

Colour flow & Colour Collage

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Abstract

This paper discusses two case studies *colour flow* and *Colour Collage*. These cases explore the visual effects of movement using coloured light as a continuous time-based medium in the field of textile design. They present new forms of *instruments*, *textile instruments*, interfaces which allow displaying light compositions inside textile surfaces. The textiles are based on woven structures integrating PMMA optical fibres, which are activated by RGB-LEDs and use a digital interface to realize light-emitting textile expressions. They explore in different ways the light emitting material, thereby not only creating new forms of physical objects, likewise introducing *physical* as well as *non-physical* aspects of *design expression – material expression*, the light emitting fibres and the light as such.

The projects propose new ways of thinking whilst designing with changeable material expressions. *Light* and *Time*, both used as *physical* and *non-physical* forms of material (optical fibres and light, programmed time duration and changing form of expression over time) create *instruments* (textile structure) and *compositions* (lighting sequences), fused into indivisible matter performing unique forms of expressions.

Keywords: light-emitting, coloured light, textiles, time, movement, PMMA optical fibres

Prelude

This paper discusses two case studies *colour flow* and *Colour Collage*. The first a series of experiments and the second an exhibition piece exploring the visual effects of movement using coloured light as a continuous time-based medium in the field of textile design. They present new forms of *instruments*, *textile instruments*, interfaces which allow displaying light compositions inside textile surfaces. The textiles are based on woven structures integrating PMMA (PolyMethylMeta-Acrylate) optical fibres, which are activated by RGB-LEDs (light emitting diodes that each contains three LEDs, one red, one green and one blue which through additive colour mixing allow displaying a wide range of custom colours) and use a digital interface to realize light-emitting textile expressions. They explore in different ways the light emitting material, thereby not only creating new forms of physical objects, new kind of textiles, likewise introducing *physical* as well as *non-physical* aspects of design expression – material expressions, the light emitting fibres and the light as such, and its preceding design processes.

These experiments aim to expand an understanding about *time* and *light* as new forms of design materials, in order to allow designers to compose time-based patterns when designing light integrated into textile structures. The projects are routed in the question: What does it mean, if time and change – constant movement – become part of the textile design expression? Thereby, the textile design pattern reveals its composition, not in one moment of time any more, but in fact over time. This practice based research work aims to create time-based textiles with an emphasis on developing aesthetics of movement – or to establish movement as an aesthetic moment in textile design. Case study one, *colour flow*, is based on extracts of the PhD thesis *Composing over time, temporal patterns – in Textile Design* (Jansen, 2015). Case study two, *Colour Collage*, is an art piece which has been created for the solo exhibition *Barbara Jansen* at Fibre Space Gallery in Stockholm in February 2016.

In the following descriptions of *colour flow* and *Colour Collage*, two forms of writing have been used. One is purely descriptive, neutral form to describe the experiments as such, whereas text titled *Research Diary Notes* includes reflections and personal comments on the experiences during work on the experiments. Most of the latter form of writing comes from my sketchbooks, in which I continuously documented the work processes.

Background

Textiles – Smart Textiles

With the beginning of the era of Smart Textiles, the textile designer is challenged with a range of materials which are characterized by their ability to change expressional and functional properties. These materials respond to environmental stimuli, user interaction and pre-programmed parameters and visualize their responses to the viewer. They open up opportunities to explore new material behaviours and designing with novel and complex aesthetics (Berzina, 2011; Krogh, N.D.; Layne, N.D.; Taylor, 2010; Wingfield, N.D.; Worbin, 2010) The availability of these new materials changes the conditions of conventional textile design; a textile pattern expression is no longer static, it once had one face, one gestalt or expression, whereas now it can show different expressions, a definite or indefinite number of times.

Traditionally the textile designer is working with colour, form, structure, material aesthetics and tactility. These design elements interact within a physical two-dimensional or three-dimensional textile structure. The created textile expressions and functions are supposed to be static, stay the same, over the lifespan of the created textile object.

Introducing new generation of materials opens up for creating several different expressions that appear one after the other. In the case of *colour flow* and *Colour Collage*, new forms of expressions appear as textile surfaces (woven, integrating PMMA optical fibres as light-emitting material) emit light sequences that continuously shift and change the colour of the light. Even though first projects have been created, where time as a design element has been started to be explored, it has not always been pointed out as such (Berzina, 2011; Gullickson, 2012; Hauan Johnsen & Urstad, 2008, Hauan Johnsen & Urstad, 2012, Hietanen, N.D.; Iversen, N.D.; Krogh, N.D.; Layne, N.D.; Ligorano, 2010; Taylor, 2010; Wingfield, N.D.; Worbin, 2010). Thereby in the present research work, the relevant parameter is time and the temporal frame, within which changes will occur and dominate the starting point of the design. Time as a design element or a material, is still a new element for a textile designer to work with. This is the reason the research work presented in this paper and in previous PhD thesis (Jansen, 2015) aims to expand an understanding about time as a design material, in order to allow designers to compose time-based patterns when designing light integrated into textile structures.

