Prototypes

Licentiate Thesis 2008
KTH School of Architecture and the Built Environment

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Jonas Runberger

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Modes of Design Development and Architectural Practice

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Jonas Runberger, Stockholm 27th of June 2008

Contexts Introduction

I believe that architecture, in its discourse, practice and implementation, is dependent on a continuous reflection and refinement of its originating forces, its processes, its effects and the discourse that it generates in society on different levels. Rather than make distinctions between critical and reflective theory and pragmatic commercial practice, I hope to establish links between specific areas in these fields. In particular, developments related to experimental practice driven by new technologies over the past 15 years, and discourses triggered by these practices, are being considered.

A Reader's Guide

This thesis is divided into two parts, the *Contexts* book and the *Projects* book. The Contexts book is based on experience from working in experimental as well as conventional practice, and a reading of contemporary discourse on new modes of design in general, and the impact of new technologies in particular. The Projects book presents and discusses experimental projects developed as part of the PhD project *Prototype Development within Architecture*, but also collaborative work in different contexts. The Contexts book relates to the Projects book through references that establish links between the two. Usually bidirectional, they allow the reader to get a contextual understanding of a concept used in the Projects book, or to get a deeper understanding of the potential use of a term found in the Contexts book. The links may also be found between different parts of the separate books. When referring from the Projects book to the Contexts book, the relevant phrase is set in bold, followed by an arrow and a page number ***like this*** ↑ [P.62]. When referring within the Projects book, the arrow is horizontal, indicating earlier or later parts of the text, ***like this*** ← [P.1] or ***this*** → [P.55]. A reference may also indicate multiple pages ***in this way*** ↑ [P.58 | P.63 | P.72]. These references could contextualize a discussion, clarify a concept or show potential outcomes of certain modes of operation, but most importantly they allow for a fluid reading between the discourses covered in the Contexts book and the projects presented as processes and results in the Projects book.

Digital Practices

The contemporary situation has the potential for establishing new meeting grounds for previously separated practices and discourses in architecture. The digital experimental practices are becoming mature, and will inevitably have to find ways to continue their work based on commercial commissions, which will demand understanding and the development of managerial models. This should be conducted in relation to conceptual design development that integrates the interests in techniques and affects with urgent cultural, social and economical issues in contemporary society. The parallel processes within the building industry are looking for sustainable solutions that bring about high quality architecture through rational and economically viable means.

There is a common distinction between service and speculative architecture, in which the former is completely dependent on the will of the client in regards to all issues, and the latter has banished the client as client from its discourse in the name of resistance or criticality.[1] I believe there is a strong potential in finding a convergence between these two approaches, in which a situation exists for practice that enables

innovation at profit, as well as a test ground for theory and discourse. My personal mode of operation is founded in techniques, methods and the management of processes, and I see this as one of many possible areas where different fields and agendas can meet.

As digital practices come of age, they also start to question the development of its design methods and modes of operation over the past ten years. While the past years have seen a strong focus on processes, as in formal design development, there is now a tendency against the formalization of the processes of design, and instead to focus on a discourse of the product (the affect of an architectural proposal) which can be related to design as a craft, that is taught and developed along classic traditions of masters and disciples. The discourse remains on the level of the object and its conceptual, performative and cultural implications, rather than the culture of design as process and production. This may be in opposition with more innovative processes of design linked to research on other aspects than aesthetics, but previous interest in design processes may prevail and remain in the discussion. The parallel continuous development in the field of parametric and computational design is in its nature dependent on formalized processes that will hopefully become more related to the affect potential of the resulting proposals. Sanford Kwinter, as one of the original thinkers and theorists of the digital era in architecture, is perhaps most famous for the introduction of the epigenetic landscape as a reference to architectural discourse. A metaphor for biological development, the graphical representation was presented in a 1993 Assemblage article, but Kwinter has later criticized it to have been received far too literally in the architectural community. The concept and the representation of the epigenetic landscape was developed by biologist Conrad Hal Waddington, and introduced into the architectural debate by Sanford Kwinter in the *Landscapes of Change* essay in Assemblage 19, 1993. He criticized that the metaphoric diagram has been implemented by many architects as a formal reference rather than a process model in his talk *What is Life* at the opening of the *Ben van Berkel and the Theatre of Immanence* exhibition in December 2007.[2] I would argue that the processes of design that I am presenting in this thesis are in themselves dependent on the effect and affect of the prototypes developed as part of the design exploration. There is a need for experiential effect and stimuli in this work, in the sense that the prototype must acquire specific characteristics that gives it identity, and provides feedback to the designer. On the other hand, the discussion of affect and performance of architectural proposals today is strongly focused on the formal principle and pure aesthetics. Such a discussion has been absent for a long time, in particular in the Swedish context and should be welcomed, but it is important that it doesn't replace other discourses related to performance, including issues of structural efficiency, sustainability, program, function and usability. Hopefully a more advanced discussion on the interaction of these issues may arise over time. While many of the issues brought up in this thesis could be seen on a general level, as applicable to fields outside architecture, or at least within architecture as a heterogeneous field; I believe in the necessity in being specific, and I have therefore chosen to use design projects that I have been working with personally, not as illustrations, but rather as vehicles for the exploration and testing of techniques, clarification of terminologies and dissemination of

1 Kipnis, Jeff, "What we ~~got~~ need is – failure to communicate!!", *Quaderns* April 2005, p.94

2 The *Ben van Berkel and the Theatre of Immanence* was an exhibition linked to the Space of Communication research group, in which the SplineGraft project by Krets was presented. The show opened with an event, which I attended, at the Portikus gallery, Frankfurt in November 2007.

findings. It is my hope that the assemblage of texts on discourse, practice, techniques and technologies as well as the documentation of specific design proposals and particular development for those proposals will engage the reader on several levels. As unified research, the work presented in this thesis explores the potential of *research by design*, a principle of research that has not yet found its form. A very important part of the included design work and the research approach in general in this thesis is the notion of the prototype. It is considered as the artifacts or systematic assemblies around which research and design work can be organized, and allows an innovative approach, rather than an approach in which a specific thesis should be tested. I see this work as related to action research (that seeks to improve the strategies of practice from within), grounded theory (with the establishment of a theoretical framework for each specific design case), and experimental research (which tests hypotheses in controlled environments). Modeling and simulation are also integral parts of the design development and adds components of empirical method in the design driven research, exemplified in the parametrical principles presented, which I otherwise consider to be primarily qualitative in the formation of processes and the assessment of architectural effects.

There is an on-going debate among (primarily) American scholars in which the "critical practice" sometimes signified by its resistance to market forces is replaced by emergent young innovative and often market oriented practices, and the relevance of theory is in itself re-evaluated with the definition of a post-critical era. In this way there is a link between contemporary tendencies within culture, society and the market, but the most powerful (and least visible) activities today are the optimization of logistics and partnerships within the building industry, often with an agenda for innovation of management models rather than architectural solutions. Can these different fields be linked on a conceptual plane only, or are there natural links to be discovered for mutual benefit? What are the implications of the international discourse on innovation, market orientation and post-criticality on a Scandinavian architectural scene, where there are few critical practices with links to academic discourse? Can recent interest in system development with design content among our major contractors be informed by international tendencies, and become drivers of innovation in Sweden?

The processes of design development are in strong focus in this dissertation, but they must also be closely linked to the ambition and result of such a development. The documentation of process is not a justification of a particular proposal, but rather informs us of how things come into being, and what forces have been operating during their conception. This is vital information in order to understand how to improve solutions, regardless whether they are social, technical, economical, aesthetical etc. and to identify innovation. I believe that there must be a plausible route that carries architecture through new opportunities and territories, while maintaining discourses of resistance, aesthetics and projective practice grounded in new theory. Contemporary techniques and managerial models have not only allowed architectural practices to re-constitute themselves, this also applies to the building industry, and other related professional fields. These fields are shifting regardless if practices of architecture are following or not, but the dynamic contemporary situation may very well provide us with new opportunities for innovative action.

Formal experiments founded in digital design have been refined since the early 1990s, initiated in a strong focus on processes, means and methods for generation and motivation of results. Today many of the practices continuing this work are turning towards an aesthetic discourse on desirable effects. Computational design of archi-

tecture has been investigated within academia since the 1950s, and can be seen as a foundation for the digital modes of representation that we are used to in contemporary culture including film, games and other visual arts. The continued exploration of computational techniques specific to architecture is now thriving within several larger architectural and engineering firms, often linked to optimization processes of complex geometries, but occasionally also interested in the management of collaborative processes within design teams. The Swedish building industry has passed through a number of generations of prefabrication and industrialization, perhaps the most noteworthy being the major residential developments on the 1960s. Today the industry is shifting gear and re-approaches the idea of industrialization, this time more aware of the value of architectural design and brand identity, while emphasizing the importance of processes rather than factories.

Personal Experience

I have been exploring the contexts addressed in this thesis in parallel through practice, research and teaching over the past nine years. Collaboration with the international architectural research and design group Servo since 1999 and partnership in research collective ***Krets*** ↑ [P.8] since 2003 has provided insight into the fields of digital experimentation in architecture as well as participation in an international context and discourse. Employment at Scheiwiller Svensson Architects (ssark) since 2000 has provided experience in the conventions of Swedish architectural practice and the directorship of ssark medialab at the same office since 2001 has provided insight into research and development within commercial practice. My activity at ssark has since 2004 been focused on research in practice, through a series of studies and reports on volumetric modular housing and later industrial production. This work has been supported by Arkus, Boverkets Byggkostnadsforum and Svenska Studentbostadsföreningen (SSBF).[3] The academic contexts have been explored through a number of different environments. I have been teaching at the KTH School of Architecture since 2000 in various contexts and collaborations, including conceptual workshops based on digital methodologies, urban planning studios and advanced electable design studios. In 2001 I was appointed a 4 month assistantship at the ETHZ in Zürich with Professor Greg Lynn.[4] In 2002 I was a visiting fellow at the Spatial Information Architecture Laboratory (SIAL) at RMIT, Melbourne, conducting a workshop in a collaboration between Servo and Krets.[5] The past years of teaching in the ***Architecture InFormation studio*** ↑ [P.100] at the KTH has included collaboration with design studios at the Architectural Association and Metropolitan Schools of Architecture in London. During the spring of 2007 I conducted a two month research trip to Los Angeles, including contacts to key people at UCLA and SCI-Arc Schools of Architecture , with support from the ARQ foundation. I am an external examiner for the Architecture & Digital Design Systems Master program at the London Metropolitan University since 2006, all together providing links to important international contexts. In general, I have worked with the ambition to interact in local contexts through research and practice, while continuing to build on international affiliations.

3 Gunterberg, Ylva and Runberger, Jonas, *Bostäder byggda med volymelement*, Boverket, 2005.
Gunterberg, Ylva and Runberger, Jonas, *Volymelement i bostadsarkitekturen*, Arkus, 2006.
www.ssark.se

4 **www.arch.ethz.ch/lynn** 17/11 2007

5 **www.sial.rmit.edu.au** 17/11 2007

My personal interest in design methods linked to digital techniques is based in the formal consequences of specific design methods and the performance of the spatial configurations that are conditioned by these methods. This is an ongoing exploration initiated during my architectural studies, later informed by the different contexts I have worked in. I prefer to retain an open-ended approach to the potentials of digital design for architecture rather than a reductive approach of optimization or simplification. My work has been continuously influenced by contemporary discourse related to design principles and performative aspects of architecture, with an emphasis on the digital, but including a strong historical interest in the experimental. During a one year exchange at the Bartlett School of Architecture, University College London (1997–1998), I conducted a step by step generative design process that originated in an analogue understanding of drawing and geometry. The concluding proposal *Dynamo: on the Generation of Spaces* was digitally modeled and consisted of an artificial landscape covering the Farringdon subway station. The *Dynamic Labyrinth* project at the KTH School of Architecture (1998) investigated important concepts of the Situationists in the design of a complex infrastructural underground system that conjoined spatial organization with sublime architectural conditions. The *Displace* project (1999) was a proposal developed in collaboration with Amir Aman and Daniel Norell for a student competition that looked at fabrication and user reconfiguration of a dispersed mediated pavilion. The KTH diploma thesis *Portals: Memory of the World Archive* (1999–2000) explored the potential for physical instantiation of hyper-linked structures through the design of a physical archive incorporating mediated spaces. The conceptualization, articulation and organization of space through digital and physical generative principles have since then been conducted within different design collaborations primarily within the ***Krets*** ↑ [P.8] research group and as a design team member of several Servo projects. This work is presented extensively within this thesis.

Thesis Background

The empirical material for this thesis is based on my experience from work in these different contexts, an extensive reading of contemporary publications in the field of digital architectural design in a wide sense, and my findings in the development of specific architectural design projects primarily within the Krets research group. The two main chapters of the Contexts book follow two distinct lines of inquiry. The first one surveys contemporary techniques and their effect (and affect) on architectural proposals. The second discusses contemporary ideologies and theories in relation to different modes of practice. There are strong links between these themes. The perceived affects of contemporary architecture are part of the cultural production in society and influence the formation of ideologies. Modes of operation within practices are reflected in their ideologies and generated discourse. The architectural design projects included in the work have been developed as design driven experimental research, in the sense that the work explores the potentials of digital design tools, fabrication methods and collaborative modes of operation. The projects are initially presented within the thesis in a short and condensed way as complete ***projects*** ↑ [P.10 | P.54 | P.86 | P.100]. They are also revisited in what I have chosen to call design loops; relevant and coherent parts of the process of design development, production or performance of the proposed design. This separation into parts allows for studies of related concepts between different projects and more focused investigations of particular concerns. The design projects have been developed in different contexts, primarily within the Krets research group.
The concepts explored reflect the motivations of

several participants, while the conclusions are based on my personal research agenda. All design loops have been reformatted for integration into the thesis, and while the projects have been developed in collaboration, the conclusions presented in the loops are mine. In a few cases, the entire design loop has been developed as a part of the work with this thesis, in which I have returned to a project developed earlier, and selected certain parts to be investigated further. Important to note is that the projects are not proposed as illustrations of themes presented in the text, nor are they motivated by the concepts or theories explored. The description of the processes of design should be regarded on the same level as the discussions of outside references; as investigations and explorations of a series of issues that are considered to be closely related by the author. In some instances strong links are identified between material of different nature, in other cases weak links allow the reader to cross refe-rence and make associations between the different fields addressed. The ***design prototypes*** ↑ [P. 12 | P. 56 | P.88] can be seen as devices exploring different issues, slowly being formed into the design project which becomes a necessary framework for advanced studies. In the written part of the thesis, a similar approach has been at play, in the sense that certain conceptual tracks have been explored in parallel, later being formed into a coherent thesis. In both cases, the work has been initiated in an interest that is being explored informed and evaluated, rather than a thesis to be proved.

While numerous digital techniques are being used in the design projects and design loops presented, the attempt is not to give a complete overview of the state of the art of digital design within architecture. The effects of the techniques used are instead considered as singular references from the complete field of digital design, and the context in the design projects is instead emphasized. Regarding the terminology used in the thesis, design always implies the verb and activity of designing, rather than a designed artifact or building. It may indicate all aspects of design activity, including construction, form definition and system development, but the aim is to clarify the meaning in each particular instance. Proposal denotes a resulting product, in the sense of a suggested configuration of space. The ***prototype*** → [P. 22] is used as an artifact or more abstract construct, and also as a verb in the form of prototyping. Other important concepts include various modes of digital design, currently employed within experimental architecture, including computational design, generative design, parametric design and topological approaches to geometry. They are also closely linked to issues of fabrication and mass-customization, and are covered in the second chapter. The general term of research by design is affiliated with the notion of practice based research, or the Swedish term konstnärlig forskning (artistic research). I believe the latter is too wide spanning in that it may refer to a general reflective artistic practice having few research implications and the former indicates any mode of practice as empirical data for research. Still, the relation between research and design is in my opinion bi-directional; there may be modes of design in practice that benefit from research methods, and there are fields of academic research that can be informed by the participation and direction of design processes.

Prototypes as Techniques

The early 1990s witnessed the first attempts at establishing new design strategies linked to digital tools primarily in the form of advanced modeling and animation software. While digital design, in the form of programming and computational development was not new, the availability of advanced software opened up this design field to allow non programmers to explore complex geometries and control algorithms. Parallel discourses also emerged, with a seminal point being the *Folding* issue of Architectural Design, where the ideas of Gilles Deleuze were also brought into the discussion.[6] The paperless studios at Columbia University educated the first generation of architects in this field in the early 1990s. Greg Lynn, being one of the professors during the introduction of computers at Columbia, acknowledges that his own design work and writing was launched through the pedagogy of these studios.[7] A diverse field of digital design has since emerged, a common denominator being the interests in geometries that defy the rationality of modernism, sometimes defined as organic, sometimes topological or non-Euclidian.

During the early 90s architectural designers were interested in the ways spaces and organizations could be conceived through the new found digital tools, and the dichotomy of virtual-actual was continuously discussed.[8] Generative procedures such as genetic algorithms and other methods were deployed in the search for a new formalism. The conception of forms in digital models was followed by the possibility of producing physical models through the use of rapid prototyping technologies such as laser sintering or stereo lithography. The material aspects were further explored in fabrication techniques such as vacuum forming of plastic, cnc-milling or different forms of casting, making a wider range of materials available. Fabrication principles have been followed by means for production of full-scale buildings and the past ten years have seen a number of seminal projects realized, including the Yokohama Port Terminal (Foreign Office Architects), the Guggenheim Museum in Bilbao (Frank Gehry and associates) and more recently the Phaeno Scientific Center in Wolfsburg (Zaha Hadid Architects).

A number of practitioners that have previously been engaged in discourses of processes and techniques are now interested in the development of aesthetic discourses. Closely linked to a contemporary context outside architecture, it still indicates a specific trajectory among others, potentially related to discussions concerning collaborative practice, the “post-critical” or “post-vanguard”, as well as innovative practices relying on design systems, prototypes and fabrication. The discussions of processes have more recently been considered of less importance since the primary purpose of that discourse may have been about justification rather than understanding the mechanisms of design processes. While the interior workings of the experimental or academic design project were often closely linked with issues of pure geometry, or the individuals processing of gathered data, the project deployed in practice (and the market) is affected by many forces during its conception and realization. The processes at work, internal or external to the deployed concept, should be presented and discussed in relation to the qualities and characteristics of the final proposal, or the final building, not as justification or motivation, but in order to understand and continuously develop modes of practice.

