From Patchwork to Appliqué:
Exploring Material Properties Through an Interaction Design Remake

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ABSTRACT
Materials and materiality in interaction design has become more and more important perspectives within the field. Material explorations of a specific material could contribute to this ongoing discussion. As means to investigate how material properties affect interactive qualities for a tangible interaction design, a remake of an existing design was created. The starting point for remake is a tangible programming space for children called Patcher where custom built RFID readers is interacted with. For this investigation, Android mobile phones with NFC readers is the material of choice when recreating the same concept. Design values in Patcher are identified as collaborative play and open-ended programming play. The creation process of Alfombra Appliqué, the remake, is presented, the design choices and how they relate to the shift of material. This leads to learnings regarding how material properties differ when using the prebuild product with a lot of design possibilities in relation to custom built hardware. These learning can be summarized into three topics. (1) When using a prebuilt product as material there will be more limitations to how a designer can change the material, it can only be bent using software. (2) A consumer market product opens up to getting the artefact available to more users, but it could depend on how the product normally is used. (3) The designer and users will have a lot more pre-knowledge of the material which gives implications on expectations. Also, the paper investigates how exploring materials and having a bricolage mindset made it possible to create a meaningful remake with other material of an existing design. It is concluded that the choice of materials and how designers work with their properties changes what is relevant and possible to design.

Author Keywords
NFC; Android mobile phones; Material; Tangible programming; Programming for Children; Design remake.

INTRODUCTION
In the field of tangible interaction, new technologies and combinations of materials has been one of the main topics for exploration, including technologies such as RFID (Radio-frequency identification), Computer vision, microcontrollers and sensors [23]. These explorations have often been conducted through building custom-made hardware, combining sensors and communication technologies. It has become easier and easier to build your own hardware with sensors and actuators, due to development of new microcontrollers such as Arduino [2] and construction kits such as Little Bits [14]. Furthermore, some of the technologies that earlier were seen as novel for interaction design has become available through standard hardware such as mobile phones. Mobile phones nowadays are equipped with sensors, more processing power and bigger screen resolution and referred to as smartphones. This has opened up a design space of employing these standard customer market devices in design. Several research papers have investigated how to design for tangible qualities with these devices [4,13,18,29]. It is especially interesting to explore what new qualities it gives and what the delimitations come with making design with parts that are ready-made.

Children’s interaction with tangible resources for enhancing digital creative construction play has also been an area of research, investigated by for instance [19]. Making this type of play collaborative and social like conventional play is in addition something that been investigated in [20]. Furthermore, there have also been projects for making this type of play using standard customer market hardware. For instance, Tarkkan et al. [24] made a tangible and visual programming language for children with a Nintendo Wii Remote [17].

The starting point for this work is a design called Patcher. It was created as part of the research by Fernæus and Tholander [8] on designing for supporting children to collaboratively create dynamic play worlds. In their research, they designed a space where children built fantasy scenes on a screen by interacting with an RFID reader and physical cards on a mat containing RFID tags. In this paper, Alfombra Appliqué is presented. Alfombra Appliqué uses the same overall idea and same design values as Patcher, but is recreated with other materials. Users scan NFC (Near Field Communication) tags placed inside a mat using Android mobile phones with NFC reader built-in. NFC can be described as a similar material to RFID, as they both use inactive tags with information that a tag-reader can read. Since NFC readers are incorporated in several mobile phones, it is interesting to see how this type of design for children’s collaborative construction play could be done with them, as it could become a design easier available to more people than a custom made RFID reader.

In this paper it is is examined how it is possible to recreate an existing design using an other material and what that tells
us about the material. This is done by going into what limitations and possibilities there are to applying Android mobile phones with NFC readers as a design material, comparing this to an other tag reading material, a custom build RFID reader. This is additionally done by discussing what methods and mindset is needed to create a remake. All this happen in the context of designing for open-ended programming play for children situated on the floor, that booth encourage collaboration and individual activity.

**BACKGROUND**

Tangible user interfaces have been a field within HCI where theme of materials come to play [10]. In that field there has often been a focus on how physical objects represent digital data and computation [9,10,23].