Light – Textiles- Optical Fibres

The light-emitting material used in the projects is PMMA optical fibres. This type of

fibres have been integrated into industrially woven structures, and emit light by the use of coloured RGB-LEDs (which are controlled by microcontrollers). Optical fibres are interesting to use as a light-emitting material in a textile context as their appearance is quite close to a transparent thread. Using a “light thread” offers an opportunity to make light become a textile piece in itself. In this way light and textile structure melt into each other and become indivisible.

There is currently no standard LED system on the market that is able to connect to textile applications (incorporating optical fibres). The present work uses a special customized LED lighting device system, which has been developed in collaboration with UK based electronic specialists, Circatron Ltd. It is a further developed version of the lighting device system used by Sarah Taylor for *Inner Light* (Taylor, 2010). The system allows coupling of the optical fibre ends to the LEDs and a digital Mix (DMX) replay system controls the lighting sequence via programming processes.

Colour flow

Introduction

Colour flow is the initial series of experiments that investigate time-based patterns, as an opening to compose over time. The series explores the creation of sequences of coloured light and the aim is to explore how to lead over from one action to another, to change from one colour to the next. The main focus here is transitions over time, i.e. how to design a transition from one colour to another via an in-between state.

In the following, descriptions of the experiments, the metaphor of *instrument* and *composition* will be used. Each textile structure (in this case a woven structure) is understood as an *instrument* on which various *compositions*, i.e. light sequences, can be played. A *composition* can consist of one or several *voices*, one or several sections activated independently in the textile structure. Thus, each *voice* can play its own melody or play in unison with other *voices*.

Experimental Set-up:

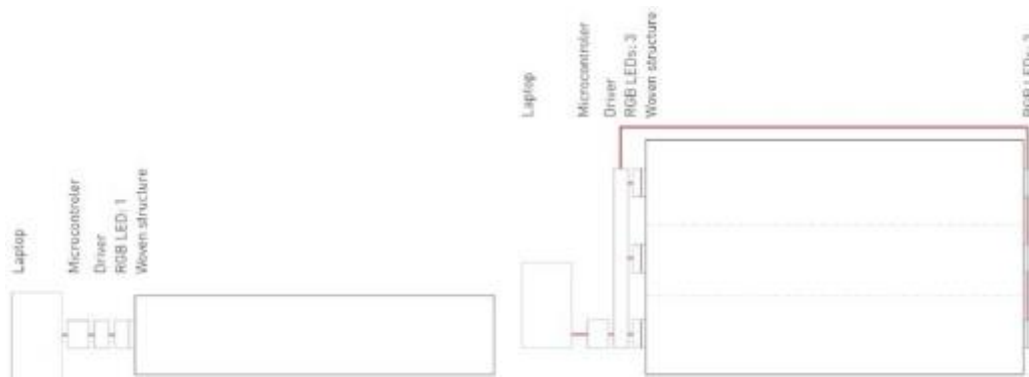


Figure 1: Colour flow_part 1; colour flow_part 2.2

Instrument = physical form of design expression

Industrial woven structure 130x30cm: the woven structure integrates PMMA optical fibres in combination with copper yarn in the weft direction. (The copper acts as a reflection base for the emitted light in order to strengthen the light effect.) The structure is divided in three equal sized horizontal sections positioned on top of each other. Each side of an individual section is connected to separate RGB-LED and independently programmable to create moving patterns of coloured light. Meaning this *instrument* consists of six *voices* which are displayed into three individual areas of the surface. The *voices* can be either played in unison, activated at the same time in the same coloured light, one monochrome lighting surface appears or play their individual melody creating three distinct colour areas or multi coloured surface effects, see figure 2.



Figure 2: Colour display: one monochrome lighting surface; three distinct colour areas; multi-coloured effects

In the case of *colour flow* the Easy Stand Alone software (original used for theatre lighting) has been used which facilitates individual control of a range of individual light fixtures. Via the software, dynamic light sequences can be programmed, so called scenes. Each scene is built up of a series of steps. A scene can either be played once or be looped. Additionally a group of different scenes can be played behind each other.

Composition = non-physical form of design expression

In three parts the creation of coloured light sequences has been explored. In the following *colour flow_part 1* and *_part 2.2* will be shortly introduced. *Colour flow_part 1* as an opening foundational colour study and *colour flow_part 2.2* is an elaboration on building more complex light composition based on several successive parts.

