'.

2 The reference is to the Emulation Theory of Representation (Grush, 2003), and computational hierarchies in robotic systems (Albus, 1984).

3 Alludes to the Situationist term *détournement*.

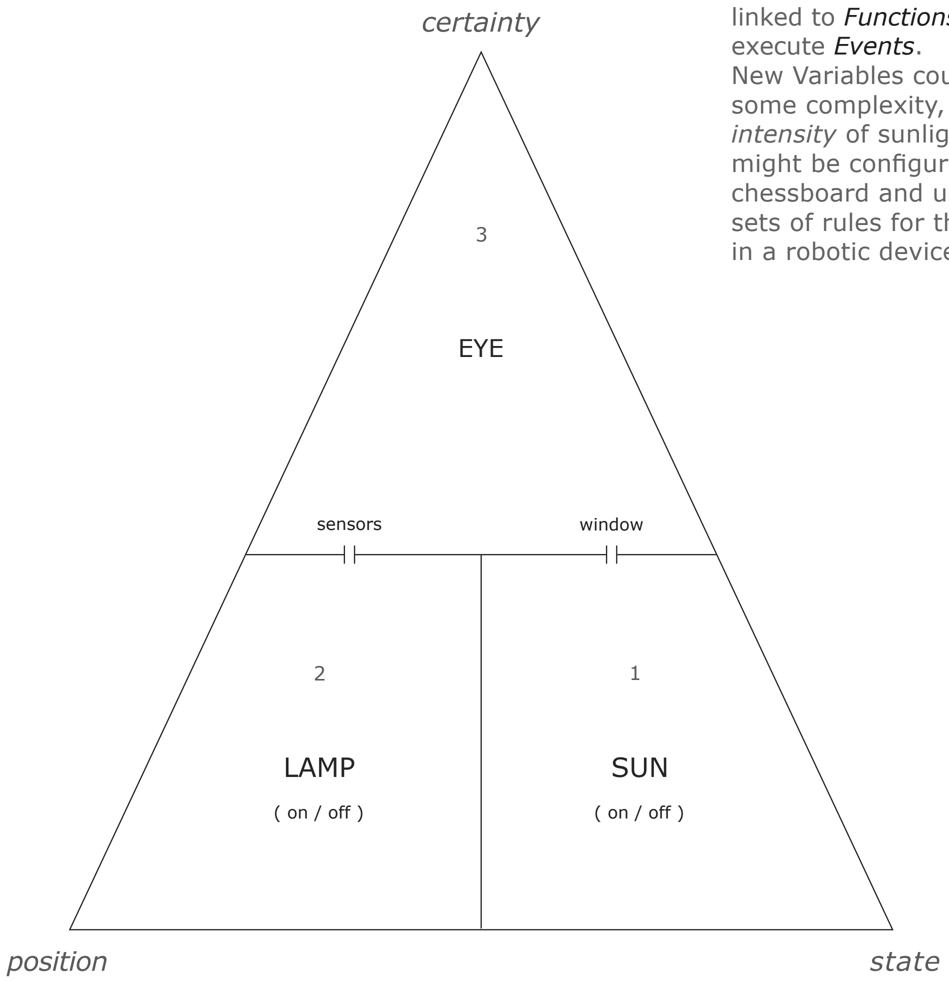
PART 2

STATE MACHINE

STATE MACHINE

The Inverter is a Conceptual Model that can be used to explore units of information (Classical Bit).

The *Inverter* consists of a solar panel connected to a box that contains a light source and a green plant. The box is situated in a room with one window. The only real connection between the box and the room is a sensor system. There are three main Parameters: Position, State, and Certainty.



1) A conscious *Agent* can assume one of the following Positions:

1 Outside the Room
2 Inside the Box
3 Inside the Room

2) Each position has one of two *States*, ON or OFF, excepting the EYE-position which is always ON/open. When the SUN is ON the LAMP is always OFF. When the SUN is OFF the LAMP is always ON.

3) When the Agent is in Position 2 it can be *certain* that: the EYE is ON and the LAMP is ON or OFF. When the Agent is in Position 1, AND the SUN is ON, it can be certain that: the EYE is ON and the LAMP is OFF.

4) A state machine like the *Inverter* can produce a number of *Conditions* **[AND/OR,IF/THEN]** which can be linked to *Functions* with various parameters in order to execute *Events*.
New Variables could be introduced to help generate some complexity, for example changes in the *intensity* of sunlight over time. An optical sensor might be configured to associate a cloudy sky with a chessboard and use incoming stimulus-data and two sets of rules for the purpose of actuating movement in a robotic device.

PART 3

HIGHER CREATIVITY

1 COLLABORATIVE INTERFACE

The Inverter is modular to a digital collaborative space with an interface structured around a whiteboard application. Selecting the *Inverter* from a drop down menu of design projects would activate a context-specific layer, including a canvas plus palette, a chat panel, and a list of stakeholders.