The contemporary situation within architectural education on a global scale is greatly influenced by digital techniques, and within this field a number of primarily aesthetic principles that

may lead on to their own discourses have evolved. These include the use of surface tessellation such as Voronoi diagrams, material efficiency principles such as minimal surfaces or their specific instantiation such as triply periodic minimal surfaces or subdivisions of surfaces in specific digital modeling tools. Frequently, the use of these techniques drifts away from their origin, such as surface division, patterning or structural performance, and moves into areas of formal configuration, effect and aesthetics. In parallel, parametric principles allow not only for formal variations, but also parameter driven solutions, which has given rise to numerous projects exploring stresses and loads in catenary systems, or wind loads in the design of high rises.[9]

The architects Ben Van Berkel and Caroline Bos of UN Studio critique parametric approaches as focusing on techniques that become pointless rituals, in the sense that the vision or fantasy of what these techniques produce has not been developed at the same pace as the methods themselves. This leaves repetitive fantasies, something that may also be observed in a cross section of student work globally. The development of these techniques in hermetic conditions (within schools) is nothing but the Beaux Arts all over again, according to the authors. They ask for more intelligence and strategic planning to design, to move into a territory applicable in practice, as well as informed visions that can work as drivers for the projects unfolding from these techniques. They are further proposing to abandon the diagram in favour of the design model, an entity that in many ways resembles the notion of the prototype presented in the context of this thesis. Design models are seen as "packages of organizational and compositional principles, supplemented by constructional parameters", and should remain abstract and non-site-specific, in order to be deployed in various situations. It should not be constrictive but rather operate as a translation model, evolving to an increasingly more real condition for each iteration of a project's development.[10] They are also introducing the *figment*, something fuller than a concept, idea or notion, incorporating a whole history and explicitly existing in a realm between representational and actual. They refer to Piranesi and Constant as creators of figments, which propels it into the realm of architectural works of a high integrity in the sense that they are complete worlds of themselves, but again, the proximity to the prototype can be detected.

So, van Berkel and Bos are registering tendencies in academia (primarily in education, and most likely in the series of more or less linked schools that are by many considered to be on a design/innovation vanguard position) that limit and restrict the understanding of new techniques, because of a distance to practice. What is then different from historical precedents in these environments? Are the new techniques so advanced and complete that they are creating their own worlds, their own artificial figments, retaining the attitude that they are worth being explored for the sake of exploration, not because they promise solutions to problems found elsewhere? Are contemporary techniques so complex that they establish their own internal discourses,

6 Deleuze, Gilles, "the Fold: Leibniz and the Baroque, The Pleats of Matter", *Architectural design: Folding in Architecture* vol. 63(1993):3/4, Wiley, 2004 reprint, p.33

7 Tschumi, Bernard & Berman, Mathew (Ed.), *INDEX Architecture, A Columbia Book of Architecture*, MIT Press, 2003, p.24

8 *ANY Magazine: The Virtual House* 19/20, September 1997, Guest Editor: John Rajchman

9 Leach, Neil, Wei-Guo, Xu, (Ed), *Emerging Talents, Emerging Technologies*, Catalogue to the exhibition with the same name at the Architectural Biennale Bejing 2006

10 van Berkel, Ben and Bos, Caroline, *UN Studio: Design Models – Architecture, Urbanism, Infrastructure*, Rizzoli, 2006, p.13, p.15, p.378

lacking the need for outside parameters? Are the resulting aesthetic discourses, while associated with historical references in ornamentation and decoration, mere justifications of geometrical exploration, rather than actual drivers? Perhaps these questions need not to be answered, at least not in a single way. The design methodo-logies that have arisen are very complex and require a very precise discourse to be continuously refined. While these routes to design need to be able operate in the world under the same conditions as any other design approach, they will continue to require an advanced discourse that includes both ***techniques and procedures as well as performative effect*** ↑ [P.46 | P.64 | P.96 | P.108]. At the same time, they will become part of practice in general, either through young firms with new approaches establishing themselves as autonomous practitioners within the field in general or through the dispersed networked agencies described in the previous chapter. Regardless, the same software systems that are employed to explore new design space will enable a borderless exchange of information, disregarding authority figures or formal organizations.

Parametric Design

The design of a parametric system is based on dynamic values rather than fixed settings. The most basic version of a parametric geometry is the numerical input of selected parts in a model, such as the length, thickness or angle of a solid. In a more advanced model, these values can depend on one another, i.e. the thickness of a structural slab may depend on the supported length. This would normally be a one-directional dependency, in the sense that extending the length would update the thickness, but not vice versa. In bi-directional or multi-directional dependencies different geometries are able to affect each other, which normally are handled in iterations, in essence establishing feedback loops within the model that are allowing for a recursive design process. As with all feedback, this could lead to an unstable equilibrium (as in positive feedback), or a stable equilibrium (as in negative feedback). In the former, the model risks great amplification and loss of control, in the later the model will find equilibrium and maintain a controlled state.[11] CAD packages deploying parametric principles are often using only one-directional dependencies. Structural form finding processes are examples of effective bi-directionality, in which a digital geometry goes through iterations of dynamic relaxation. The classic examples are the catenary structures[12] developed by Antonio Gaudi and Frei Otto, in which physical chain models automatically establish optimized structural performance, and update to any change of topological configuration.

Axel Kilian refers to parametrically supported design processes as “design exploration through constraints”, and makes a number of relevant definitions. ***Constraints*** ↑ [P.82] are seen as limiting factors in design that can help focus the design process by formulating the “boundaries of available resources”. Kilian explores constraints of material, functional, topological and geometrical character. The *design explorer* is an assembly of constraints that apply to the design problem. *Design exploration* entails variations of design solutions and goals deployed to reach a better design solution, performed through the set-up of an exploration system that “incorporates the constraints but allows for the exploration of the unconstrained aspects of a possible design”. *Design drivers* are the constraints with the most weight in the design explorer and therefore are the most influential. *Bidirectional links* defines a relation between two entities in which the role of the driver and the driven can switch.

A translation model is an "externalized intellectual, computational or physical construct that can relate design constraints in one representation to design constraints in the target representation".[13]

Kilian exemplifies the translation of constraints into drivers in a number of ways. The most obvious material constraint is a tension-only form-finding model, very similar to inverted cate nary structures, in principle a hanging model. This model would include a material factor that indicates the minimum allowable cross section for any structural member. Other material constraints may deal with fabrication of physical manifestations of a digital design, such as flat-sheet fabrication by laser or plasma cutters, which entails the translation of free-form shapes into developable or planar surfaces.

A solution space is a conceptual territory of possible solutions to a particular problem. In a parametric design system, the ***design solution space*** ↑ [P. 40] can be seen as the literal possible configurations with the set constraints of all parameters. This space can be multi-dimensional, ranging from 1D to infinite, depending on the number of involved parameters. The design development could be seen as the navigation of this space (or exploration, as Kilian defines it), in which alternate solutions can be generated and compared. A more detailed map of the solution space would indicate regions in which certain issues are optimized, and this field could support design decision that depend on multiple conditional aspects. It is important to note that while the definition of the solution space seems to indicate that processes and their results can be automated and formalized completely, most problems within design are wicked problems, i.e. they do not have a clear definition.[14] The interactions around the parametric systems in which the solutions space is defined, is very much dependant on other considerations, based on parallel studies and conceptual strategies.

The notions of ***fabrication and production*** → [P. 28 | P. 30] can be seen as both constraints and drivers, and can be considered to represent two distinct but overlapping fields. Fabrication deals with the possibility making something physical, often with the aid of automated processes, while production also considers whether the means of making are rational enough to allow it to mass customized or otherwise be applied in a market. Projects can be initiated out of ***particular fabrication processes*** ↑ [P.44 | P.48 | P.62 | P.72 | P.80 | P.102 | P.104] or production potentials, or at least aim at integrate research components that change production constraints during the design development. Stylianos Dritsas speak of *design operators* as "computation-based constructs that enable designers to represent, generate and evaluate their ideas by the means of a specific medium".[15] He sees them as mechanisms that provide control over a process between various sources, and includes traditional architectur-

11 In cybernetics and control theory, feedback is a process whereby some proportion of the output signal of a system is passed (fed back) to the input. This is often used to control the dynamic behavior of the system. Examples of feedback can be found in most complex systems, such as engineering, architecture, economics, and biology. **http://en.wikipedia.org/wiki/Feedback 14/11 2007**

12 In physics, the catenary is the shape of a hanging flexible chain or cable when supported at its ends and acted upon by a uniform gravitational force (its own weight). In Architecture, the catenary is the ideal curve for an arch which supports only its own weight. **http://en.wikipedia.org/wiki/Catenary 14/12 2007**

13 Kilian, Axel, *Design Exploration through Bidirectional Modeling of Constraints*, doctoral thesis, MIT, 2006, p.59

14 Wicked problems can have incomplete and changing requirements and solutions that are difficult to recognize, as opposed to clear solutions of mathematical problems or puzzles. **http://en.wikipedia.org/wiki/Wicked_problems 22/5 2008**

15 Dritsas, Stylianos, *Design Operators*, master thesis, MIT, 2004, p.7

al techniques such as drawing with a straight edge and compass. The concept of computation adds a transformational process between a generic input and output, and he suggests two crucial characteristics; *time-compression* and *representation-expansion*. With examples of the introduction of CAD systems into architectural design, time-compression deals with the automation of previously tedious tasks, such as drawing repetitive details, replacing well known design behaviors and operating primarily as a quantitative enhancement. Representation-expansion regards the potential to represent forms that were very difficult to draw previously, such as complex non-Euclidian geometries, with qualitative benefits that expand the possible design solutions.

Objectile indicates a function that virtually contains an infinite number of objects, or a form with multiple events.[16] While the concept can be easily linked to mass-production/mass customization dichotomies, a more relevant case may be the digital design systems often linked to new fabrication methods, especially in the use of parametrical design tools, and specific design proposals that explore them extensively. The design of the objectile therefore entails the design of a system or set, with variants that can depend on a large number of different parameters. At any given moment the boundaries of possible objects are ***defining the solution space*** ↑ [P. 40], which may depend on suggested use, or outside parameters, but also issues of design identity. Gilles Deleuze defines objectile as a status of an object with respects to its "temporal modulation that implies as the beginnings of a continuous variation of matter as continuous development of form".[17] The concept has been explored by Bernard Cache, once a Deleuze disciple, who even named his practice after it. An early adopter of computational design techniques and the fabrication/production dichotomy, Cache is simultaneously operating in a very conceptual/theoretical territory, and a pragmatic/industrial counterpart. In many ways, his design process deals with the development of computational rules for production, and the exploration of its limits. As an integrated part, his work deals with emergent patterns and effects that are intentional but infused with great variation within its solution space. He also rethinks the idea and image of the (architectural) object, which he considers to be the "set of constraints at the intersection of which the object is created".[18]

Rules and constraints are central to the literary movement Oulipo, or the Workshop/workroom for Potential literature (Ouvroir de Littérature Potentielle), founded in France in 1960. The ten founding members consisted of writers, mathematicians, professors and pataphysicians. Today 37 members are listed (deceased members are not removed). In short, the purpose of the work of the Oulipians can be defined as the development of new forms and structures that may be used by others in any way they see fit, often with added examples of literary work developed according to these structures. In another sense, the members considered writing to be work which could be structured and organized to deliver text of exceptional merit and affectivity without being referred to as created through pure inspiration. Important concepts for the Oulipian include constraints (that goes beyond rules of language apparent only to those who have never questioned it, forcing the system out of its routine functioning revealing its hidden resources), combinatorics (in the study of different potential configurations) and recurrence (suggesting texts that invite the reader to continue the production of the work to infinity). Oulipo also claims to be anti-chance, in a way imitating chance while obeying a law. Oulipo does not want to impose any thesis, the intention is to formulate problems and eventually offer solutions that allow anyone to construct a text. Examples of work according

to Oulipo principles include George Perec's poem *La disparition* without the letter e (constrained in the form of a lipogram, meaning that a letter is missing), the S+7 method defined by Jean Lescure (an automatic transformation of existing text by replacing every noun with the noun seven entries after it in a given dictionary) and the *Cent Mille Milliards de poems* by Raymond Queneau (10 sonnets with the recombinatorial potential of each of the 14 verses, giving 10^{14} possible sonnets).[19]

The Oulipo interest in constraints, both within their own design work (as writers and artists), and as parts of the produced ***work with integrated potentials of recombination*** ↑ [P. 22 | P. 86] that allow the reader to some extent to participate in the artistic process, are related to the design of systems. It is clear that they were not interested in random chance, but rather explored processes that lead to very particular results, sometimes unexpected, but certainly of quality. The fact that the conditions and rules of Oulipo are independent of factors outside of the artistic processes, such as economical or other pragmatic conditional aspects, but rather are made important for the generation of artistic effect and quality, further emphasizes the relevance for a parametric approach that focuses on these issues.

The use of workroom or workshop inherent in the acronym Oulipo itself, suggest an interest in the collaborative aspects of these phenomena, and the systematic definition of the rules of engagement in these processes, makes them an interesting reference to the practices within system development and computational design of today. In addition, the invitation of the reader into the artistic act, is reflected in ***responsive performative aspects of many contemporary projects, as well as projects that allow the user to manipulate and redesign parametric models*** ↑ [P. 46 | P. 64 | P. 96].

As architects take on the development of parametric design systems with rules and constraints, there is in analogy with the Oulipo movement, where there is often a search for a variation of expression that mimics randomness, but still under extreme control. Parameters could range from contextual input to programmatic concerns and formal specifics, decided by the designer/architect, in order to achieve a desired effect/affect. The parametric design system may at this point introduce a paradox/anomaly; on the one hand it remains open to articulation and reacts to input, on the other hand it continuously expresses its origins though its code or geometrical relationships, exemplified by ***Virtools behavioral models*** ↑ [P. 88], Rhino Script or ***GenerativeComponents transaction files*** ↑ [P. 36 | P. 66 | P. 80 | P. 100]. If the design is specifically targeted towards spatial effects, through formal or even a responsive approach, these areas may become even more blurred. Architectural design using parametric models is in many ways related to system development, in the sense that a 2nd order system is designed with project specific performance in mind. The parametric model can be seen as a control system, in which the designer can manipulate and explore a proposal too complex to comprehend without the aid of a system. While some parameters may be driven by external forces such as analytical site data, material performance characteristics or programmatic organization, the adaptation of this information is subject to the design intentions and needs to be formalized during the development of the parametric

16 Carpo, Mario, "Ten years of folding", *Architectural design: Folding in Architecture* vol. 63(1993):3/4, Wiley, 2004 reprint, p.16

17 Deleuze, Gilles, *the Fold: Leibniz and the Baroque*, The Athlone Press Ltd, 1993, p.19

18 Cache, Bernard, *Earth Moves: The Furnishing of Territories*, The MIT Press, 1995, p.97

19 Motte Jr, Warren F. (ed. & transl.), *Oulipo: a primer of potential literature*, University of Nebraska Press, 1986

model. Additional parameters are added to provide control mechanisms for the system, in order to explore the solution space that it provides. In this sense, the development of the parametric system is similar to the design of a control rig, a geometrical construct that will never be physically built, but sets the rules of design process. When linked to fabrication and production, these systems allow for design along the principles of difference and repetition, in which families of similar, yet not identical, features can be produced, originating from the same system. As stated by Robert Aish, creator of the GenerativeComponents parametric application and former research director at Bentley Systems, "we have to match our tools to the concepts around which designers want to build their skills".[20]

Building Information Models

Building Information Models (BIMs) are being used in all parts of the building industry today. While they may be considered to be parametric models to a large extent, the most important property in these models is the linking of data to geometries. This information may regard dimensions, materials, production time, cost etc. The integration of this information may be used for trouble shooting design solutions, budget estimates and procurement, as well as management of projects and buildings. The drivers for a BIM are normally focused on the optimization of processes and logistics, and there are not necessarily any parameters included that promote architectural innovation. In relation to the terminology suggested by Stylianos Dritsas, the main driver for BIM development is time-compression, of course also closely linked to the industry notion of quality; the rigorous control of mistakes and mishaps during the production process. A recent survey shows that the top concern among BIM users is the need for drawing production. Smart objects with maintained associations and relations (in essence parametric) were asked for, but primarily as readily available object libraries for standard products (in which the parameters are set, but the parameter space is not designed). The questionnaire that provided the input to the survey did not include specific questions regarding architectural potentials of the systems, but included the options "Ability to support preliminary conceptual design modeling" (ranked 9 of 19), "Extensibility and customization of the solution" (ranked 13) and the relative ranking of "Intuitiveness and ease of use promising a short learning curve, VERSUS, (b) Enhanced scope and better capability to model complex forms." (the former was preferred with 3.67 to 2.39). 46 % of the respondents were architects, and 80.2 % of the practices involved were architectural firms. The survey was commissioned by a software provider, as a basis for future application development. What is worrying is that efficiency and quality (in the industry sense) are top priorities, and the capacity to develop innovative designs is not.[21] Not only may BIM modeling not be further developed towards new innovation in formal design, it may even narrow down the architectural potential of today, in the sense that it may standardize the virtual aspects of architecture (that is, the potentials that we may envisage) in a similar way that mass-production standardized the physical aspects of architecture.[22] While the previous discussion of parametric models in design argued that the potential of a parametric system is to remain in control of advanced architectural proposals which may deal with input from external sources as well as complex relationships set up as part of the design agenda, the control often associated to BIM is one of standardization and limitation. The aim of BIM development has been to use ICT to get control of complex processes of design and production regarding any kind of project, and provide process control tools rather than formal design tool, even if the design

process is transformed in order to fit the classification systems adopted. Industry Foundation Classes (IFC), is a non- proprietary data structure, not based on geometrical information but only the data associated with it. The aim of IFC development has been to establish a platform independent framework with a collective terminology and file exchange format between different systems. Again, IFC is dealing with standards and classes, which also has made the implementation (in Sweden) slow, since there are clashes with other established standards. The suggested way forward has been to go through standardization of geometrical representations of objects in CAD systems, and the standardization of the relationships between these objects.[23] If IFC remains on a level of information handling rather than component standardization, there are many opportunities to integrate the types of parametric systems presented elsewhere in this thesis with the IFC classification, as long as innovations in design, form, structure and materiality can be reflected in the continuous development of these classes. Another frequent topic is the way of interfacing and filtering information for different disciplines. This is inevitable in the complex information structures needed for today's processes, as identified by Dritsas as *information hiding* and *scope visibility resolution*, terms borrowed from computer science.[24] These terms refer to the need to filter information from a common database to the participating parties. The architect may continue to work on the design not having to directly confront the engineering specificities, the structural engineer manipulates only the material relevant to structural solutions, the fabricator is only interested in the parameters for production etc. As Dritsas suggests, the person having the information maintains the control of a certain domain. Even though the aim is not to further isolate the disciplines participating in a project, the limited information communicated most likely says very little about the motivation and context behind a particular design decision, and therefore cannot provide any understanding of the consequences of any change done by a discipline with limited information. A ***parametric transformable model with prototypical characteristics (or behavior)*** ↑ [P. 38 | P. 85 | P. 95], could provide an understanding of the impact of changes without a full view of all information (the prototype would "act" to make sure a change does not constitute a dramatic contradiction to design intention, structural integrity or technical performance). In this sense, prototypes linked to the BIM, may provide more adequate interfaces for the different parties, avoiding an overly streamlined organization, with little opportunity for innovation. A prototype is not only a set of limited principles, but must include enough of the complexity of a proposal to actually perform to some extent. This means, that the redundant information from one collaborator most likely will be partly accessible to other parties, and there is a gradient rather than a fixed border between data considered relevant and the material used for development within one discipline. This may encourage each participating party to not only give answers to questions posed, but actually realize other opportunities.