A distinctive mindset to have when working with tangible interfaces is Bricolage. Vallgårda and Fernaeus [27] suggest that it is suitable for interaction design because the way a bicolour works with the given conditions where imperfections of materials is no question and planning is done ad hoc. Also, they argue that this mindset gives more cultural grounding and adds some mythical thinking, that can lead to more unexpected results.

As mentioned earlier, the field of tangible user interfaces has often focused a lot on coupling the digital to the physical. A contrast to this is the action centric perspective on tangible interaction [9]. Fernaeus, Tholander and Jonsson argue in favor of looking at tangibles as resources for action instead of representing data. This to actually focus on the activity that the designer wants to design for, i.e. what the designer want to express.

Gross et al. [10] presents ways the views on materials and computational composites in interaction design are related to medium specific theory. It is a theory used in arts and media that describes how different things can be expressed depending on the specifics of the media. They emphasize that the critique that the media specific theory has received can be used to look at material in interaction design. One critique concerns how technical and social development change what is thinkable and possible to do with a medium. Neither the possibilities nor the audience’s pre-knowledge of a medium are static. Further more, it is pointed out how good art can not be critiqued by how well it uses the medium because then many important pieces would no longer be anything to have. Its described how expression can be seen as what actually matters [10].

This partly contrasts to what Fernaeus and Sundström [6] discuss when looking back on old design research cases. It is seen how focusing too much on fulfilling some conceptual mission of what one as a designer has decided on before starting to build makes it easy to miss that everything is not possible to create with the material at hand. In example, at times the expected behavior of a radio signal is completely different than the designers had predicted before implementing the idea. They argue that is is not enough to sketch scenarios when working with new materials in new ways. Exploring the materials gives knowledge of how the materials affect the design [6].

**RELATED WORK**

Exploring NFC reading mobile phones as material makes it important to look at what has been created before using this material. Tangible interaction design for children’s social interaction is an other topic relevant to look into for this case. Looking at other programming interfaces for children is also central. Below, related work under these themes is presented.

**NFC technology in mobile phones as design material**

Applications of NFC have often been payment related, but there are also various other applications such as health care and position based applications [21]. Sarmenta [21] explored casual NFC-enabled mobile gaming with Nokia mobile phones and read only NFC tags in form of e.g. transport cards. Broll et al. [4] have explored creating a NFC-display, a projector screen with tags on the backside, for interaction with NFC enabled mobile phones. In this way investigating having multiple objects for users to scan, that are places side by side.

**Designing for tangible social interaction**

The interaction gestalt of an artifact may influence the social interaction. Bekker et al. [3] have addressed social player interaction patterns as a design value when designing for children’s physical and social play with interactive artifacts. They have seen how interaction possibilities and characteristics of interactive artifacts affect the social interaction. One such case is that a shared item leads to more social interaction between players. An other case is that an object with an interesting or funny output leads to conversation. Marshall et al. [15] describe how the properties of a physical tabletop and a digital screen differ. The difference affects the social interaction between the users when fighting for control of the system. An important aspect for social interaction of the programming space Patch was how the programming cards worked for collaboration and planning [7]. Moreover, the clean design of the creator blocks, without buttons or screens, made an activity where attention was drawn to the shared aspects of the design and not the device itself [8].

**Programming interfaces for children**

Several programming user interfaces and languages for children exist. Both commercial products and research projects can be found. One commonly used tool is Scratch [22] where children can put together games and stories using a graphical programming language that focus on the way of thinking. Others have done visual programming environments for programming physical constructions, for instance Lego Mindstorms [26]. An example where children directly program a physical toy is bee bot [25]. The bee is programmed with buttons located on the bee to create movement sequences.

One example of creating a programming language together with children is the work by Tarkan et al. [24]. They developed a cooking based programming language called toque together with children. As been seen in earlier research, the
children in their design group found loops and iterations complex and boring. They preferred working with parallelism, such as the possibility to have multiple cooks instead of one doing multiple stuff over again [24].

Many programming interfaces for children do have one programming mode and one play mode, e.g. the before mentioned Scratch [22] and Lego Mindstorms [26]. Tarkan et al. [24] tries to escape having two modes for their programming language because of what [16] had discovered of children when they move in and out of the role of playing a story and creating it. For Patcher the global actions for playing and stopping worked as unifying action for the group creating[5].