PART III of the study anchors the *Inverter* project as the basis for a design intervention by providing a literature survey on collaborative environments, as well as the wireframe of a possible user interface. It will then pursue a theoretical direction in order to investigate the production of knowledge in design contexts.

1.1 Background information, survey

The term 'co-creation' was used in *Virtual Worlds: No Interface to design* (Bricken, 1991) to describe collaboration in cyberspace between engineers, designers, and participants. John Feland's case study (2007) of a virtual innovation team discusses how design thinking is able to *"evolve concepts across [...] technical, business, and human issues."* In his thesis, Martin Mauve (2000) developed a communication protocol and a synchronous VRML web application, based on his model of distributed interactive media that includes shared whiteboards, networked computer games, and virtual environments. Thomas Leerberg refers to Stankiewicz' evolutionary technology systems in his discussion of the *Topos*

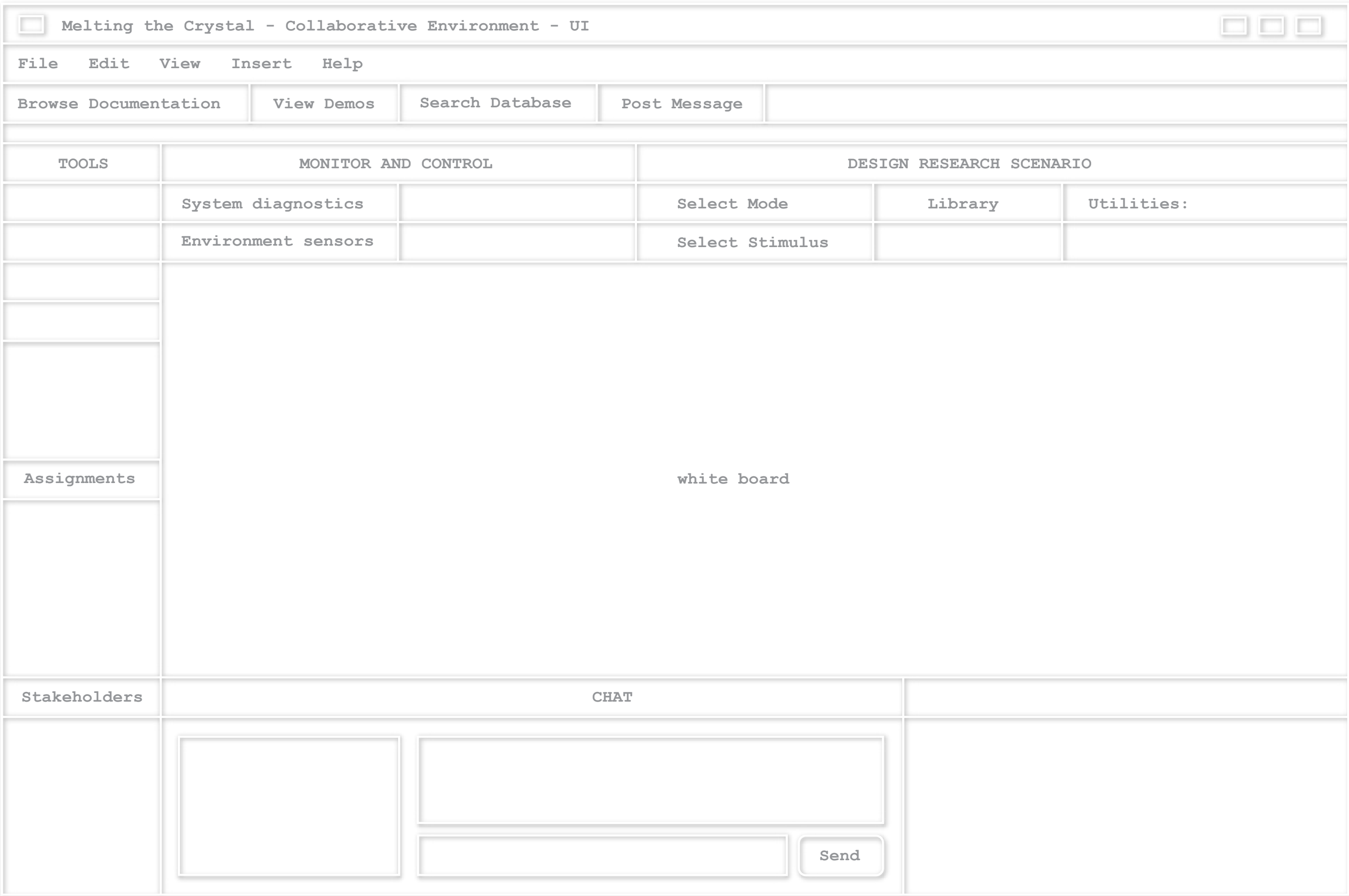


Figure 3 Wireframe of a collaborative user interface.