Generally spoken there are two ways in which a LED can be switched on or off: via *holding time*, the change of light colour occurs in distinct steps and via *fading time*, the change of light colour occurs through a dimming/fading process within a scale range, or a combination between *holding* and *fading time* appears. See figure 3, see videos: video 1 (<https://youtu.be/HFw3WrVrggE>), video 2 (https://youtu.be/b_dsJ064gnI), video 3 (<https://youtu.be/Z03332zWhok>). (Note, that the frequencies of the camera and the RGB-LEDs controlling the textile are not matching, therefore a flickering/vibrating effect appears in the video material, which does not show in the original piece.)

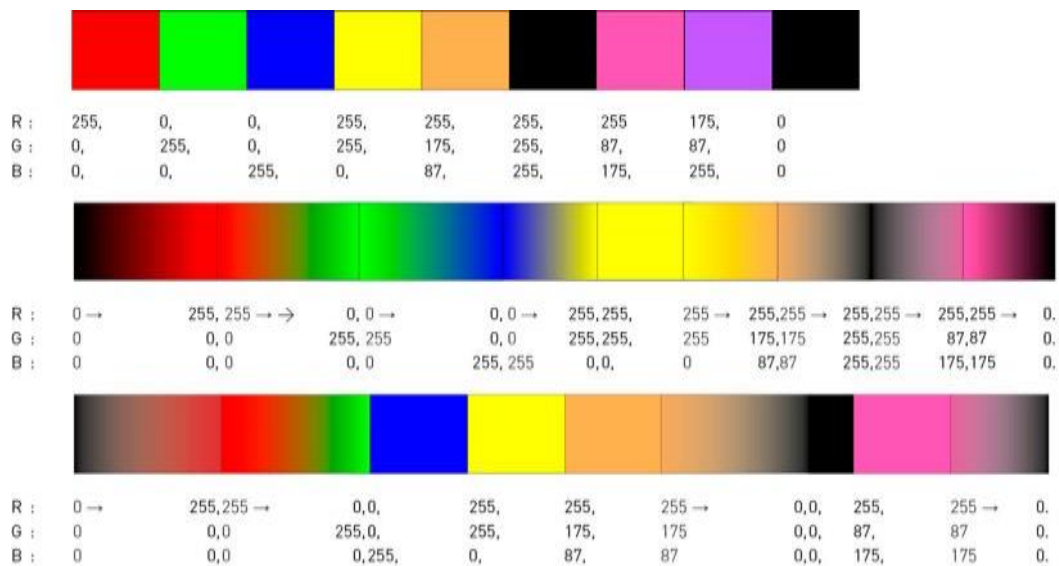


Figure 3: Time progression/colour combinations: via holding time; fading time; holding + fading time

In *colour flow_part 1*, one of the sections of the textile structure was explored and treated as one *voice*, as one single colour surface. The light has been activated from one side of the section, see figure 1. A photo was selected as an inspiration for the choice of colour range, see figure 4. Fifteen colours were randomly chosen in an attempt to sample the entire colour spectrum of the photo. All in all three different *colour orders* were created: *colour order 1*: the initial random choice of colour, *colour order 2*: re-arranged colours in order to create the smoothest possible colour transition from orange/apricot to red/purple

and finally to blue, *colour order 3*: re-arranged colours to achieve a multi-coloured effect (German ‘bunt’), see figure 5.



Figure 4: Inspiration photo



Figure 5: Three colour orders

All *colour orders* have been explored with a range of different time-lines or scenes, playing only via *holding time* or a combination of *holding* and *fading times* with varying time durations between them, see figure 6.

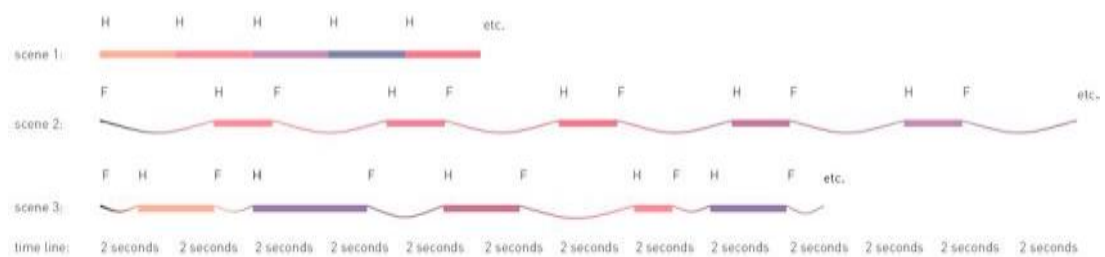


Figure 6: Three different time-lines/scenes

For example using only *holding times* creates clear distinct steps but maintains a quite static form of colour change, see figure 6, *scene 1*, see video 4 (<https://youtu.be/1ZKRPxmX8v8>). Introducing a combination of repeated *fading* + *holding times* with an approximate ratio of 3:1 in combination with *colour order 2*

enhances a smooth, fluid transition from one colour to the next, see figure 6, *scene 2*, see video 5 (https://youtu.be/08z0H1TL4_g). Combining an irregular time-line (differentiated non-repeated sequence of time durations of *fading + holding times*) and *colour order 3* attempts the opposite in order to reach a more rhythmic feeling, a more melodic scene progression, see figure 6, *scene 3*, see video 5 (previous link).

