# Pixel Materiali - a System for Creating and Understanding Pixel Animations

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## ABSTRACT

Pixel Materiali ("Physical Pixels" in Italian) is a physical play environment which enables children to create pixel-like animations, and through this process to understand the basics of digital images and animation. Pixel Materiali is designed as a simple, highly intuitive system in which children interact with physical tiles while technology - in the form of camera and computer - is evident and understandable, but remains in the periphery of the experience. This paper reports the motivations, design considerations and outcome of using Pixel Materiali with children.

## Author Keywords

Children, animation, learning environments, interaction design, intuitive design, collaborative systems, tabletop systems.

## ACM Classification Keywords

H.5.1 [**Information Interfaces And Presentation**]: Multimedia Information Systems – *Animations*.
H.5.2 [**Information Interfaces And Presentation**]: User Interfaces -  Haptic I/O, *Input devices and strategies*.

## INTRODUCTION

Children today are familiar with digital screen-based imagery from a young age via computer monitors, handheld game devices and mobile phones. However, they generally encounter this type of media as spectators of finished, polished outcomes, and seldom have the opportunity to express themselves in a similar type of visual language. Moreover, the polished outcomes they encounter do not reveal the mechanisms behind the creation of digital images and animation: the ways in which a digital image, and an animated clip, are constructed.

Pixel Materiali offers children the opportunity to create their own imagery and their own animated sequence using

simple, physical building blocks. This experience gives then a firsthand understanding of the mechanisms of digital images and animation, and creates a direct link between the playful, creative process they experience and the 'finished' images and movies they are familiar with.

## MOTIVATIONS

Pixel-based animation is a form of magic. Behind this magic are two well-hidden secrets: that images are made of a collection of squares, and that motion is made of a collection of images. The goal of Pixel Materiali is to create a highly simple interactive play environment for children in which these understandings are achieved without any form of explicit teaching. Pixel Materiali reveals these two secrets of pixel-based animation in the following manner:

1. Images are a collection of squares (pixels)
Children create images by choosing the black or white side of small physical tiles. This exemplifies the concept of pixels in the most abstract, bit-like form. The concept of resolution is represented by having small (2.5cm) and large (5cm) tiles.

2. Movies are a collection images (frames)
As they work, children decide when to capture each pixel image, and can constantly see their captured images accumulate into an ever-expanding movie sequence.

Not many other projects explore the issue of explaining digital image representation to children. It may be that this "hidden mechanism" is not perceived as important for children to understand.

On the other hand, there are many projects that help children to create animation. However we have found that most of these focus on screen-based animation, rather than on physical systems enabling animation of physical artifacts [e.g. 1].

A notable exception is Animaatiokone, an installation for experimenting and learning about stop-motion animation [2]. Animaatiokone is a cleverly crafted animation station. All elements (camera, screen, buttons) are embedded within the station and the user interface is relatively simple. Animation is performed inside a transparent studio dome. Animaatiokone is created for use with clay animation, a

medium which requires careful crafting for creating a character and gentle manual work in animating it.

In Pixel Materili we design a simple system that offers children freedom to create their own image, within a given format that presents some of the constraints of the digital medium. These constraints - a given size, tiles, two colors - force them to deal with the abstraction of their desired theme, but do not eliminate their creativity. Later in the process these same constraints help children to animate their image easily, with no gentle manual dexterity required.



Figure 1 – a child using Pixel Materiali

### SYSTEM DESCRIPTION

The components of the Pixel Materiali system are:

A table surface with a grid of pixel-like tiles (placed on a thin sponge-mat), a camera suspended above the table, a big button which triggers capture of the current table image, a screen with two adjacent displays (the "now" view and the "animation" view), and a PC running an application that captures the camera view and generates the animation   (out of children's view).

The system is used as follows: children create pixel images by flipping "pixels" (tiles with a white side and a black side) to the desired color. When happy with the completed image, they use the button to capture the first camera image. Then, they flip some tiles and make another capture, and so forth for as many steps as they desire.
On a screen located next to the pixel surface, two views are displayed side  by side: the "now" view, constantly showing the camera view of the activity happening on the table; and the "animation" view, showing the captured images that have been taken in sequence: an on-going animation that gets longer with every image captured.