virtual design space, while *Developing Future Interactive Systems* (Bellman, 2005) examines a collaborative environment where embodied utilities are themselves users interacting with each other as well as humans. In their paper entitled *Environments for Creativity – A Lab for Making Things* (2007), Ellen Yi-Luen Do and Mark Gross propose a shared design space that is extended indefinitely by building tools, iterative prototypes and 'objects to think with'. Mary Lou Maher et al. (2006) consider computer-mediated communication in the Virtual Design Studio, emphasising the role of shared representation in successful collaborative designs. Research by Albert Esterline et al. (2006) examines the *LOGOS Multi-agent System* which is a sophisticated environment developed by NASA. Software agents collaborate with each other, as well as human operators, while resolving faults, retrieving database information, or paging experts for assistance. Thomas Binder et. al (2004) investigate how the concept of configurability proliferates both physical and digital realms to inspire new mixed-media environments with tangible user interfaces.

1.2 eCollaboration

"eCollaboration technologies need to be understood as open and versatile technologies, in that they reveal and enfold their full potential only in the context of emerging practices." (Riemer et. al, 2009)

eCollaboration systems facilitate: (1) Communication [email, instant messaging, chat], (2) Co-ordination [group calendar, project management, task list], and (3) Collaboration [shared documents, electronic whiteboard].

Riemer et. al propose the following research dimensions:

- The *Level of Analysis* locates eCollaboration in terms of individual experience, organisations, or society at large;
- The term *Usage Domain* identifies a particular subject area, e.g. collaborative writing or knowledge management;
- *Systems Lifecycle* refers to stage-based descriptions, ranging from design, implementation, adoption and use, through to the effects and wider implications.

2 THE PRODUCTION OF KNOWLEDGE

The following section considers topics such as wicked problems, Mode 2 knowledge, design knowledge, and design thinking. It will rely on familiar processes of doing and evaluating (what Schön would call reflective design practices) and remain true to its core subjects of interaction- and interface design. An attempt will be made to generate a critical/analytical context by bringing the present intervention [as a responsive system and the basis for a research tool] into relation with the production of knowledge.

2.1 Wicked problems

Disturbance breaks tranquillity! And yet, without difference space can't change and time stands still. Wicked problems are subject to reciprocal effects that occur between the formulation of a problem and the development of a solution. According to Rittel and Webber (1973) *"one cannot first understand, then solve."* Searching is interacting, in which case finding the source of the problem should mark the beginning of a solution. Wicked problems are complex and interwoven: They permit no design in neutral isolation and they have no stopping rule. If presence means intervention too, then the designing act would be as much connected to the impact downstream as it was to the problem upstream. The real cause of a discrepancy may be time-locked, such as original sin or the end of the sun, leaving only symptoms of the problem to be cured. Since *"the level at which a problem is settled"* (Rittel and Webber, 1973) is ultimately unknown, a design solution may invoke *"models of a real without origin"* (Baudrillard, 1992) or a logical paradox.

2.2 New unknown

"Man muss [Experimentalsysteme] als Orte der Emergenz ansehen, als Strukturen, die wir uns ausgedacht haben, um Nicht-Ausdenkbares einzufangen." (Rheinberger, 2007)

What could be new when catching up with the present depends on the speed of light? Perhaps *the new* can be imagined like a difference, like a thunderbolt to pry open the other side of the night. Since the new is unforeseeable and the unknown uncontrollable - that is, contingent, in potentia, or subject to chance, the right conditions must be conceived to make it happen.

The term *unknown* alludes to the 'in-between' -- a becoming future of possibilities through dissolution and recombination -- where interaction between artefacts, consciousnesses, communications and bodies (Jonas, 2006) leads to spatio-temporal interferences with states of equilibrium that substantiate *"life as an abstract phenomenon, a set of vital functions implementable in various material bases"* (Langton, 1996). Design is a praxis of the unknown (Stephan, 2010) and designers should stay in contact with the unknown to be closer to life.

Figure 4: The Pillars of Creation
Photo: NASA, ESA, and M. Livio and the Hubble 20th Anniversary Team (STScI). Permission: Public Domain

2.3 Interface design

1) An interactive system may be autonomous -- as in the case of symmetry operations during crystal growth or algorithmic self-assembly of DNA -- or it may be agent-based, for instance animals who use stones to open hard-shelled fruit.
Gui Bonsiepe not only separated design from a theoretical framework based on form, style, and function by linking it to the domain of effective action (Mareis, 2011), but also described *the interface* (1996) as a dimension for structuring interactions between body, tools, and goals. Design has itself been described as an interface, allowing designers to cast futures by combining knowledge with new patterns to synthesize objects. Nevertheless, a prediction of the future by making it implies that something effect its own cause - which is to catch the unthinkable.