In *colour flow_part 2.2* all three section of the textile are activated and partly treated as one and partly as separated *voices*, creating both one monochrome lighting surface all over the surface or two to three distinct coloured stripes with monochrome or multi-coloured light effects. It is an attempt to create a composition consisting of four parts, elaborating the full potential of this instrument.

Thereby *part one* treats all sections as one *voice*, colour changes appearing identical and synchronic over time playing a more melodic and contrasting colour order. *Part two* and *three* are characterized through a melodic interplay between a fine-graded colour range and contrasting colours appearing in ongoing varying tempi. Contrast and the feeling of movement are created by movement up and down the structure. As soon as the fifth *voice* is activated, *voices* two and five both play their sequences on the middle section. This facilitates a multi-coloured effect in this section and also opens up opportunities for further directions of movement, e.g. from left to right and vice versa. The *fourth scene* activates all three sections of the fabric temporally from one or both sides, highlighting the maximum complexity of lighting in this specific instrument.

(Graphic representation of *colour flow_part 1, 2, + 2.2* can be seen in Jansen, 2015, pages 46f, 54ff, 68ff and Appendix 2: Poster 1: *colour flow_part 2.2*, see video 6 (https://youtu.be/_IoBsFbou3I).

Research Diary Note:

Having displayed and discussed colour flow in different development stages and presentations revealed that the context, in which the instrument and its composition are viewed in, strongly influences the audience acceptance. Therefore, the feedback has vigorously affected the final form of colour flow_part 2.2. Originally aiming for utmost fluidity between the colours, like in colour flow_part 1 scene 2, the transition between the colours is so smooth, that it is hardly noticeable. Underlining the aim for a contemplative calming expression. The work towards increasing fluidity between the colours based on observation of

the changing daylight. The transitions of sunrise and sunset emerge so fluid and slow that you hardly consciously notice it. You observe the colour change in the fabric, and wonder what is happening? Is

anything happening? Looking away for a moment and back again, suddenly you see the colour has in fact changed, very slow, but still noticeable. I managed to get quite close to it. Unfortunately, in a “fast” presentation situation, there the focus is to demonstrate the potential of colour display the slowness of colour change is a challenge. The audience doesn't seem to have the patience for slowness, lost interest, instead would show excitement by contrasting and faster colour interplay. Therefore, colour flow_part 2.2 is an example for more “rapid presentation situations” displaying general possibilities of colour potential.

Whilst a further development of slowness and fluidity of colour transmission seems to require a carefully chosen presentation setting, where the audience is willing to contemplate longer with an art piece. Alternatively, maybe even an everyday environment, where the textile work would as the daylight –play an unconscious role, and could be fully discovered over a long time exposure.

Colour Collage

Introduction

Colour Collage is a composition in three parts. Its point of origin was to create an exhibition composition for an existing instrument in a limited period of two months for a specific exhibition context, the Fiberspace Gallery in Stockholm. Whilst *colour flow* used one image as an inspiration source to develop a *colour palette*, the *temporal progression* was created independent from the inspiration source. Though *Colour Collage* attempted to go beyond that by using three images as source of inspiration to explore a new method in order to create a *colour palette* and *colour order* and therewith the *temporal progression*. Each part bases on one of the inspiration images and creates a different colour atmosphere, in respect to colour tonality as well as movement qualities. You might say the only *red thread* in this story of three chapters - three parts - is a shifting *lax-red* to *lax-rose*, as well as an increasing crescendo of vivid liveliness.

