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Markerless Facial Motion Capture

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MARKERLESS FACIAL MOTION CAPTURE

By

Sara Jessica Saito

B.A., Southern Illinois University, 2013

A Research Paper
Submitted in Partial Fulfillment of the Requirements for the
Master of Science.

Department of Mass Communications and Media Arts
Southern Illinois University Carbondale
May 2015

RESEARCH PAPER APPROVAL

Markerless Facial Motion Capture

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Fulfillment of the Requirements

for the Degree of

Master of Science

in the field of Professional Media & Media Management

Approved by:

Professor Perkins-Buzo, Chair

Graduate School
Southern Illinois University Carbondale
April 9th, 2015

AN ABSTRACT OF THE RESEARCH PAPER OF

Sara Jessica Saito, for the Master of Science degree in Professional Media & Media Management, presented on April 9th, 2015, at Southern Illinois University Carbondale.

TITLE: Markerless Facial Motion Capture

MAJOR PROFESSOR: Professor Perkins-Buzo

   With the ever-rising capabilities of motion capture systems; this project explored markerless facial motion capture programs using the Kinect Sensor for Xbox. Many systems today still use markers and end up retargeting after a motion capture recording. This project used a simpler process of setting up and being able to display the effects live. An off-the-shelf system was built using a computer, a Kinect Sensor, a plug-in from Brekel, and Autodesk software. The first goal was to create a process that was able to capture and project live facial motion for fewer than $500 USD. Anything over $500 USD was considered to be more of a professional studio set-up. With an inexpensive setup, amateur users can do motion capture outside of a studio. The second goal was to observe the outcome of the audiences' responses and see if interaction felt more mechanical than human.

ACKNOWLEDGMENTS

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CHAPTER 1

INTRODUCTION

Intention of Project

With an extensive background in animation and new media, motion capture intrigues me with the expanding methods of technology. As new technology develops, the possibilities seem endless; and that's where I see the opening of a latest development in animation: markerless motion capture.

The intention of this project was to use motion capture techniques to further aid my animations so that my workflow is efficient and fluid. Now, motion capture itself is not ultimately defined as a true method of animation, but more as a visual effects component. For example, the Academy Awards guidelines still do not include motion capture to be a part of the animation award category (Academy of Motion Picture Arts and Sciences, n.d.). From the assistance of video game technology, the gaming industry and cinematic industry are coming into coherence, increasing technological advancements for entertainment.

Technological Influence

With these advancements in technology, cinema may change drastically in the next 10 years. Television has already been impacted by CGI and 3D animation. Examples of these advancements can be seen in the compositing used by TV shows like Game of Thrones, The Walking Dead and animation like the spinoff series from the movie How to Train Your Dragon. With developments like Machinima —

the process of making realtime animated films by utilizing the 3D graphics technology of computer games (Dictionary.com, 2014) — video games are becoming increasingly cinematic in their storytelling. The two entertainment worlds are meshing to better entertain our imaginations. Video games will always remain heavily interactive and cinema will become much more of a fantasy world.

Significance of Project to Field

This project was presented in real-time on a wall in front of friends and family at home. The setting for this project was in a private space and casual. Behind the scenes, a voice actor (me) was seated in front of the motion capture software. The voice actor asked specific questions to the group. These questions were merely the basis of casual conversation to keep everyone interested and engaged.

Metaphorically speaking, this project simulated the Turing test in a way. By having a real human behind the scenes, the avatar would be even more human like and have a greater sense of "artificial intelligence". Though, behind the scenes, everyone knew it was really a human being.

Not only did the project help measure the interactivity between my art and the viewers, but it will also help future animators gain more understanding about markerless facial motion capture. In addition, a blog was created and updated with tutorials and troubleshooting techniques for those wanting to learn more about the software being used. It will make others aware of the technology available and what can be done with it in terms of motion capture.

