Relational Textile Expressions for Space Design- an example of practice-based research in architectural design

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Abstract
Referring to the relationship between practice and theory in architecture, Allen defines architectural design as a *material practice*. He discusses the development of specific theoretical writing as naturally grounded on designed examples. Therefore, he sees the design object and the design process as “engaged reality” representing the natural connection to architectural theory, instead of grounding architectural theory on borrowed principles from other theoretical disciplines (Allen, 2000). Starting with Allen’s definition on architectural design as a *material practice*, this paper develops further the discussion on practice-based research methods and on the role of the artifact in development of foundational theory of architectural design. *Relational Textile Expressions for Space Design* is an example of practice-based research in architectural design, where research by material design aims to develop theoretical knowledge based on designed experiments.

Keywords: smart textiles, interactive textures, architecture.

Research in design-practice as foundation for design theory

The Prototype

If the natural sciences ground new knowledge on the study of natural phenomena as main object of observation, research in design builds its foundational knowledge on a different ground. As method of research, practice-based research in design builds new theory on design examples. The object of study in design research is “the artificial environment made by human beings”(Bayazit, 2004). The prototype, in this case, is both a designed object and also an analytic tool for formulating new questions to develop the knowledge for the specific field. Research, in this case, uses the design process as “empirical study” to generate new directions for the design practice (Hallnäs, 2010).
The role of the prototype becomes essential in this frame of research since it combines “the language of experience” (Stappers, 2007) - the knowledge that a designer has from his/her specific field, that serves as a contextualization for his/her research. Therefore, the design examples do not speak a neutral language. The examples represent a specific perspective that combines design skills to the language of a specific field (Biggs, 2004). By design, the model becomes a tool for interpretation.

The design examples are physical objects that come closer to the real product. Hence, they represent an interpretation of what the product could become. The prototypes, in this context, are not finished products; they are conceptual tools built to be objects of experimentation and criticism. Thus, the design examples are tools of technically plausible ideation, realistic enough to illustrate design ideals (Gaver, Martin, 2000). They talk about the present but predict a future situation (Jones, 1992).

Smart Textiles as Analytic Tool for Architectural Design

My paper presents an example of practice-based research in smart textiles design. The focus of the research is to explore by design the expressional potential of smart textiles in relationship with space design. Therefore, in this paper, the design of textile material plays a central role generating both an object of design and also one of observation. The projects present explorations that focus on designing new textile expressions where surface transformation is explored by the textile design. The function of the textile prototype is to materialize different design ideas by the textile construction, where the design process is quintessential to generate primarily new knowledge for textile design.

The paper opens up a design program as frame for design explorations. The role of the design program in this research is to suggest a new design area that needs to be explored. The Relational Textiles program defines a multidisciplinary design space. Consequently, the specific knowledge brought in the design process does not belong to a specific design field. Design variables from architecture, textile and interaction design gather to define various surface expressions and to materialize different design perspectives by means of textile design.

The focus of this paper is to explore various space expressions of transformation by means of a textile material tool; that is to start the design from the textile structural dimension to suggest space. Therefore, the specific dimension of textile knitted structure becomes an essential element in the design process, where relationships between near field scales of design and the far field are explored. The design of the multiple layers of patterns embedded in the textile surface is not limited by the physicality of its structural design; they are further enriched by computation. Combining a physical method of prototyping to a
digitalized one in the textile construction, the surface expression can be enlarged by new dynamic scales of design.

The design program aims to expand the virtual space of surface prototyping to a material one using textiles as main media for design explorations in the dynamic materiality of space. Consequently, combining computation and textiles is a way to explore the surface design by a complementary method defined by a material tool. Compared with the digital tools of modeling, the textile computational model is not material neutral. The textile prototyping tool inherits the fundamental textural properties of the textile material, opening for new expressions and interactions in space design. Accordingly, smart textiles are designed and used in this research as an expressional design tool that works in between material and immaterial spaces. Therefore, the research relates the concreteness of real scale textile material to the abstract digital space of surface prototyping in order to generate new designs.

In this context, the texture of the surface becomes a variable element to express intermediary scales of design starting from the textile construction up the scale of space. Consequently, including design variables such as transformation and sensing as variables of surface design, its texture becomes responsive opening for new interactions in space. The interactive textural scales of the surface are relative, built by the relationship between the expressions of transformation of the textile surface and the human relative position and actions in space.

