

Animaatiokone: an Installation for Creating Clay Animation

Perttu Hämäläinen

Helsinki University of Technology
P.O.Box 5400, FIN-02015 HUT,
Finland
perttu.hamalainen@hut.fi

Mikko Lindholm, Ari Nykänen

University of Art and Design Helsinki
Hämeentie 135C, FIN-00560 Helsinki,
Finland
mlindholm@uiah.fi, ari.nykanen@uiah.fi

Johanna Höysniemi

University of Tampere
Kanslerinrinne 1, FIN-33014 UTA,
Finland
johanna@cs.uta.fi

Abstract

This paper describes Animaatiokone, an installation for experimenting and learning about stop-motion animation. Located in a movie theater, it allows people to create clay animation while waiting for a movie. Collaboration between users is supported, for example, by sharing of clay actors. The installation's user interface allows even beginners to create and edit animation with help of automatic onion-skinning and simple controls developed through iterative testing and prototyping. In test use, the installation has been popular and hundreds of animations have been created and made available via the installation's homepage <http://www.animaatiokone.net>.

Categories & Subject Descriptors: H.5.2 [Information Interfaces and Presentation]: User Interfaces---input devices and strategies, interaction styles

General Terms: Design, Experimentation

Keywords: clay animation, collaborative storytelling

INTRODUCTION

Animation has become omnipresent in digital media, thanks to modern software tools for creating and distributing animation. An early interactive 2D computer animation system by Baecker 1 was soon followed by a scripted 3D system 4 and then a 3D animation system for people with no computer background 9. Animation tools have then evolved to the current software used to create web content, games, and movies. A 2.5D animation system has also been described 10. However, although many 2D animation systems use scanned, hand-drawn pictures as the starting point 6, all research reported on 3D animation deals with computer generated animation and there are no studies of computerizing traditional clay or puppet animation.

This paper describes Animaatiokone (Finnish for "animation machine"), an installation for creating clay animation, shown in Figures 1 and 8. Our main design goal was to hide the complexities of computer technology and

make animating as easy as possible, so that novice users could experiment and learn about clay animation in a casual and fun environment, for example when waiting for a movie in the lobby of a movie theater. The installation is based on a PC computer, a webcam, and a microphone.

Our goal was also to support collaborative storytelling, inspired by the work of Cassell and Ryokai 514 and Benford *et al.* 2 among others. The animations form a continuous story: The next animator can continue from where the previous one finished or start a new scene, but the previous animations cannot be deleted. The overhead display allows other people to watch the animator at work and users also often share each other's clay actors, created on a table beside the installation, as shown in Figure 9. The animations can be viewed at the installation's homepage, where you can check out what twists the next animators came up with and what perils your actors ended up in.



Figure 1. Front and side views of Animaatiokone. Animating takes place inside the transparent studio dome. The user interface consists of a camera and a button panel inside the dome, the computer display and microphone embedded above the dome and second panel in the front.

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STARTING POINTS AND MOTIVATION

Observing Animators and Existing Tools

Clay animation has a distinctive aesthetic difficult to mimic using 3D modeling and animation software. Although new material models and haptic user interfaces in the style of McDonnell *et al.* 11 will make fully computerized clay animation easier in the future, there is a need for clay animation software operating with images captured from a camera to the computer's hard disk. The authors realized this when observing the creation of two animated short films shot using a digital video camera. It was evident that the animators lacked the ability to delete erroneous frames and immediately check the animation after shooting a frame. It was realized that the features could be implemented in software, in addition to *onion-skinning*, for which the animators used a video mixer: The mixer was used to capture a still image of the last shot frame, which then could be blended on-screen with the current view of the camera, producing a result similar to the bottom-right window in Figure 2. The onion-skinning view shows the changes between the captured frame and the frame to be captured, which helps in creating smooth movement. Clay animation software can also provide other useful features, such as a timeline view of consecutive frames familiar from video editing software.

Easy-to-use clay animation software can also be motivated from an educational viewpoint. Clay animation is concrete and easy to approach for the beginner, while it still allows you to learn widely applicable skills of hand-eye coordination, sculpture and animation. Instead of manipulating textures and spline curves, you simply grab a handful of plasticine, shape it into an actor and take a series of pictures, moving the actor a bit after each picture. Much of modern audiovisual production is digital, but according to Garvey 7, the leading digital production houses are increasingly giving preference to traditional artistic skills in their recruiting.