20 Aish, Robert, "From Intuition to Precision", in *AA Files 52*, AA Publications, 2005 p.62-63

21 Khemlani, Lachmi, "Top Criteria for BIM Solutions: AECbytes Survey Results", *AECbytes Special Report*, October 10, 2007, http://www.aecbytes.com/feature/2007/BIMSurveyReport.html 13/01 2008

22 An example of this is a comment from Kjell Ivar Bakkmoen, who in a 2006 BIM presentation claimed that the necessary parameters of any wall as defined by length, width and height only, and in response to a question on curved walls, challenged the relevance of any spatial innovation ("who says a round wall is any good").*Visual Forum 2006*, Gothenburg. I presented in the same session.

23 Ekholm, Anders, "Teroetiska grunder för informationssystem vid byggande och förvaltning", Wikforss, Örjan (ed.), *Byggandets informationsteknologi, så används och utvecklas IT I byggandet*, Svensk byggtjänst, 2003, p. 203-250

24 Dritsas, Stylianos, *Design Operators*, master thesis, MIT, 2004,p. 34

Architect Branko Kolarevic argues that an important divide between architecture and construction started when drawings primarily became contract documents, and with the appearance of the general contractor in the 19th century. He suggests that the convergence of representation and productions processes, even on the level of BIM, is an opportunity to transform the architectural profession as well as the building industry. He suggests a digital praxis, in which design, analysis, manufacture and the assembly of buildings are integrated through digital systems, allowing architects, engineers and builders to redefine the relationship between conception and production.[25] While the existence and implementation of these technologies, and the potential overlaps between design and production that are a result of them, may enable such collaboration, there is a discrepancy between the agendas driving the implementation in the different disciplines. As mentioned before, the rationale behind most BIM implementation is to compress time and minimize mistakes in production, which of course would also be benefited by the integrations of digital systems and a closer relation between design and production. The open question is however which end is driving which; does the link from design to production simply transpose limits of production methods today into the design environment, allowing for instance the selection of a kit of parts? Or can advanced design approaches and tools actually drive the production into new territories, and challenge what is actually rational? Experimentation with digital models linked to production tools is nothing new, but with few exceptions it is not implemented in large scale projects at a competitive cost range. BIM is becoming an industry standard however, and with it new systematic ways of working, and as Kolarevic states a transformation of the building industry. There is still a potential to integrate an expanded design potential with these new modes of working, and the idea of the prototype may be one way to address this. A 2006 article in the Los Angeles Times compared a number of young local firms as the garage bands of architecture, active in academia as teachers and in complete control over small scale projects with offices incorporating facilities for fabrication and production.[26] On another scale the New York based practice Sharples Holden Pasquarelli speaks of versioning as an important concept and method in their design work; iterations of digital models with parametric properties are continuously exchanged between all partners in a project, and building documents are replaced with machine instructions for the production of architectural components, allowing for the mass customization of complete projects.[27]

Prototypes

The notion of the ***prototype*** ↑ [P. 12 | P. 56 | P. 88] indicates an entity with certain characteristics. The word traditionally suggests a forerunner, role model or template for later examples to follow, proto defining the earliest or first in time. It is, in this sense, the result of a design process and subject to evaluation after many design decisions. For the purposes of this thesis, this idea of the prototype is less emphasized, and instead it is considered an object of continuous investigation, initiated early on in the process. An important aspect is its *deformability*; it can operate to a certain degree, but it must also be adjustable and refinable. It is not a representation but the real thing; although still malleable it will perform and be subject to assessment. It must set up a design environment as a collaborative space to allow multiple users/designers to probe, interact and develop it. Most important of all, it must not be inert. It is the basis for a design narrative, in which multiple authors can co-create the series of events that push the design further. It can co-exist in and shift between multiple media, and

resembles a *transitional object*, in the sense that it instigates change and development.[28] While the prototype in architecture is often seen as a full-scale model testing materials and technical solutions, the definition comes closer to the working model, independent of scale and media. In order to distinguish the characteristics of the prototype, both in relation to the term prototype as used by other design fields and its relation to the model as used within architecture, definitions of the two will be reviewed.

Jan Capjon suggests an expansion of notion of the prototype into *visiotypes* (modelling of visionary solutions), *negotiotypes* (flexible models for conceptual negotiation between collaborators) and *seriotypes* (test of production series).[29] These categories may originate from the fact that Capjon is active in industrial design and product development, fields in which prototyping is firmly defined as the physical models used to test a design against users or other parameters.

In their book *Product Design and Development* authors Steven Eppinger and Karl Ulrich, present prototypes as frequently classified along two dimensions. The first is the degree to which a prototype is physical or analytical. The physical prototype is a tangible artifact which approximates certain aspects of the product. This could take the form of a proof-of-concept prototype such as a mock-up developed to test an idea quickly, experimental hardware that tests functionality, or simply physical form for customer approval. The analytical prototype allows aspects to be analyzed in other ways than in built form, including computer simulations, coded spreadsheets or digital models such as finite element analysis of structural integrity. The second dimension is whether a prototype is *comprehensive* or *focused*. A comprehensive prototype implements most, or even all, of the attributes of the final product, often in the form of a full-scale fully operational version. A focused prototype explores only a few of the aspects of the product, as in the form of a foam model or a hand built circuit board that tests the performance of electronic hardware. Often, multiple focused prototypes are built to implement various aspects. In the school book example, prototypes are used for four main purposes: *learning*, *communication*, *integration* and *milestone*. The top priority is of course to learn whether the product works as expected. The communication between all participating parties, including top managers, producers and customers is also crucial. The prototype may also integrate various subsystems of the product developed elsewhere, as in test bed, alpha, beta or preproduction prototypes. Within software industries, this can be exemplified in the daily build, in which a new version of the software is compiled every day. The milestone prototypes are key versions that pass certain more rigorous tests, thereby demonstrating progress, and can be the pass or fail of the project all together. The parameters of analytical prototypes are easier to update, and they are therefore often used to narrow down the range of parameters before physical prototyping is implemented. The physical prototype is better at showing unanticipated phenomena that are not related to the objective of the prototype, and can either provide valuable

25 Kolarevic, Branko (ed.), *Architecture in the digital age: design and manufacturing*, Taylor & Francis Ltd, 2005, p.57

26 **http://www.calendarlive.com/printedition/calendar/suncal/cl-ca-fabrication19mar19,0,3423196.story?coll=cl-suncal** 19/3 2006

27 *Architectural Design: Versioning*, vol. 72, issue 5, (September/October 2002), Wiley, 2002, selected articles

28 De Geus, Arie, citing D.W Winnicot, *Playing and Reality* (Routledge 1982), in which Winnicot defined toys as transitional objects that would allow a child to experiment with reality without fear of consequences, helping the child to transit from one level of understanding to another.
De Geus, Arie, *The Living Company: Growth, Learning and Longevity in Business*, Nicholas Brealey Publishing, 1999, p.81

29 Capjon, Jan, *Trial-and-Error-based Innovation; Catalysing Shared Engagement in Design Conceptualisation*, doctoral thesis, Oslo School of Architecture, 2004, p.289

insight, or be irrelevant to the final product because of the use of the wrong materials etc.[30]

Michael Schrage, co-director of the MIT Media Lab's E-Markets Initiative, defines the prototype as a way of "communicating how organizations use media to manage their innovation processes."[31] He further declares prototyping to be a multimedia process in which prototypes are developed in steps. The media chosen has a great effect on the design environment and may even evoke new designs. The prototype both answers and raises questions. It is not the product of a methodical development path; instead it "emerges from interactions around iterations of the prototype".[32] The innovation process does not come up with finished prototypes; the prototypes themselves drive the innovation process. Schrage concludes by asking himself how organizations must change when the prototyping no longer deals only with individual products, processes and services but also with hybrids that raise fundamental questions about the organization itself. This would also apply for architectural research and practice alike, with the development of alternate discourse and methodology.[33] When implemented these issues seems to target the concept of innovation in a way that focuses on a successful marketing of a product and the prototype becomes a placeholder for an idea that a user can hold in her hand and provide feedback on.[34] This approach can also be identified as a general take on this topic within the field of Industrial Design, in which *user oriented development* has been very promoted for a number of years. This is somewhat surprising in relation to the agenda of MIT Media Lab as "enabling technology for learning and expression by people and machines", a quite vague statement that over the years has seen projects emerge which at the time had no known implementation.[35] Always trying to look into fields that are still undeveloped, the Lab has a history of strong affiliation with a number of corporations, but this has still allowed for quite independent work. While the prototype is quite established in the field of Industrial Design, the notions put forward by Schrage in his writing still invoke an unusual approach, in the sense of a starting point with potentials rather than a problem. When shifted into the territory of Architecture this may indicate a project development free of an initial program or specification.

John S. Gero distinguishes prototypes as the first on which others are modeled, relating them to archetypes (the first and often singular of a type) and stereotypes (copies without change). While the meaning of prototype as role model or template is seen as less interesting within the scope of this text, Gero makes other definitions that are more valid here. He suggests that a designed artifact can be broadly interpreted in terms of function, structure and behaviour, but the early stage design prototype may consist of detailed material in only two of these groups. Gero's definition of design as an activity involves exploration of what variables might be appropriate, including goal variables as well as decision variables. Part of this exploration consists of learning about emerging features as the design process unfolds. To allow for designers to begin designing with incomplete information available, he proposes the use of design prototypes as schemas, or frameworks, that can link different aspects relevant to the project, including qualitative, computational and context knowledge as well as constraints. During design development, instances are created from the design prototype, a pruned subset inheriting the structure of the prototype but not all knowledge, allowing for formulation of a design problem at different levels of abstraction. He makes a distinction between routine and innovative design; the former is based completely on existing designs, the latter is nonroutine but developed by manipulating variables, producing work that is still within the boundaries

of a well defined space of potential solutions. A third area, creative design, is defined as non-routine but also establishing new variables, producing new types extending the space of solution and potentially forming a disjoint solution space; a paradigm shift.[36]

Architect and researcher Anders Johansson sets up three important criteria for his definition of the model that makes it especially relevant to discussions of the prototype.[37] It has a "distinct purpose in its use", it "is possible to manipulate over and over again" and it "must be possible to see as a world, and be an entity in its own right". He also states that a model is a (secondary) system that represents another (primary) system, "used when the presentation of the primary system in itself is not available...".[38] An important aspect of the model is that it is accessible and possible to manipulate; it must therefore be developed into an articulated system with internal characteristics. In the case of the architectural model, Johansson assumes that it is created with the purpose of making a change in a physical space (primary system) possible. The model (secondary system) is created initially as a representation of this space. Changes are simulated by manipulation in the model, later implemented in the primary system, requiring a necessary relation between the primary and secondary systems. The model is the laboratory for experimentation, momentarily suspended from reference to the primary system. Johansson also describes the possibility of the process of model construction bringing about a deviation from reproduction of site, resulting in the model being cut off from the represented space, and acquiring the status of a 'work' in itself. This deviation entails that the model must acquire characteristics that make it self sufficient in some aspects, not unlike the performative behavior of the prototype. With a parametric set-up, the prototype may literally act out the characteristics that Johansson in terms of the model in his thesis. A user familiar with the development protocol may engage with the prototype as a working model on a system level, interacting with code or ***advanced parametric modeling software*** ↑ [P.36 | P.66 | P.80 | P.88 | P.100]. A collaborative designer with no specialist skills may use a prepared parametric interface, or simply feed a model via a ***spreadsheet*** ↑ [P. 40]. A non-designer may contribute through well prepared ***user friendly experiential models, operating within the design solution space*** ↑ [P. 96].

Foreign Office Architects suggests a prototypical approach to the exploration of complex material organizations, as opposed to a typological approach which may include a priori claims on validity. They see the prototype as technical and material mediators, mediating information into form, suitable for deployment in alternative conditions. In this sense they do not regard project specific data to be the origin of the organ-

30 Eppinger, Steven & Ulrich, Karl, *Product design and development*, McGraw-Hill, New York, 2008, p.245

31 Schrage, Michael, *Serious Play: How the World's Best Companies Simulate to Innovate*, Harvard Business School Press, 2000, p.7

32 Ibid., p.128

33 *AKAD* is currently defining a discourse around practice-based research, through projects, seminars and articles. **www.akad.se.**
Grillner, Katja and Ståhl, Lars-Henrik, "Developing Practice-based Research in Architecture and Design", *Nordic Journal of Architectural Research*, nr. 1 2003, p.15

34 Workshop with Michael Schrage on *Innovation and Prototyping* at CID/KTH, Stockholm, in November 2004, and a general reading of issues discussed in the *Joining Forces* conference on Design at University of Art and Design in Helsinki in September 2005.

35 **http://www.media.mit.edu/about/research.html** 13/11 2007

36 Gero, John S, "Design Prototypes", *AI Magazine*, Volume 11, 1990, p.26

37 Johansson, Anders, *The Architectural Metaphor: Textual Models in Spatial Construction*, doctoral thesis, the Royal Institute of Technology, Stockholm, 2003, p.235

38 Ibid, p.43

ization of a project, but "the vector of differentiation of the prototype". The prototype itself should be constituted according to a model of internal differentiation, responsiveness and proliferation. It potentially be the vehicle that links otherwise disparate projects together.[39] This suggests the prototype as an archive, which on one hand would deploy a similar starting point into different project contexts, but could also register and be informed by the vectors taken in each specific project in order to provide a development of the practice surrounding it. In order to be continuously relevant and applicable to different contexts, the prototype must also engage the user, in its capacity to build up a world of design criteria, possibilities and effects. *Transitional objects* and *transitional experience*, as introduced by Donald Woods Winnicott, refer to a particular developmental sequence . Winnicott related the concept of the transitional object to a more general one, transitional phenomenon, which he considered to be the basis of science, religion and all of culture. Transitional objects and phenomena, he said, are neither subjective nor objective but partake of both.[40]

The ***prototype as defined through this research project performs in a number of different ways and situations*** ↑ [P.46 | P.52 | P.64 | P.96]. Primarily it gives continuous feedback during the design phase, and the shift between different media allows it to address issues regarding its future operation. The different media enables collaborative effort, but different media protocols can also make this difficult such as in the case of specialist competence in programming. Secondarily, when displayed to a general audience at different stages, ***it must perform in a direct and legible way, not unlike a reactive art piece*** ↑ [P.53 | P.79 | P.89]. In addition, when incorporating new production technologies, the prototype also allows a direct link between the design stage and production, enabling a mode of operation that has been detached from the architectural profession for a long time.

Design Space and Design Narratives for Collaboration

Thomas Leerberg defines *embedded spaces* as the spaces in which the design process takes place, a design space with constraints and opportunities that are undiscovered and unformulated, but still can have a great effect on the parameters and properties of a design product.[41] He suggests that such a space needs to have a specifically constructed structure, which systematizes the design process. Furthermore, he suggests that there are different views on the design process. The operational view is related to the traditional view based on problem solving and optimization of production, referred to by Donald A. Schön as *technical rationality*. The constructive view optimizes the environment in which the design process takes place, with a dynamic interaction between aesthetic, technological, sociological, economic and political aspects, referable to Schön's *Reflection-in-Action*.[42]

Leerberg uses the notion of *design spaces* as defined by Rikard Stankiewicz; a combinatorial space generated by a set of operands, defined as the "structure-function" (or process-function) relationships used in designing and assembling artifacts. Stankiewicz defines four historical regimes of technology to which the evolution of design spaces correspond; the craft regime, the engineering regime, the architectural regime and the research regime. The architectural regime is seen as emerging with the design of complex multifunctional systems such as buildings, urban complexes, large scale software systems and organizations. He also suggests the emergence of a fifth major technological regime, possibly best defined as computational.[43]

The standard collaborative situation involving design teams can be performed in many ways, and while architectural design collaboration may be less developed regarding method, other disciplines have well formulated modes of collaboration such as brain storming, pitching ideas etc. The variants of collaboration are here regarded as integral activities of a participatory design project seen on a micro level in a participatory project. The notions of collaboration and commission are proposed as tools to enable all members within a design team to be aware of their (shifting) role within the process and thereby use their full potential.

If the continuous participatory set-up, in which two or more individuals have an ongoing discussion around a design problem, share the same model or representational tool and make decisions through consensus, could be defined as collaboration by participation, its counterpart would be collaboration by commission. This would entail a variant of the collaborative design process in which one individual temporarily takes on the responsibility to investigate a certain aspect of the design problem. The design team places an order for this investigation, and grants the individual autonomy in making decisions to a certain degree. The "specifications" must be well defined, while allowing the freedom to still include an innovative approach. This approach may be necessary when the design process requires specific skills available only to one team member (such as knowledge of a certain type of software, extensive knowledge of a specific area, being a specialist or being dependant of the use of separate development protocols), but can also be used when this is not the case. In some cases commissions may be given to parties outside of the design team (such as to another design team in a student workshop, or to a consultant with expert skills), but the principles may not differ from the singular team. If a practice defines itself through modes of collaborations, is it already internalizing itself in a way that limits potential modes of (networked) collaboration? Is it relevant to speak about internal modes of collaboration without trying to specify the exact nature of them? If all design practices constantly interact around different modes of collaboration, perhaps it is more important to investigate smaller loops within a complex chain of events, and discrete acts in which interaction between different actors becomes vital. The idea of the commission, even as a local event within an internal collaborative process, entails that two parties agree on an individual development along the lines of a somewhat specified agenda. The participants may research or develop parts of a solution individually, to later reconvene and reassess the new results.