The Design Process

Schön sees the role of the reflection on the design process as a fundamental method to generate new knowledge by using the experience specific for a design field and adapting it continuously to fulfill the desired vision (Schön, 1983). Combining skills and reflections as a method of research is a way to discover new patterns of work during the design process. That is to use designing both to experiment and reflect, where the “unselfconsciuous process” while making the design meets the “selfconsciuous” one of reflecting on the work (Alexander, 1964).

The role of the design process is essential in my research to explain decisions and observations based on practical work. The development of various knitted constructions together with the integration of electronics and the programing of the patterns blend together in the design process in order to explore various textile expressions. The design process has also a strong technical approach. Therefore, new methods of work using knitting as fabrication technique are developed in relationship to the textile
expression. The prototypes do not position themselves as finished products they are meant to serve as examples for further reflection when different design spaces meet.

The reflective role in the design process, in this case, functions as a “corrective to overlearning” tool that describes the relationship in between making of a design and the decisions taken during the design process, as well to reformulate new ideas that come up as result of the process.

Interpreting design results

Reflecting on the outcomes from the design process, Simon’s refers to the results of the design activity as generative tool for new processes (Simon, 1996). Accordingly, the purpose of the research in design is to build foundations for new knowledge to create design; that is to extend continuously the horizon of understanding with new design spaces. As Alexander clearly states when describing the purpose of the language of patterns he developed while studying housing and city planning; that is to create a structure for the future designs in order to define new problems not to solve them. According to that, he developed a pattern language to be understood and enriched to “the countless thousands of other languages” to be developed further on (Alexander, 1977). Going back to Jones’ reflection on designing, he also refers to design as “initiation of change in manmade things”. In this context, he expands the objectives of design from the object to the actions that initiate changes in all the systems around the object from production to society (Jones, 1992).

The design discourse in practice based research builds on the interpretation of reality. Thus, it refers to future situations not to present states but uses the present state to predict the future. In this frame, the interpretation of the research results starts from a “realistic object” as tool for observation but its role is not to validate results. The outcome is to present alternative ways of designing. Accordingly, the interpretation is seen as generative tool for new processes not as an end statement. The outcome of research in design is to build foundations for new knowledge to create design, that is to develop new methods and techniques or new expressions that enlarge the design vocabulary. Biggs writes about the value of research relating it to contextualization. In this context, he defines research results as a communication channel for a specific field by which the work is acknowledged. Therefore, the interpretation has to inspire by the quality of design examples (Biggs, 2006).

Relational Textiles as Architectural Discourse

Based on the practical examples, the outcome of my research, will be discussed in relation to two directions of design methodology and that of design vocabulary.
When talking about the design methodology, the outcome of the experiments aim to build a conceptual framework for discussing design methods as result of the reflections on the design process. In this case, the designed examples are referred from the perspective of relational textiles as a design process.

Shifting perspectives and placing the design examples from the perspective of relational textiles as a design result, the second direction of the outcome aims to define a material vocabulary. In this case, the designed examples are used as foundations to initiate a new design vocabulary of relational textile expressions for space design.

Therefore, the outcome of the research relates two contexts for design, that of relational textiles as material by design and as material for design, bridging two design perspectives— one related to textiles design and fabrication and the other one to textiles as potential applications in architecture.

**Relational Textiles as Design Process**

In this context, the identity of the material is described by the relationship to its design process. So as to structure the outcome from the design process, the notion of frame of reference is introduced to describe each frame of design.

**Def.** The frame of reference refers to a conceptual framework that defines a design perspective.

The designed examples in this paper sum up three design perspectives that of textile, interaction and architectural design. Each textile material is defined by the relationship between the three frames of reference suggesting methods for textile design. Therefore, the design variables from each frame are related and interact with each other in the design process defining specific material end expressions.

Example:

*Moonlighter* is one of the textile prototypes developed in this research frame. The textile is part of the bigger collection- Knitted light, where interactive knitted structures have been designed in order to complement glass facades (Dumitrescu, 2010). The project “Knitted Light” explored by design the relationship between textile patterns and space transformation in relation to the dynamic of natural light and human interaction in space.