We found out that although there are no research reports on clay animation software, there exists software that provide some of the features needed. Adobe Premiere¹, a popular video editing software package, enables you to capture stop-motion animation. However, it suffers from the fact that it is designed to operate with video clips instead of single frames. Frame-level editing is not supported by the user interface: the captured frames cannot be viewed and erroneous frames cannot be deleted on the fly. Instead, the user has to stop capturing to render the frames into a video clip that can be viewed in a separate viewer window. Stop-Motion Pro², a professional stop-motion animation software, and a free animation software called Anasazi³

feature fast previews and simple onion-skinning, but they do not provide a timeline view. In Anasazi, you cannot delete frames and in Stop Motion Pro, you have to go into a special 'editing mode' to do it. Overall, the existing software are not optimized for the workflow and do not exploit the possibilities of modern processors and graphics hardware to their full extent. Also, the software vendors do not provide reports of the possible user tests backing up their design.

The First Prototype of the Software

Based on our observations, the first prototype of the Animaatiokone software was created, shown in Figure 2. The display is divided into three windows: a timeline view (top), a playback view (bottom left), and a camera view (bottom right). The playback view shows the frame at the cursor. In a way, the playback and camera views form a close-up of the timeline - when a frame is captured, it is stored next to the cursor on the timeline.

The prototype had onion-skinning capabilities similar to Anasazi and Stop Motion Pro. The slider in the camera window controlled the amounts of the actual camera input and the playback view mixed together. In Figure 2, the slider is in the middle position so that both views are summed with a weight of 0.5.

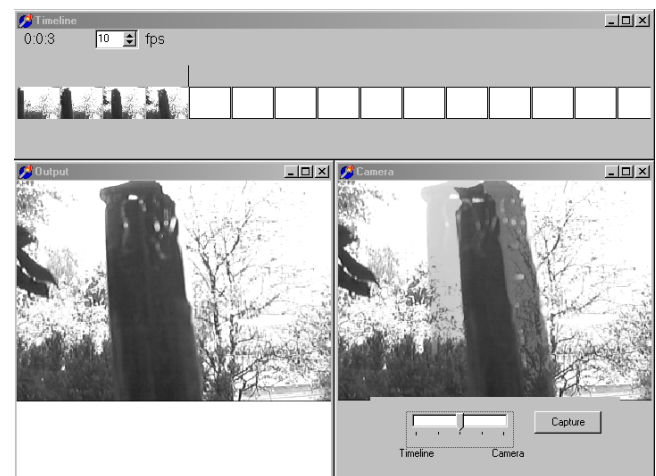


Figure 2. A screenshot of the first prototype of the software.

Animating as a Collaborative, Social Experience

The Animaatiokone software was originally created for animating the characters of a computer game. The idea of the installation was conceived when the prototype was tried out at a Christmas party in December 2001. It was found out that with the prototype's simple but effective user interface, creating clay animation was a great social pastime. Based on our experiences, we wanted to make animating a social experience shared by a group of people brainstorming ideas and taking turns in creating characters and animating. An installation seemed an efficient way of introducing computerized clay animation to a wide audience, since no hardware would be required from the

¹ <http://www.adobe.com/products/premiere/main.html>

² <http://www.stopmotionpro.com>

³ <http://www.animateclay.com/capture.htm>

users, contrary to simply making the software available via the Internet.

Besides being fun, collaborative storytelling is motivated by educational research showing that working in pairs and small groups can have beneficial effects on learning and development [12].

OVERVIEW OF THE DESIGN PROCESS

We now give an overview of the chronology of events and the design rationale. The following sections then discuss the user interface and other aspects of the installation in more detail.

Developing the installation can be divided into the following steps:

- Testing and revising the software prototype. We interviewed three animators, developed a 2D onion-skinning control and tested it with a group of 7 art students.
- Testing a low-tech prototype of the installation and revising the software. We tested the prototype at a party with 10 people, reduced the functionality of the software and simplified the user interface.
- Testing and revising the installation. The installation was exhibited at the 15th Love & Anarchy Helsinki Film Festival, Animatricks 2002 animation film festival and other public events. We added the audio recording functionality requested by many users and automated the onion-skinning. The finished installation toured as a part of the pixelACHE 2003 festival in Helsinki, New York and Montreal (Quebec).

