The Design Alphabet for Textiles as applied Method at the Frontiers of Textile Design Research

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Abstract

In applied textile design research between institutions and industry members the project groups are mainly interdisciplinary and it is therefore necessary to find agreement on the design vision in order to achieve results successfully and to communicate with the partners from different fields. Our textile design research method (TDRM) addresses this kind of interdisciplinary framework for design research in order to structure the collaboration within our practice-based context. The method consists of four steps, which have been identified as being crucial to the application of product language to textile design research projects: 1) Design Vision; 2) Systematic experiments; 3) Design Alphabet for Textiles; 4) Design Briefing.

Within our TDRM the design alphabet has a key function as it materializes the design vision on the first hand and serves as a decision tool for future product developments in the innovation process. This paper presents the design alphabet and its application within three cases: DAFAT, Interior Embroidery and E-broidery. The established method interprets and challenges the traditional knowledge about how textiles are constructed and designed. Therewith it will enrich the present and predict a future product language in order to enable innovative materials and product identities in the textile field.

Keywords

Textile Design; Design Research; Smart Textiles; Digital Printing; Machine Embroidery

Introduction

Our research institute conducts applied, interdisciplinary research with industry partners in the field of textile design. In order to execute our applied research projects in a structured way and to be able to communicate with the interdisciplinary partners, we developed a textile design research method (TDRM). In this paper we focus on a crucial phase in the TDRM, which we call the design alphabet. We first explain how we came to develop the TDRM and what crucial role the design alphabet plays in this method. We illustrate the application of the design alphabet within three research projects undertaken by our research institute1: DAFAT, Interior Embroidery and E-broidery.

The textile design research method (TDRM)

When our institute was established six years ago, we started developing a variety of research projects in the field of textile design. Very soon, we realized how difficult it was to collaborate with partners as they could not grasp how we worked. While we knew that design is a systematic procedure, they felt that it was an intuitive, random process that they could

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1 Our research institute had the project lead in all three projects.
not relate to. This misunderstanding led to a lot of problems and we looked for ways to translate our inherent knowing of ‘how to design’ into a concrete method (Weber Marin, Muegger, Adler 2014). We realized that it was essential to create a strong design vision at the very beginning of each project. This vision would help all stakeholders to communicate with each other and understand the common objectives. But how do you develop a vision for a product that does not even exist yet? The theory of product language (Steffen, 2009) distinguishes symbolic – immaterial - aspects of a product next to the aesthetics and functional (material) aspects. Building on this theory of being able to describe the immaterial aspects of a product, we developed step 1 of the TDRM: the creation of a design vision. The design vision answers to questions such as how the product should feel, what people associate with when they see it and what it represents. Instead of starting off with nothing at the beginning of a project, a vision visualized in key words and mood boards will guide us throughout the entire duration of the project. Starting from the vision (1) we then apply ‘reverse engineering’: translating the vision into the development of concrete products step by step.

The next phase consists of materializing the vision into systematic experiments (2). While the vision stays abstract for many research partners, translating the vision into experiments gives them a hands-on understanding. We use their technologies to make experiments so that they can touch them and feel what the quality is. This helps them to relate to the vision on a material level and supports the communication within the project team.

The third step in the TDRM is the creation of the design alphabet (3). The systematic experiments reveal a broad variety of samples that are evaluated by specific criteria based on the design vision. The design alphabet is essential in the TDRM because it is the summary of the design vision: not on an abstract or imagery level, but on a material, hands-on, real level. And then on this reality and these facts, we can build products which can be successful because our partners can actually produce them. The design alphabet has a key function as it materializes the design vision on the first hand and serves as a decision tool for future product developments in the innovation process.

The design alphabet represents the relevant design criteria and leads to a technical and semantic design briefing (4). The design alphabet is used to describe precisely the envisioned aesthetic and technical research outcomes including the immaterial effects. The outcomes are described in the design briefing by parameters and characteristics of a design, referring to the design vision and are related to the specific target market. The design briefing includes the immaterial effects which was already included in the design vision, and it includes the real facts which are shown/proven in the design alphabet. Figure 1 visualizes the different phases of the TDRM and how it connects to the follow-up activities undertaken by industry partners (step 5 and 6). In this paper we focus only on steps 1-4 as they present our research activity, after which the industry partners take over the lead and develop prototypes and products based on the design briefing. Our experience with the TDRM is that it enables companies to think outside of the box and reach out to new markets and product categories.
Case 1: Design Research Project ‘DAFAT’

The first project is DAFAT (Digital Application of Colour on Textile) that takes design research as the driving force for technical innovation to generate new aesthetics in the field of textile print design. The state of the art techniques commonly used in industrial printing in the textile sector are silk-screen printing and inkjet printing. Both techniques imprint the textile dye into the textile resulting in the colour becoming part of the textile. Departing point for DAFAT was a process whereby the colour regains its materiality and the application technique becomes part of the design process (similar to the brush movement in painting). The innovation on the textile surface is that the colour changes the surface of the textile by introducing a 3D structure and by creating patterns through the activity of a new application tool. Unique about the process is that it is automated - enabling the creation of reproducible items – and at the same time an intervention by the designer is possible in the process, which creates individual originality.