An important obstacle in successful design collaboration is the different agendas, premises and capacities of the collaborating parties, regardless of whether they are part of the same discipline, or in an interdisciplinary constellation. One approach may be process modeling, in which the organizational structure and information flows are visualized, and interfaces between different realms can be defined concerning what kind of information is exchanged. While a major part of the information used by a participating party (such as a company, a particular architect or designer or a specialist) may be considered redundant for other parties, the definition of

39 *Foreign Office Architects*, 2G International Architecture Review, Editorial Gustavo Gili, 2000, p.133

40 **http://en.wikipedia.org/wiki/Transitional_object** 01/09/2007

41 Leerberg, Thomas, *Embedded Spaces*, PhD thesis, The Danish Center for Integrated Design, 2004, p.106

42 Schön, Donald A., *The Reflective Practitioner: How Professionals Think in Action*, Arena Ashgate Publishing, 1996

43 Stankiwewicz, Rikard, "The Concept of Design Space", in Ziman, J., ed., *Technological Innovation as an Evolutionary Process*, Cambridge University Press, 2000

what information is important for the exchange may be crucial. A specialist may clearly define what parameters he/she needs to receive in order to make an adequate analysis or proposal for a particular problem, and a designer may define the range for preferred solutions, but in both cases, there is probably limited knowledge of the characteristics of the redundant information of the other party. The aforementioned BIM principle and its principle of information hiding limit the data available for each party, so that each user only sees the relevant information for his/her purposes. Even more often, each party may have an individual model, from which relevant data is extracted and transported to collaborating parties. In all these cases, a decision has been made as to what specific type of information should be relevant to each individual party.

Fabrication

Fabrication implies in its essence the act of creation. This encompasses the manufacture of physical objects, as well as the fabrication of truth, normally suggesting a falsification of the truth. If fabrication is used for the (new) creation of a unique object, in the sense that it makes use of techniques to produce forms that could not be manufactured before, this can be related to the fabrication of truths, and the production of new meaning. If this is related to the notion of the prototype, as a malleable object/system for participant interaction, the idea of fabrication indicates a speculative approach, in which the temporary belief of the fabricated truths among all participants is essential. Fabrication is also related to fiction, another speculation that we are more prone to enjoy, if not believe, and see as a valuable and relevant resource (particularly as allegorical ways of referring to actual events etc). "Truth is not relative and not subjective, but de-pendant on belonging to the same thought collective." Furthermore, truth is not a convention but rather an event in historical perspective or a stylized thought constraint in its contemporary context.[44] Does this reinforce the importance of sharing the same protocols (for collaboration)?

For the purpose of this text, ***fabrication operates on the level of defining form and materiality, through specific fabrication techniques*** ↑ [P.72 | P.80 | P.102 | P.104]. This implies that while fabrication predominantly exists within the design process, testing aspects of proposals, it also explores issues of production by implementing similar techniques to those used in later production stages. In fact, it has the capacity to conjoin not only the formal and material performance of a proposal, but also the processes of design and production in a quite rare way, potentially allowing for iterative and recursive design processes that blur the borders between these areas. The digital fabrication tools used within other disciplines such as industrial design have been appropriated into a number of architectural practices and educational curricula over the past 15 years or so. The term used frequently in other design fields is rapid prototyping; this cannot easily be applied within architecture, often due to scale and material differences. Can digital fabrication tools link issues of esthetic and performative exploration in architectural design and issues of production along the lines of mass-customization? Can fabrication as speculation also be related to figments as defined by van Berkel/Bos? While production also connotes the making of objects, or even literature and art, it is so closely related to economic systems and the regularly manufactured, that is the mass produced. In a time where mass-production is being challenged by mass customization, the meaning of production may shift towards the production of variation, if for no other reason than to attempt to define two separate but related fields. Fabrication is the act of design and manufacture of unique

parts. Production involves more complex processes in its logistics and relates to market as well as more diverse contexts. If conjoined, fabrication may be at the core of initial development, linking the concept with formal qualities and materializations, with prototypes still being very malleable. Fabrication is a small step towards realization, taking advantage of conclusions from several iterations of prototypes, and also feeding back information from the production process into future iterations of fabrications (in a version-like manner).

The *Manufacturing Material Effect* symposium at Ball State University included participants from Europe and the US.[45] The two day event was of particular interest since the speakers represented computational specialists, architectural designers with an interest in aesthetic discourse, and to certain extents, fabricators and industrialists working with pragmatic issues of large scale production. The presentations suggested that, while many practitioners who over the past decade have been primarily based in teaching and experimental design featured in exhibitions now are shifting into market dependant practice, there was also a strong demand for a renewed discourse for design and aesthetics, one that would be less dependent on theory or philosophy and more focused on formal aspects of articulation. In smaller firms, this discourse is strongly linked to experiments with digital systems linked to material qualities, as well as production principles, building a research that includes both formal agendas and pragmatic skills of production. At the same time, there is a lot of work produced in full scale primarily motivated by the fact that it was possible to build, at best testing new design and production techniques, but rarely discussed critically for its architectural qualities, or how it was conceived and developed during its design process management. Along these lines, the issue of difficulty was brought forward. It was suggested that previous architectural experiments were in a sense conducted because they were difficult, with new technologies employed in order to design and fabricate what was not realizable before. In contrast, the issue today would be to design architecture that is difficult to perceive, with effects that are vague and complex and that remains always partly incomprehensible, but inherently affect a visitor and gives a strong experience.[46]
As digital practices linked to fabrication and production are maturing, it is inevitable that the field of research is expanding, or at least shifting, and while small-scale projects in could be fully controlled in all its aspects, large-scale projects face new problems, the solutions of which seem to legitimize them as research, or at least successful experiments. While the symposium put the spotlight on manufacturing, materiality and effect in its theme, the conversations that arose in panels and presentations often dealt with either the digital techniques at the foundation of these matters, or the processes that are part of this kind of production, in particular the interactions between designers and producers. This is again a sign of the times, as a previously academic and experimental practice of architecture primarily working out of universities and dependent on good will fabrication among producers, now are facing commercially active producers that manage to establish viable business models and thereby affordable new lines of products.

44 Latour, Bruno, *Reassembling the Social: An Introduction to Actor-Network-Theory*, Oxford University Press, 2005, p.113
45 *Manufacturing Material Effects*, conference at Ball State University, Indianapolis, attended by author, April 2007
46 Ibid, remarks by former Servo partner David Erdman.

Mass Customization

Joseph Pine, one of the first inventors of the term *mass customization* defines mass-production as having the goal to develop, produce, market, and deliver goods and services at prices so low that nearly everyone can afford them. Mass customization on the other hand, has the goal to develop, produce, market, and deliver "affordable goods and services with enough variety and customization that nearly everyone finds exactly what they want". The integration of technological innovation plays a vital role in this paradigm. Mass customization is the synthesis of two management systems in the mass-production of individually customized goods and services, an integration that allows for production at prices that approach and sometimes beat those of mass producers. The integration of embedded intelligence through microprocessors allows for increased adaptability of products and can reinforce greater variety and shorter development cycles. The use of new process technologies such as adaptable manufacturing systems and computer integrated manufacturing techniques makes it increasingly economical to produce great variety. Among the relevant customer demand factors are basic necessities versus complete luxuries, easily defined versus uncertain customer needs/wants, homogenous versus heterogeneous demand and rate of change in customer needs /wants. This is also suggested in the preface to Pine's treatise on mass customization, in which a number of dichotomies are considered to be false; strategy versus operations, cost versus quality, centralized versus decentralized as well as parts versus whole.[47]

Mario Carpo speaks of an alliance between "artisanal (pre-mechanical) and digital (post-mechanical) technologies", exemplified in the work of Shoei Yoh. Manual production is foreign to economies of scale, since each single object would come at the same price regardless if it was one of a thousand identical copies, or unique in form. If digital production technologies are used to their fullest extents, standardization becomes obsolete, as each single object may as well be unique. Economies of scope are conceptually similar to economies of scale, but focus on the demand side rather than supply side, which emphasizes differentiation in product, but also marketing and distribution. The latter is a mode of production frequently associated with mass customization, in which one process may produce variations of products. The ***solution space*** ↑ [P. 40] is a central concept within design and production of mass customized objects, meaning the complete range of possible outcomes of a specific process.[48] Carpo further develops the ideas on variations and economies of scope in his text for the 2004 Architecture Biennale in Venice, in which he discusses the identity of mass customized objects. While a digital formalism may have emerged based on curved surfaces and complex geometries, Carpo claims that the most significant aspect of new modes of fabrication is the difference between each object. Also referring to the notion of the non standard, he emphasizes that these ideas should be more linked to a ***mode of production than a formal principle*** ↑ [P.34 | P.80 | P.96 | P.102]. Referring to the objectile paradigm of Deleuze, he suggests that the non-standard products are different, but within certain limits.[49] While the current effect of these limits from the machines for production may be considered temporary, and may gradually disappear as the machines become more versatile, the actual computer programming that would control these machines may be more conditional on this development, in the sense that the products of a non-standard series may be recognizable as part of the same family. In this way Carpo suggests that new standards of digital production "are not based on identical reproduction of visual forms but rather on the transmission of invisible algorithms". He regards this as a return to a pre-

standardization time, in which we recognized similarities rather than "identicalities". The search for similarities was a skill of pattern recognition that allowed us to place the same meaning on signs that had something in common. Carpo proposes that we may once again have to learn how to recognize the similarities, analogies and visual approximations of the past and forget the "cult of identicality" that has perpetuated the cultural industry. Carpo's conclusion is that perception and identity in architecture will no longer be a mechanical operation, as we have identified repetitive forms or messages, such as commercial logos, but rather "an organic extension of human intelligence" in the sense that we will again depend on our ability to recognize diffuse patterns to navigate our environment.[50]

Remediation

Bolter and Grusin argue that *remediation*, or the repurposing of media, is not a new phenomenon, although digital media's reusing and changing characteristics of traditional ones has made it more obvious. They see the term remediation as a way to complicate the act of repurposing, which implies the reuse of content in another media. This can be exemplified by the entertainment industries' habit of making a movie from a book, or transforming a printed encyclopaedia to CD-ROM, both in which the new medium provides new potential, but not necessaily a conscious interplay between the media. Remediation is a continuous exchange between different media, which affects both an older andnewer one. In the representation of one media in another, an older medium might be highlighted and represented uncritically in digital form, as in the case of making collections of historical texts or images available to the public. A new medium may also absorb the old entirely, such as the CG effects of recent Hollywood productions, which aims at making the newer computer graphics medium vanish inside the film medium.[51]

Remediation can also be seen as an act of reformation.[52] In this sense one media can also reform an older one, giving it more potential and making it more permanent rather than obsolete, such as the effect of the VCR on the TV.[53] *Immediacy* is a principle of remediation in which the medium in itself becomes transparent, making the viewer forget that the experience is mediated by being completely immersed. *Hypermediacy* on the other hand is defined as making the use of multiple media obvious, often with annotation or collages of simultaneous representations, allowing for understanding rather than experience. Important definitions of media such as *hot* and *cool media* have been given by Marshall McLuhan. A hot media, exemplified by a movie, has a high definition filled with data and demands little processing by its receiver. A cool media, such as a comic strip, has little information and the receiver needs to add information to make it legible and give it effect. He also suggested that an older media may become the

47 Pine II, B Joseph, *Mass Customization: The New Frontier in Business Competition*, Harvard Business School Press, 1993, p.48

48 Carpo, Mario, "Ten years of folding", *Architectural design: Folding in Architecture* vol. 63(1993):3/4, Wiley, 2004 reprint, p.17

49 Deleuze, Gilles, *the Fold: Leibniz and the Baroque*, The Athlone Press Ltd, 1993, p.19

50 Carpo, Mario, "Pattern Recognition", *Metamorph*, exhibition catalogue for the 9th International Architecture Exhibition, Fondazione La Biennale di Venezia, 2004, p.44

51 Bolter, David Jay and Grusin, Richard, *Remediation: Understanding New Media*, The MIT Press, 2000

52 *Remediation* is also the removal of pollution or contami nants from land (including sediments in waterways) for the general protection of the environment or, quite commonly, from a brownfield site so that it can be reused. **http://en.wikipedia.org/wiki/Remediation** 25.10.2005

53 Bolter and Grusin here cite Paul Levinson, who in *The Soft Edge* (Routledge 1997) proposes that the remediation of media is a progressive development in which media tech nology step by step becomes more "human".

content of a newer media, in the sense that we cannot understand the properties of the former until it fades out and is replaced by a newer.[54]

N. Katherine Hayles adheres to the definitions of remediation stated by Bolter and Grusin in her book *Writing Machines*.[55] The title alludes however to the "multiple ways in which writing and materiality come together". As a theorist of media, technology and literature, she refers to the inscription technologies used to produce text, including printing presses and computers, but she also refers to the structures that make the materiality of the texts visible and addressable by a reader. Her definition *technotext* is related to hypertext, with the three characteristics of multiple reading paths, chunked text and linking mechanism. The obvious example is the World Wide Web, a vast hypertext, but Hayles also looks at hypertextual characteristics in print. While proposing media specific analyses, with an awareness of the qualities of each specific media, she suggests that all media is constantly engaged in a recursive dynamic of imitating each other. This has become very apparent in the emergence of hyperliterature, with examples of printed texts imitating the hyperlinked performance of electronic media.

Hayles identifies media that acquires material qualities, exemplified with the book *A Humument* by Tom Phillips.[56] This artist book is an adaptation of an obscure novel by William Mallock; *A Human Document*.[57] Philips treated the physical book, page by page covering most of the words, re-inscribing it with a new narrative. The text is used as a source for new text and images, transcribed over the original text. In *A Humument* each page becomes extremely visible, it never becomes a portal or achieves aspects of immediacy, and Phillips treatment allows the medium to acquire material qualities. Phillips regards the original book as an "inexhaustible hypertext", with many possible iterations, and imagined that in a series of *A Humument* each new copy could have a number of pages treated in an alternate way, eventually resulting in a completely different version.[58]

Comparing the presence of inscription technologies in literature to the representational modes of operation within architecture, it is important to note how these are operational, through the drawing, the model and projection. They imply an active, transitative condition, negotiating the gap between ideas and material, allowing the architect to transform reality by indirect means. In a way, they have always included ***aspects of remediation through the translations between drawing and building, although the critical approach to these tools of the trade may have been weak*** ↑ [P.28 | P.32 | P.46]. The architectural representation may be considered to have hypermediacy characteristics, in the way that a user (trained and critical architect) can clearly identify the format, and in the way that multiple media must be used to give the full information of a project. If the architectural representation is understood as a design environment however, it can achieve immersive qualities, in the way that the trained architect or designer can experience the projected proposal. In this sense it also gains material characteristics. Compared to the inscription technologies defined by Hayles, the architectural design environment, especially in the digital age, is dependent on a collaborative communication circuit, and is fused with a consciousness in the way that the tools used do affect the result produced. While architectural notational systems were developed to allow collaboration in the building of complex projects, they also establish the design environments and protocols that allow multiple authors to participate in the design. The act of remediation in architectural design is further developed with the introduction of multiple prototypes that operate in parallel, requiring a transfer of infor-

mation between different media such as ***digital surface modeling, parametric design models, behavioral simulation software and physical prototyping*** ↑ [P. 64]. The interfaces between these prototypes, or the different disciplines sharing a Building Information Model, may have to operate both on a level of immersion (experiencing the proposal or parts of it) and hypermediacy (to a certain extent understanding the conditions and prerequisites of a particular solution). A well-developed interface for a parametric system as part of a prototype may shift between data-driven hypermediated elements such as ***spreadsheets of data*** ↑ [P. 40] and design environments where ***experiential effects are an important part of the parametric set-up*** ↑ [P.92 | P. 96].

Formal Strategies

The introduction of the notion of *elegance* expands on a previous discourse on architectural effect and affect that has evolved in different contexts. John Rajchman elaborates on the relation of these terms to new architectural form, as informed by digital tools and defined as *other geometries*, in which he sees the *effective* and the *affective* as two spatial dispositions. The first tries to "insert movements, figures, stories and activities into some larger organization that predates and survives them". The second "seeks to release figures or movements from any such organization, allowing them to go off on unexpected paths or relate to one another in undetermined ways". He argues that any constructed space reveals a tension between the two dispositions, with the only difference of which one we put first.[59] Tracing the geometry of an affective space back to "geometries of becoming" from mathematical foundations in Alfred North Whitehead, through Alan Turing and artificial intelligence to recent architectural speculation on complex systems and self-organization, Rajchman identifies the interest in dynamic and emergent properties rather than fixed, static or calculated effects. He argues that there is an operative formalism, which focuses on what forms can do, rather than what they mean or represent. This would require a less systematic spatial construction, with forms that are "more singular, more original, free to behave in other, less predictable ways or affect us along other, less direct lines".[60] When posing the question of how to introduce this anorganized and complex space into building, it is apparent that Rajchman is interested in the processes that could enable and create affective space, as well as the experience of being affected. Sylvia Lavin introduces a potential *Contemporary Mood* in her short contribution in the Latent Utopias exhibition catalogue. She claims that architects today, in order to be innovative, or rather to be an architect of today and to teach students of architecture, the discipline itself must "relinquish its nostalgic modernity and get contemporary". She quotes a 1954 copy of Architectural Record that asks why a modern house needs a flat roof, glass walls or exposed structure, and suggests that it may have a Victorian curve or two. She looks at special and everyday effects, and compares these to contemporaneity and modernity, in which the former have a shelf life and are especially vivid, while the latter, as in the work of Mies van der Rohe, operate

54 McLuhan, Marshall, *Understanding Media: The Extensions of Man*, 1st Ed. McGraw Hill, NY 1964; reissued by Gingko Press, 2003

55 Hayles, N. Katherine, *Writing Machines*, MIT Press Media work Pamphlet Series, 2002

56 Phillips, Tom, *A Humument*, Tetrad Press, 1980

57 Mallock, W H, *A Human Document*, Chapman and Hall, 1892

58 Phillips, Tom, *A Humument*, Thames and Hudson Ltd, 2005
In the latest edition of the book over half the pages from the 1980 edition have been replaced.