Within the research, I strove to work on a student-level budget so those with less financial means can also pursue this interest. Additionally, with the absence of an

abundance of tutorials for this study, I plan on my research aiding those curious about this particular subject.

Outline of Research

In Chapter 2, the project pipeline is presented so that others can gain an understanding for the time it takes to complete a facial motion capture project.

Chapter 3 describes the workflow moving from personal experiences to a user manual. It also explains the different choices made to accomplish the facial motion capture. These alternatives are notable for further explorations in facial mo-cap methods.

In Chapter 4 the research from the project is presented along with the opinions received from viewers.

Chapter 5 discusses the potential for future research into other paradigms for using markerless facial motion capture.

CHAPTER 2

MOTIVATION

Project Importance

This project is very important to me because it taught me more about motion capture techniques through hands-on experience. I worked independently while piecing together information from others' experiences with low-budget motion capture. The goal had been to use 'live-action markerless motion capture' using depth-cameras such as the Kinect sensor. After examining other means of motion capture, this technique was the most logical option. I was able to see how far I could push the technology even though I hit some roadblocks during the process.

Project Pipeline

The duration of this work took 4 months from start to finish. Preparing for this endeavor had taken longer than expected. One problem that occurred was communicating with the various companies to try and acquire discounted software. In some cases, the companies would not respond or not have any academic-priced versions. Luckily, with the Brekel software, the response was very timely with a discounted product and free trial. Downloading and installing the Autodesk software was free and immediate from the company's website. Using these methods, a student can have access to all of these tools within a week.

To set a plan for motion capture, the first step would be to create a model in Autodesk Maya. This process may take anywhere from one week to one month depending on the modeler's skill level. With my skill level, it took me about three weeks

to create a head suitable for facial motion capture. I spent about two months preparing the model through trial and error to create an exportable file. With my Quick Start Guide, an animator can prepare their model for motion capture within one month. (This animator should be classroom trained, or at least have intermediate skills in order to follow the Quick Start Guide with complete understanding). During the fourth month, I fine-tuned my model and connected the system for live motion capture.

CHAPTER 3

ESSENTIAL SETUPS

Requirements

To follow my workflow for a markerless facial mo-cap system, one needs Brekel Pro Face and Autodesk software (Maya 2013 and MotionBuilder 2013). It is critical to check the compatibility of the programs with the computer system used. Brekel does not work with Mac Operating Systems. Windows 7 was the OS used for this project. Another element to add to the process is the Kinect Sensor for Xbox. This depth camera is vital to motion capture. The Kinect Sensor for Windows is also compatible with Brekel Pro Face. Installing the OpenNi 2 driver for the Kinect Sensor allows the depth-camera to communicate. For connecting the Kinect with the PC, a PC AC Kinect Adapter is required. With the hardware and software ready to be used, the setup for motion capture is now prepared.

Narration of Workflow

Preparation for motion capture. I created the model from scratch using Autodesk Maya 2013. Using an updated Autodesk Maya 2015 was appealing, however there was a learning curve with new and improved tools. Many times, I found myself looking at the manual instead of being able to find video tutorials demonstrating the new tool techniques. To speed my workflow I decided to use what I knew best and stick with Autodesk Maya 2013.

Creating a model was not as time consuming as creating the settings for the FBX file it would be converted to. When creating a face or model in Autodesk Maya, it is

important to save the file as an MB document. It isn't necessary to convert the file into

FBX until the very end of preparation for motion capture. While creating a symmetrical

face in the program, it is crucial that the vertices are indeed symmetrical. If the vertices

are asymmetrical, an error will occur later that prohibits further actions. Taking these

steps with the highest precautions are just preliminary tasks into a successful workflow.

   Eyes. Eyes are helpful to create but aren't necessary when trying to do facial motion

capture. The idea may seem preposterous but the key point is to focus on moving the

face with this system. Another task that isn't necessary is structuring a rig for the model.