The project was funded by the Swiss Government and four textile industry partners from the areas of textile machinery, fashion, textile dyes and weaving. The goal of the project was to turn the design vision into reality and develop an industrial machine, which can digitally apply different kinds of colour (inks, dyes, paint, pastes and additives) with a spray onto textile. This new digital application tool enables the creation of a new type of textile surface, which is aesthetically innovative compared to the technical state of the art application with an inkjet printer or silk-screen printer. At the same time a novel design process is defined, which is approximated and described by the design alphabet.

Since the knowledge of the envisioned future aesthetics and how the aspired machine will manifest these envisioned aesthetics is not yet available in words or illustrations, it is required to outline handmade, tangible samples in the first place.
Based on these samples, we developed a specific design alphabet to set highly demanding aesthetic requirements for the new technology and the machine that needs to be built. These requirements are different from the aesthetic produced by the state of the art technologies and work as a guideline for the mechanical engineers in machine manufacturing. The design alphabet for the new machine consists of classical drawing shapes like points, lines, circles, etc. These classical shapes were adapted taking the new design effects generated through combining different printing materials like ink, dye, paint as well as pastes and additives with a spray serving as an application tool into account.

In order to validate the alphabet with the new technical parameters, we have conducted systematic experiments on the machine. While experimenting with the alphabet on textiles, we encountered various difficulties that forced us to develop new design solutions and further develop the application tool. As Nimkulrat explains: “Disturbance leads us to notice the aspects of the tool and turns it into an object to be thought about.” [Nimkulrat, 2012]. This process of reflection-in-action [Schön, 1983] provided us with valuable insights to improve the technical design briefing.

Through learning how to generate new designs/effects by using different kinds of colour (inks, dyes, paint, pastes, additives) in combination with the manipulation of the machine’s different parameters, a new design process is evoked. In order to implement this new process, to teach designers how novel patterns can be created by the new technology and to demonstrate the design innovation with the new technology, a technical design briefing for designers is essential. The aspired machine offers three major assets compared to a
traditional digital printer or silk-screen printer. The first asset is the possibility to print a design in layers. For example a first layer could consist of a random effect sprayed from a far distance, a second layer could react on that effect by overprinting the first layer with a thick bulging haptic line in a puffy material and a third layer could again spray over these bulging lines, etc. In other words: Design happens in different layers, it is not a finished pattern sent to the digital printer to be printed. Secondly, there is no restriction which layer is printed first or how many times a layer is printed, however, the chosen layer sequence defines the result. A different layer sequence results in a visually different print. That is, designers are not obliged to write a finished printing script for a layer sequence. After every layer a designer can decide again what should happen next. The third asset is the possibility to intervene in the print process while the machine is running. This asset gives designers the possibility to start of with one design idea, begin printing and then react on the print in real time by changing the design if necessary even before one print layer is finished.

[Fig. 4] Technical design briefing

Therefore the creation of textile patterns with the DAFAT machine demands a three-step process:

1. First, the designs have to be built in layers consisting of different carefully selected colours (inks, dyes, paints, pastes, additives), shapes or effects.

2. Secondly, a layer sequence has to be chosen in consideration of which colours (inks, dyes, paint, pastes, additives), shapes or effects should interact with what colours (inks, dyes, paint, pastes, additives), shapes or effects.

3. The third step of creating the textile pattern takes place in interaction with the machine by changing the machine’s parameters and if needed changing/playing with the layer sequence during printing.