Experimental Set-up:

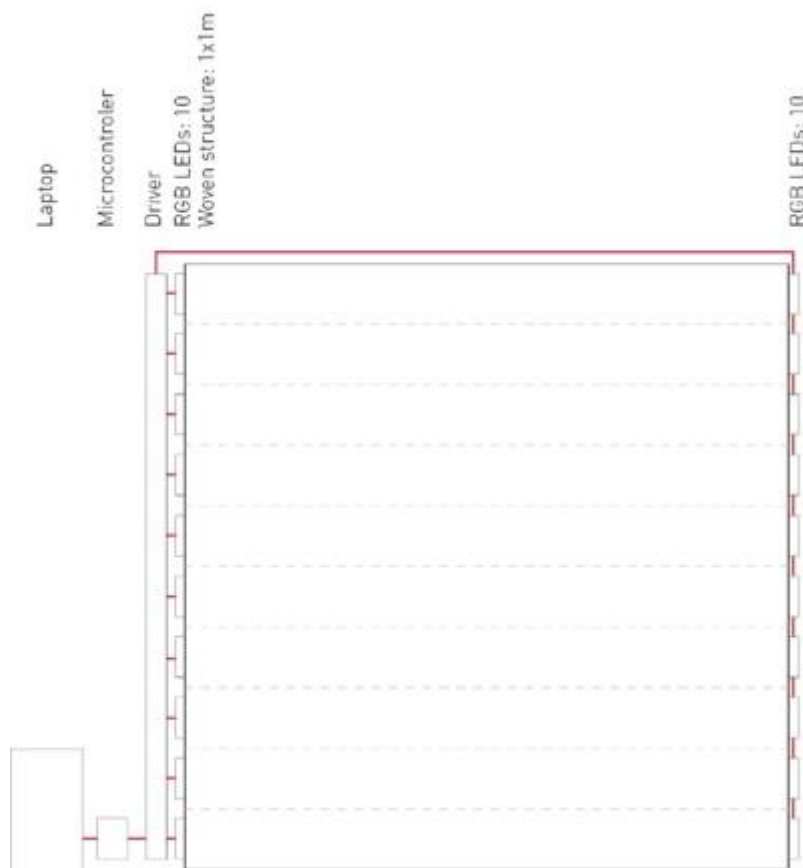


Figure 7: Colour Collage

Instrument = physical form of design expression

Industrial woven structure 100x100cm: the woven structure integrates PMMA optical fibres in combination with white paper yarn in the weft direction. (The paper yarn acts as a reflection base for the emitted light in order to strengthen the light effect.) The structure is divided in ten equal sized horizontal sections positioned on top of each other. Each side of an individual section is connected to a separate RGB-LED and independently programmable to create moving patterns of coloured light using a microcontroller. Meaning this instrument consists of twenty *voices*, which are displayed into ten individual areas of the surface. The *voices* can be either played in unison, activated at the same time in the same coloured light, one monochrome lighting surface appears or play their individual melody creating ten distinct colour areas or multi coloured surface effects, see figure 8.

In the case of *Colour Collage* the Easy Stand Alone software has been used.



Figure 8: Colour display: three different colour atmospheres; combination of distinct colour areas and multi-coloured effects

Composition = non-physical form of design expression

Colour Collage is a complex composition building on three parts. Each part used an image [one photo from the magazine Frankie and two postcards: see *part one*: figure 9, left side, see *part two* link: <https://www.navigart.fr/picassoparis/#/artwork/160000000000575?layout=grid&page=0&filters=query:picasso,+la+nageuse,+1929> (Note: the colour representation of the painting in the link does not match with the colour representation of the postcard), see *part three*: figure 9, right side] as inspiration source for its *colour palette* and *colour order*. For each part, a colour range was chosen in an attempt to sample the entire colour spectrum of that specific image. Each image was dissected with a grid of vertical and horizontal lines. Ten vertical lines (in accord with ten sections of the textile) being read from the bottom upwards. In addition, twenty-one, fifteen and twenty-four horizontal line for *part one*, *two*, and *three*. See example from *part three* figure 10. At each intersection of a horizontal line with one specific vertical line, the next colour for that vertical line: vertical axes/time progression has been picked.