There have been seen how some children prefers a storytelling approach to programming to giving instructions to a figure [24]. Ryokai et al. [20] have modified a Pleo robot to make it possible to program a story to Pleo. Earlier, Ryokai and Cassel [19] did work on tangible digital storytelling located on the floor, the StoryMat. The design aimed to adapt to children’s normal play and they wanted to keep it open for the children interpreting different things.

Open ended programming play

Fernaeus [5] takes the point of view to programming as an activity of making a whole out of pieces, using different prebuilt parts and combining them in different ways to create something. Also [20] design for programming being flexible, renegotiable and bricolage-like.

These views on programming play and storytelling is related to the concept of open-ended play, discussed by Bekker et al [3]. They define open-ended play as instead of providing pre-defined game goals, interaction opportunities are provided. The objects and interactions with them get their meaning from how they get used.

THE PATCHWORK: Patcher

Around ten years ago Fernaeus and Tholander [8] wrote about creating a a space for children’s construction play on the floor. Their design was called Patcher and laid out the groundwork for this design. As a background to the design process of Alfombra Appliqué, the main features of Patcher will be presented. Beyond having papers describing the design as a resource of information, one of the researchers, Ylva Fernaeus, was the supervisor of this master thesis and helped providing more details at times.

Patcher is a tangible programming space for children’s collaborative creation of screen-based systems [8]. The creation process of Patcher was inspired from object-oriented programming. It has visual objects to which predefined behaviors can be added, similar to having objects inheriting properties from other objects.

Figure 1 shows the setup up of their system. It consists of:

- A visual projection showing the system the children are building
- Programming cards
- RFID readers, called creator blocks, wirelessely connected to the computer behind the Patcher system

Patchler is interacted with by users sitting on a mat with a grid on it. A grid representing positions on the screen. Users create figures to put on the screen using programming cards and creator blocks (RFID reader with Bluetooth connectivity) [8]. When a creator block is placed on the mat a rectangle is revealed on the corresponding position on the screen display. To create a new object the user chooses a location on the screen by positioning the creator block and putting a programming card with a figure on top of it. Already existing figures can get equipped with behaviors by putting behavior cards on top of the creator block. In addition to cards with figures and behaviors, users also perform global actions such as playing, stopping and saving with Patcher’s control cards.

Two design value themes where identifies from Patcher and set up as important for the remake. (1) Social interaction is a central part of Patcher, allowing for an activity where children both can work by themselves and collaborate. (2) The choice to make it into a programming play activity. A creative programming activity with no predefines tasks. But, where children are let to form the activity while playing and interacting with the system.

DESIGN PROCESS

The design process started with the context of already having a design concept. Starting off with this kind of foundation is not the ordinary design process seen in interaction design, it is somehow related to bricolage practice [27]. The idea is taken from an already existing design and the material of choice is here a prebuilt product, a mobile phone with NFC reader. A great part of the design process consisted of material explorations to see what was possible to do with the mobile phones as tag-reading devices. The material at choice

- A mat with a grid of RFID tag underneath corresponding to positions on the screen display
has been explored by implementing small prototypes and reading about the technology and finally implementing a working prototype. As [6] argue, when working with materials in new ways it is not enough to sketch on scenarios to design, it is important to know how the materials affects the design. The process also withheld other interaction design methods such as a workshop, scenario sketches and letting users test.

The creator blocks in Patcher were built by the researchers and were connected to the computer using Bluetooth technology. How these were built is not much reflected on in the research written about the design, the following details comes from talking to Ylva Fernaeus about their making process. To manipulate the distance for which tags could be read they manually adjusted the antenna of the RFID reader. The creator blocks antennas were adjusted to be able to read tags with a distance of approximately 10 cm across the whole surface of the block.

NCF is a technology for wireless short-range communication, distance for communication is 4 cm or less. Android devices with NFC can read information from tags and exchange data with other Android devices with NFC [1]. NFC is a development from RFID and has the same characteristic, where the user has to put things close for them to interact. In this exploration the Android mobile phone used is of the model Nexus 5 [11].