It just made the model better rigged for future animating. I went ahead and built bones

and joint for my model though it wasn't needed in the final process. The most difficult

part of this particular process was connecting the separate eyes to the main model.

Since my pivot points were not centered on the eyes, every time I would try to constrain

the eyes to the facial rig errors would appear and the model would disappear. I

attempted to use each of the constrain tools Autodesk Maya had to offer: orient

constraints, point constraints, and aim constraints. Immediately after I had bound the rig

to the objects, the eyes would not move properly (as shown in Figures 1 & 2).
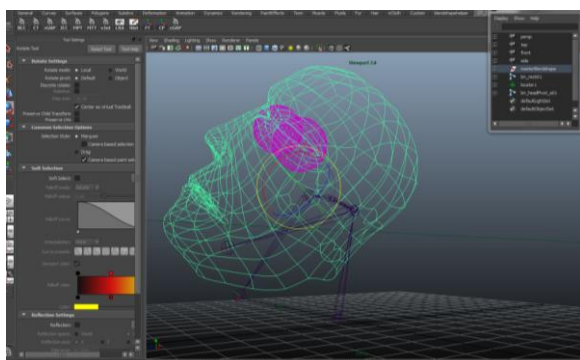
Figure 1. The eyes are aligned before the bind.
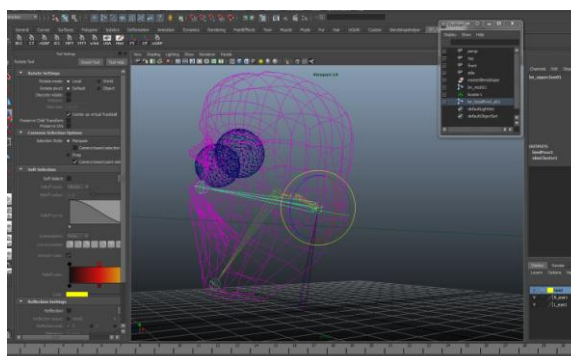
Figure 2. The eyes are not aligned after the bind.

After researching more about eye attachment for motion capture, I found that even the high-grade systems, such as FaceShift, had flaws with eye movement too. This influenced my decision on deleting the eyes and focusing on the face. I had the rig set up but in the final process I waited until I created the blendshapes to bind the face to the rig.

   Painting weights. The next portion of my tutorial was to paint weights on my surfaces. One significant problem that occurred was having a faulty border edge. Border edges occur when there are additional edges attached to one vertice (see Figure 3).
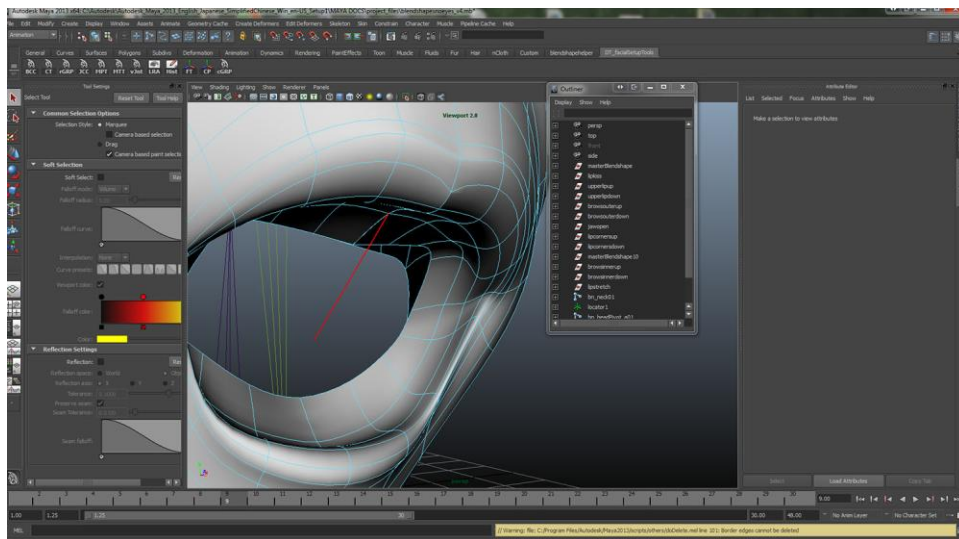
Figure 3. An example of a border edge (shown in red).