Es schien mir Zeit schneller als Raum. Statt giftig Feuer durch die Erd' Dein Schatten fang' in Vollmond-Nacht. Und schnell durchgeh' ihn wie Papier zum nächsten Tag der neuen Welt. (Ritschel, 2010)

2) Paradox, split causality, infinite regress can lead to valid assumptions, assertions and postulates. The discovery of a phenomenon may occur before or after a theory has been formed: Once the presence of background radiation was interpreted to be a remnant of the Big Bang, it was utilised to reinforce the big bang model of the universe.

Interfaces able to bring forth "a state of flow" effect a reduction of difference to the extent of transparency, or even 'fusing' the entities of human and artefact into one. If an interface were imagined as *"a mirror where the object and the subject [can be] reversed,"* we might endeavour to put space and time exactly opposite each other and next apply this notion to the proposition of traversing space faster than light by folding it [in order to eliminate time]. Based on the assumption that black holes generate enough gravitational force to stop time, the design task might be to conceive a hypothetical device able to reproduce such conditions so as to establish a wormhole connection between two points in space.

John Venable (2006) suggests that *"a design theory should be a predictive theory about the utility of applying [a solution]; A utility theory makes an assertion that a particular type or class of technology [...] has utility in solving or improving a problematic situation."*

2.4 Mode 2 knowledge, new systemic wholes

1) Contexts of application are central to Mode 2 which arose out of the need to conduct 'situated research' outside the academic setting. The production of Mode 2 knowledge tends to be affected by supply and demand, resulting in transitory aggregations of technologies and expertise. Problem solving in a heterogeneous team often involves special methodologies and new forms of transdisciplinary knowledge that: (a) Flow back into the emerging solution space, (b) Will be embodied as tacit knowledge by participants, and (c) Could be distributed socially within a professional culture.

>> What kind of problems arise when market mechanisms are mixed with socially distributed research data? Since conflicting factors could come into play when research is 'pegged' to market rates, one may assume that economic sense will put its due pressure on representations of the truth. And if social- and market forces alone determine *what* is to be researched, *how* the research is conducted, or *when* the results are released, then Mode 2 researchers might become vulnerable to encumbrance, tutelage, or going short ...

"[Die Modus 2-Wissensproduktion] ist für die Designforschung von besonderem Interesse, da es zum einen einen hohen Beschreibungswert für ihre Praktiken und Anwendungskontexte bereitstellt, zugleich aber auch als Argument für ihre epistemologische und methodologische Legitimierung und Weiterentwicklung dient." (Mareis, 2011)

2) The question of epistemology (Wagner, 2001) is considered briefly in the last chapters. It would be interesting to bring Nowotny's *total environment* [problems, methods, dissemination, utility] into relation with Clark and Chalmers' extended-mind theory - especially agent-tool interfaces or *"systems continuously re-negotiating their own limits, components, data-stores and interfaces"* (Clarke, 2004). Our freedom to produce new forms of transdisciplinary knowledge may well increase if we link synaptic plasticity with world transformation, or perhaps follow the non-linear movements of information, mind, and matter across Popper's three worlds.[1] In this formation of 'new systemic wholes' which goes back to the ancient planetary gates, the 'interface' has receded continuously by trading locomotive space for transparency - that is, remapping far space to near space for the purpose of enlightenment.

1 The reference is to Karl Popper's three worlds: The world of physical objects, the world of mental states, and the world of *"objective contents of thoughts."*

2.5 Design knowledge

1) The term ***design*** [designare] stands not only for design practices, but also for the production of knowledge. According to Nigel Cross, design research can be organised into three categories [design *epistemology*, design *praxiology*, design *phenomenology*] which are based on three sources of design knowledge, namely people, processes, and products (Cross, 1999). He also describes the development of a design culture with its own 'things to know', 'ways of knowing', and 'ways of finding out'. Cross differentiates between *scientific design* [Design Methods Movement], the *science of design*, and *design science*.