In an early prototype, a user interacts with a mobile phone, a physical color palette and a paper with a tag grid underneath. Each color of the color palette has a tag and as a user scans a color, the mobile phone screen gets that color. Next, users choose where in a 5x3 grid they want to put the color, scans that position in the grid and the square on the screen takes that color (see figure 2).

![Figure 2. Building the color palette prototype was part of the exploration of NFC in Android mobile phones](image)

Early design work also consisted of sketching. Sketches where done of the whole context: with users, the mat and mobile phones. The reason for these kind of sketches was to avoid focusing only on making a mobile application and also to visualize the whole situation. Moreover, the design has been formed through discussions with the supervisor of this thesis, peer students and through a design workshop (see figure 3) with HCI master students.

Further, a working prototype was developed. In this project the physical mat used in the Patcher system was accessible. The very first approach was to make something out of the existing object. However, the reader in the phone reads middle wavelength tags whereas the RFID tags in the Patcher mat was of another type. This opened up some options to what could be created, but having to acquire NFC-tags. Still, the Patcher mat was used in the prototype as an ordinary mat to put pieces of paper and fabric with NFC tags on top of it, due to limited time for making a new mat.

The working prototype was tested by children during a playtest. The playtest was conducted to learn how the design would be used in a real setting. Furthermore, it was done to help out seeing if this new design had a potential to fulfill the design values of the original design.

Three children interacted at the working prototype of Alfombra Appliqué during the playtest. Consent for participation had been retrieved from the children’s parents. All three children were boys between six and seven years old from the same preschool class. The method used for the playtest was peer tutoring [12], which has been found effective when letting children test a system. Two of the children started out interacting with the prototype in 20 minutes. Subsequently, the third child was brought in and the ones who already knew how the prototype worked were asked to explain it to the child who joined in. The sound from the playtest was recorded and some parts of it were filmed using a mobile phone. Pen and paper was used to take some small notes on opinions the participants had on the prototype and to show interest of their opinion from the researcher. The playtest was situated in a small playroom of close to the classroom. The study took place during school hours.

The learnings from making the working prototype lead to an extension of the design. The extended design was not implemented in the scope of this thesis and will be presented with sketches.

**THE APPLIQUÉ: ALFOMBRA APPLIQUÉ**

In this section the resulting design, the working prototype, the playtest and the extended design is presented. This is to
give an extensive understanding of the interactive system to be able to follow the analysis of the interactive qualities.

**Figure 4. Early sketch of Alfombra Appliqué**

**Basic Idea**

Alfombra Appliqué is a mat containing tags where children play with mobile phones to create animated figures on a monitor screen. In figure 4 an early sketch is seen. The mat has different objects that can be scanned with the mobile phone. These objects represent figures and behaviors. When a figure is scanned with a phone, the figure is “picked up” to the mobile phone. Then, scanning a behavior sets this behavior to the figure. In the sketch the child sitting down have just added a moving-in-circles behavior to her teddy figure. The figure can then be left off to the monitor, to act out its behavior, by scanning a tag.

**Working Prototype**

In the working prototype there are four different figures that users can create, one behavior that the users can choose to add to the figures and a grid of tags, representing the monitor screen positions. The grid is used for dropping off figures to act out their behaviors in the monitor screen. In figure 5 an overview of the working prototype in use can be seen.

The working prototype has three parts making the whole: the monitor screen, the mat and the mobile phone. In this version the figures are insects. In Figure 6 these insects are shown from how they look on the monitor. There are two types of beetles, one red and one green, and two types of ants, one black and one orange. The logic behind what is happening on the screen is done with the Unity game engine. The content, background image and animated insects are retrieved from their assets store made by an artist and animator [28].

On the mat the four types of insects are made of fabric in an Appliqué manner. The behavior and the grid positions are made of paper. The graphical interface on the phone shows a net. After scanning an insect it ends up in the net and right above a symbol of the behavior is shown when the behavior has been scanned.