-**Architectural frame**

The design intention in Moonlighter is to relate different interaction spaces by textile design. The textile is able to interact and mediate between inside and outside spaces as a texture for façade and pattern for the
interior space. In this reference frame, the decisions on the *scale of the pattern* and *position of the textile* in relationship with the building were essential for the design.

**-textile frame**

For the textile design frame, material construction is essential in order to define surface design. The knitted structures in *Moonlighter* are designed in relationship with light. Therefore, the knitted structure, in this example, is designed to weave in the initial textile structure a second pattern of interactive light. The layer of artificial light in Moonlighter is embedded in the textile structure relating the light pattern to the textile-ridged texture(fig. 1). The initial knitted surface is a static design that is enlarged with new scales of changeable light patterns (fig. 2). Therefore, in the textile reference frame, design considerations on the relationship between *variable* and *invariable* textile patterns appeared essential when defining the surface layout.

**-interaction frame**

The knitted surfaces in *Moonlighter* express the movement in space by the changes produced in the surface texture(fig. 3). The sound that people are making in space is expressed by the appearance of the light pattern embedded in the textile structure(fig. 4). In this frame, the relationship between possible *actions* in space and the changes in surface *appearance* were essential to define surface design.
The interactions in Moonlighter are planned as far field expressions—where textile expression and space interaction are correlated by the textile design. The metal and stiff plastic yarns used are concealing the textile tactile expression. Therefore, the material expresses far field interactions. The layer of interactive light patterns embedded in the textile surface relates to scale of the façade. Thus, the changes of the pattern can be visualized and activated from distance. The interactive light pattern enlarges the static textural textile features relating its near field expression to the far field of view. The sound in space can activate the textural patterns of light from far field positions in space (fig.5).
Relational Textiles as Design Result

The outcome is based on the reflections on the result of the design process - textiles for design, where the end material expression brings new perspectives to space design.

Def. “Relational Textiles” describe a material design space with various fields of reference defined by the relationship between the three reference frames - textile, interaction and architectural.

Each designed example embeds all three reference frames. In this context, the interaction design frame is variable relating to the textile frame or to the architectural frame in various ways. Therefore the textile opens a range of expressional perspectives - fields of reference for space design.

Def. The notion of field of reference, in this context, is defined as the range of expressional perspectives introduced by the textile design in space.

There are various relationships between the different frames of reference involved in the design of relational textiles for the interaction space. Each textile design introduces a field of reference in the interaction space where different "positions" in the field relate to the frames of references in various ways.
Therefore, each textile identity is described by an expression that relates to the fields of reference that introduces to space design.

Example:
_Moonlighter_ opens a wide field of reference in the architectural space defined by far field expressions. The textile’s different scales of patterns negotiate in between different interaction spaces inside-outside. In this case, the material relational field is augmented- the near field of the textile expression is extended up to the far field by the interaction frame. Therefore, we describe _Moonlighter_ as an expression of _amplification._

Material Design as Foundation for Practice-Based Research

Doordan sees the role of materials in design research as a meeting element of various “disciplinary perspectives and methodologies”(Doordan, 2003). Smart textiles, as architectural materials bring together various design perspectives in one material concept, since the textile physical structure is enriched by computation. That is to introduce a new textile identity to the architectural design context. Therefore, this research opens up a design space where textile, interaction and architectural design meet in the design of interactive textile surfaces.

Research within the area of smart textiles expands from material fabrication and needs to communicate new knowledge to other design fields, since technological development conveys new material identities to the traditional world of textiles. The potentials of new textiles have to be accessible to the designers in order to be useful for further design explorations.

Therefore, two questions appear essential that structure the discussion on the outcome of my research:
_What does it mean to materialize/design) expressions of space transformation through textile design?_
_What is the expressional potential that this specific material brings to space design?_

Designed experiments have been carried out to explore these questions and to illustrate ideas of interactive knitted textile surfaces, where the textile identity is understood primarily by fabrication. The outcome of this research translates new knowledge out of the practical work by building a common reference frame for the smart textile design merging three design perspectives. Related to fabrication, the explicit knowledge that the smart textiles’ identity brings to the architectural design field is represented by the design methodology and material expressions that appear as a result of the reflections on the design
process. Therefore, questions that link textile expression to space interaction appear essential to explore a new material space for architectural design and to generate new design knowledge.

References