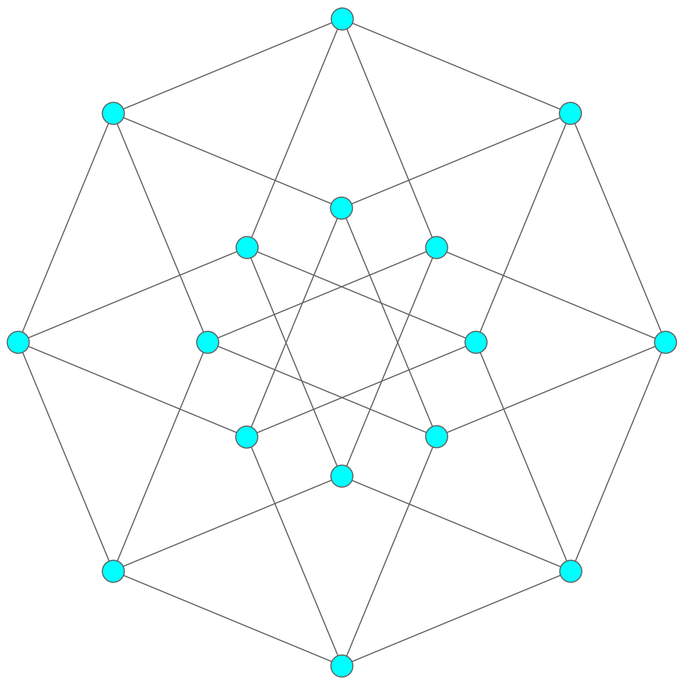


Figure 5: Hypercube (tesseract)

The term design science was coined by Buckminster Fuller and has recently been defined in the context of information systems as *"the material culture or artificial world, the study of the skills, experience, expertise, values, technologies and knowledge involved in design."* (McKay and Marshall, 2007)

2) How knowledge, meaning and data are encoded [INPUT] by designers also affects how the same will be received [OUTPUT]. Input generally consists of *constants* such as numbers, letters, chemical elements, and includes *variables* like human will, emotions, consciousness or intent. Output values based on the artefact's constants arguably remain unchanged - as in the conservation of mass. By reflecting at least *some* human qualities of their originator, however, output values based on the artefact's variables would be affected by the socio-cultural context of each receiving agent.
To be able to enter the living present, knowledge stored in the artefact requires human interaction. To actively stay here, such knowledge needs to survive physiological state changes, personal abstractions, emotions, etc. that inevitably occur during the [cognitive] transformation of text and images into the synaptic tags[2] of a persistent memory.

"Depending on whether we grant to the future the supervening power to rewrite the present and past, so too we must problematize the notions of identity, origin, and development." (Grosz, 1999)

3) Artefacts might be designed to conserve a vital constant for a future set of variables (which is also part of their adaptive potential). In spite of its 'syntactic modernity' the Palladian villa remained bound by *"the Greek classical prototype, [which is] itself a codification of the human measure where Ionic imitates a slender woman and the Doric order man."* Since the design of neoclassical buildings is driven by shape grammars, a valid recombination of tectonic elements will be subject to a set of rules. Intelligent machines, of course, can be programmed to recognise such patterns and to manipulate their symbols, but they wouldn't associate them with *meaning* beyond 'systemic possibility' or the patterns themselves (Franck, 2009). Not in the sense that thinking humans associate a two-dimensional drawing with an actual masonry complex. And if a rule-based engine is fixed on correctness, we can be certain that computers choose truth over beauty even when they evaluate the aesthetic quality of their output ...

2.6 Design thinking

"Für das Design Thinking ist es essentiell, die Tools kollaborativ in einem interdisziplinären Team, lösungsorientiert aber ergebnisoffen einzusetzen." (Beckhaus, 2011)

1) Charles Owen (2007) used the term 'Finder' for creative thinkers who apply analytical methods to explain existing patterns in the world, and the term 'Maker' to designate thinkers (like designers) who combine knowledge with emerging patterns to synthesize objects. Owen's conceptual map of Design Thinking associates the *Synthetic/Real* [Making] with the field of Design. And while science tends to be focused on truth, correctness and provability, design is more likely to be valued in terms of aesthetics, effectiveness and appropriateness.

"Dem bisherigen Design Thinking fehlt in der Hauptsache eine zeitliche Komponente. Interaktion bedeutet in erster Linie ein zeitliches Gewebe, dann erst ein räumliches. Entsprechend sind kognitive Prozesse vor allem zeitliche Prozesse." (Romero-Tejedor, 2011)

2) Design is a deliberative activity that will find appropriate means to bring a concept to life. In *Animated Architecture* (Schumacher, 2002), 4D time-figures elegantly constitute *"the substance of spatial articulation,"* whereby the granted form of an object is replaced by a dynamic *"morphology in relation to behaviour."*
Romero-Tejedor draws particular attention to the temporal dimension of a design, according to which the work should be: (a) Conceptualised during the *semantic phase*, (b) Related to a spatio-temporal meshwork during the *topological phase*, and (c) Made visible by using a set of metrics during the *geometric phase*.