Figure 9: *double-frill* by Karen Walker; *Trädets Skugga* by Maria Lundström

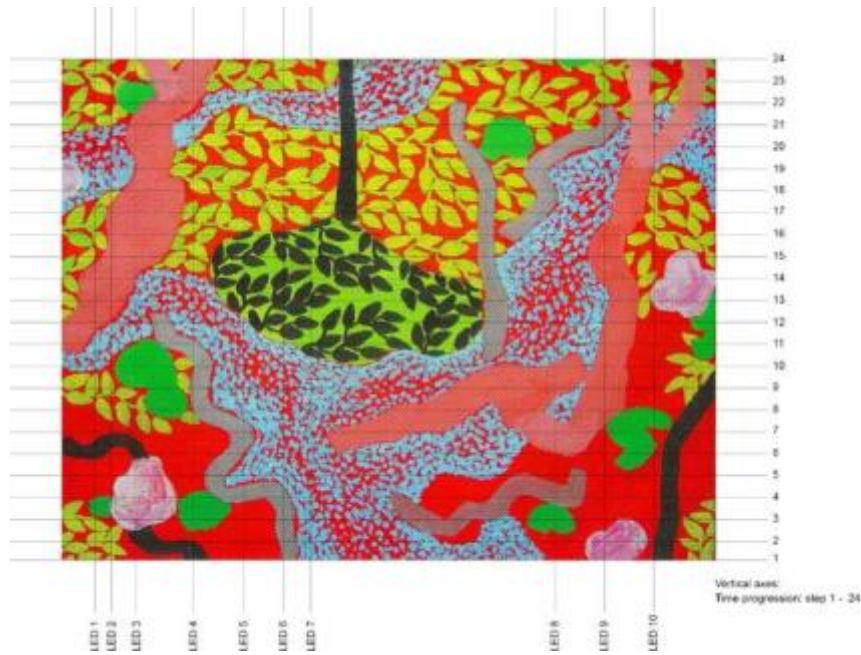


Figure 10: Trädets Skugga by Maria Lundström (postcard version) and grid

The figurative motive of the images did not play a role, rather the way colour has been applied on a surface. Smooth-fading background transitions in brownish-grey + bold clear differentiated lax-red in the front; lively shaded blue beside a dancing lax-rose; energetic puzzle of pinks + red + greens + blue + greys + black (*Part 1: double-frill* by Karen Walker; *Part 2: La nageuse* by Pablo Picasso; *Part 3: Trädets Skugga* by Maria Lundström).

Research Diary Note: and from here on it gets a bit crazy.... Yes, there was an initial systematic plan of how to dissect the images in vertical and horizontal lines and thereby generating a colour palette, a colour order and with that the base for a time-grid, a temporal progression. Each of the three colour orders have been initially tried out in an identical timing for each step of a scene; for example a scene is built from steps of 1 second holding time, or steps of a 0,3 second fading and 1 second holding time. BUT then things went their own way. Starting by the re-discovery of the challenge, the frustration of trying to achieve colour precision in the work with RGB-LEDs displayed into an optical fibre textile. It is just impossible.

You pick a colour red, from the original image, write down its RGB values, you open Easy Stand Alone software and program those exact values and out comes this:

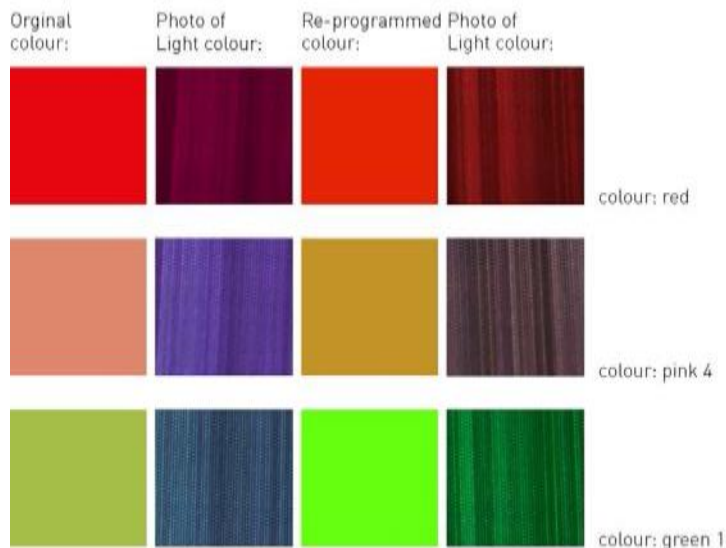


Figure 11: three examples of original chosen colour, photo of their appearance inside the structure, re-programming and photo of that appearance inside the structure.

Research Diary Note: It is impossible to go from a digital RGB colour value to an RGB colour emitted through the textile, and equally unmanageable is to get the correct colour representation of the light emitting textile in a photo. Those colours of the photos, likewise do not match the colours in the physical object. So what to do about that?

As already in detail discussed in the PhD thesis (Jansen, 2015) there is not only the issue that the colours emitting from the textile never display a homogeneous colour at the programmed moment in time, on the contrary they rather appear in a multi-coloured effect, see example figure 12.

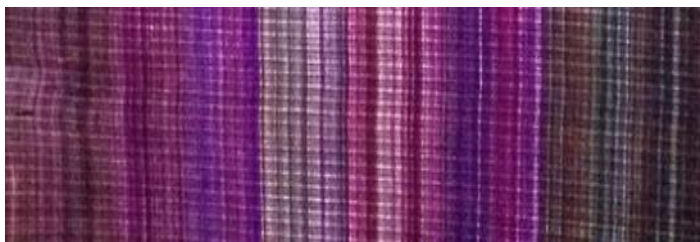


Figure 12: Multi-coloured effect emitted from structure

Using RGB-LEDs, light colours are created through the additive colour mixing principle and in theory should allow to create a wide range of colours. Theoretically, the light of the fully lit red, green and blue LEDs creates white light and when light intensity of any of the three LEDs is varied, a range of colours appears (e.g. R: 100%, G: 100%, B: 0% =

yellow). However, the fact that the three LEDs are spatially mounted apart from one another brings with it the complication that only a very small portion of the lit area displays a 100% overlap of the emitted light and, thus, other portions of the lit area emit additional colours. Several experiments have been conducted under the PhD to enhance the quality of the colour mixing process (see Jansen, 2015, page 55-61), but until today no technical solution has been achieved. That leaves two challenges: it is hardly possible to create a monochrome area of light and the programmed RGB values never appear in the same colour in the textile then on the screen.