59 Rajchman, John, *Constructions*, Writing Architecture series, MIT Press, 1997, p.92

60 Ibid., p.104

with atmospheres of the modern, but most of all as all-over effects with little differentiation from zone to zone and surface to surface. "There are no Miesian special effects", Lavin claims.[61]

Greg Lynn suggests that there is an "emerging sensibility of intricacy" among artists, designers and architects, in which the terms implies compositions of small scale and diverse elements. Disparate elements are fused into continuity, while components can be identified as parts of a whole. "Detail is everywhere", and not discrete and concentrated into an isolated instance, rather intricacy occurs where macro- and micro-scales are intertwined. Lynn claims that visual sensibility emerges from technique rather than figuration or content, with no reliance on material properties.[62]

In the *Elegance* issue of Architectural Design, Ali Rahim defines Elegance as the result of processes that are not only rigorous in technique, but are also handled by very capable designers with a strong aesthetic sensibility. Other important aspects include the relationship between the part to the whole, argued to be seen as seamless, and interior as a driver for the exterior, where internal organization and bodily sensation are being transformed but not compromised by external conditions. According to Rahim, elegance is a pure aesthetic aspect of building, which has little relation to program or function, or even materiality, but is highly dependent on individual design sensibility and a developed formal discourse. An important concept is affect, which also occurs in related discourses. To Rahim Affects are defined as the capacity both to affect and be affected, whereas effect implies a one-way direction of causality.[63] In the same AD issue, Manuel DeLanda brings up ***Material Elegance*** ↑ [P. 46 | P.104], with a starting point in material optimization and its origins in the 17th century, through Euler's calculus, to the establishment of a nearly aesthetic approach to nature, in which simplicity becomes the prevailing concept. As a concept of material elegance, simplicity represents "an economy of means in the achievement of conceptual goals", but DeLanda emphasizes the damage that another aspect of the concept has put forward. Here, simplicity means familiarity, and results in the use of methods of calculation that are simple to use because they are known, rather than how they are constituted. Alternate studies shows a much more complex situation, in which solutions space (or phase space) of equations could have several optima, shown by Poincaré at the end of the 19th century. When multiple attractors operate within these models, the result becomes probabilistic despite the fact that each attractor in itself is deterministic, and this is, according to DeLanda, the topological source for elegance in material processes. He exemplifies natural processes of elegance in the classic example of the forming of the soap bubble (with minimum surface tension) and the forming of crystals (with minimum bonding energy), and artificial one with Frei Otto's form-finding operations and ***algorithmic genetic algorithms*** ↑ [P. 76], that may have a usefulness at multiple scales.[64]

Manuel DeLanda distinguishes elegance as the result of automated processes, and distances himself from the designer. The relationship (or dichotomy) of form-finding processes and parametrically informed design decisions are difficult to identify, but in those examples in which both occur, perhaps one always contributes to the definition of the solution space (phase space) of the other? This may also provide an opening for making connections between optimizing adaptable processes within the building industry, parametric design skill and sensibility, and (aesthetic) discourse.

In *Arguing for Elegance*, Patrik Schumacher claims that Elegance has "an unquestioned value

of immediate appeal" and needs no argument for existence. Still, he looks for and identifies purposes beyond itself, in particular regarding capacities to improve orientation within complex organizations. Schumacher ties Elegance to inflection, in the sense that layers and subsystems within a system are mutually inflected, in which a new part will affect the whole, and be inflected in itself. According to this definition additive procedures cannot achieve elegance. Considering the contemporary situation a time of refinement of concepts, he emphasizes the operation of elegance in the development of large scale buildings, in which the "social complexity" of an organization must be translated into the "spatial complexity of an architectural complex". Here, "elegance facilitates orientation within a spatial complex arrangement and thus ensures the legibility of a complex social formation. Again, elegance articulates complexity. And the articulation of complexity prevents perplexity." He identifies two separate lineages of innovative practices, one that follows their innovation into a mainstream production and adaptation into the market, the other remains in the "domain of the avant-garde" and continues to explore new ideas. He traces a linage of development of "computing elegance" and the concepts that have followed it. Coherence, pliancy and intricacy were compositional ambitions that could be fulfilled by surface modeling, space frames have been used to add structure that enables continuous deformations, but are all parts of a conceptual development with few physical manifestations. In large-scale realization, elegance becomes a priority, with "demands of geometric lawfulness, precision and high-order surface continuity" as important concerns. He outlines a "design trajectory" that unfolds during design development, in which the network of compositional relations is elaborated and tightened, in time becoming self-constraining and almost self determining.[65]

Schumacher refers to the built project, and how elegance is clarifying complex situations within it, but he also identifies issues emerging during project development. The emphasis on process has diminished the past years, and is even sometimes actively rejected. Through the experiences of the Phaeno centre, Schumacher is able to acknowledge a new generation of processes, that are not argumentative or justifying, but rather facilitating project development from concept to built structure.[66] This brings conceptual design with specific aesthetic ambitions into the realm of professional project development, and potentially also system development, which puts demands of management and logistics not only for production issues, but also design processes.

Each new concept, such as ***Affect or Elegance*** ↑ [P. 8], is in this context elaborating on the same discourse, a narrowed down part of the aesthetic aspects of architecture, linked to certain modes of working. In general it shifts between advocating and justifying this field of operation within design, and exploring new aesthetic territories. In its best moments, glimpses of something are given, at other times it is the steady beat of arguments for the already invented/discovered, but still in the process of being elaborated. The

61 Lavin, Sylvia , "In a contemporary mood", Hadid, Zaha and Schumacher, Patrik (eds.), *Latent Utopias: Experiments in Contemporary Architecture*, Exhibition Catalogue, Steirischer Herbst, 2002, p.46

62 Lynn, Greg, "Intricacy", prepared on the occasion of the exhibition *Intricacy*, institute of contemporary art, university of Pennsylvania, 2003

63 Rahim, Ali and Jamelle, Hina, "Elegance in the Age of Digital Technique", *Architectural Design: Elegance*, vol. 77, issue 1, (January/February 2007), Wiley, 2007, p.6

64 DeLanda, Manuel, "Material Elegance", *Architectural Design: Elegance*, vol. 77, issue 1, (January/February 2007), Wiley, 2007, p.18

65 Schumacher, Patrik, "Arguing for Elegance", *Architectural Design: Elegance*, vol. 77, issue 1, (January/February 2007), Wiley, 2007, p.28

66 *Zaha Hadid Architects*, Lead Designer Christos Passos, Phaeno Science Centre, Wolfsburg, Germany, 2005

development of such concepts as effect, affect and elegance, similar to the issues of methods and processes discussed previously, lingers between the argumentative/justifying and the projective when appended to digital design. In many ways, there seems to be a pursuit of new definitions, as drivers of discourse, while there is little exact discussion of particular design approaches among the usual suspects. The most interesting arguments arise when the projects encounter resistances from outside the discourse, as in experiences from the Phaeno project. While the emphasis on experiential affects/effects of the various projects that filter through the discourse is very interesting, it seems to potentially link to other discourses that earlier were set in opposition to digital practice, such as an architectural approach with a foundation in phenomenology. Great interest is now given to the experiential effect, exemplified in the collaboration between architectural firms like GL Form or Xefirotarch with Imaginary Forces, a media company working on movies like *Minority Report* (2002) and *Transformers* (2007). This would suggest a potential overlap with architects traditionally associated with very material and pragmatic practice, such as Stephen Holl or Peter Zumthor. Perhaps there is a difference in experiential kind. While the mentioned architects affiliated with phenomenology have a strong interest in experiences dealing with tactile and sensory qualities of spaces and material, they are perhaps also retaining a minimalist approach, looking for subtle and minute effects. The digital practices, as their associates in the experience industry, may be more interested in fantastic experiences, and special effects. Still, a future discourse may be informed with crossovers between today's disparate schools of architecture.

On another note, UN Studio emphasizes the need to know, calculate and direct effects in order to make an architecture that is truly utilitarian. Effects are seen as the manifestation of phenomena, including sensory experience of the external world, fantasies and ideas, and experiences of emotion and affect. New effects within architecture are contributing new understandings of time and space, and that scientific imagination can be applied practically within architecture through the invention of new techniques. Employing geometrical models such as the moebius strip or the klein bottle, UN Studio defines architectural effects as dependant on the orientability of spatial organizations. In the *Move* series, the volume on *Effects* concludes the trilogy with the previous chapters of *Imagination* and *Techniques*.[67]

I believe that these concepts would have more potential when informed with content that is often considered separated from the current discourses on formal effects. As identified by UN Studio and Patrik Schumacher, the formal effects of a building may be very utilitarian in the sense of orientation and legibility. Formal expression as brand identity is of course very accepted and refined in the product design and development today, but it is also becoming strongly linked to performance in the sense of behavior. A clear example is the Iphone, a product with an alluring affect that makes it a successful product in markets it has not even been introduced to. European customers buy their copy in the US and have to hack it to make it usable in their home countries. Boasting a unique user interface, it opens up a new interest in the underlying performance of products, with a strong link to its formal design. In a similar way, a stronger tie between the formal/aesthetic and performative aspects of architecture such as structural innovation, programmatic adequacy or responsive user interaction may make the arguments for a more affective architecture stronger, and provide a physical en-vironment that can fuse the experience of everyday life with aspects of the fantastic and effectual.

Another field which is yet unexplored is the importance of experiential effects during design development. Again, this could be argued to be a lineage in the practices associated with phenomenology, where material properties of models or drawings are considered vital for the design process. While I believe that there is a considerable difference between material performance in models of different scales, and that mannerist drawings are more myth-making well performing techniques, I do recognize the need for aesthetic performance during the design process. Again, the prototype is here considered to depend on those qualities in order to entice the developer and allow adequate decisions on its performance. To certain extents, especially in regards to collaborative projects, an important part of the work when the prototype is set up is to make it ***navigational, legible and experiential in a way that invites all participants to interact*** ↑ [P.86 | P.96].

67 van Berkel, Ben and Bos, Caroline, *Move 3: Effects, radiant synthetic*, UN Studio & Goose Press, 1999

Prototypes of Practice

A projective practice suggests the will to project something (new) into reality, to change the conditions in which the practice itself is operating. In order to accomplish this, a practice must be equipped with tools to understand this reality and its cultural, social and economic aspects. There must also be methods to process this information, capacity to formulate and conceptualize an agenda and means to develop and realize proposals that can alter pre-existing conditions. A performative aspect in architectural practice suggests a focus not on the meaning of a building, text or drawing, but on what it can do and "how it operates in – and on – the world".[68] Critical architecture has been defined as resistant to dominant cultural operations and distanced from prevailing formal standards.[69]

This text will look into particular fields of projective, performative and critical architecture, allowing specific readings of specific contexts. It will establish links and associations between projective practices and strategies for digital design, fabrication, system development and networking, tapping into a discourse of practice as well as pragmatic innovation within the build ing industry. The introduction to the Latent Utopias exhibition catalogue states that the architectural profession today is required to experiment, because of new concepts of space linked to digital technologies, the "proto-architecture" that emerges from these experiments meets reality through the interaction and "creative appropriation" of its audiences. The authors consider the critical practices of the late 20th century to be driven by a principle of negativity, with concepts such as de-construction, dis-location, decoding and de-territorializing operating as a "creative destruction" in their attempts to articulate the Zeitgeist. The authors Patrik Schumacher and Zaha Hadid argue that the projects presented in this way claim no utopian meaning, but rather pose questions with no answers given, and define this as intervention research.[70]

This is indeed an interesting mode of experimental operation, but as with all experiments, it requires testing, if not of its thesis, perhaps of its latent potentials. While the argument is that this is achieved in the interaction from the audience, it is questionable if this is enough, if it can be documented, and how it actually affects the next developed project. If compared to art criticism, is it the architectural discourse accompanying this body of work that accomplishes this? The discourse driven by these types of projects has primarily been internal to its peers for the past decade, but has been opened up in the discussion of the post-critical presented later.

Discourse of Practice

The positions and responses to the "post-critical" approach presented are regarded a constructive material for a very important contemporary discussion. This may lead to alternate readings of the objective in these articles, but the aim here is to identify and pursue important issues and concepts that are useful to aims of this thesis; to find links and opportunities between the so far quite separated paths unfolding within experimental practice, culture and the building industry. While the death of theory is most likely over rated, there is no question to my mind that conditions for practice have changed significantly, and that the provocations posed by different parties have brought up many issues that may not have surfaced otherwise. The various responses also tie issues previously separated closer together into what may be seen as an intricate web of relations between theories, discourses,

practices and resistance, projection and innovation. In many cases, initial provocative statements also have urged respondents to more clearly define their reading of certain related concepts, allowing for multiple yet in depth readings of a number of important definitions.

A discourse of practice can be understood in at least two quite different ways. It can be seen as a part of theoretical discourse that interests itself in practice, be it projective, critical, performative or other modes. The purpose is then to make use of issues of practice in the continued development of an architectural theory. It can also be discussed as a discourse on practice in that seeks to develop and re-evaluate how practice is performed. This could be related to management science, or any of a number of fields in business and economy that so far has eluded the traditional architectural practice. In the exchanges around the issues of post-criticality these two distinctions are sometimes blurred. This may enable a double reading, in which the two inform each other, but risks misunderstandings and ill informed criticism. At present, there is no strong discourse that manages to merge the two, or at least make one more relevant to the other. Hopefully, the discussion on this material may provide a platform for the establishment of future exchanges along those lines.

The Projective Practice

What aspects are crucial in a projective practice? If the basic premise for such a practice is to be able to continuously propose alternate architectural solutions that are different and better than those developed by competing practices, there must be a working method within such a practice that supports and encourages innovation. There are numerous fields that can be addressed as the target of innovative architecture, but perhaps it is still possible on a general level to define a number of key features that must be integrated in the inner workings and management of the projective practice. There must be mechanisms that allow and promote experiment and evaluation within the daily work, as well as identification evaluation of important findings, in relation to the tasks at hand, but also as part of a long term strategy. The projective practice should also actively take part in the transformation of the field of architectural practice in general, by communicating and disseminating its findings in different venues.

The reframing and reformulation of design problems can be related to the development of systems to respond to various design problems, in the sense that a meta-level of design development has to be developed. Current tendencies to develop industrialized systems for design, production, assembly and management of buildings are slowly turning away from standardization and prefabrication of building parts, with the architect providing architectural design as varnish, to the establishment of learning organization in which architects and other collaborating outside partners are continuously contributing to new solutions, but also new re-evaluations of the context in which they are deployed. These "practices" need to take on the characteristics of the intelligence agency, while retaining and refining the rationality of production. These initiatives come from a purely economical standpoint of cutting costs, but have been upgraded through the realization that brand value is

68 Allen, Stan, "Introduction: practice vs. project", in *Practice: architecture, technique and representation*, G+B Arts International, 2000, p.XXV

69 Hays, K Michael, "Critical Architecture: Between Culture and Form", *Perspecta 21*, MIT Press, 1984, p.14

70 Hadid, Zaha and Schumacher, Patrik, *Latent Utopias: Experiments in Contemporary Architecture*, Exhibition Catalogue, Steirischer Herbst, 2002, p.7

important even in the building industry, and the capacity of architecture is recognized to provide this.[71]

Further development along these lines entails new *research & development* constellations, in which the working modes around prototypes may be adopted on various levels, providing a simultaneous simulation of innovations along with design and configuration of known system parts. The product of such collaborations may involve concept buildings, innovations in smaller scale such as building components as well as the continuous development of the management framework, through iterations of design. While the contemporary view on system development, as the one within major contractors, is aimed at finding solutions on a general level, to be applied in specific building projects with few modifications, there may also be a need for system development to be performed as part of the specific project. This could entail the development of parametric design systems, based on innovations made previously, but customized for the particular project.

If the architect in these collaborations can reformulate the given design problems, does that imply that there must be/may be an intentional "hidden agenda" of an architectural practice (or in a specific project) that deploys strategies in order to achieve goals outside the scope of the contractor or client? Can this be a "new resistance", or a proactive way to operate within the marketplace in which these strategies can co-exist with the needs of the client?

While the focus in Donald Schön's studies on *reflection-in-action* is on the individual, special circumstances arise when he looks at reflection-in-action for the manager, who reflects on the phenomena of organizational life. The stage for his activity and the object of his inquiry, organizations are "repositories of cumulative built-up knowledge: principles and maxims of practice, images of mission and identity, facts about the task environment, techniques of operation and stories of past experience. The organizational structure itself may promote or inhibit reflection-in-action.[72] Managers function as agents of organizational learning within a system that both guides and limits the directions of organizational inquiry that risks becoming immune to reflection-in-action. Problems that arise may not be openly discussed due to the inability to formulate the issues involved.

The Performative Practice

A *performative utterance* is defined as being part of a certain kind of action, such as a command ("go!"), a promise ("I do" in a marriage ceremony) or the action of naming ("I name this ship the Queen Elizabeth").[73] The purpose of these sentences is not to say something, but to perform a certain kind of action. This suggests that the work of a performative practice is not commenting, but rather induces action through its architectural proposals. Stan Allen suggests that the architectural project is used as a framework for the performative practice, in order to explore interests and concerns of the particular practice. He suggests that the performative practice would continuously rework the limits of the discipline from within. Rather than seeing the project as a static construct in which theories could be tested, the practice moves towards performance, where consequences and effects are the most valuable. Allen states that practice is no static construct, but is rather defined by its movements and trajectories. "There is no theory, there is no practice. There are only practices, which consist of action and agency". Any act that brings up new ideas or sets up scenarios which impact cultural environments is actually a component of the practice. Maybe we lack forums for these

actions. As Allen claims, "architecture is a material practice, working in and among the world of things", able to transform reality through a mix between the real and the abstract. If a project is a construct, defined from a client's brief, transformed by the idea of the architect, it should be re-appropriated by the architect as a vehicle for all aspects of the specific practice, and the built proposal will remain a component of a larger context. Issues outside the project as defined by the client are encapsulated, thereby expanding the scope of the project in the minds of the architects, and becoming part of the proposal.[74] The notion of the ***performative may also be at play inside the design process, if the basis for development entails the establishment of systematic design models in the form of parametric systems or prototypes*** ↑ [P.12 | P.46 | P.56 | P.64 | P.88 | P.96]. In this case, the performance is not affecting the context outside the environment in which a design is conceived, but rather gives feedback on particular design actions, suggesting a more contextual effect at a later stage. Robert Somol defines design as an instrumental process which is capable of "instigating new demands and desires from interested parties, and may even fold unexpected players into the mix".[75] He suggests that the shift from a critical to a projective practice maximizes the potential for a contemporary architecture of doing, in the sense of issuing performatives that are not descriptions of the world, but rather prescribe how the world should be. In this sense they are not scientific, but rather political, and do not record facts, but project desire. In this perspective, Somol introduces the idea of a fan base linked to the performative practice, produced through the fabrication of audiences, rather than designing for a given public. The performative project operates in the public, reforming its contexts by introducing new ideas, but will ultimately depend on being appreciated by the public.