### DESIGN RATIONALE

Pixel Materiali is designed first and foremost as a game, and is perceived by children as such. The following three

goals guided our design decisions: design for intuitive understanding, design for aesthetic appeal, and design for working together.
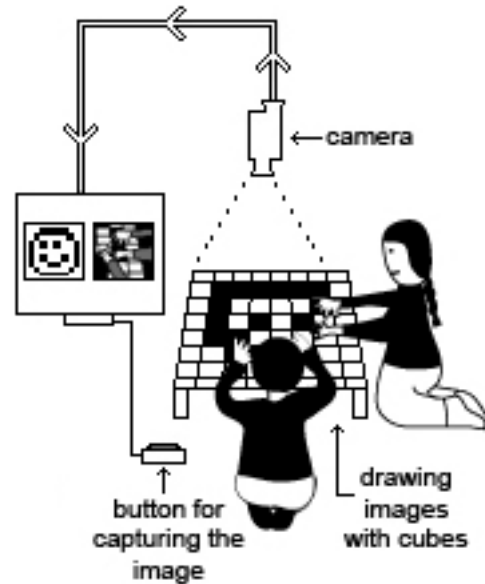


Figure 2 – a diagram of the system

### Design for intuitive understanding

All steps in the process of creating the image and animating it are apparent to the children, and they receive constant feedback for every action they perform.

While working with the physical pixels children see the pixel surface, with their hands over it, in the 'now' view. This bridges between the physical action (flipping tiles) on the table and the next step, in which they capture the pixel image with the camera. In the small sized 'now' display, the gaps between the pixels are eliminated and a smooth image emerges.

The 'animation' view constantly shows the captured image sequence in a loop. The first time the button is pressed a static image is created, and the second press brings this image to life. Every time an image is captured the animation loop restarts, with the new picture included.

### Design for aesthetic appeal

Our goal was to design Pixel Materiali in a fashion that will be appealing to children without being childish, and in a way that will be educational without any outwardly didactic elements. Pixel Materiali contains no text, symbols or explicit instruction. The design is planned to appeal through its directness: the pixels as inviting, physical playthings, and the button is a big object, tempting and physically pleasing to press.

The styling of the pixel table and software is minimalist, using black and white (the only colorful element in the system is the green camera button). This design places the

pixels in the foreground of attention and makes the system fit for a wide range of ages.



Figure 3 – children building an image together

### Design for collaboration

Pixel Materiali can be used by one child alone, or by up to three children in a collaborative manner. Working together gives children the option of shared play, creating a joint animation through a process of negotiation and discovering how to use it best through shared exploration.

Pixel Materiali used in a group can be seen as a special form of "Single Display Groupware" (SDG) in which each user takes responsibility over her "reach area" of the pixel grid, and the display (both table and screen) is shared. The SDG type of collaboration structure has been shown to foster collaboration and creativity between children [3].

Similarly, the study of augmented tabletop environments has shown that this form of interaction can foster collaboration [e.g., 4]. However the design of these systems introduces challenges, one of which is to deal with displays in which orientation gives one location around the table precedence over others [5]. The following design choices were made to facilitate collaboration in Pixel Materiali:
- The pixel surface was built on a custom made table, which creates equal access from all four of its sides. The need to place a screen nearby limits the quasi-equal sides to three.

- To ensure that no position is dominant over the others, the camera button was made into a portable element: a small box that is attached to the system with a flexible pipe and can be moved between the children (see Fig. 1).

- The size of the pixel table (68*68cm) is such that an elementary school child will need to move around the table to reach all pixel-tiles, while three children playing together can work while each is seated at one side of the table.

### OUTCOME

Pixel Materiali has been installed in two venues: a science festival (in Genoa, Italy) and a children's museum (in Ivrea, Italy). It has been used by many hundreds of children (a sample of children's animations can be seen here: http://www.miss-tal.com/pixelmateriali). No formal user

testing was conducted, but after having seen many children using Pixel Materiali we have extracted a collection of observations, presented below.

### Intuitive understandings

Pixel Materiali is highly engaging for children; it's fun. We found that it appeals to a very wide range of ages – from four-year olds to adults. Children younger than six usually needed some form of ongoing encouragement from an older person, to overcome shyness and to follow the process through. From around the age of six children could use the system on their own, reaching an understanding of the setup and the flow of information after playing with the tiles and making some exploratory button presses.