Research Diary Note: sitting in a total dark room for weeks and going crazy, switching on a lamp to see the colours on my postcards, switching off the light to see the colour in the textile, on, off, on, off, on, off and in-between a computer screen, showing something else. At a certain point you can no other than letting go, firstly you have to kill your darlings, turning upside down you inspiration images and forget about them, secondly forget about any systematic attempt of tackling the colours and temporal form of progression, they having their own live. Then it is about listening to the colours in front of you and trying to find balance, and tension, transition and crescendo ... daring to trust your unconscious intuition again, by allowing the colours in front of you to have their own live, play and dance.

And of course by allowing this to happen, the researcher gets in trouble, as no longer every design decision can be justified nor explained. The artwork claims its own rights. See video 7 (<https://youtu.be/aUmf6S1WVSE>).

Discussion

Composing – Notions

In order to be able to describe these new time-based expressions and to compose over time, new *notions* (definitions) like tempo, rhythm, time and movement and *design variables* (i.e. elements to design with) have been defined in the context of time-based textiles. *Light, darkness, light intensity, (light) colour, and duration* are the new *design variables* to work with whilst creating light-emitting textiles. The *design variables* describe WHAT you are working with. For example using three light colours red, yellow, and green each of them with duration of 1 second, still a variation of expressions can

appear depending on HOW they appear. Do they fade in or not, do they appear behind

each other in time or parallel or a combination of these? In which way follow smaller or bigger phrases each other, in a larger composition? Using identical ingredients, *design variables*, can create a wide range of expressions, depending on HOW they have been composed with each other. Therewith shape a distinct feeling of *tempo*, *rhythm*, *time* progression and *movement* and thus the overall expression.

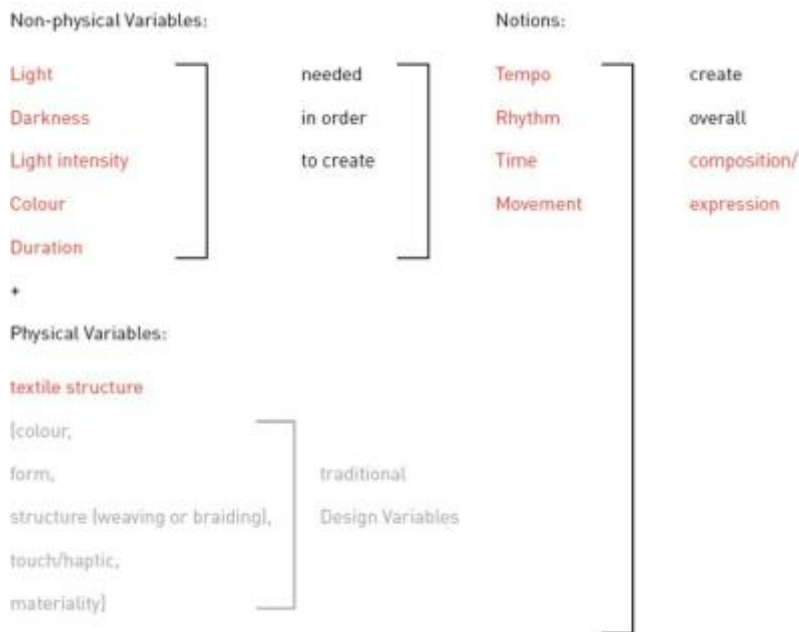


Figure 13: Variables and Notions

Instrument and Composition

During the research process, it became very clear that the time-based composition is not alone in defining the final expression. The textile structure displaying or playing the time-based composition is equally important: both of them equal influence the movement expression. Now, one could say that the textile design/composition is based on two main elements: the *instrument* and the *composition*. Each specific *instrument* has its possibilities and limitations, wherewith it sets the frame for the temporal compositions. It defines the amount of possible *voices* inside one *instrument*, as well as the form the light is shaped to inside the structure, i.e. the *instrument*.

For example: a woven structure, horizontal rectangle, is divided in three horizontal sections. Each section can be played from its two sides, i.e. maximum of six *voices* is possible. Two opposite *voices* create a pair. Each pair is shaped in a stripe, throughout the whole width of the structure. The *voices* can be played in chronological or non-chronological order, this and the shape of the *voice* creates a specific movement form and

character.