While experimenting with the three assets (designs in layers, layer sequence and interaction during printing), the design vision is becoming explicit. Laminating one layer after the other as well as using printing material from ink up to high viscosity pastes and additives results in colour regaining materiality. Because it is possible to interact with the machine by changing the machine’s parameters in real time, the DAFAT machine becomes more than just a printer it turns into a design tool. It represents hand and brush at the same time comparing the process with painting.
After three years of development work, two new application prototypes have been produced. The first is a sprayer for textile dyes and the second an application tool for pastes with high viscosity. The textile sprayer applies the colour to the textile without creating 3D-structures thereby deviating from the design vision. As a first step in the project, this technical step demonstrated a new application method on textiles using common inkjet dye. This step was necessary because of the complexity of the development process. The spray works like a plotter applying ink based on digital vector files. The parameters controlling the spray performance became new design parameters: the air pressure, the amount of colour, the velocity of the spray movement on the textile and the distance of the spray nozzle to the textile. While the spraying is in progress, some of these parameters can be changed in real-time, creating new design effects on pre-programmed digital file commands. This prototype works like a design machine and integrates the customer’s wish for reproducible yet individual textile fabrics. The design alphabet translates the digital design motive into the aesthetics created by the machine and gives the designer inspiration and instruction how to apply the machine.

The second prototype applies pastes with high viscosity to the textile. The technical and aesthetic innovation aspect of this prototype is more novel than the first prototype and in that sense it approaches the design vision. Until now, pastes with high viscosity could not be applied in a digitally controlled way and automated onto textiles. The prototype enables to change the tactility of the textile by creating new structures on the surface. As such, the textile design product language is enriched by introducing new patterns and textile design elements like coloured textile structures of variable height (1 to 5 mm) and variable width (2 to 5 mm), which may have a sharp outline or a spreading outline. Design elements are 3D moulded lines, splattered nets, regular and irregular 3D-paste patterns which may be coloured with pigments, with glitter, with reflecting or phosphorescent colour effects.

**Case 2: Design Research Project ‘Interior Embroidery’**

The second research project focuses on the application of embroidery on non-textile materials. Due to reduced orders the Swiss textile industry is currently forced to look for new fields of activities. In addition within the interior design market a demand for tangibly interesting surfaces in terms of tenderness, warmth, relief and structural changes can be noticed in contemporary material and product developments. Based on this observation a feasibility study of embroidery on non-textile materials was carried out in 2010. The results of the study where that the processing of veneer with textile embroidery could be carried out, specifications for new material characteristics could be defined and a survey about the state
of the art was conducted. This feasibility study provides the basis of the bespoken project Interior Embroidery.

Interior embroidery was an interdisciplinary cooperation between eight companies, including six textile companies and two specialists in wood processing, product design and production. The project lead was with our research institute and the project was funded by the Swiss Government. The goal of the project was to develop an industrial process that combines the textile embroidery technology with the processing of wooden veneer in order to create a new design language. This novel technology would lead to the creation of unique interior design products that would enable the embroidery industry to enter new market.

The design vision is demonstrating the added value for wooden surfaces finished by textile embroidery technology, which will offer a new decorative look and an unusual soft feel to wood used in interior design. Furthermore, applying a repetitively stitched yarn on the normally brittle wood creates textile-like characteristics. It holds the potential to inspire for diverse applications of wooden veneer in interior and product design. The strong driving force in this project originated from the imagination of these potential fields of future applications in interior and product design and results in the decision to develop a new production process, which leads to these innovative wooden surfaces. To achieve this within the given industrial scale, the project team developed an appropriate technical know-how and defined a specific production chain from veneer production, to embroidery, to furniture making. At the same time a comprehensive new design language was developed, which explored the technical limits of the embroidery technology adjusted to the specific dimensions of interior objects. The design vision and the technical know-how of textile and interior processes led to the set-up of new business opportunities introducing traditional embroidery into the interior design market.

Referring to the textile design research method underlying each interdisciplinary project, design and material experiment, the development of the design alphabet and its evaluation was executed as follows:

According to the given industrial circumstances and requirements, a variety of veneer and yarn materials was embroidered within a systematic framework of experiments and designs. Yarns ranging from chenille and leather to hemp rope, from shiny lurex to voluminous woollen stitching yarns were used. Each yarn was combined with either a dark or bright wooden veneer in various small trial motives (dimension 8x8cm). These motifs represent the product language of wooden embroideries: from extremely dense to wide and loosely stitched lines, from geometrical forms with sharp edges to organic bodies with 3D-embroidery-effects. These systematic experiments illustrate on the one hand the technical limits of the industrial embroidery machine and reveal new functional and aesthetical characteristics of the material combination. On the other hand, due to the cooperation between designers and technicians in this early stage, the project group discusses and finds agreement in the new product language, which adjusts the traditionally small dimension of the embroidery patterns to interior design. In reference to the elaborated design vision and criteria in the beginning of the project, a selective assortment can be taken from the results of these systematic experiments in order to represent both aspects: the technical feasibility and the aspired design language for interiors.