**Figure 5. Overview of the working prototype of Alfombra Appliqué**

The interaction starts with the monitor screen being empty, just a beige background image is shown. Then, a user scans an insect. The scanned insects could for example be a green beetle, the user hears a sound feedback of that the scanning worked and sees a green beetle in the graphical net on the mobile phone screen. After that, the user can decide to put the green beetle in the right corner at the top of the screen and scans the grid tile on the right hand side in the front. Now the green beetle appears in the top right corner of the monitor screen and has disappeared from the mobile phone screen. Simultaneously, another user scans the orange ant and decides that this insect should be moving. The user then scans the up-down tile and a symbol with two arrows is showed right above the net. When the user drops off the ant to the screens bottom left corner, it starts walking up and down continuously.

**Figure 6. Detailed views on the different parts of the system: a) snippet from the shared screen, b) the mat and c) the mobile phone screen without and with an insect picked up.**
Playtest

The interaction with the prototype, creating bugs, led to social interaction patterns between the children during the playtest. The two of them took turns deciding which insect they were to create many of. For example, one of them first said that they should create many of the green beetles. After creating a number of that kind, the other one decided that they had to create more red beetles and after adding two more green ones the first child followed into the creating of red beetles.

Figure 7. Two of the children participating in the playtest.

Here is a little extract of the two first children conversation when interacting with the prototype:

1: There are so many walking over there, where there were none before. There are many ants and insects. Oh! That one is puking.
2: Which?
1: The red one, it is puking.
2: hehe
1: And then, it’s pooping.
2: haha
2: I see a green that is pooping. I saw a green that pooped.
1: Oh, so many! And that green one is just standing there.
2: aah
1: And is doing nothing
2: And look! That green one up here. It is chewing on an ant all the time.
1: aah

This extract shows another social interaction that took place, they discussed interpreted properties of the insects. The insects on the big screen of the prototype was just standing still or running up and down but the children interpreted more things happening.

This also exemplifies how the design allows for open-ended play. The participants created meaning out of what was happening on the shared screen and they defined what the play was about, it had not been predefined. When the third child joined in, one of the first ones had started to get tired of playing with Alfombra Appliqué, five minutes into the second part of the playtest he walked away to play with some other toys. And later the new child got curios of what he was doing and joined in on the other play. Before this, the first two children explained to the one who joined in how Alfombra Appliqué works. They explained how it worked, but after some minutes the third child asked if it was actually them that were creating the insects on the monitor screen. This shows that the coupling between the grid tiles and the screen is not graspable immediately.

Through the playtest the participating children had some proposals to the system. When they had got tired of creating bugs they were asked how Alfombra Appliqué could be made differently. One thing they proposed, that was especially interesting, was to steer the insects with the mobile phone. They suggested steering the insects by moving the phone in the air. This is interesting in the way that they clearly knew the interaction possibilities of the mobile phones. Other than that, they wanted to be able to take back insects from the monitor screen to the mobile phone again. One observation made when looking back on the video material collected during the playtest is how the mobile phones are clunky to interact with. The children in the playtest either almost dropped the phones into the tiles of the mat using one hand or manipulated the phones with two hands.

Extended design

A lot of learning where made when creating and testing the working prototype. Some of these where explored by sketching an extended design proposal. The developments of the design will be described, the basic concept is the same and will not be in focus.

Figure 8. A user placing the mobile phone on a position tile and getting a preview of where the insect will end up.

In the resulting design an interaction step has been added to Alfombra Appliqué when the user places out an insect (see figure 8). When the user places the phone on a grid tile, a shadow of where the insect can end up is shown on the monitor screen, it just shows for a while, as it is not possible to
detect when a phone leaves a tile. The user drops the insect by touching the insect. These changes are made to create a clearer connection between grid and screen.

Another change is the possibility to modify the behaviors that has been added to an insect (figure 9). For the continuous movements the velocity is modified when a user pushes the behavior icon. Taking advantage of interaction possibilities of the touch screen.

To set the focus on what is possible to do within Alfombra Appliqué the analysis has an action centric approach to tangible interaction [9]. The interactive qualities allowed for in Alfombra Appliqué are summarized in table 1. These qualities will be analyzed by the categories: digitally mediated action; sensory experience and perception; physical manipulation; referential, social and contextually oriented action.