The Critical Practice

In 1984 Michael Hays outlined a *critical architecture* as "resistant to the self-confirming, conciliatory operations of a dominant culture and yet irreducible to a purely formal structure disengaged from the contingencies of place and time". He situates critical architecture between the representation of preexisting cultural values and the autonomy of an abstract formal system; defining a critical realm between culture and form. He uses projects by Mies van der Rohe that he describes as critical, resistant and oppositional, in the sense that they cannot be reduced either to representations of outside forces or to a dogmatic reproducible formal system. Hays means that Mies had the objective of distinguishing architecture from the forces that influence it; conditions established by market, by taste, the personal aspirations of its author, its technical origins and its purpose according to tradition. This required the positioning between culture (of ideas) and form (free of circumstance), and the establishment of an autonomous architecture. Hays argues for a critical architecture, similar to Mies, that achieves a resistant author-

71 This is supported by my personal experiences from industrial initiatives and system development for *Skanska Teknik*.

72 Schön, Donald A., *The Reflective Practitioner: How Professionals Think in Action*, Arena Ashgate Publishing, 1996, p.242

73 The notion of *performative utterances* was introduced by John Langshaw Austin in his 1946 paper "Other minds" Austin, J.L. (Urmson, J.O. & Warnock, G.J. eds.), *Philosophical Papers*, Oxford University Press, (Oxford), 1961 [Originally published in 1946]. **http://en.wikipedia.org/wiki/Performative, http://en.wikipedia.org/wiki/J._L._Austin** 10/11 2007

74 Allen, Stan, "Introduction: practice vs. project", in *Practice: architecture, technique and representation*, G+B Arts International, 2000, p.XVII

75 Somol, Robert: "Indifferent Urbanism: Graphic Standards and Urban Norms", workshop paper presented at *Holcim Forum 2007*, **http://www.holcimfoundation.org/Portals/1/docs/ F07/WK-Norm/F07-WK-Norm-somol02.pdf** 8/06 2008

ity that "can resist the authority of culture, stand against the generality of habit and the generality of nostalgic memory, and still have a very pre-cise intention". A direct quote from Mies suggests relations between processes and form: "We refuse to recognize problems of form, but only problems of building. Form is not the aim of our work, but only the result. Form by itself does not exist. Form as an aim is formalism; and that we reject". On the other hand, Hays claims that "Mies' architecture conceals the real origins of its formation by displacing them with a material substitute – an irreducibly architectural object. It effectively cancels the complex network of colliding forces in which architecture originates to present us with the silent fact of its existence".[76]

It may seem that it is the built form and its effects that are crucial, and that critical architecture would operate through a "culturally informed product", the proposed building. This brings about an important conflict in the contemporary discussion, that of process and result. If the projective, performative practice is adapting to its context, and works with the flow of capital, is not the understanding of process crucial? Yet again, in the discussion of contemporary architecture, there is a tendency to focus on the result, and its performance.

Exchanges on Post-Criticality

The past five years have seen a lively, predominantly American, discussion on the role of theory and practice, and the critical or projective practice. A series of exchanges have surface in a number of publications and lectures, and ideas around new modes of practice, have been promoted sometimes as a critique of critical theory, or at least identified as such. Re-occurring is the idea of a shift from the critical to the projective, through practice that is proposing new solutions rather than commenting on existing situations and conditions.

In their 2002 article *Notes around the Doppler Effect and other Moods of Modernism*, Robert Somol and Sarah Whiting introduce a shift from critical to projective practice. They argue that the discipline has been "absorbed and exhausted by the project of criticality", and that what was before exceptional practice is today everyday life, and finds it necessary or useful to provide an alternative to the dominant paradigm of criticality. Somol and Whiting compare the shift from a critical to a projective discipline to the notion of *hot* and *cool practice* as suggested by Marshall McLuhan. The cool project in depends on the participation of the user. On the other hand, Somol and Whiting make another comparison to acting, in which the architectural equivalent to method acting, a constructed mode of operating representing hot practice, would be method desig-ning, in which architecture would represent its procedure of formation. This signifies the critical practice, in the way it would re-enact memories and the past. If the critical practice established autonomy by defining architecture's field or discipline, Somol and Whiting suggest an architecture would acknowledge the effects and exchanges of architecture's inherent multiplicities such as material, program, writing, atmosphere, form, technologies, economics etc.[77]

The Somol/Whiting article is part of a series of exchanges initiated by Michael Speaks in an Architectural Record article from 2000, in which he claims that avant-garde practice and the theory that supported it "has proved inadequate in the vicissitudes of the contemporary world", that the rapidly changing contemporary situation needs a faster and more adaptive practice. He refers to Alejandro Zaera-Polo's (Foreign Office Architects/FOA) construction of a niche-seeking map, a pragmatic device for adjusting practices to changing conditions. These practices would track the assemblies of "techniques, relationships, intelligence and dispositions that shape

design", aspects that add value that distinguishes one firm from another. Concluding by relating to Deleuze's proposals of theories that enable us to act, rather than tether us to fundamental truths, Speaks argues for a freedom of movement that can be achieved by intellectual entrepreneurs and managers of change. Still, there is a need for new architectural thinking, but it must focus on time, interactivity and innovation, rather than space, genius and the utopian search for the new.[78] Speaks continues to develop these ideas in a series of articles in A+U, part one introducing the concept of *design intelligence*, and the following 11 parts presenting architectural practices of relevance in interviews. Speaks claims that utopian ideas and projects have given way to "little truths", or chatters of intelligence. The drivers of architectural development are no longer philosophical, political or scientific truths, but rather levels of credible intelligence, indicating if something might be true. The post-vanguard practices of the 21st century are replacing ideas, theories and concepts with entrepreneurial modes of operation, driven by innovation, and completely dependent on intelligence. Speaks identifies these tendencies in a range of different practices and projects, including FOA's Yokohama Port Terminal (in which a small office achieves the capacities of offices 10 times its size through intelligence), Dutch firms MAX1 and Crimson (developing organizational intelligence that negotiates the software of policy directives, zoning and legal codes with building or infrastructural hardware), Field Operations (where landscape urbanists Stan Allen and James Corner design artificial ecologies that are deployed in interactive layers of fields rather than as single design elements) or SHoP Architects (utilizing design intelligence that extends from branding and marketing to product and building design).[79]

George Baird responds to what he considers to be a serious attack on theory and criticality by Somol/Whiting and others, asking for a supporting projective theory for the new projective architecture. He predicts that it otherwise will be degraded to "merely" pragmatic and "merely" decorative with great speed.[80] Reinhold Martin emphasizes the reading of these projective practices as sharing a commitment to "an affect-driven, non oppositional, nonresistant, non-dissenting and therefore nonutopian form of architectural production". In the collective work of these architects, he sees an enthusiasm to accept the protocols of cultural and architectural "progress" for its own sake, and a preference to misrecognize the demand for vision as an opportunity rather than what Martin defines as an "intensification of neoimperial desires". He poses the possibility that the "relaxed" post-critical stance is an authoritarian call to order and for all to "kill off the ghost of radical politics by converting political critiques into aesthetic critiques and then slowly draining even that of any dialectical force it may have inadvertently retained". He finally calls out for the content of the project; a vision and perhaps the reinstatement of utopia, not as a call for a perfect world, but a literal non-place that infuses reality with other worlds.[81]

76 Hays, K Michael, "Critical Architecture: Between Culture and Form", *Perspecta 21*, MIT Press, 1984, p.14

77 Somol, Robert and Whiting, Sarah, "Notes around the Doppler Effect and other Moods of Modernism", *Perspecta 33*, MIT Press, 2002

78 Speaks, Michael, "Tales from the Avant-Garde: how the new economy is transforming theory and practice", *Architectural Record*, December 2000, p.74

79 Speaks, Michael, "Design Intelligence", 12 articles, *A+U* (2002:12–2003:12)

80 Baird, George, "Criticality´ and its Discontents", *Harvard Design Magazine*, Fall2004/Winter2005 **http://www.gsd.harvard.edu/research/publications/hdm/back/21_baird.html** 7/6 2008

81 Martin, Reinhold, "Critical of What? Toward a Utopian Realism", *Harvard Design Magazine*, nr 22, Spring/Summer 2005

Jeff Kipnis questions whether resistance is not a valid concept within a projective practice, and he is seeking a convincing "metacritical account" that can promote the changes suggested by Somol/Whiting.[82] He suggests that the new practice also needs a radical rethinking of the discourse of resistance "posed in terms of sensations rather than negotiations", or it risks becoming an excuse for mere service practice with cool products. On the notion of affect and effect, Kipnis makes comparisons to the soundtrack of a movie, that stages the evocative milieu of the film, and his first intuitive idea of how the new discourse of resistance may unfold, he suggests an architecture that can be in dialogue with the performing arts. The performative and evocative aspects suggested by Kipnis may entail not only the resulting design proposals but can, as previously mentioned, also be an active part of the design development through the integration of performative prototypes. As conduits between different designers (performers) and contexts (audience), these prototypes would co-exist in different media, shifting between these states through remediation, retaining characteristics from one representational mode into another while also ***acquiring new performative qualities during the process*** ↑ [P. 46 | P. 64 | P. 96].

The Critical, Projective and Performative Project

When Stan Allen speaks of the architectural project, he is referring to "an overarching theoretical construct, defined from someplace else, and expressed in a language other than practice's everyday discourse".[83] It is the notion of an ideological framework that surpasses the daily work, and sets an agenda beyond the criteria of clients, market, media or economics. Even so, he suggests that the practical unity of material architectural practice is provisional and based on assemblies of procedures, rather than based on outside theory or discourse. In fact, he suggests a difference between modes of operation identified as founded in practice or project. In the project approach the architect looks for solutions that fit with the overall frameworks or ideologies, in the practice approach relevant compromises can be achieved based on local and temporal conditions that still deliver an architecture of "integrated structure and smooth flow", an architecture of coherent and perceivable spatial and conceptual qualities. The definitions of practice and project given by Stan Allen operate on a conceptual level, where the project indicates a higher agenda or motivator, rather than the architectural project in the sense of a local and temporal assembly of activities that result in a proposal for a building, a survey, a publication or similar products that are normally produced by architects. In analogue, practice refers to assemblies of activities that are "capable of producing ideas and effects through the volatile medium of artifacts and images rather than exclusively through the mediation of language". Allen does suggest that theory needs a project in the form of a static construct or template of beliefs against which individual actions can be tested for conformance, while practice is seen as performance in the sense of paying attention to consequences and effects.

A more basic reading of Allen's conceptual definitions may still make similar conclusions, on the basis of the project as the entity that forms a temporal collaboration with a particular aim (such as the proposal for a building design), and practice as the activities that are part of this (and also extends before and after the temporal limits of the project). The project can then include the collective protocols that allow multiple participants, even within the scope of a particular practice, to join forces towards a common goal. Network practices, that may operate by the provisional project based partnerships, may need to establish local frameworks for the estab-

lishment of projective projects that go beyond the scope of problem solving. Or, they may join in the pragmatic conditions of the local project, while developing individual critical agendas that make use of developed design work in order to build discourse. In an innovation driven research context, the project may ***emerge out of different research tracks, creating a framework in which these before not associated agendas may support each other*** ↑ [P. 10 | P. 46]. It can achieve agency in itself, based on its different constitutive trajectories, and perform both as a propositional result of these processes, and as a context for continuous investigations by multiple parties. The networked practices involved with these projects would be able to operate critically, projective and performative in different scales, by reframing and re-contextualizing their work.

Intelligent and Agile Practices

Intelligence in the way it is used within the Central Intelligence Service (CIA) refers to information valued for its relevance rather than its accuracy, in contrast to data which refers to precise information or facts referring to verified information. Active data refers to constantly updated and urgently needed information of relevance. Intelligence has the double meaning of active data as well as the gathering and analyzing of this information.[84] This suggests a combination of aptness for gathering and identifying relevant information in the field, and the ability to analyze and suggest action to be taken according to the information, in conjunction with a given agenda of an organization. While this may be seen as nothing new in relation to conventional architectural practices, where one can hope for an adequate analysis of a given context before an architectural proposal is suggested, the reference to intelligence organizations suggest a much more adaptive organization, in which the evaluation of information and identification of intelligence cannot be accomplished without a simultaneous link to a concept or an agenda. Information is not active intelligence unless it is deemed to be relevant for a certain kind of action.

The agility of a practice can be seen as the capacity to adapt to different contexts in regard to types of assignments or market conditions, but also the ability to interact with other participants and agencies, as will be discussed later regarding network practices. Intelligent and agile abilities can be deployed regardless whether a practice is defined as more prone to a projective, performative or critical mode of operation, even though these modes may influence the way such a practice would process data or adapt to its surroundings. An intelligent practice may still be considered to operate in a more contextual way, with a field of operation of a wider span than the previous critical practices.

The use of *design intelligence* as a concept, as introduced by Michael Speaks, carries the multiple capacity of introducing a discourse of practice as well as an architectural business model. In general, architectural practice is not known for being innovative about its process management; new modes of practice are rather based on tools, concepts or formal qualities. The deployment of intelligence as a driver for practice suggests a potential for incorporating a formalization of innovation processes that can be closely linked to conceptual frameworks as well as architectural effect. The modeling and management of processes are linked to the traditional architectural way of documenting the design

82 Kipnis, Jeffrey, "Is Resistance Futile?", *Log 5*, Spring/Summer 2005, Anyone Corporation, p.105

83 Allen, Stan, "Introduction: practice vs. project", *Practice: architecture, technique and representation*, G+B Arts International, 2000, p.XIV

84 **http://en.wikipedia.org/wiki/Intelligence_%28 information_gathering%29** 1/11 2007

process, through diagrams, maps, conceptual drawings and lately in code or the variation of parametric systems, but should be regarded as ways of understanding how a certain result can be achieved, rather than a justification for a certain proposal (which perhaps is how these representations have been previously used in critical practice and academia).

Michael Speaks initiates his introductory article to his A+U series on Design Intelligence by referring to the events following September 11, especially in regard to different responses to the politics of redevelopment and visionary remedies for the losses, but also in the recognition of the efficiency and intelligence of new (terrorist) networks that can act with speed and deliberation. This also opens the connotation of Intelligence to the Open Source Intelligence (OSINT) deployed by the CIA, an information processing discipline that involves finding, selecting, and acquiring information from open sources and analyzing it to produce actionable intelligence. Open here refers to information that is publicly available (as opposed to covert information), and not to the sharing of development (or conclusions) that developers of open-source software adhere to. Speaks uses this reference to emphasize the capability of acting on acquired and processed information, which is perhaps the most important aspect of intelligence within the practices he defines. This becomes a way to signify them in relation to the historical avant-garde, and whether the New York ground zero will be rebuilt by 20th century modernism of genius or 21st century modernism driven by intelligence. Focusing on discourses of practice, Speaks traces a history of the 20th century, from an avant-garde driven by national philosophy, to the International Style stripped from all ideology except consumerism, followed by critical architectures and Post-modernism, Deconstructivism and Critical Regionalism. The turn of the century is then reflected in the demise of practices that became burdened by theory and the emergence of practices with an evolved capacity to survive and operate under ever faster changing conditions.[85]

The resistance to market or consumer culture or perhaps capitalism in general as attributed to the critical practices, whether linked to the autonomy of the discipline or not, seems to indicate a practice of high integrity. Does this ensure a practice of high ethical standards in itself, or are the critically commenting projects of the past most of all a self branding of a generation of practices? The discussion which has been brought to the surface in these exchanges seems to be still internal to the discipline of architecture, and only major events such as the WTC incident in 2001 are able to penetrate this barrier and shift the comments to the border of political ideology.

Harvard Design Magazine tried to make an assessment of the contemporary and near future issues for architectural design by posing questions to a number of architects, including Stan Allen, Zaha Hadid and Patrick Schumacher. Stan Allen identifies two alternatives for the future of innovative architecture in the U.S. The first is identified as purely market driven work, in which research and experiment is fine as a past-time. The other alternative would be continued resistance and experimentation, following an avant-garde tradition. Allen suggests that a problem with the avant-garde is that any departure from the narrow path of criticality is considered a compromise, sellout or retreat. He instead asks for a “viable, progressive project capable of incorporating the innovative design research of the past decades into a productive new model of practice”. It would need to be legible to the public, have an active engagement with new technology and be committed to creative means of implementation. It would be an experimental practice that is not self referential but takes on

real problems. Theoretical reflection would be crucial but not an end in itself. The practice must be agile and reflexive, and confront serious issues, including the ecological crisis, the globalization of practice in the contemporary city or the impact of digital technology on design.

When approaching the notion of design intelligence, Allen understands it as implying a creative use of design expertise in "a looser, more entrepreneurial relationship to the market". The notion of intelligence is recognized as the synthetic and projective capacity unique to the architecture and design disciplines, as well as the reference to military intelligence and fragmented information and suspect sources, in the sense that architects need to be open to the "chatter" of the surrounding world and put that information to work. Allen emphasizes that these new models of practice situate conventional practice, defined as "conventionally conventional", in opposition to the "established strategies of the avant-garde (critique, narrative, or negation)", defined as "conventionally unconventional". They would rather "examine new forms of collaboration and be open to the innovations of allied disciplines".