At first, the focus was in developing an optimal clay animation user interface but after testing the low-tech prototype, we found out that all the functionality that was useful in a desktop software tool could not be accommodated in the installation. We then focused on simplifying the software and finishing the installation's physical design according to the following design principles:

- The installation should be self-explanatory and simple enough so that a novice user can learn to use it with no instructions. However, it should provide enough functionality to have a clear advantage over shooting animation on film or video.
- The user interface should ideally have no modes so that all functionality is accessible and visible at once, an approach suggested by Lefebvre and Sciulli [8]. It is important that the previous user cannot leave the installation in a state that confuses the next user.
- The installation's controls must be robust enough to endure prolonged use with hands dirty with plasticine. This ruled out a mouse or a trackball as input devices, leaving us with push-buttons, levers and sliders as in coin-op machines.

Film festivals were chosen as the primary target environment because we wanted the installation to be accessible to large audiences involving both beginners and professionals.

The design team consists of a researcher with a background in interaction design and information technology, a new media artist/ animator and a visual designer/ industrial designer/ animator. The animators joined the team after first being in the roles of interviewees and software testers. The inclusion of the artists was crucial for the abstract idea of an animation installation to take a concrete form.

REVISING THE SOFTWARE PROTOTYPE: 2D ONION-SKINNING

In the interviews of the animators, it was found out that the simple onion skinning similar to other animation software was not optimal. The animators wanted to be able to compare the camera's view to multiple frames when creating movement using keyframes, that is, first capturing the start and end poses of a character and then the poses between. This style of nonlinear work is common in 2D animation [6], but it has not been possible in clay animation using traditional linear video and film equipment.

To meet the requirements, we developed the 2D onion-skinning control shown in Figure 3. It allows the user to control the blending of three images: the camera view and the current and next frames on the timeline. The crosshair is moved by clicking and dragging with the mouse. With the crosshair placed at a vertex of the triangle, only one image is visible, whereas all the three images are blended with weights of 0.33 when the crosshair is placed in the middle of the triangle. The 2D onion-skinning was approved by the animators interviewed, as well as the art students who tested the software.

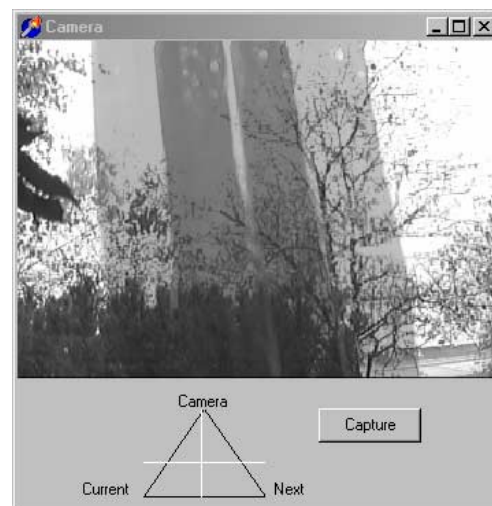


Figure 3. 2D onion-skinning. The position of the crosshair inside the triangle controls the blending of three images: the camera's live view and the current and next frames.

THE LOW-TECH INSTALLATION PROTOTYPE

We tested the low-tech installation prototype in Figure 4 in a casual social setting of a birthday party. A total of 10 guests were asked to treat the installation as a guestbook, each guest creating at least one short piece of animation. The prototype consisted of a television, a drawing/modeling surface, a rail-mounted camera, and a stripped-down keyboard augmented with the onion-skinning slider shown in Figure 5. The slider worked similarly to the graphical one of the first prototype.

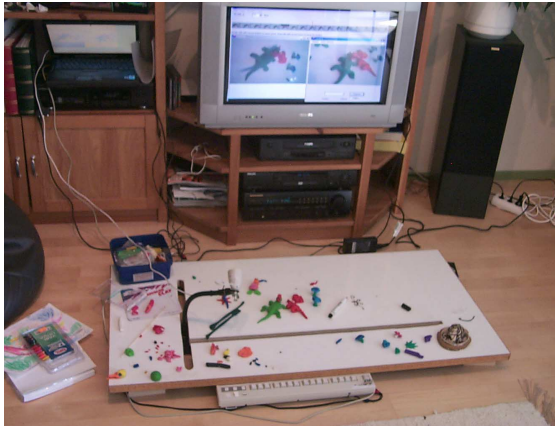


Figure 4. The low-tech installation prototype consisting of a television, a drawing/modeling surface, a rail-mounted camera, and a stripped-down keyboard attached to the front.