2 Reference to long-term potentiation which is linked to learning and memory.

3 CONCLUDING REMARKS

"Für das Wesen des Designs ist nicht allein das für den Wahrnehmungsraum bestimmte Zeichen (designatus), sondern vielmehr das in den Möglichkeitsraum Entworfene (proiectus) maßgeblich. Design als Projekt, in dem das Unsichtbare, Unverständliche oder Unannehmbare in der Gegenwart für die Zukunft sichtbar, verstehbar bzw. annehmbar gemacht wird: Design als Bestimmung der Kontingenz." (Park, 2011)

The anticipatory dimension of design supports dynamic spatial propositions for unknown future objects.

1) In *world discovery*, the agentive figure of the taxonomist/-philosopher determines the nature of things by means of representational- and ontological integration - that is, through *the description of the actual* based on perception and internal modeling, as well as through *the construction of meaning* based on external media objects, including speech-sounds and text.

>> The Ptolemaic grid preceded the physical objects of terra incognita which had yet to be found by European seafarers and recorded on a map.

>> A concept for moving visual data uncorrupted through space and time by encoding it was treated in Alberti's *De Statua* [where the artefact is resolved into three-dimensional co-ordinates].

>> For the DNA blueprint of life, the 'design contingency' was arguably to implement "a set of vital functions" (Langton, 1996) in a biological base - culminating in a mind-body configuration to describe its presence scientifically as deoxyribonucleic acid. In another world or dimension, the same functions might have been implemented in a different material base and with a different outcome.

2) In *world-making* the agentive figure of the meditator/-artificer generates immanent- and changeable objects - machinic, biomachinic, electric and so forth. This requires the contemplation of intelligible forms and an image in the mind's eye that will be expressed by illuminating sensible matter.

- Unknown future objects, spaces and dimensions;
- Less probable- and unrealised realities;
- Epistemic claims, undecidable propositions.

The dual role of contemplating higher intellect, while actualising thoughts beyond the material interface, is maintained through difference, division, and repetition, leaving one part unaffected and connected with its source. The meditator/-artificer would sooner forget its divine origin than mistake itself for the cause of this world.

Figure 6: Meditation of the Painter by André Masson.

4 DISCUSSION

"The sun is not to be identified with sight, but is responsible for sight and is itself within the visible realm." (Plato, Republic)

1) A design intervention often precedes the act of designing - it borrows from the empiricist tradition, is both analytical and generative. Design involves the *application* of knowledge and the *production* of knowledge, whether the objective was design research or the practice of design per se.
Melting the Crystal required library research in plant electrophysiology and the design of an experiment inspired by responsive architecture. The claim was made that *"a green plant [could be turned] into a kind of cybernetic organism,"* leading to the assumption that flora too would adapt to new environments even to the extent of quantifiable *"traces of plasticity and modified behaviour."*

As a conceptual model, *The Inverter* (Part II) lends itself to a deliberation of sundry oppositions between knowing [a priori], experiencing or being. It permits the observation of its driving mechanisms - sunset, sunrise, night and day - from inside- and outside the room [P1,P3]; however, what takes place inside the box [P2] cannot be mediated and requires either physical presence or adherence to the rules.
In the context of Dewey's Spectator Theory of Knowledge, it could be implied that knowing and experiencing are mutually exclusive if the agent's presence is needed in two places at the same time. (Perhaps the position of a body at rest is easier fixed if time stands still.) Popper suggests that knowledge can exist autonomously [in World Three] though it may be brought to the conscious awareness of a knower through certain works of art.

"The question of epistemology itself emerges as the problem of the relation between the 'reality' of the world and the 'representations' that human beings provide of the world in their philosophy and science." (Wagner, 2001)

2) An epistemic conflict arises when certainty relies on both *consciousness* [which is generated from worldly materials] and *the materiality of the body* [which could be an 'account of the mind']. And hearing yourself think, or mentally unfolding a cube into a cross, or writing something on a piece of paper probably involves the same epistemic certainties.
If it were possible to develop a Brain Computer Interface (BCI) able to render [bioelectric] facsimiles of mental objects, *some* mind-brain would have to stay in the loop to acknowledge the fact ...

TERMINATOR: Hold the CPU by its base tab. Pull.
Following the instructions, she reaches in with a pair of tweezers and PULLS -- there is a BURST OF STATIC and the screen goes BLACK. (Terminator 2: Judgement Day, 1991)

3) How can variations in the production of knowledge interact with complex selective pressures and still result in coherent collective action? Classical pluralism combined the model of nature - beautiful and frightening - with the rights of man and rules of conduct and deliberation. It proposed that the common good is to be *found*, not *given*, and indicates that a consensual state of equilibrium is not contrary in principle to socio-cultural diversity.
According to Structuration Theory, "the production of society" is advanced by each social encounter. At the same time, the freedom to make of society what you wish is limited by someone else's freedom to do the same, which is a question of responsibility. The reduction of control thus faced by social actors may produce a "reality of the uncertain" which can be overcome through shared representation and moments of consensus - as were Excalibur, the Declaration of Independence, or the fall of the Berlin Wall.