Allen also comments on the frequent use of innovation to define the new in architecture. He proposes that true innovation would likely go unrecognized, and perhaps be only noticeable
as the unfamiliar use of familiar strategies. It would, according to Allen, work incrementally, building on what is known, but would be "capable of setting off a cascade of effects – architectural, social, and perhaps political – that over time create the potential for more significant change".[86]

Speaks sums up issues that have arisen in (primarily) American schools of architecture during the first few years of the 21st century in another Architectural Record article, in which he acknowledges extensive developments in (digital) technique, but a lack of accompanying intellectual culture. The accompanying set of theories has become a source of resistance in itself; there is an urgency to find "new theory" to replace the old, which according to Speaks opposes the need of a new "intellectual framework that supports rather than inhibits innovation". He refers to Jeffrey Kipnis, who in a dis cussion on architectural education in Vienna states that schools should teach architectural expertise, which is more than technique, and only by mastering this expertise can one move into a territory of architectural innovation. While this implies that there is knowledge and skills to be learned in order to bring about innovation in practice, neither Kipnis nor Speaks identifies what these are. Speaks suggests that this knowledge is currently being acquired in smaller firms that have adopted a way of working based on prototypes, where digital techniques are used to engage in pragmatic issues of architectural production as well as deploying iterative design processes. This in turn allows the architect not only to provide several solutions to a stated design problem, but also to reframe and define alternate design problems that could not be formulated before.[87]

85 Speaks, Michael, "Design Intelligence", 12 articles, *A+U* (2002:12–2003:12)

86 This is a recap of Stan Allen's response to the first question posed by Harvard Design Magazine: "What do you think are, in your country, the most important current issues or challenges for architects, landscape architects and/or urban designers, and why?".
Allen, Stan et al., (Respondents), "Stocktaking, Nine Questions About the Present and Future of Design", *Harvard Design Magazine*, Spring/Summer 2004, Harvard University Graduate School of Design, 2004, p.5

87 Speaks, Michael, "After Theory", *Architectural Record*, 06.05 June 2005

Is this not a potential route to the grounding of innovative practice, not only by looking for active intelligence in the market, but also by deploying potential strategies that enable changes in those conditions, as well as in the built environment, both which are highly affective of social conditions of the public? A new discourse on projective practice may on one hand be more accessible to other disciplines, opening for a new mode of in depth cross-disciplinary discourse, but can also take part in discussions on the public domain by allowing "critical" projects to be implemented and instantiated in society. And is the performative action of a practice also necessary, as Robert Somol suggests, in order to establish the "fan base" that allows innovations in practice to actually project into the public domain in discourse as well as implementations of projects at different scales? What is the nature and characteristics of the performative project when it has to communicate to a wider audience of varying background? Can the definitions of the prototype, as an enticing and experiential, as well as malleable environment, be a model for these interactions?

Projective Practice and Network Technologies

The discussion of the post-critical has in many cases been associated with practices driven by new digital technology, where techniques and methods often are deployed to change the conditions for architectural practice itself. This may be motivated by different interests such as a search for new aesthetics and performative affects, explorations of the computational, or the use of new fabrication technologies for fabrication or participation in system development that rely on production efficiency and logistics in new industrial paradigms. Many of these techniques add on to traditional architectural representation, augmenting the drawings of the past with interactive, immersive and networked models adopted from numerous other disciplines, or developed by computational designers within architecture. Architectural representation has of course been vital to the development of progressive architecture, and certainly is in use among the so-called critical practices. Peter Eisenman makes advanced use of the axonometric in his House series. Daniel Libeskind's drawings and models use displaced projection to extremes. In this sense, the new tools are but another layer of architectural experimental practice. However, a number of related representational techniques are being employed in both experimental practice and the industry at large, in particular the building information model (BIM), and in relation to this numerous models for analysis, simulation and optimization. A number of concepts are related to these representational systems. While these may shift meaning in different camps, they seem to have emerged simultaneously for different reasons, and are perhaps most of all significant for contemporary conditions. *Mass customization*, *building information models* and *parametric design* are typical terms in frequent use. The concept of *innovation* and the innovative is in abundance as well, but used quite differently. In the industry, and in other fields such as industrial design, it indicates the successful implementation of an invention or idea into society, often a successful marketing strategy, but also simply getting something to become used. In many architectural discourses it has come to mean simply making new things, and is probably a bit too diluted. In my personal work, and within the work of Krets, an innovation driven process has been defined as a design exploration with an initially un-clear agenda, originating in an interest in a phenomena, technology or method, which is then pushed through an iterative process that in time acquires the

integrity to be collected into a project, and a potential proposal. This includes the work with the texts in this thesis, which are exploring territories in different field, in the hope of establishing links, and find patterns that leads the research forward. While the different contexts sharing these concepts do not mix naturally, there have been opportunities for common discussion. The SmartGeometry conferences over the past few years have been pushing the use of the ***GenerativeComponents parametric software*** ↑ [P.36 | P.66 | P.80 | P.100], developed by Bentley Systems.[88] These events have included many participants from both practice and academia, typically specialists from various internal groups in larger firms (Foster and Partners Specialist Modelling Group, Arup's Advanced Geometry Unit as well as Arup Sport, KPF Research, Aedas Advanced Modelling Group and others) as well as academic students and researchers (MIT Medialab, University of East London, Architectural Association, Penn State and others). The events typically focus on issues of computation and tooling, rather than other architectural issues that all these parties are working with in general, which makes them more of a support venue rather than a platform for critical discourse. There are also the ACADIA annual conferences that gather users in a similar way around a yearly theme including geometry, responsive systems or similar issues.[89] These events are more open since they are not based on a particular software system, yet they tend to have the same focus on computation and tools. The exploration and implementation of new technologies in all fields of practice may allow for the comparison between experimental and more conventional practice, while avoiding the notion of a chronology or linear development between them (experimental being a forerunner of conventional practice, but over time becoming conventional). Rather the two must co-exist and there may be interesting concepts that are shared between them. The way *Information and Communications Technologies* (ICT) are being used today, one can argue that architectural practice is not possible without being networked. There is still much development that must be done, and much that is underway, in particular regarding BIM and its connectivity to processes for both design and production. This has been widely discussed and tested in R&D work done by architects and contractors as well as in research institutions.[90] This work primarily evolves inside very traditional structures however. In parallel, there are a number of experimental practices and organizations that depend heavily on the innovative use of ICT for their organization, their design procedures and often also as integrated parts in the proposed architectural solutions. These practices are using ICT in order to be projective; they develop their founding concepts, they design, collaborate, produce and commu nicate their work through technology. In this sense, they can be defined as network practices.

88 The *SmartGeometry* group is dedicated to educating the construction professions in the new skills which will be required to use advanced 3D applications effectively. During the past years the focus has been aimed at support ing GenerativeComponents, developed by Bentley Systems as an application to the Microstation CAD package. **www.smartgeometry.com** 13/11 2007

89 **www.acadia.org** 15/11 2007

90 I have been personally involved in two separate industrial development programs for *Skanska Teknik* as an employee of Scheiwiller Svensson Architects.

Anthony Burke and Therese Tierney are broadly inclusive in when they assemble material on network practices. They approach the topic as designers of systems and artifacts, which suggest the consideration of both the enabling networks for practice, and the design of proposals that operate within a networked realm. In the publication they edited on the topic, *Network Practices: New Strategies in Architecture and Design*, they attempt to "analyze how art, science and architecture shape, and are shaped by, a diverse array of social, cultural, and technical networks and how they respond to rapidly changing mobile, wireless, and ultimately information embedded environments". [91] Beyond technical issues, they define a number of themes as previously unexamined in regard to the network practice. The creative potential of physical, social and technical networks in formation enables frameworks that re-organize themselves dynamically. The intersection of design, social space and networked media creates new opportunities for collaborative practice and opens a new field of collective media artifacts. Internet and new media art are advancing open-source software development that suggests new channels for production and knowledge sharing applicable to other fields. Architectural theory and production is being equipped to deal with the complexities of networked space through new forms of practice and exploring new spatial conditions.

Christopher Hight links the idea of the network practice with how the objects of architectural knowledge are understood, in the sense that the subject is given by actors "exterior to architecture", while the agency of the architectural actant remains. The architectural proposals designed by a well defined architectural author would in themselves be networked and immersed in the new urban conditions that have arisen though technology. He uses the design and research collective Servo as an example, and identifies an urbanism "diffused into electromagnetic waves, measured by bandwidth rather than distance" in their projects. The network mode of the Servo practice itself is identified by the fact that its four members are located in four different cities. While the projects have often been designed for and enacted in the gallery space, Hight considers this "a reinvestment in the agency of architecture through its retooling to engage the emerging issues of media space and social formations" rather than a continuation of avant-garde formalistic exploration that has a tradition of being presented in exhibitions.[92] Hélène Lipstadt's reading of Hight's notion of architectural agency is that it returns to the classical authorship, confirming the role of the architectural designer regardless of the dynamics of networks. She also suggests that many networked practices, while being concerned with modes of architectural production, also theorize their "practice in an intellectualist fashion", linking back to an aesthetic tradition of authorship.[93]

The focus on the instantiation of the proposal in space and its communicative capacities, as well as its theoretical framework is confirmed by the members of Servo. Drawing on the traditions of technological experimentation performed by Experiments in Art and Technology (E.A.T.)[94] and others, they see the responsive networks included in their designed environments as parallel processes in which "the exchange of data instantiates itself in the material properties or organizational qualities of a space", present in the material qualities of a project (through fabrication processes) as well as responsive behaviors (seen as secondary effects). The collaborative network is illustrated in a "diagrammatic system" that illustrates the connection with other discrete practices, integrated in project development primarily through various forms of design and production software, manufacturing processes and information systems, suggesting both human and non-human actors. The main benefit

from the dispersed inner network of the Servo practice itself is identified as the ability "to draw upon and incorporate aspects particular to the design cultures of the various cities in which it is located, allowing the work to be more interregional and international in nature". This suggests that there is an exchange of design impetus, or at least influence, from parties outside the inner circuit also on the design process itself.[95]

The work of Servo is most frequently presented in the form of their responsive physical prototypes and exhibition designs including the Thermocline furniture system, the Lattice Archipelogics gallery installation, the Genealogy of Speed display infrastructure and the Dark Places exhibition design. While these projects may open up for outside participation through the responsive and interactive properties of the designed environments, the processes that created them seem to follow more traditional modes of design, the collaborative networks are at least not so visible outside of stated credits. The earlier ***Urbantoys*** ↑ [P. 86] project, instantiated in two versions, is in a way pinpointing issues of network practice of design collaboration in a much clearer and projective sense. The project diffuses the conventional roles of manufacturer, architect, designer and client through the development of a design interface, or design solution space. Situated within an Internet website environment, it allows a visitor to interact with a digital 3D environment through the manipulation of a set of parts; malleable urban toys of no defined scale. The performative aspects of the project set up a new kind of relationship between designer, manufacturer and customer. The user is invited to act on a supplied catalogue of materials and infiltrate the design process. By submitting designs to and sampling designs from an online archive, the visitors' designs are made available to other potential authors. Potentially, the digitally catalogued urbantoys may be retrieved, fabricated and delivered to the user. The user/consumer of the piece is at the same time potentially a producer and author of designs that might be sampled by other users, as well as manufactured and delivered. Urbantoys v.1 was developed for two different venues, a gallery installation at the CRAC exhibition at Liljevalchs in Stockholm 2000 and the online exhibition N2Art the same year. ***Urbantoys v.2 was developed in collaboration with Krets*** ↑ [P. 88], who was commissioned by Servo to design the responsive design system. This work was carried out through collaborative scripting in the Virtools game development software, which allowed for a continuous exchange of scripts as well as testing of the digital prototypes of the system.[96] In the exhibition catalogue accompanying the presentation of the Urbantoys v.2 project Servo speaks of the ambiguities between performance and production, and between purveyance and authorship, as general concepts and as traced in the project itself. The idea of *purveyance*, which has not been elaborated by Servo in later projects, entails the establishment of systems that enable multiple authorship and variable outcomes as opposed to a single spatial proposition. The statement that "architectural purveyance claims the territory between a

91 Burke, Anthony and Tierney, Therese (ed.), *Network Practices: New Strategies in Architecture and Design*, Princeton Architectural Press, 2007, p.25

92 Hight, Christopher, "Preface to the multitude –The return to the network practice in architecture", in Grillner, Glembrandt, Wallenstein (ed.), *01. AKAD: Experimental Research in Architecture and Design*, AXL Books, 2005

93 Lipstadt, Hélène, 'Exoticising the Domestic': on New Collaborative Paradigms and Advanced Design Practices, in Anstey, Grillner and Hughes (ed.), *Architecture and Authorship*, Black Dog Publishing, 2007

94 *Experiments in Art and Technology* was a non-profit organization established to promote collaborations between artists and engineers initiated in 1967.

95 Erdman, Gow, Karlsson and Perry, "Parallel Processing: Design/Practice", *Architectural design: Collective Intelligence in Design*, vol. 76, issue 5, (2006):5, Wiley, 2006, p.80

96 Virtools is currently owned by Dassault Systemes.

spatial proposition and its audience as a site" suggests the modeling of processes as well as proposals. The way the project is graphically presented, including a diagram linking the available operations of designing, cataloguing, manufacturing and delivering, also suggests a business model in development.[97] The performative aspect of the project involves the design participation of the user rather than the behavior of a final proposal, which allows individual involvement in the otherwise metaphorical diagram. While only parts of the project were fully enabled, the manufacture being suggested by exemplifying rapid prototyping models and no delivery was ever made, this draft of a potential practice that actually offered anyone to participate in a design network was very suggestive in itself.

There are many emerging formations of specialists that link computational skills with explorations of spatial formations through collaborative networks. Some are being established inside other firms, such as the aforementioned Specialist Modelling Group (Foster and Partners), Advanced Geometry Unit (Arup), KPF Research and Aedas Advanced Modelling Group, operating as in-house method and technique developers. The members of these groups frequently share knowledge through forums, Internet communities and research related fields, including project specific details to some extents. There are also individual actors that shift between different affiliations. Marc Fornes uses the personal platform theverymany[98], and has been associated with Zaha Hadid Architects but is now established in New York with a link to SOM. Pablo Miranda has nurtured armyofclerks[99] with activity within Krets and at the KTH School of Architecture in Stockholm and is now a member of the Aedas Advanced Modelling Group. Materialsystems[100] is the practice of Andrew Kudless, who also has been affiliated with California College of the Arts, Ohio State University, the Architectural Association (London), Yale University, and Rice University. While these individual practitioners are specialists for hire, they also come equipped with their personal conceptual and aesthetical platform, reflected in the chosen name, and in this sense they become individual nodes in the networks they affiliate with, including commercial firms. Not only do they engage themselves with the technologies and protocols frequently associated with network practices, they are proposing an alternate way of network practice, in which they freely can move between classical architectural agencies in order to focus their attention on the themes and techniques they are most interested in. Perhaps this is unintentional and the mode of operation is simply the effect of current interests in particular skills, but the formalization of these kinds of small mobile practices may be of great interest to new markets based on innovation and conceptual development.

Sanford Kwinter presents a notion of design as an organizational activity that can also be seen as the design of organizations, which can be extended into the design of management models for design. In other disciplines, management seems to come much more naturally, and is of course extremely related to the work produced within an organization. Thereby, management of design processes within architecture is of course also important for the results delivered, i.e. the architectural design proposals.[101] Birger Sevaldson suggests that the potential benefits of digital design techniques can only be reaped by rethinking design methodologies. Rather than historical examples of design research that attempt to establish generic methods, Sevaldson proposes the importance of the design of processes, in the form of project specific design strategies.[102] The current use of Information and Communications Technologies within architecture on different levels may suggest that the design management processes are automatically integrated into

contemporary design activities, and it could be argued that the actual design methodologies should not change, the ICT systems should preferably be ubiquitous but invisible. On the other hand, the potential for understanding design processes on all levels is better than ever. We can integrate analytical tools to make better decisions, we can simulate light and weather conditions, we can directly fabricate physical samples in order to test material characteristics as well as production principles and we can design parametric malleable systems that allow us to try many variants simultaneously rather than using a linear search for a perfect form. In order to be aware of the new potentials in design development in all its complexity with the integration of multiple new analysis and design tools, there is a need to ***model the processes involved, as a post-documentation for knowledge transfer between projects*** ↑ [P. 47], but also in order to speculate on new processes for innovation.

Christopher Hight and Chris Perry look for potential collective intelligence in design primarily in the relationship between design practices and telecommunication technologies. They suggest that new forms of social, economic and political power are emerging that are enabled by the same technologies that were developed to control society (in national, international and intercorporate power struggles). These new organizations are exemplified by file-sharing communities, encyclopedia networks, open-source movements and peer-to-peer networks, but also by number of architectural design practices and research groups. In these groups the authors identify the development of design environments that frequently link design technologies with design products. They locate two scales of collective intelligence, the scale of design practice, and the scale of design technology and product, arguing that one cannot differentiate practice from product or the social aspect of design cultures from the technological.[103]

Pierre Levy, one of the important theorists behind the concept of *collective intelligence*, argues that individuals and very small companies are more capable of continuous reorganization and enhancement of individual skills than large companies. In relation to these practices, he defines collective intelligence as a form of universally distributed intelligence, constantly enhanced, coordinated in real time and resulting in a mobilization of skills. The foundation lies in the mutual recognition and enrichment of individuals rather than the cult of communities. The coordination of intelligence depends on new communication systems, that are not only enabling the transmission of information in different formats, but also allowing members of delocalized digital communities to coordinate their interactions, "situated along dynamic maps of shared context".[104] In addition, these systems must allow the communities to change and shift, much like the environments of web 2.0 applications such as MySpace, Facebook or Wikipedia. Identifying four distinct anthropological spaces through history, the Nomadic, the Territorial, the Commodity and the Knowledge space, the last signifying the present, Levy suggest that mankind again is becoming nomadic. While time in territorial space was highly regulated and controlled by spatial means (walls, canals, bridges, gates), the

97 Arrhenius, Sara (ed.), *ReShape!*, exhibition catalogue, 50th Venice Biennale, Iaspis, 2003
98 **http://www.theverymany.net** 18/01 2008
99 **http://www.armyofclerks.net** 18/01 2008
100 http://www.materialsystems.org 18/01 2008
101 Kwinter, Sanford, "Confessions of An Organicist", *Log 5*, Spring/Summer 2005, Anyone Corporation, p.71
102 Sevaldson, Birger, *Developing Digital Design Techniques, Investigations on Creative Design Computing*, PhD thesis, Oslo School of Architecture, 2005, p.31
103 Hight, Christopher and Perry, Chris, "Collective Intelligence in Design", *Architectural design: Collective Intelligence in Design*, vol. 76 (2006):5, Wiley, 2006, p.5
104 Levy, Pierre, *Collective Intelligence*, Perseus Books, 1999

collective intellect is organized around mechanisms that reflect multitudes of events, in continuous emergence making the subjective visible. The anthropological spaces are irreversible, and thereby each previous space co-exists with the next one. Each space conditions its follower; without stable and respected law economy could not grow. Without schools and educational systems knowledge space could not exist. Collective intellects therefore benefit from technologies that emerged from the commodity space, the time when the conquering of territories became less important than global trade. The exchange of knowledge and skill both enable the development of artifacts, and depend on them for distribution. The contemporary immersion of ICT in professional as well as daily life, can establish formal networks for this exchange, when hardware and software intertwine to become part of all activities. In this sense, networked design practices allow for a dynamic reconfiguration of skill sets and approaches. This depends on the communication between different nodes in such a network, regardless if a node is an exterior independent organization or an individual, or an in-house unit with some independence. The modes of exchanges between different nodes are of different nature, and can include pure information, geometrical or consisting of other data, but also continuous feedback on delivered work, or well defined commissions and specifications of tasks. In the work shared between different nodes it may also be impossible to distinguish the activity and deliveries of the different parties. In all cases, there is a need to be aware of the protocols for these exchanges; the shared knowledge of format, technique, language or other means of communication that allows for the exchange of information in a valuable way. Alexander Galloway defines *protocols* as the "language that regulates flow, directs netspace, codes relationships and connects life-forms... Protocol is always a second order process; it governs the architecture of the architecture of objects."[105] In other words, protocols are vital for the management of collaborative design processes, and for the continued development of those processes.