Only when a specific *composition* is played on a particular *instrument* a certain *expression* is created. Several *expressions* can be created through/on one *instrument* when different *compositions* are played on it. A specific shaped *instrument* lays the foundation for the non-physical material to act, to move, to express itself, the light.

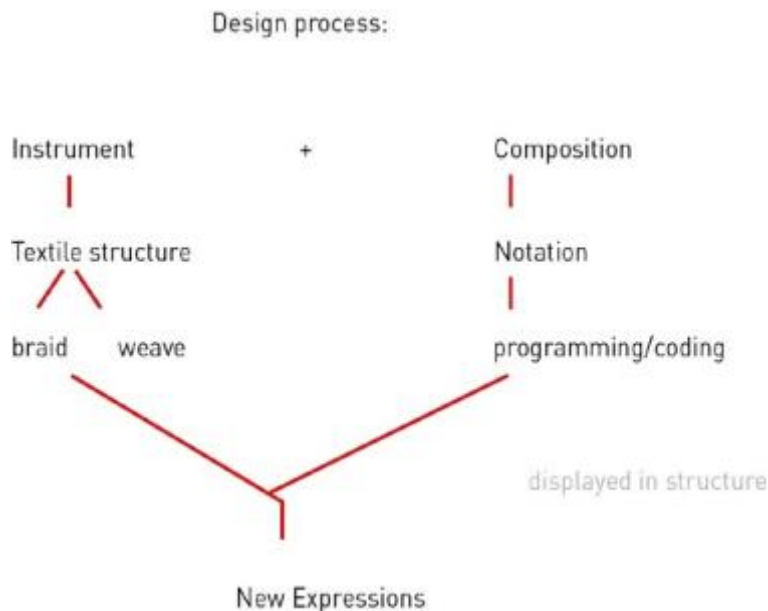


Figure 14: Instrument and Composition

Coda

Concluding each case study has generated a physical object that can display a range of time-based light patterns/compositions, thereby, demonstrating a variety of new expressional possibilities in the field of textile light design. *Light* and *Time*, both used as physical and non-physical forms of material (optical fibres and light, programmed time duration and changing form of expression over time) create *instruments* (textile structure) and *compositions* (lighting sequences), fused into indivisible matter performing unique forms of expressions.

Coming back to my initial research question: What does it mean, if time and change – constant movement – becomes part of the textile design expression? It requires to develop an understanding about *time* as a *design material* and to propose new ways of thinking whilst designing with changeable material expressions. Through examples of introducing music terminology, like the metaphor of *instrument* and *composition*, a foundation to

describe the distinction between physical and temporal form of expressions has been laid. Introducing *notions* like *tempo*, *rhythm*, *time* and *movement*, which are crucial elements for the new temporal forms of expressions, find verbal form. These *metaphors* and *notions* add on to the vocabulary of a textile designer in order to describe these new forms of time-based expressions. Furthermore, support the design process with temporal changing material expressions, which extend the textile designer's palette towards *tempo*, *rhythm*, *time* and *movement*. To look out for terminology from the time-based arts, like music, and how these art forms explore the temporal aspects of their media is highly inspirational and supportive whilst moving from a traditional field like textile design, which classical is only concerned with static forms of expressions towards multiple temporal forms of aesthetics.

It remains a challenge to communicate the full scope of achievement in the frame of disseminating a written form of documentation, as both the created expressions, as well the process of making reach beyond linguistic matter. Even though the paper, as well as the thesis it is based on, are accompanied richly with graphic material and video. New forms of physical and non-physical expressions call for new forms of communications. It remains my hope that we continue striving for them into the future. Might our next dialogue be accompanied by my *instruments*, and you being able to witness them performing their *composition*.

Acknowledgements

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Figures

Figures 1-8: All graphic material by Barbara Jansen.

Figure 9: left side: Karen Walker: *double-frill*, high-resolution image kindly provided by: <https://www.karenwalker.com/>

Figure 9: right side: Maria Lundström: *Trädets Skugga*, high resolution image kindly provided by: Maria Lundström, www.marialundstrom.se

Figure 10: Maria Lundström: *Trädets Skugga* (postcard version), publication permission kindly provided by Maria Lundström, additionell grid and time progression by Barbara Jansen

Figure 11: Graphic material by Barbara Jansen, photography of light textile by Henrik Bengtsson, Imaginara

Figures 12-14: All graphic material by Barbara Jansen.

Videos

Video 1-6: director Barbara Jansen, film and editing Filip Asphäll, University of Borås, 2012-2015

Video 7: director Barbara Jansen, film and editing Henrik Bengtsson, Imaginara, 2017