**Physical Manipulation**

Physical manipulation is about how resources can be acted upon physically and how having them physical gives extra value [9]. The mat part of Alfombra Appliqué with its symbols is not just representing digital data but can also be used as a mat for other uses.

In explorations of the interactive qualities of NFC tags with the android mobile phones it was noticed that the mobile phones read the tags on the backside somewhere in the middle, while the creator blocks in the Patcher system could read tags both from the floor and placed on top.

In the process of making Alfombra Appliqué there was a decision of taking away the programming cards. This decision could be questioned as the cards had served for planning of the activity, negotiation and social interaction by physically sorting and passing cards [7]. The decision to not use programming cards was driven by the fact that the phone reads tags from underneath. In addition, the phones are pretty big, heavy and clumsy, especially for children as noted in the playtest, and having programming cards would force the users to lift up both the phone and a card. It would not be possible to read a card lying on the mat; it would be conflicting with the tags of the mat. Having all objects that are possible to scan outspread on the mat could be the best way for interacting with these phones in this context.

**Referential, social and contextually oriented action**

Referential and social action is about how objects can be used for social and shared interaction [9]. Mobile phones with their small screens could lead to more individual actions, in comparison to a shared RFID reader. This has been tried to get balances out by the other resources and will be analyzed.

The material specifics of the mobile phone as reader led to having all objects that can be scanned on the floor. Though, having the action for choosing a figure to make or a behavior to give as scanning actions was not obvious. One alternative certainly was making use of the interaction possibilities of the mobile, designing a graphical menu for users to find and choose figures and behaviors. But, to put them as symbols on the mat suits the value of making the activity collaborative. This kind of design affords a non-verbal communication between players as they can see what the others are doing. When the design has more behaviors and figures it could lead to users hiding resources to each other by physically blocking them with their bodies. This would never happen if all users had all recourses in the mobile phone.

**ANALYSIS OF THE DESIGN**

The consequences of taking use of the main concept and identified design values from Patcher when designing Alfombra Appliqué with new technology will be analyzed. How the material formed the interactive qualities is the central theme. Moving from a design using custom made readers with just Bluetooth communication and RFID reader embedded to using mobile phones with a big range of technologies embedded resulted in a whole range of design decisions that was not obvious how to deal with.

![Figure 9. Sketches showing modification of a behavior. Users select the movement behavior symbol on the mobile phone and are then able to change the velocity of the movement.](image)

Having multiple behaviors that insects can take is the last extension (see figure 10). Multiple behaviors that both could be other movements or how the figures relate to each other. This is motivated by the pursuit to create more play opportunities.

![Figure 10. The set of behaviors have been extended from just the "up-down" behavior to give more opportunities](image)
Digitally mediated action

- Select position.
- Picking up insects/behaviors.
- Modifying insects.

Bug/Behavior Tiles

- Get picked up by the mobile phone.

Grid tiles

- Select position

Monitor Screen

Sensory experiences and perception

- Seeing what you picked up.
- Detecting if reading tag went well with the sound feedback.

- Getting overview of what can be done.

- Seeing where bugs can be placed.

- Get an overview. Interpret what is happening. Showing where an insect will end up

Physical manipulation

- Placing and moving mobile phone into tiles.

- Sitting.

- Sitting, crawling

Referential, social and contextually oriented action

Individual action

- Non-verbal seeing what the others are doing.
- Relocating oneself physical towards the wanted bug

- Non-verbal seeing what the others are doing.
- Relocating oneself to position.

- Pointing, talking about what is missing.
- Discussing what is happening

<table>
<thead>
<tr>
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<th>Bug/Behavior Tiles</th>
<th>Grid tiles</th>
<th>Monitor Screen</th>
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<td>Digitally mediated action</td>
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<td>Referential, social and contextually oriented action</td>
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Table 1. A summary of the actions that Alfombra Appliqué allow for. The columns show different parts of Alfombra Appliqué, i.e. the resources for different actions. The rows show different categories of actions that tangibles allow for.

To have peer-to-peer communication through NFC is an interaction design opportunity for the Android phones with NFC readers. In the scope of this exploration it has not been something that have been explored. Still, it could be a fascinating interaction for users to share insects built with each other by holding two phones together. It would be interesting for the social aspects. Yet, this would of course lead to new design decisions concerning how to make it clear who is sending and who is receiving or if the one sending will still keep the insect that they just sent.