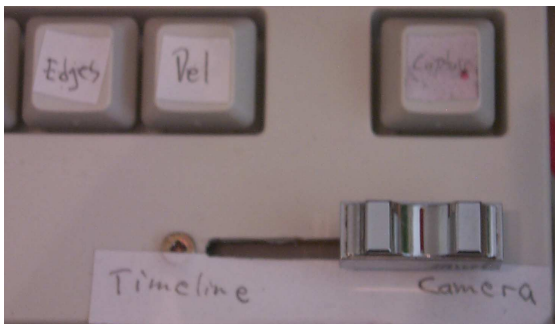


Figure 5. The low-tech prototype featured a physical onion-skinning slider attached to the keyboard.

Stripping Down Functionality

The prototype did not restrict where the users could capture images on the timeline. We wanted to test whether they would engage in collaborative storytelling by continuing each other's animations or changing the meaning of events by adding new animation in the middle. In film and television, images are interpreted in the context of the preceding and succeeding images [3]. For example, a shot of an aircraft dropping bombs followed by a shot of a burning village is interpreted as the aircraft bombing the village, although the shots could be from different times and places.

It was found out that the users expected to capture images in the end of the timeline. After browsing and viewing the

previously made animations, they often forgot the cursor in the middle of the timeline. Images were then captured unintentionally where the cursor was located, effectively ruining the animation.

Based on our experiences, we decided to make the capturing of frames always move the cursor to the end of the timeline. We also decided to add an option for saving the animation. Saving protects the animation from changes so that the next user cannot delete it.

The simple slider for the onion-skinning was a practical compromise for the prototype. However, it ended up also in the final installation, since the 2D onion-skinning does not provide any added value if frames are only captured in the end of the timeline.

The prototype could also be used for drawn animation. Dealing with the sheets of paper would be cumbersome in a public installation, but the prototype's surface could be drawn on using a whiteboard marker pen and the drawings could be erased simply by rubbing with fingers. However, plasticine was the medium of choice for all the users. Clay actors work hierarchically so that you only need to manipulate a joint to bend a limb, whereas you have to redraw the whole limb when working with a pen.

Video Help

Although the original goal was that the installation could be used completely without help, we noted that the users should be explained at least the functionality of the capture and play buttons, although the information often passed on from the previous user to the next. We implemented help in the form of a button for showing a short introduction video.

FINISHING THE INSTALLATION

The finished installation is shown in Figure 1 and in Figures 8-12. Based on the low-tech prototype we arrived at a final set of buttons shown in Figures 11 and 12. The capture, delete and play buttons were used the most when capturing animation so we placed them in a panel inside the dome of the installation. Browsing, saving and help buttons were placed on front panel. Note that the front panel has a second play button that shows the animation in full screen size.

Visual Design of the Installation's Software

Anasazi and Stop Motion Pro only show a single camera/onion-skinning view without a separate playback window or a timeline. This has the advantage of providing a larger view for animating with greater precision. The prototype could also be used in this manner by maximizing the camera window. In this case, the window changed to playback mode during playback.

The main design decision for the installation's graphics was to choose the types of windows to be used. To avoid modes, we chose to stay with the separate playback and onion-skinning windows used in the prototype. We also

changed the onion-skinning so that the camera view would always have a blend amount of at least 50 percent, prohibiting the new user from facing a meaningless display of similar playback and camera windows. The separate views provide less resolution when animating, but in clay animations created in a short time, the amount of detail and thus the need for resolution is small compared to professional work or drawn animation.

In principle, the display could be simplified by omitting the timeline view. However, from an educational point of view, we considered it important to show how the individual frames contribute to the animation. Seeing a new thumbnail image appear in the end of the timeline also provides concrete feedback when the user captures a new image.

The final visual design of the software is shown in Figure 10. In addition to the windows, the installation's display shows a graphical onion-skinning slider that follows the motion of the physical one.

Automatic Onion-Skinning

During the testing of the finished installation it was noted that only few users actually used the onion-skinning slider and those who did kept it in a position where the camera's live view and the last captured frame were mixed together. The camera's view alone was used only when starting a new animation.

We eventually disabled the slider and made the onion-skinning work automatically so that the camera's view is shown alone only when capturing the first frame after saving the animation (usually done when a user quits working).

Dubbing a Soundtrack

The final added feature was the ability to record a soundtrack, requested by many users. We embedded a microphone below the monitor and added a button for starting recording. During recording, the animation is played and all sounds are recorded live. The amount of retakes is unlimited.