The design alphabet for interior embroidery embodies a new quality of material. Therefore every piece of the alphabet for wooden embroideries has to fulfill the following criteria:

- An unusual soft and/ or three-dimensional feel;
- The proportion and dimension of the pattern is applicable to interior design and on for further processing by wood specialists;
- It cannot be reproduced in any other technique than machine embroidery.

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2 Partners: IGS St.Gallen consisting of six embroidery companies, Sitag AG, ag möbelfabrik horgenglarus
This selection of samples that has been created according to the above-mentioned criteria represents the design alphabet for interior embroideries. Based on the design alphabet, the design process and planning of prototypes in original size could be considered and initiated. After the characteristics of the chosen material samples were analysed and translated into the design briefings, they were handed over to the project partners in order to manufacture the prototypes accordingly. In addition a specific market research was executed with professionals from potential customer groups for wooden embroidered products to collect feedback on the potential market performance of these products. The design briefing represents the identified potential application areas such as surfaces furniture and three-dimensionally embroidered upholstery materials.

The results of the project are a collection of product prototypes representing an ‘interior embroidery scenery’ and a so-called ‘toolbox’ with materials visualizing the design options for wooden embroideries referring to the product-scenery. These items reveal the variety of possible applications and embody the aesthetic potential of interior embroidery. Design options, such as surprising 3D-effects on veneer and unusual textile materials for the use in interior design is easily accessible through this ‘interior embroidery-scenery’ and ‘toolbox’. These items also disclose, that the design has to follow certain guidelines, such as lines in the embroidery design should not be parallel to the wood fibre. It is meant to inspire designers and future customers of the Swiss embroidery companies for diverse applications. They are important tools for designers within the industry who are going to develop interior embroideries in the future. The purposeful choice of almost neutral colours for the samples in the toolbox and the interior embroidery scenery gives support in terms of a possible variety in design language and leaves the design direction of future projects open.
Even though the project interior embroidery has officially come to an end, the experimentation of transferring ancient and traditional design knowledge and industrial ‘craftsmanship’ of Swiss embroidery companies onto new materials is ongoing. The project has given the participating companies a clear direction of how to develop novel products and enter new markets. Some of them are hesitant as such a strategic decision requires not just the implementation of the new technology in the production process, but also the development of an entire new business network that is currently outside the reach of these companies. At the time of writing this paper one of the six companies is pioneering the new technology, shifting its focus towards new markets within interior and architecture design.

**Case 3: Design Research Project ‘E-broidery’**

The third research project concentrates on the integration of lighting into textiles. Looking at the state of the art of the combination of electronics and textiles remarkable attempts to integrate active lighting into textiles started even as electricity and light bulbs became a commodity in the late 19th century. Nowadays there are many products and projects that combine light and textiles. The topic of textile electronics is dynamically evolving and provides a great variety of technological concepts, products and designs. Due to the huge amount of potential applications lots of sectors are pushing different techniques in order to develop flexible, light, wearable, interactive products. The topic has been taken up in industrial surroundings, but also within the visionary start-up and DIY-sector (do-it-yourself). While for example screens are getting thinner and more flexible and smartphones are becoming more than hardware, a large variety of clothing items are becoming ‘brighter’ through integrated lights and screens.

When the e-broidery project started in 2011 none of the many inventions were manufactured in an automated process. Most inventions did not get beyond the prototype phase due to the vast amount of handwork involved in integrating the electronics into textiles. Very often these prototypes did not enter the market because they lack functionalities common to textiles such as washability, drape and tactile characteristics.

The challenge was to move beyond the creation of one-of-a-kind pieces made for red carpet occasions and develop an automated process that would enable mass production of smart clothing. The Swiss company Forster Rohner was aware of this demand and developed a
project called FRTI, Forster Rohner Textile Innovations, in 2009. The goal was to integrate electronics in textiles through the traditional stitching process that the company had used for creating precious embroidery fabrics for couture customers since over a century. In 2011 the company asked our institute to collaborate in deepening textile research and bringing in a strong design perspective as to be able to launch new products in the market: the project e-broidery was born.

The goal of e-broidery project was to develop the first industrial embroidery process that enables the integration of active lighting into fabrics without compromising on the core textile properties like washability, drape and feel. The design vision described a new dimension in the design of fabric surfaces by integrating active lighting. It was achieved through an interdisciplinary project team consisting of textile designers, textile engineers, electrical engineers and material scientists. The Swiss Government funded the project and the project lead is with us. The project team followed the textile design research method that led to innovative results.