**Sensory experiences and perception**

Coming back to the mat with the figures and behaviors as symbols on it, more than being a design decision to encourage social activity, it also gives an overview of what is possible to do. This is one of the interactive qualities supporting sensory experience and perception.

In the design process it was tested putting multiple tags with 5 cm distance in between for a prototype. It is technically possible for the reader of the phone to read the correct tag, as the reading distance is 4 cm. However, it was noticed, as others also have done [4], that the delimiting factor is not how closely the NFC tags can be put but the size of the mobile phone (height of the Nexus 5 ~13,5 cm) with the NFC reader.

Having the objects that can be scanned small and close to each other gives an uncertainty to the user because the phone will cover more than one object. Also, a user does not know exactly where in the phone the reader is placed. This led to making all objects to be scanned around the size of the phone. In the Patcher case the reading distance was the delimiting factor. A distance the designers actually were able to tweak. In that way their custom built hardware was easier to change. Another attempt, to avoid the uncertainty of where the phone scans tags, was designing the graphical interface for the mobile phone in a clearer way. To help the user understand the scanning it was decided to make a circle with the appearance of a net in the middle of the screen to show the user where to pick up an insect.

One problem in the first working prototype was the coupling between the grid tiles and the positions on the screen. In other words, the users had problems being sure where their insect would end up on the common screen. In the resulting design an alternative is presented that is much like the solution for Patcher. Even though, for Alfombra Appliqué an extra step in the interaction is needed as the system on the screen always is in runtime.

Another way, that actually would take away the grid tiles, is to employ the technology that where explored by Leigh et al. in [13], where they explore interacting with content on a computer screen with a touch screen mobile phone. The interaction technique is similar; you have to come close with the mobile phone to interact. Using this for the Alfombra Appliqué would mean that the user would drop off an insect by touching the screen with the mobile phone. The big benefit of doing it this way is the directness of the manipulation. Holding the phone against a horizontal screen monitor could however become not the most pleasant movement, as the phones are thin, big and relatively heavy. And as mentioned earlier, during the playtest the children trying it out handled the phones by almost dropping them onto the tiles of the floor, or manipulated them with two hands. The screen could
also be transformed into a horizontal screen lying on the floor, so a user does not have to hold on to the phone while choosing the position of the insect. This could lead to a more careful interaction because of the more fragile nature of a screen compared to just an ordinary mat.

On the screen of the phone the resources for making in Alfombra Appliqué was not showed. On the screen of the phone the recourses for making in Alfombra Appliqué could lead to tinkering, testing and playfulness. The characteristic of always being in runtime is interesting to elaborate more on. The runtime could almost be seen as a force, like playing with running water; building ponds or playing “pooh-sticks”. Moreover, for play in general there are no ways of undoing and saving, the play is continuous. Nevertheless, a core feature in the digital is that it makes it possible to undo, redo and save, and this is vital especially in creative applications such as programming [5]. The design does allow for easily making a new bug and in this way test a new idea and also it is possible to take back bugs or to start over the whole game.

**DISCUSSION**

Learnings on how the properties of NFC reading mobile phones differ from a custom built RFID reader will be discussed in this section.

One difference from Patchers is that Alfombra Appliqué uses already existing technology. This both opened up the design space and limited it. The broad range of possibilities with these Android mobile phones with several sensors and high-resolution touch screens creates many design possibilities. However, these kinds of platforms are built as they are and since they are not possible to modify, the design gets dependent on the design of the mobile phone. It makes it necessary to work with the material properties and the imperfections of the device. An example of this is the way the mobile phones used for Alfombra Appliqué reads the tags just from a particular spot on the back.

Another interesting aspect of using consumer market products instead of a custom built hardware is that using these could make it easier to make the design available to more users. As mobile phones are widespread product and even though small children don’t have mobile their parents probably do. Looking at how a design like Alfombra Appliqué could be reach an audience and how it fits into users’ mobile phone usage could be something for continues investigation.