Figure 7: The European Green Belt in Sonneberg Germany, part of the former Iron Curtain that was dismantled and transformed into an ecological network (Biotopverbund).
Author: Lubikl. Permission: GNU Free Documentation License

"Conserving biodiversity is in the interest of all humankind, as biological resources are the pillars for all human societies." (www.biodiv.org)

4) The protection of the environment should be part of the development process, whereby the trend has been to move away from parasitic- toward symbiotic growth (Seidl, 2012) which is the path to Green Growth and the green tech industry. With this in mind, the *Inverter* project (Part I) is presented as: (1) *"A microcosm [..] comprising organic and artificial components,"* (2) *"An effective state space to explore new balances between the good earth and its human inhabitants,"* and (3) The basis for a change agent able to turn a circulus vitiosus [vicious circle] into a circulus virtuosus.

>> Conserving nature without also generating economic value can be challenging - and yet, without acting on things like climate change economic production is destined to decline. In that light, it is interesting that the German forestry sector contributes less than one per cent to the country's gross domestic product, while the value creation from raw timber may increase by a factor of up to seven in a region like the Black Forest (where less than three per cent of the workforce is responsible for cultivating more than 80% of the land). Moreover, any economic activity related to that region's tourist trade depends on the 'product' *groomed cultural landscape* which is provided quasi free of charge through land use and forestry. And in contrast to old growth forests, sustainably managed forests significantly contribute to enabling ecological services like the storage of $cO2$.

5) An inspiring example for the sustainable use of resources is the European Green Belt initiative which successfully transformed a political barrier into an international ecological network and a model of transboundary cooperation. By going beyond the conservation of cultural landscapes, one design rationale has been to decrease the isolation of protected habitats, thereby increasing the potential mobility of endangered species, which can help prevent their extinction.
The Green Belt is structured around protected core areas which are flanked by buffer zones and connected by linear- and stepping stone corridors to provide functional linkage. The capacity of the Belt is greatly enhanced by an interactive [GIS- & Natura 2000] database containing information on habitat types, condition monitoring, and species abundance.