Through formulating and visualizing an overall goal and design vision the interdisciplinary team developed a common language. The goals can be summarised as follows: “Lights and textiles are merging into a new and innovative product dimension. It allows the user to observe the different views of smart and illuminated textiles and to experience the subtle expression of such textile surfaces.” The new dimension originates from the fusion of contrasting characteristics: ‘immateriality’ (lights) and ‘materiality’ (textiles). Through moodboards and trendcast the design vision is documented and results in the identification of three different aspects of the design language, out of which the future products of illuminated textiles should express at least one of them:

- Modern Craft & Poesy: In a playful way the LED lights will reveal softly and change its visibility dynamically and in interaction with its surrounding [Mueggler, 2011].
- Opulence verses Light(ness): The LEDs mystically highlight the sculptural appearance of the textile surface while the strong and heavy textile contrast the immateriality of lights.
- Experimental colour: The colour of the textile material together with the colourful light of LEDs interfere in natural and artificial light situations of the surrounding.4

3 e-broidery Partners: Institutions – Lucerne University of Applied Siences and Arts, NTB Institute, Schweizerische Textilfachschule, Industry – FRTI, Création Baumann, IST AG, Elektrisola Feindraht AG
4 Observed was the color range using cold-white LED. The technique will be further developed to work with RGB-LEDs in the follow up KTI project, starting 2014
Based on a broad market research with future target groups these three aspects represent the initial vision from a design perspective. It has to follow the technical restrictions as well as the market requirements in terms of costs and fulfil the expectations from the future user groups regarding usability. This narrow framework however is the reference to analyse the results out of the systematic experiments in order to develop the design alphabet as final criteria for technical decisions and developments of prototypes throughout the process.

Not only functional requirements have to be fulfilled, but “technology has to align with emotions”. [Jokinen, 2013] As the functionality and aesthetic of textiles change through the integration of electronics, the usual requirements and most likely also the target groups have to be redefined. Therewith the vision of product identity and requirements for (textile)designers, marketing and salesmen have to be redefined. [Steffen, 2009]

Systematic experiments have been executed to challenge the limits of design expressions due to technical restrictions. It was necessary to carefully observe the perception of the light in the textile surface in order to learn how to design illuminated surfaces in the future. The experiments mainly focus on different distances between observer and illuminated fabric to discover the principles of readability of lights for example as individual dots or as groups of lights representing a motif such as lines, circles, etc. and the intensity of the light in different surroundings.
After the execution of several such experiments the relevant aspects influencing the appearance of illuminated textiles in interiors could be pointed out. They include the overall look and feel of the textile in combination with the expression of the lights and have led to the following criteria as part of the Design Alphabet:

- E-broidery textiles have different aspects, each one of it (on-mode, off-mode, etc.) shall be interesting to look at;
- The light has to be changeable and adjustable in strength (brightness) and speed (in case of dynamic light sequences);
- The e-broidery textiles are delicately featuring both lights and textile design;
- The combination of light and textiles introduces a new product dimension as they together broaden the current experience of interior fabrics creating a unique and valuable atmosphere.

This project has been completed successfully. Création Baumann launched the first e-broidery collection in October 2013. The collection named “eLumino” has also been nominated for the Swiss Design Price 2013.
Conclusion

This paper describes how the four-step methodology of textile design based on product language theory has been applied in the context of three research projects. All three projects were applied research projects involving interdisciplinary teams with team members ranging from textile designers to engineers to sales people. The projects reveal that the textile design research method challenges traditional knowledge about how textiles are constructed and designed. As such, the textile design research method (TDRM) proves to be a unique tool for designers in developing innovative textile products and processes that push the borders of textile design into electronics, interior and architecture design.

This method affects the process level of innovation as well as the material aspects and design level. The use of this method and the reflection of such on its outcomes demonstrated to be a comprehensive tool both for designers and other disciplines and it enabled us to successfully develop innovative textile processes and products. With this procedure holistic conclusion could be drawn from a variety of applied research projects with different partners. In our interdisciplinary projects the designer takes an essential role by challenging the technical limits through a broadly established and consciously applied design perspective. In addition this is diversely and well formulated through several publications starting 1975.5

Based on the state of the art throughout the specific topics of textile research projects, we identified the design vision to be a constructive driving force for textile product innovation. The established method interprets and challenges the traditional knowledge about how textiles are constructed and designed. Therewith it will enrich the present and predict a future product language in order to enable innovative materials and product identities in the textile field.

5 Ex.1: Albernathy / Townsend, 1975 Ex.2: Albernathy / Utterback, 1975
References