In a 1999 text, Bart Lootsma differentiates between architects that strive to become experts who "offers designs or specializes in form" and those who becomes managers through intensive cooperation and skillful negotiation, generalists in a society of specialists.[106] The network practice is of course dependent on both specialists (in the design of form and other areas) as well as managers. The digital premises that enable the networks to form and reform, need agency and direction. New roles of practitioners not unlike those in other areas such as the movie industry may emerge; directors, producers, technical specialists. These practices typically form around the project (the Movie), and even acknowledge it to be the guiding force of progress.[107] An architectural practice that implements the advanced used of technology as a basis for experiment, design and production, is prone to depend on refined roles within its organization. In a dynamic project organization based on the participation of independent specialists, this is even more important. The awareness of the relevance of managerial skills that can encapsulate conceptual development, design of form and computational processes of design and fabrication seems to be distant. While such a practice may adhere to a classical profile based on a particular formal identity, linked to a principal and recognized in the produced built work, perhaps a more interesting notion would be to adopt the principle of the movie industry, and allow the project to be the primary driver, accumulating internal research and design concepts, contextual analysis, client requirements and third party interests. The identity of such a practice may very well lie in its ability to develop strong conceptual and sus-

tainable architecture replacing the single master mind with a collective intelligence of specialist and individuals who all take part in the management of its processes.

When Greg Lynn, principal of GL Form and a forerunner in digital design in architecture, was asked to comment on the state of digital design among a new generation of architects he started by discussing the practices he omitted in his review. Apart from simple ignorance, he gave two reasons for not referring to these practices. The first category would be practices that focus on procedural, analytical, bottom-up and algorithmic processes, which Lynn is suspicious of partly because of a claim to program design truths, and perhaps more importantly because it defers aesthetic and theoretical claims. The second category use digital technology to realize conventional architectural ambitions for reasons of commercial expediency and mindless variety. He recognizes the digital domain within architecture that he himself in many ways established, to now be extensive enough to make these distinctions. When Lynn addresses the various practices under his scrutiny, he looks at aspects such as massing principle versus component or subdivision approach (in the work of Servo and Min/Day), the composition of discrete technical and formal systems (in Tom Wiscombe's Emergent and the early work of Servo) or more integrated and interwoven structural and decorative layers (as in GNUFORM). Still, he brings up the procedural and aesthetically incoherent work of Axel Kilian, identifying his ability to collaborate and consult with a network of designers as a sign of agility, while lacking in artistic signature. Finally, Lynn suggests a contemporary mode of operation as being technical, nerdy, engineering-oriented, prone to programming and misusing software for their own devices, but more importantly, knowing what they are trying to achieve in terms of architectural effects.[108]

There are other relevant theoretical models for technologically infused networks of human and non-human participants that may give an understanding of potential innovation though design collaboration that includes projective and speculative components. *Actor Network Theory* (ANT) is an approach to social theory and research with affiliations to science studies and it attempts to situate scientific expertise in a social, historical and philosophical context.[109] ANT in many ways critiques conventional and critical sociology (and very emphatically the concept of the "social"), but is perhaps mostly known for promoting artifacts and objects to a state of agency. In this way it maps relations and networks that are both material and semiotic, that is between objects and concepts. A primary focus is on processes of innovation and knowledge-creation in science and technology. ANT has also borrowed from narrative theories, with the hope to gain a freedom of movement that can be detected in the diversity of worlds of fiction. 110 Bruno Latour, one of the main ANT advocates, states that an insight in the world of literature can enrich the definitions of ANT sociologists, through the speculative and propositional qualities immersed in the production as well as reading of narrative text. Of particular interest, would be the development of such processes in their relation to both human and artifacts.

105 Galloway, Alexander and Thacker, Eugene, "Protocol, Control and Networks", *Grey Room*, no 17, MIT Press, 2004, p.6

106 Lootsma, Bart, "Reality Bytes", in *Daidalos 69/70*, 1998/99, p.8

107 Based on a discussion with David Wingate, dramatist and lecturer in film production at University West, Trollhättan.

108 Lynn, Greg, "Constellations in Practice", *Praxis*, New Technologies://New Architectures, issue 6, 2004, p.8

109 **http://en.wikipedia.org/wiki/Actor_network_theory** 04/09 2007

An important definition of the prototypes within the work included in this thesis is that they have specific characteristics and behaviors, ***they perform (as actors) during their own conception and development*** ↑ [P.12 | P.56 | P.88]. They enable and promote work that can acquire new trajectories and meaning during its process. This kind of working mode, defined within the design research group Krets as innovation driven, can have a project starting point in an interest in social, cultural or technological phenomena rather than a program of functions. Through iterations of design studies these phenomena are explored and intertwined into a design project that assembles different prototypes into a coherent whole. In essence a speculation of an architectural proposal is emerging from the narrative of the design process. Krets is not a formalized organization with a clear agenda; the projects developed have instead depended on individual interests, initiatives schedules and constraints, and the operation within the group is in itself of a network character. Funding for material and production has been project specific, provided by a number of different sponsors, but the compensation for time invested by Krets partners has primarily come from individual research funding. This also implies that the shared explorative design work developed is tied back into individual research agendas, such as this PhD project, and is assessed and evaluated according to research criteria partly outside of the design environment in which it was conceived.

Contexts Postscript

Jonathan Hill traces the relevance of architectural design as research through history, in that he sees architecture heritage in common with painting and sculpture, as the three original visual arts. Architectural design is more than problem solving; it also, as art, formulates and questions ideas. He poses the question of what design can bring to research, and suggests that it can combine intuition, reason and ideas from a number of disciplines, in a "manner comparable to the most innovative and experimental research in the sciences". Architectural research is rarely verifiable in the confident way of scientific research, and its design processes can even rest on the assumption that they cannot be explained. Hill hopes that design can develop a greater desire to communicate ideas and methods from other research fields, while still rejecting the sometimes illusory notion of complete transparency in its dissemination.[111]

Michael Biggs argues that artifacts and written material should both be integrated in the doctoral submission of a practice-based doctoral thesis. A written part is necessary in order to provide context and shared ground with the audience. Furthermore, it would be necessary in order to make a distinction between assertions and arguments.[112] I would add to this that the artifact also operates as a tool for the process of these kinds of research projects, in the sense that it is not only the experience of the final object that matters, but also the experience of designing that object. This is crucial knowledge that must be evaluated and communicated in an appropriate way. The format for this may be even more dependent on the audience however, being professional practitioners, researchers or the public.

The 2006 AKAD exhibition at Lunds Konsthall collected work from a number of research projects supported by the organization (and in turn by Vetenskapsrådet), including the complete work of Krets up until that point.[113] The character of this work differs between the projects and the assembly could be seen as representing the practice-based research currently performed within architectural academia in Sweden. The conditions for each project also differ widely, and only a few participants are conducting the work within doctoral studies. The Krets material consisted of a combination of performative installations for visitor interaction, the ***presentation of production technologies and documentation of design processes and seminar proceedings*** ↑ [P.27 | P.51 | P.65 | P.99]. While the main critique of the exhibition in media was directed towards Lunds Konsthall itself, in presenting this kind of work, other concerns were focused on the accessibility of the presented work. Arguments have been made that the projects should have been more focused on the experiential parts of the projects, allowing passersby to experience the qualities of this research, rather than in-depth presentations of concepts and underlying processes. Other comments state that this type of work should have remained within the institutions in which it has been developed. These opinions raise a number of issues. Are the artifacts produced by these projects sufficient to communicate results

110 Latour, Bruno, *Reassembling the Social: An Introduction to Actor-Network-Theory*, Oxford University Press, 2005, p.55 ref to, Pavel, Thomas G., Fictional Worlds, Harvard University Press, 1989

111 Hill, Jonathan, "Introduction: opposites that overlap", *The Journal of Architecture*, Volume 8, Summer 2003, p.163

112 Biggs, Michael A R, "Learning from Experience: Approaches to the experiential component of practice-based research", *Forskning, Reflektion, Utveckling*, Vetenskapsrådet 2004, p.6

113 AKAD, the *Academy for Practice-based Research in Architecture and Design*, has been developing the discourse around practice-based research, through projects, seminars and articles. The organization has supported the work of Krets, who also participated in the exhibition at Lunds Konsthall. **http://www.akad.se**

(to a general audience) and to be evaluated (by researchers' peers)? What is the relevance of documentation of design/research processes in the dissemination of the work? In other venues, the work of Krets has been presented with much less documentation and supporting material. The events have been ***regarded as test beds and part of the design exploration*** ↑ [P.27 | P.30 | P.77 | P.98 | P.99], including evaluating the performance of prototypes in interaction with visitors, rather than as venues for dissemination.

Regarding treatises and publications of architectural design, there are different views on how to present design ambitions, design processes, proposals and evaluations of result, including the architectural text-book that suggests a way to accomplish a specific task, processes shown with the objective of motivating a specific solution (a sound process ensures a valid result), theoretical readings of works of architecture, or superficial imagery that provides money shots[114] of a built or un-built project. Stan Allen suggests that the writing of the architect differs in significant ways from the writings of the historian or scholar. He refers in part to a "shop talk" that concerns the technical and instrumental aspects of daily practice, based on examples and not on principles. This entails the exchange of possible techniques, methods or solutions, rather than the argument for a particular school of thought, or the justification for a specific line of argument.[115]

In *Tooling*, a publication in the Pamphlet Architecture series, Benjamin Aranda and Chris Lasch present seven algorithmic techniques that can be used to describe certain natural phenomena, but in their case these are used as logics for construction. Each technique is presented alongside a recipe, shapes made by that recipe, a project that uses that recipe within an architectural context and a programmatic computercode makes the recipe available to the reader. The authors claim that the algorithm is a way to mediate between the preferences of a designer and the chosen geometrical principles, creating the "potential for crystallization". A primary objective of *Tooling* is to show that "one of the biggest challenges of algorithmic architecture lies in establishing very coherent, pre-material rules that can be used ... to control this field". After this is defined, the actual design can begin.[116] The emphasis in the *Tooling* introduction is on the usability of algorithms in general, which then should be proven through the seven examples of spiral, pack, weave, blend, crack, flock and tile. Sanford Kwinter celebrates the approach of the authors in his afterword, claiming it to be a first in realizing that design must not focus on the first order regulatory processes, but rather on the "second order controls that regulate the regulatory processes themselves". Still, the collection of recipes may be seen as motivators and justifications for the collection of design projects, in the sense that each project is a specific design developed by the authors. Are the projects initially developed as tests for seven recipes, or have the recipes been deduced from projects already designed by the authors? The fact that the associated website for the distribution of the computational code is yet to go on-line, more than a year after the publication supports the latter.[117]

In Jonathan Hill's published PhD thesis in research by design, he introduces the work as following "two simultaneous journeys: one conceptual, from the professional architect to the illegal architect, the other physical, from the Royal Institute of British Architects to the proposed Institute of Illegal Architects".[118] The text part of Hill's thesis is a classical dissertation, criticizing the role of the Royal Institute of British Architects (RIBA) as a protector of the architect, rather than the quality of architecture. The parallel track, defined as the physical journey, entails a (quite conceptual and highly symbolic) design proposal for an Institute for Illegal Architects (who cannot

be RIBA members), to be located on Portland Place just outside the RIBA in London.

The *Archigram* publication, in the spirit of its claim to be an ACHItecture teleGRAM, used images and visions to put pressure on the actual built environment. As a magazine, it turned media into a site for architectural intervention, with projects communicated almost non-verbally through representation, sometimes even borrowing children's book techniques in the form of pop-up books or cut-out models to be assembled by its readers. The progression of the form and content of the magazine, from *Archigram 1* with a strong criticism of Modernism, through the large scale utopian proposals of the Plug-in City and Computer City to later mobile non-building projects, continued to propose and project ideas of innovation in architecture and culture, accompanied by conferences, talks and exhibitions.[119] The publication in itself opened up this discussion to a wider field though the employment of graphics and great communicative skills firmly engaged in the contemporary Zeitgeist. Mark Wigley puts forward the idea of the architecture of networks in relation to the networked condition of architectures. He suggests that Archigram and other architects of that time tried to model the electronic networks that emerged during their time, in order to test ways of occupying them.[120] Wigley suggests that they are not only producing images of the networked world we live in, they are also reproducing their own mode of operation. In a sense the Archigram publication was a performative action of a practice that argued that most of their projects were buildable, and they aimed for the working mode of a regular practice implementing their designs as built objects.

Leon Battista Alberti avoided the use of imagery for recording and transmitting scientific data, most likely to avoid the risk for drawings or illustrations to be distorted through the reproduction of manuscripts. He would rather have text based descriptions instructing the reader how to reproduce images. He even invented machines and methods for translation back and forth between image and text, first introduced in the transformation of the plan of Rome into polar coordinates, presented in his *Descriptio urbis Romae*.[121] In a way, this could be compared to hardware and software, or scripts/algorithms that allowed the recreation of a particular statue in different workshops regardless of geography.[122]

The relation between process and effect in the way architectural projects are being presented

114 Money shot: the image that sells the project, or the sequence of a film on which its commercial success depends, Sometimes it also refers to the image that cost the most money to produce. **http://en.wikipedia.org/wiki/Money_shot** 23/5 2008

115 Allen, Stan, "Introduction: practice vs. project", *Practice: architecture, technique and representation*, G+B Arts International, 2000, p.XXV

116 Aranda, Benjamin and Lasch, Christopher, *Tooling*, Princeton Architectural Press, 2006

117 At the time of writing this the website states "Website component of Pamphlet Architecture #27: Tooling is coming soon ..." **http://www.arandalasch.com/tooling** 08/01 2008

118 Hill, Jonathan, *The Illegal Architect*, Black Dog Publishing, 1998, cover

119 Sandler, Simon, *Archigram: Architecture without Architecture*, the MIT Press, 2005

120 Wigley, Mark, "The Architectural Brain", Burke, Anthony and Tierney, Therese (ed.), *Network Practices: New Strategies in Architecture and Design*, Princeton Architectural Press, 2007, p.30

121 Carpo, Mario, "Alberti's Media Lab", in Carpo, Mario and Lemerle, Frédérique (ed), *Perspective, Projections & Design: technologies of architectural representation*, Routledge, 2008, p.47

122 Carpo, Mario, *Architecture in the Age of Printing*, The MIT Press, 2001

and discussed are considered important for many reasons. Often it is regarded as a motivation, as processes that validate the results. In other cases practices are defining themselves through very particular interests in processes or methods, in which the presentation of these not only motivates a project, but also the practice itself. The process may be presented as a recipe for certain effects, as in the work of Aranda and Lasch. I believe that the documentation of a particular process and the techniques deployed through within it is important in order to understand the relation between intentions and results, not in order to motivate or justify them. While we may be mostly interested in the performance of architecture and its social and cultural implications, the way it is designed and produced is extremely relevant in order to be able to continue the development of the discipline. In order to make a more articulated architecture possible and relevant in contemporary society, there is also a need to continue to articulate the processes behind it.

The design projects and design loops of this dissertation involve very specific methods, are developed in quite free experimental environments and result in very articulated proposals with subjective decisions on aesthetics. The work does not operate as templates for generic methods, situations or aesthetic preferences, but indicates the need for project specific development along these or similar lines. The dissemination of the work must therefore include as detailed descriptions of its development processes, any outside conditions and the resulting proposals, using any mode of representation necessary. This material, in the form of the included design loops, is annotated with additional relevant information from the projects, or outside references. This collected work of the *Projects* book, and the arguments made in the *Contexts* book, are intertwined through the system of references, and are presented to the reader as a disparate but networked assembly of general and specific ideas, a publication of recipes, instructions, arguments and statements from which knowledge of design and research processes as well as the effect of those activities can be drawn. The project descriptions suggest instrumental, operational and specific explorations of techniques, practice and effects. The definitions and investigations of important concepts and techniques, as defined by others, expand the understanding of these approaches. The overview of discourses of practice acknowledges the importance of a continuous debate on motivations and effects of architectural agencies.

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Events

The Prototypical Shelter
panel member at round table discussion, the Art University of Linz, May 2008

Final seminar
external reviewer Michael Speaks, dean at Kentucky University, College of Design, Stockholm, April 2008

Advanced research seminar
external reviewer Fredrik Nilsson, research direcor White Architects, Stockholm, February 2008

Creative Systems – Architecture in a new industrialized context
CINARK, The Royal Danish Academy of Fine Arts, School of Architecture, attended by author, September 2007

Manufacturing Material Effects
Ball State University, Indianapolis, attended by author, April 2007

SmartGeometry2007
workshop and conference, New York, author workshop participant and presenter, January 2007

Space of Communication
member of the Online research group at the Städelschule, Frankfurt, 2006 – 2007

Visual Forum 2006
Center of Visualization, Gothenburg, author presenting the lecture "Representation as a design instrument", April 2006

Research Spaces
conference, the Bartlett + the Slade, London, presenting the paper "Remediation as operation and strategy within architectural design development", November 2005

Joining Forces
conference, University of Art and Design, Helsinki, presenting the paper "PARCEL – Developing Performative Prototypes in Architectural Design", September 2005

Info_liations / Ex_foliations
visiting fellow at Spatial Information Architecture Laboratory (SIAL), RMIT, Melbourne, Australia, 2003

Exhibitions

Ben van Berkel and the Theatre of Immanence, featuring *SplineGraft*, exhibition at Portikus, Frankfurt, 2007

Open House – Architecture and Technology for Intelligent Living, featuring *SplineGraft*, traveling exhibition organized by Vitra Design Stiftung , 2006

AKAD at Lunds Konsthall, presentation of the complete research of Krets, 2006

Onedotzero_stockholm, Moderna museet, Urbantoys v.2, with Krets for Servo, 2005

Art.Platform, Stockholm, *Streaming Architecture Projective Space*, with ssark medialab and Splintermind, 2004

Stockholm Arts + Science 2004, featuring PARCEL, with Krets in affiliation to AKAD, 2004

Reshape!, Iaspis sideshow at Venice Biennale 2003, featuring Urbantoys v.2, with Krets for Servo, 2003