### Creating the image and animating it

The Pixel Materiali activity can be divided into two phases: creating the initial image, and animating it. We found that the first phase was a bit more challenging than the second one. The second stage - animating - is immediately delightful and rewarding. In the first one - creating the image - reaching an image that makes children happy using the pixel structure requires some effort.
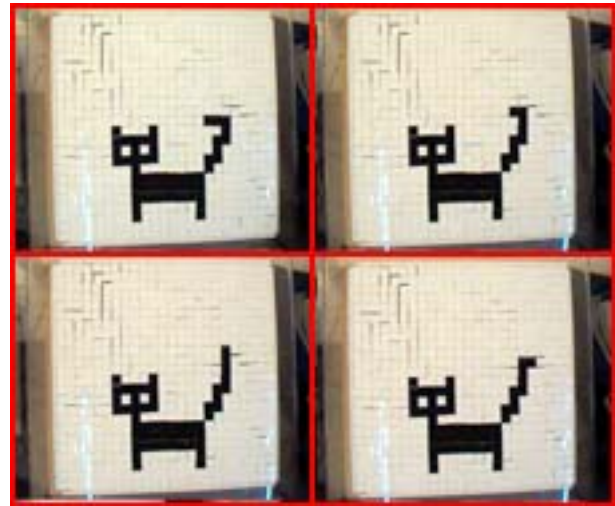


Figure 4 – four frames of an animated sequence

In this first stage children gradually reach an understanding of the limitations of the pixel medium, and find ways to employ the constrained system they have. They discover how to create round angles, how to plan the right size of image – not too big or to small – and where to start the image so as to use the grid size to its fullest. We observed that sometimes children would start flipping pixels and then realize that they are starting too big or not in the right location on the board. In this case they were usually happy to start over.

In the second stage, the moment in which children take the second capture and the animation comes to life is a moment of great satisfaction. Not one child was indifferent to this moment, in which a small change made in the pixels created life and expression in their image! This peak

moment created high motivation and we found that, depending on their patience and age, children would engross themselves in the animating activity for usually between 10 and 15 minutes (a few continued for as long as 40 minutes).

In animating, the younger children sometimes needed guidance to understand that smaller steps – little, gradual changes in pixels - give better results in the animation. But once they realized this – often alone after one or two captures - they would get a full grip on it. Older children were usually able to understand this from the start. Some of the more patient children realized they could utilize the automatic looping of the animation view to create a smooth, endless animation – such as a tortoise walking across the surface and returning from the other side.

Pixel Materiali is designed without any way to undo an accidental capture or to edit the previous captured steps. A nice surprise for us was that these possibilities were not at all missed by children. "Mistakes" such as hands appearing in the captured image did not bother them, and were treated as a natural part of the process. Our impression was that children were engaged, yet not attached. This was also evident when they left the installation – they were not upset about losing their creation and did not mind seeing other children replace their pixel image with a new one.

### Collaboration

Using Pixel Materiali in a group is challenging. It requires a strong form of collaboration: creating a shared image necessitates advance planning. If one starts at one end and one at the other, coordination is needed in order to meet at the right place. In these planning phases, interesting interactions emerged between children. A typical process could be: thinking of a theme, defining the borders together, then planning who does what (the eyes, hair, mouth) and so forth. The shared goal usually made this process worthwhile. Tight collaboration was also required in agreeing on the moment of image capture, thus ensuring that no one's hands were in the photo. Older people tending the installation sometimes helped younger children on this point by introducing a little ritual in which all children said: "mani fuori" ("hands out") together and withdrew their hands from the pixel surface.

### FUTURE WORK

The minimalism of the Pixel Materiali system was successful, and we hesitate to add more features to it. However, one element we are eager to try is the addition of sound. Sound represents another step in bringing the image to life, and in attaining strong effects from small changes. We look forward to seeing how children will employ the potential of audio-visual effects.

### CONCLUSIONS

In conversations we had with children we sometimes suggested the connection between their outcome in Pixel

Materiali and the polished animations they are familiar with. Their responses indicate that this was clear and evident to them. We think that the natural way in which they treated the activity throughout the process is another sign of having made this connection. In future research we should find a direct way to assess this question and reach an unambiguous answer.

In our view, the great thing about animation is not the technology that stands behind it, but the significance of small details in creating an effect. In animation, small changes have big impact; and this is true in general in arts, whether visual, auditory or the written word.

The Pixel Materiali system (as opposed to animation frames drawn by hand) inherently encourages these small changes through its bit-like essence in that creating nuances, like the wag of a tail, are small work (see Fig. 4). This feature of the pixels, which made drawing the initial image quite some work, seems to have helped children successfully reach animations that pleased them.

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