5 BIBLIOGRAPHY

Barber, B: 2006, ‘The Future of Technology and Strong Democracy’ in ‘The New Media Theory Reader’, Open University Press.
Beckhaus, S: 2011, ‘Im Team stark: Design Thinking und User-Centered Design’ in: Workshop-Proceedings der Tagung Mensch & Computer, Universitätsverlag Chemnitz.
Binder, T et al: 2004, Supporting configurability in a mixed-media environment for design students, Springer-Verlag London Limited.
Braitenberg, V: 1984, Vehicles - Experiments in Synthetic Psychology, The MIT Press.
Bricken, M: 1991, VIRTUAL WORLDS: NO INTERFACE TO DESIGN, Washington Technology Center.
Bullivant, L: 2006, Responsive Environments, V&A Publications.
Cameron, J and Wisher, W: 1991, Terminator 2: Judgement Day, Screenplay.
Clark, A: 2001, Mindware: An Introduction to the Philosophy of Cognitive Science, Oxford University Press Inc.
Clark, A: 2004, ‘Re-inventing Ourselves: The Plasticity of Embodiment, Sensing, and Mind’ in: Journal of Philosophy and Medicine.
Commission of the European Communities: 2009, Design as a driver of user-centred innovation, Commission Staff Working Document.
Conklin, J: ‘Wicked Problems and Social Complexity’ in: CogNexus Institute brochure.
Cooper, D [ed.]: 1999, Epistemology: The Classic Readings, Blackwell Publishers Ltd.
Cross, N: 2001, ‘Designerly Ways of Knowing: Design Discipline versus Design Science’ in: Design Issues, Vol. 17, No. 3.
Cross, N: 1999, ‘Design Research: A Disciplined Conversation’ in: Design Issues: Volume 15, Number 2.
Diezmann, T and Gremmler, T: 2003, Grids for the Dynamic Image, AVA Publishing SA.
Do, E and Gross, M: 2007, Environments for Creativity – A Lab for Making Things, ACM.
Downton, P: 2003, Design Research, School of Architecture and Design, RMIT University.
Eisner, P: 1997, Event Horizon, Screenplay.
Essick, J: 2009, Hands-On Introduction to LabVIEW for Scientists and Engineers, Oxford University Press Inc.
Esterline, A: 2006, ‘A Process-Algebraic Agent Abstraction’ in: Agent Technology from a Formal Perspective, Springer-Verlag London Limited.
Findeli, A: 1997, ‘Rethinking Design Education for the 21st Century’ in: Design Issues: Volume 17.
Geidezis, L and Frobel, K [eds]: 2002, Das Grüne Band: Ein Handlungsleitfaden, Bund für Umwelt und Naturschutz Deutschland.
Gethmann, D and Hauser, S [eds.]: 2009, Kulturtechnik Entwerfern, transcript Verlag.
Gibbons, M: 2001, Innovation and the Developing System of Knowledge Production, Retrieved September 2011 from: http://edie.cprost.sfu.ca/summer/papers/Michael.Gibbons.html
Gregor, S: (forthcoming), The Nature of Theory in Information Systems, Management Information Systems Quarterly.
Grosz, E: 1999, Becomings: Explorations in Time, Memory, and Futures, Cornell University Press.
Grush, R: 2003, In Defense of Some ‘Cartesian’ Assumptions Concerning the Brain and Its Operation, Kluwer Academic Publishers.
Hutchins, E and Klausen, T: 2002, ‘Distributed Cognition in an airline cockpit’ in: Ethnographic Research, Sage Publications.
Jonas, W and Münch, J: Forschung durch Design als integratives Prozessmodell - eine Skizze.
Jonas, W: 2006, Research through Design through research - a problem statement and a conceptual sketch, The Design Research Society, International Conference in Lisbon.
Jonas, W: 2006, Mind the gap! – Über Wissen und Nichtwissen im Design.
Jonas, W: 2002, Die Spezialisten des Dazwischen - Überlegungen zum Design als Interface-Disziplin, Retrieved October 2011 from: http://home.snafu.de/jonasw/JONAS4-58.html
Landeszentrale für politische Bildung Baden-Württemberg: 2001, Der Bürger im Staat, 51. Jahrgang Heft 1.
Langton, C: 1996, Artificial Life, The MIT Press, Massachusetts.
Liestol, G et al. [eds]: 2003, Digital Media Revisited, The MIT Press.
MacGregor, S and Torres-Coronas, T [eds]: 2007, Higher Creativity for Virtual Teams: Developing Platforms for Co-Creation, Information Science Reference.
Maher, M et al: 2006, Understanding Virtual Design Studios, Springer-Verlag.
McKay, J and Marshall, P: 2007, ‘Science, Design, and Design Science: Seeking Clarity to Move Design Science Research Forward in Information Systems’. Proceedings of the 18th Australasian Conference on Information Systems.
Mareis, C: 2011, Design als Wissenskultur, transcript Verlag.
Mareis, C and Joost, G. et al.: 2010, Entwerfen, Wissen, Produzieren, transcript Verlag.
Mauve, M: 2000, Distributed Interactive Media, Akademische Verlagsgesellschaft Aka GmbH Berlin.
Michel, R [ed.]: 2007, Design Research Now, Birkhauser Verlag AG.
Owen, C: 2007, ‘Design Thinking: Notes on its Nature and Use’ in: Design Research Quarterly Vol. 2, N0. 1.
Park, J: 2011, ‘Designpädagogik: Eine Skizze’ in: Öffnungszeiten 25: Papiere zur Designwissenschaft.
Rheinberger, H: 2007, ‘Man weiss nicht genau, was man nicht weiss. Über die Kunst, das Unbekannte zu erforschen’ in: Neue Zürcher Zeitung.
Riemer, K et al.: 2009, eCollaboration: On the nature and emergence of communication and collaboration technologies, Institute of Information Management, University of St. Gallen.
Rittel, H and Webber, M: 1973, Dilemmas in a General Theory of Planning, Elsevier Scientific Publishing Company.
Roederer, J: 2005, Information and its Role in Nature, Springer-Verlag Berlin Heidelberg.
Romero-Tejedor, F and Jonas, W [eds.]: 2010, Positionen zur Designwissenschaft, Kassel University Press.
Romero-Tejedor, F: 2011, ‘Das Denken im Design’ in: Workshop-Proceedings der Tagung Mensch & Computer, Universitätsverlag Chemnitz.
Sanchez-Segural, M [ed.]: 2005, Developing Future Interactive Systems, IDEA Group Publishing.
Schumacher, P: 2002, ‘Robotic Fields: Spatialising the Dynamics of Corporate Organisation’ in: Designing for a Digital World, Wiley-Academy.
Seidl, B: Aufschwung in Sicht?, Retrieved June 2012 from: http://boerse.ard.de
Terry, A et al. [ed]: 2006, The Green Belt of Europe: From Vision to Reality, International Union for Conservation of Nature and Natural Resources.
Venable, J: 2006, The Role of Theory and Theorising in Design Science Research, CGU.
Volkov, A [ed.]: 2006, Plant Electrophysiology: Theory and Methods, Springer-Verlag Berlin Heidelberg.
Wagner, P: 2001, Theorizing Modernity, Sage Publications Ltd.