When painting weights on a surface, these edges become increasingly visible. To correct the border edge that had appeared in the mouth of my model, I rotated the edge to create a face that I could later delete (as shown in Figure 4).
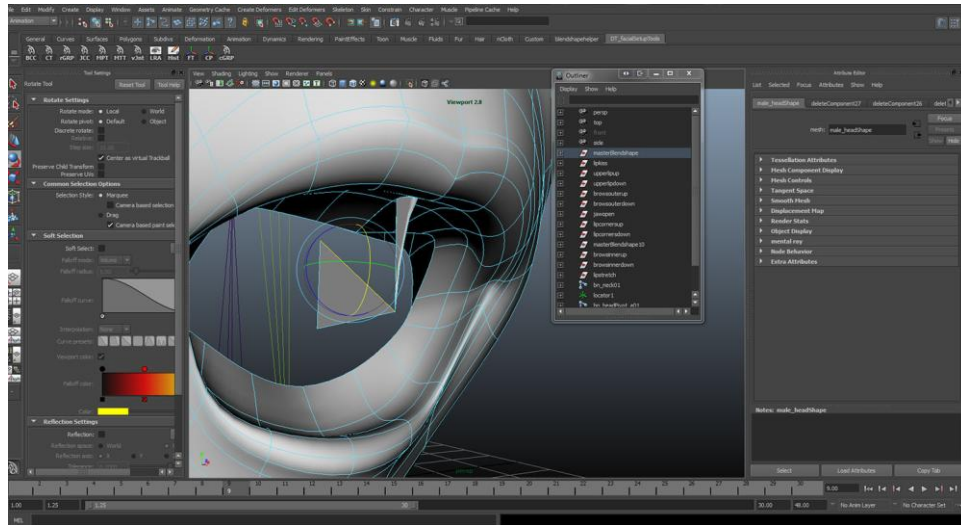
Figure 4. This figure shows the rotation of the border edge.

This technique worked well and within moments the border edge was gone. Although this fix was successful, I had noted on my blog, "The topology is greatly affected especially if you do this after you bind and initially paint weights." As stated before, it is important to check the model for potential border edges before binding the rig and painting weights.

    Blendshapes. The most vital step of creating a successful FBX file for motion capture is to create blendshapes (refer to figure 5). These can also be known as facial morphs and deformers.

Figure 5. This figure is a rendering of various blendshapes.

Creating blendshapes took two days to complete at first. After some practice I was able to create 12 new blendshapes within an hour. To simplify the task of creating blendshapes I had mentioned in my blog, "Start with the mouth and then work with the eyes. The mouth has so much room for error with geometry that it can slow you down greatly. On top of that, after making one or two blendshapes, try creating the deformers and see if they work, then go back, create the others and then bind them. This would show you all the flaws Maya might have when exporting the geometry." It is extremely important that the blendshapes are not only titled correctly when creating them, but named accordingly as well. In the blendshape window, make sure the small text boxes are appropriately named for each blendshape and that they are not all the same. Figure 6 shows the incorrect title for the particular blendshape whereas Figure 7 displays the correct organization.

Figure 6. The titles are not labeled properly.

Figure 7. The titles are labeled correctly.

If the names are identical in the small text box, then all of the blendshapes won't be present when opened in MotionBuilder and only one would appear. This mistake happened in the first test of opening up my blendshapes in MotionBuilder. I had

panicked when I found only one blendshape had been exported. After the blendshapes are created the final step in Autodesk Maya is to export the FBX file.