TECHNOLOGY

Although the installation is fairly simple from a technical point of view, there were a few insights to be gained before implementing the software. The basic problem was how to enable smooth playback and real-time onion-skinning with the best possible image quality, optimally with no compression. We utilized the fact that the amount of computing resources available depends on the state of the software as follows:

1. The most time-critical state is during playback, as a constant frame-rate must be maintained. During playback, onion-skinning is suspended and quarter resolution (320x240) preview images are used.
2. When inspecting the captured frames or the onion-skinning view during taking pictures, the best possible

image quality is needed, but the update rate of the display is not as critical as in playback. Thus, we use full-resolution (640x480) images for both playback and onion-skinning views.

3. When the user captures a frame, a slight delay is acceptable. We did not carry out comparative tests, but a delay of 500ms seems tolerable. We exploit this to save the captured image to the hard drive using three resolutions: a 32x24 pixel thumbnail used in the timeline view, a preview image used during playback, and a full-resolution image used when browsing and inspecting the timeline.

Basically, we moved as much of the image processing as possible to the least time-critical states. The solution is a good compromise that allows lossless capturing of animation at basically any resolution while still requiring no rendering before previewing the animation. Lossless capturing is important to provide best results when rendering the animations for the final distribution channel, be it DVD, Internet or some other. During playback, the image quality is not optimal, but a resolution of 320x240 is sufficient considering the low level of detail of the animations. The bandwidth requirements could also be reduced with image compression techniques instead of reducing resolution, but it has not yet been implemented.

The software runs on a 1.2GHz Pentium III notebook PC hidden inside the body of the installation. The software was programmed using Borland Delphi for the user interface and C++ for the image processing.

DISCUSSION

Animaatiokone has been touring for a year at various film festivals and exhibitions and all the animations created by hundreds of users can be viewed at the website www.animaatiokone.net. Although the physical design of the installation best suits teenagers and adults, children can also use Animaatiokone with a stand under their feet. In an exhibition in Belgium, several groups of elementary school children created animations together with their teachers. However, it was evident that children need careful instructing to understand the amount of images needed. The best results were obtained by showing by example and using simple rules, such as "move the character only a half centimeter at a time".

The goal of collaborative storytelling did not produce very interesting results in terms of stories continued by several animators. Animations are created as a free association process, as in the sequence in Figure 6, where a piggy enters the scene, waves to the camera, and eats a mushroom. Then, in the hands of a new animator, a snake comes out from the pig's belly and the pig melts away. The snake is also an example of intertextuality - according to the animator, the idea of a creature bursting out of the piggy's belly originated from the movie *Alien*.



Figure 6. Frames from animation created with the low-tech prototype. The piggy waves its hand, eats a mushroom and the next animator makes a snake come out of the piggy's belly.

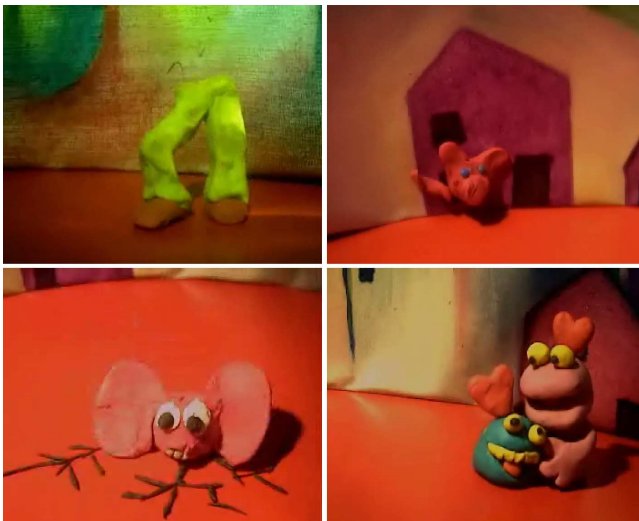


Figure 7. Examples of animations created with the finished installation. Experiments in animating walking are common, but a creative solution is to omit the upper body, which helps in balancing. The background has also been exploited creatively, as in the piggy peeking out of a window or the creature falling through the 'breaking' stage. The hearts of the cuddly characters can be seen as wordless thought balloons.

Beginners often seem to be satisfied with 'Hello, world' experiments, that is, creating a character and making it perform a simple motion, such as walking or waving a hand. After the first months of touring with Animaatiokone, we soon identified several popular themes, such as walking, eating other characters (usually absurdly large ones), slapstick, and cute characters. As with all tools, things easy to do are done often - making a character eat large things looks funny and is easy to animate using plasticine. On our website, you can find an edited video of the themes and some examples are also shown in Figure 7.