Yet another important difference between these materials is that a mobile phone is a day-to-day object that users already know of, they have experiences of interacting with phones and know about their interaction possibilities, whereas the creator block in Patchers was created for that design. A mobile phone has a lot of design and interaction possibilities. The first prototype did only take use of the NFC reading and the screen of the mobile phone. As described earlier in the text, the children participating in the playtest wanted to do more with the phones. This does not mean designers always should try to take use of all sensors and interaction possibilities when designing with mobile phone. Just that it is important to be aware of users’ expectations on materials.
The design could be criticized to focus too much on different material properties and how this affected design decisions. It could be said, related to the critique of the medium-specificity hypothesis [10] that what is interesting about the design is not these properties but what is expressed. On the other hand, there has been a focus trying to achieve the same design values and idea as Patcher. The goal of making a design that allows for collaboration drove having shared tangible resources. Trying to encourage open-ended programming play motivated the idea of having one part of the system always in runtime. There has not been a focus on trying to take use of the mobile phones in the right way. When the material change is analyzed the design is looked upon from an action-centric perspective. The critique that Fernæus, Tholander and Jonsson [9] holds towards the creation of tangible interfaces is similar to Gross et al. [10] when they look at tangible interface with views from critique of medium-specificity hypothesis. They both focus on that research on tangible interfaces often focused on the coupling between physical material and the digital. On the other hand, material exploration and reflections on properties has been a big part of creating Alfombra Appliqué but trying to avoid the perspective of representation of the digital by using the action centric approach to tangible interaction design. In this creation process there has in some sense been a new way of using this material, as most applications of NFC been payment related [21].

As Fernæus and Sundström [6] point out, when working with new material it is often necessary to start building with the material to actually know what can be expressed.

The method employed, creating a remake, is somehow a little different from the convention. The method was inspired by a bricolage mindset [27] and took an existing design and remade it. Creating a remake made out a starting point for the design and gave it some cultural grounding. Working in this way helped in seeing the imperfections in the material when creating Alfombra Appliqué. The negative part of working in this way could be that it made it harder to open up the design space, the ideas got pretty bond to the original design. Using peer tutoring [12] in the playtest worked to some extent. The method helped seeing that some parts of the design was hard to get. One problem tough, during the playtest, was that it was hard knowing how long to test with the first group. That one participant got tired shortly after the third one joined in indicates that the first session could been shorter.

One dimension of the material choice has not been discussed. This dimension is about that Wi-Fi connectivity for connecting the phone to the computer used in the prototype in contrast to Bluetooth used in Patcher. This has not much been discussed as it was not essential for discussing the design values and the resources for action.

CONCLUSION
Remaking a design with other materials had consequences for the resulting design. This shift did in some ways change what activity the design allowed for. Utilizing a mobile phone as well as a shared screen made it possible not to split up the activity in a creation and playing mode. For Alfombra Appliqué creation and playing is instead spatial, contributing to the discussion on programming interfaces for children. The material specifics of how the NFC reader is embedded in Android phones led to taking away the idea of programming cards from Patcher, changing the possible activity to some degree. To allow for collaborative programming play was important, thus programming resources were kept tangible and a common screen was used. Moreover, it was important to also make room for individual activity making it possible to interact with content on the mobile phone.

The material properties of a mobile phone with NFC reader has been compared to the creator block in Patcher. The differences of these materials is be related to how Alfombra Appliqué is created with a standard device, a mobile phone, and Patcher with a custom build RFID-reader. This leads to three learnings for employing prebuilt devices with various design possibilities in tangible interaction design. First, a prebuilt standard device is not equally flexible as custom build hardware it can only be changed by software. Secondly, designing a consumer market device could make a ground for spreading a tangible design to more users. Thirdly, users have expectations on a material they already know.

These two solutions are using different material and this design process shows how a change in materials changes what is possible and relevant to do. But, in the big picture it actually shows how different materials can be used to express similar experiences. Regardless, it would have been unwise to try to replicate every part of Patcher when creating the new design with an other material. Alfombra Appliqué is a similar and in the same time new experience to Patcher. This was made possible from exploring the material and having an in someway bricolage mind-set. Designing with existing consumer market products in a tangible interaction design context makes material explorations vital to succeed.

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