  FBX. The final phase of preparing a model is properly exporting the file so that it is compatible with motion capture methods in MotionBuilder. To be safe, I used an older version of FBX and exported the file as "fbx 2011" (shown in Figure 8).
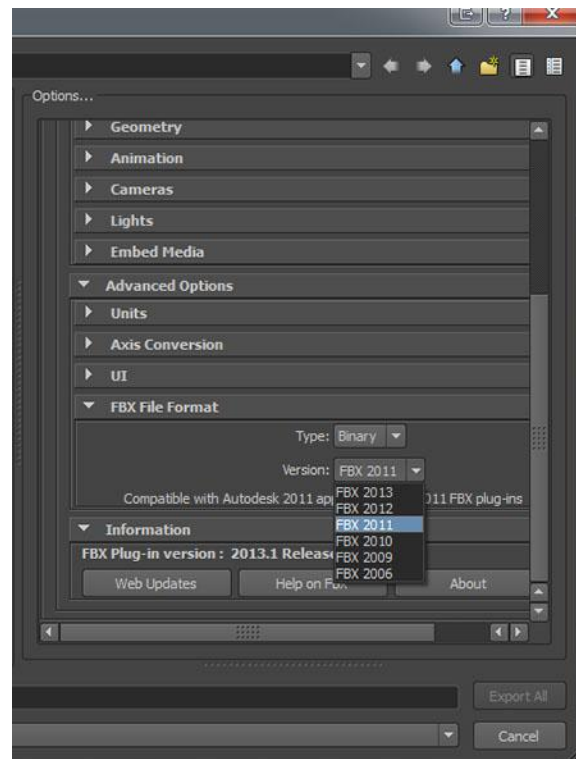
Figure 8. The FBX selection is found in the "Options" section during export.

When exporting the selection, under the "edit presets" option, the main components that need to be changed are turning off the cameras and lights, and choosing "fbx 2011" as the FBX file format. These will lead to a successful export.

  Setup for motion capture. To begin the setup for a live capture, it is necessary that the software required is installed and the hardware is plugged in. First, the Brekel software must be opened, then MotionBuilder. Once in MotionBuilder, the FBX can be

accessed through File >Open. I had mistakenly tried the "motion file import" option and

had unsuccessful attempts at opening the FBX file.

    Brekel Device. In the Brekel tutorial I was following, I first had to drag the Brekel

Device from my Asset Browser onto my character. Figure 9 displays the location of the