We have been surprised by the creativity of the users, examples of which are shown in Figure 7. Animaatiokone

does not provide wires or other means of supporting airborne or unstable characters, so one user created a hilariously expressive pair of walking and jumping legs, which are a lot easier to keep in balance than a whole actor with an upper body. The same kind of constraint-evading creativity manifests in the soundtracks. In addition to human voices, footsteps and other sound effects have been created by using the body of the installation as a percussion instrument. Music has also been made by mimicking instruments with voice or using mobile phone ringing tones. On the other hand, having no sound forces you to come up with visual means of conveying emotion, as in the case of the cuddly characters in Figure 7, created before dubbing was implemented.

Compared to Storymat 14, Animaatiokone provides fewer possibilities for continuing the stories of other users, since new images are captured only in the end of the timeline. With Storymat, stories are recorded with a microphone and any story can be paused at any point and picked up by a new user. Our low-tech prototype provided similar functionality by allowing the users to capture images at any place on the timeline, but it was found confusing. The case is also more difficult with animation since the characters made by the previous users may not be available.

Collaboration and communication between users of Animaatiokone can be divided into two levels:

- Co-present collaboration and communication within a group of people using the machine. This manifests in the form of sharing characters and dubbing the animations together. This is supported by the table on which characters can be created collaboratively and the overhead display from which everyone can see the animator at work.
- Mediated collaboration and communication between users that do not meet each other. This is enabled by the timeline, the shared characters and the website.

Sharing clay actors seems to be the most influential way of communicating in both cases. Inspirational characters tend to have longer life spans, appearing in many animations.

Benford *et al.* 2 discuss applications that enable, encourage and enforce collaboration. In their terms, "*Encouraging collaboration is more proactive than only enabling collaboration. Something new is gained by choosing to work together.*" Although brainstorming ideas together often leads to better results than creating your animation alone, the benefits of collaboration are most obvious when recording a soundtrack. As all sounds must be generated live at a single take, more than one voice produces a richer result, especially if there are many talking characters.

Although Animaatiokone is basically just an environment for using an animation tool, the installation seems to work as edutainment (education and entertainment) as well. The social aspects and the visual design of the installation make animating fun and we have had a lot of positive feedback

and media attention. To quote a review, “*The sympathetic, anthropomorphic ‘Incredible Animaatiokone’ is guaranteed to put you in a good mood*”. Similarly, an essay inspired by the installation starts as “*Once upon a Saturday morning, the child inside of me awoke. The perky, red Animaatiokone stood in the lobby of Wiljam, waiting for new animator talent to gather around. Excited, I rushed to get my hands in plasticine...*” People have even asked for coin-operated versions of Animaatiokone for pubs etc., but it would be rather cumbersome since the installation requires constant support. Fresh plasticine must be supplied daily, since it eventually ends up in unusable clumps of scrappy colors.

CONCLUSION AND FUTURE WORK

We have described the design of a novel user interface and installation for creating clay animation. Hundreds of users, many of them beginners, have successfully created animation with the installation. The installation was awarded special prize of the jury in the Prix Möbius International 2003 interactive media culture competition.

Although we are satisfied with the outcome of the project, it has also been an example of how difficult it is to accommodate the needs of both experts and beginners in the design. In the beginning, we focused on developing the software based on interviewing art students and animators, which resulted in the 2D onion-skinning control that had then to be discarded to produce an installation approachable by a larger audience. However, the installation still provides a clear advantage over existing tools, combining instant previews, full-resolution lossless capture and the ability to correct errors by deleting and recapturing frames. The development time was not wasted as we are now focusing in refining the software for home and school use. Beginner-level art education has lacked the proper tools for animation and our experiences show that the user interface of the installation makes clay animation easy to approach.

It should be noted that since the frame-rate of the camera view is not critical, a variety of real-time processing and analysis algorithms can be implemented. One useful feature could be to detect fingers from the captured images, since leaving your fingers accidentally in the camera’s view when capturing seems to be the most frequent error made by beginners. We are also inspecting automatic generation of motion blur, as well as the possibilities of using modern digital cameras to produce high-resolution, film-quality animation with home equipment.

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Figure 8. Using Animaatiokone. Animating takes place inside the studio dome, where there's a backdrop and a movable camera. The display above the dome allows people around to watch the animator at work.



Figure 9. You can sculpt your actors on a table next to the machine.



Figure 10. The final visual design of the installation's software



Figure 11. The panel inside the dome contains buttons for capturing and deleting frames and previewing the animation.



Figure 12. The buttons on the front of the machine allow browsing the animations, recording a soundtrack, saving the animation and displaying an introductory video.