Brekel Device.
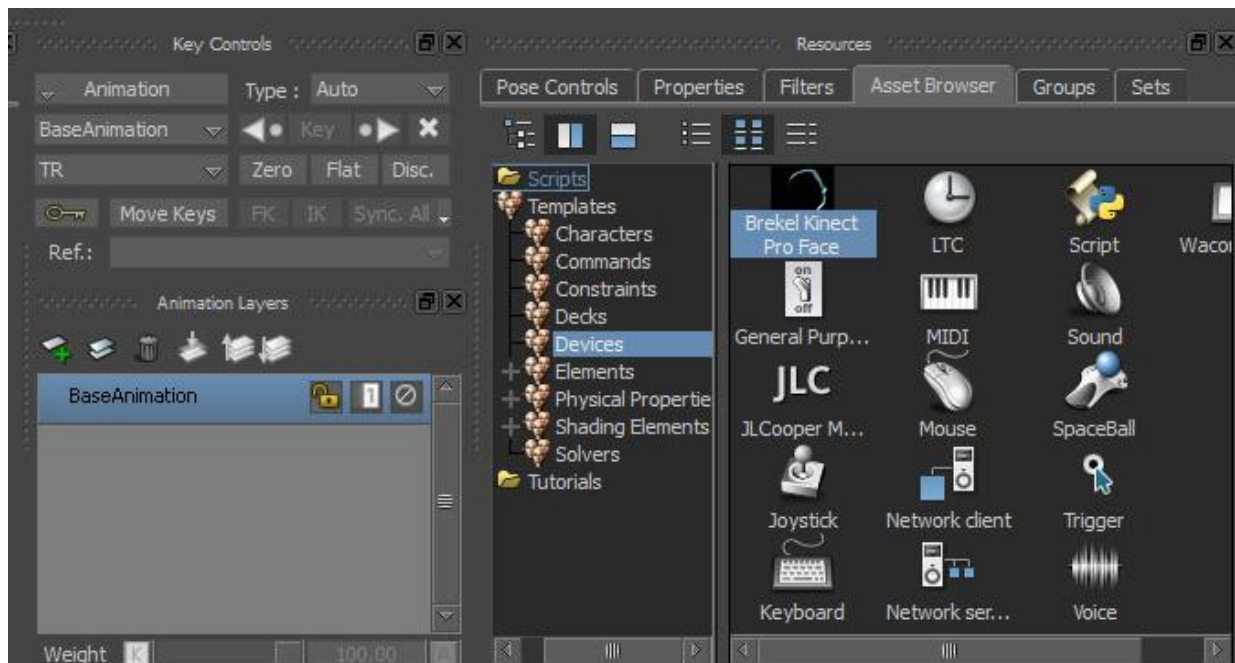
Figure 9. The Brekel Pro Face Device is found in the Asset Browser of MotionBuilder.

This action connected the model to the plug-in software. The next step was to go into

the Devices tab, under the Brekel Device window, and create model bindings (as shown

in Figure 10). In the same window, next to "Character Faces", I had also clicked on the

"Create New" button.
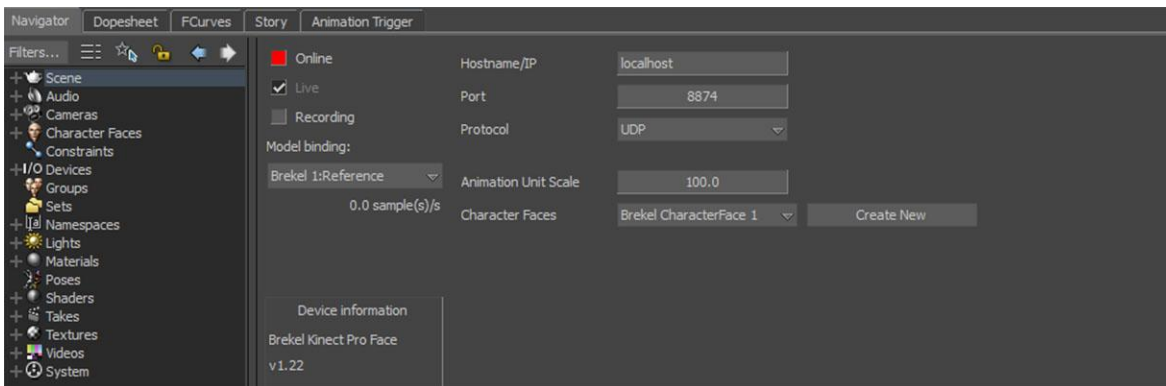
Figure 10. This figure shows the location of the Model binding scroll-tabs used to bind the character.

Networks. A mindless error I had stumbled upon while connecting the system was that the networks in Brekel and MotionBuilder did not match up. While in that same Brekel Device window of MotionBuilder, setting the protocol to "UDP" will allow the programs to communicate effectively. Going into the Brekel UI, the top right corner will help navigate to the network options (see Figure11). I had to use the scroll tab to find the "UDP" network and match it with the MotionBuilder protocol settings.
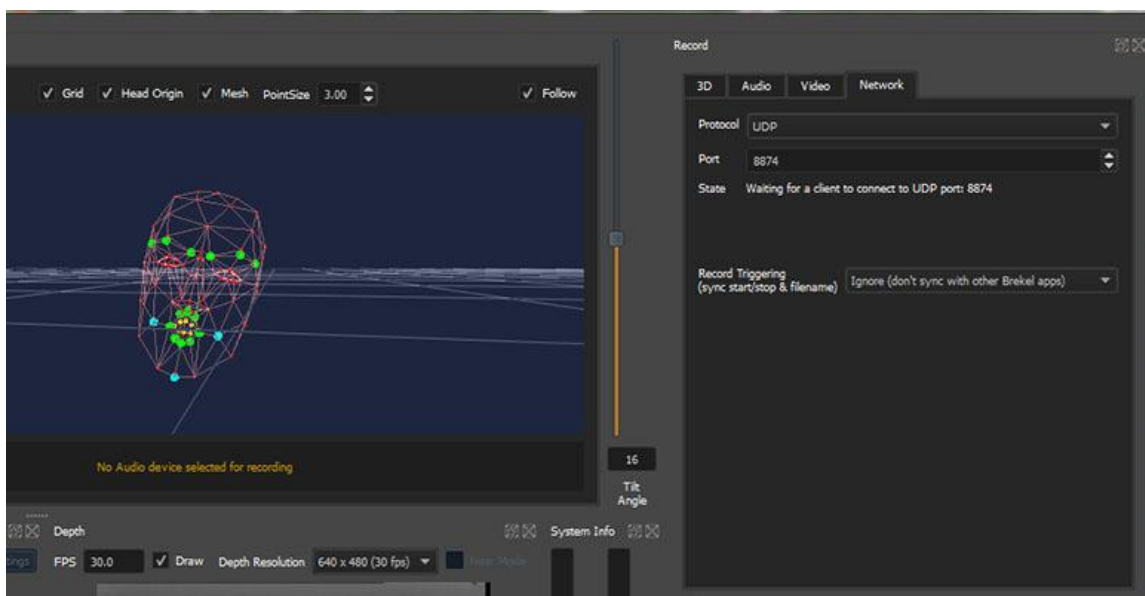
Figure 11. The "UDP" protocol is found in the Network tab in the Brekel UI.

Communication between Brekel and MotionBuilder. After I had the networks and bindings set up, I went to "Brekel Character Face" found in the "Character Faces" filter on the left side of the MotionBuilder UI. In figure 12, I needed to check the "Active" box.
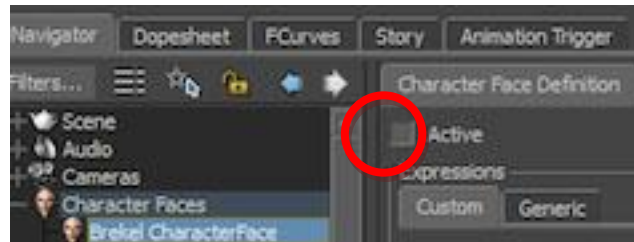
Figure 12. The "Active" box needs to be checked.

This action helped read the shapes for motion capture, as well as presenting a quick test to see that the system works. Because I did not calibrate the sliding weights on the individual shapes, the movements of the current shapes were unstable. I will get to the solution for this in the next couple of steps.

Going back into the "Brekel Kinect Pro Face" in the "Devices" filter, I had to make sure the "online" and "live" boxes are checked and that recording remained off. Recording was not as important since my project was a live performance in the program. With "Active" and "Online" selected, I was instantly able to see the movements being captured by my model on the stage.

Now seeing that the networks were connected, I had to go back and deselect the "Active" option in the "Brekel Character Face" window (refer back to Figure 12). With my networks disconnected I could calibrate the blendshapes with more control. To do this, I had to hold the "ALT" key while dragging the model onto the "Shapes Mapping" tab. This allowed me to regulate the amount of movement for each individual blendshape. I

had to make sure that the blendshape I was weighting was matched to the action described (as shown in Figure 13).
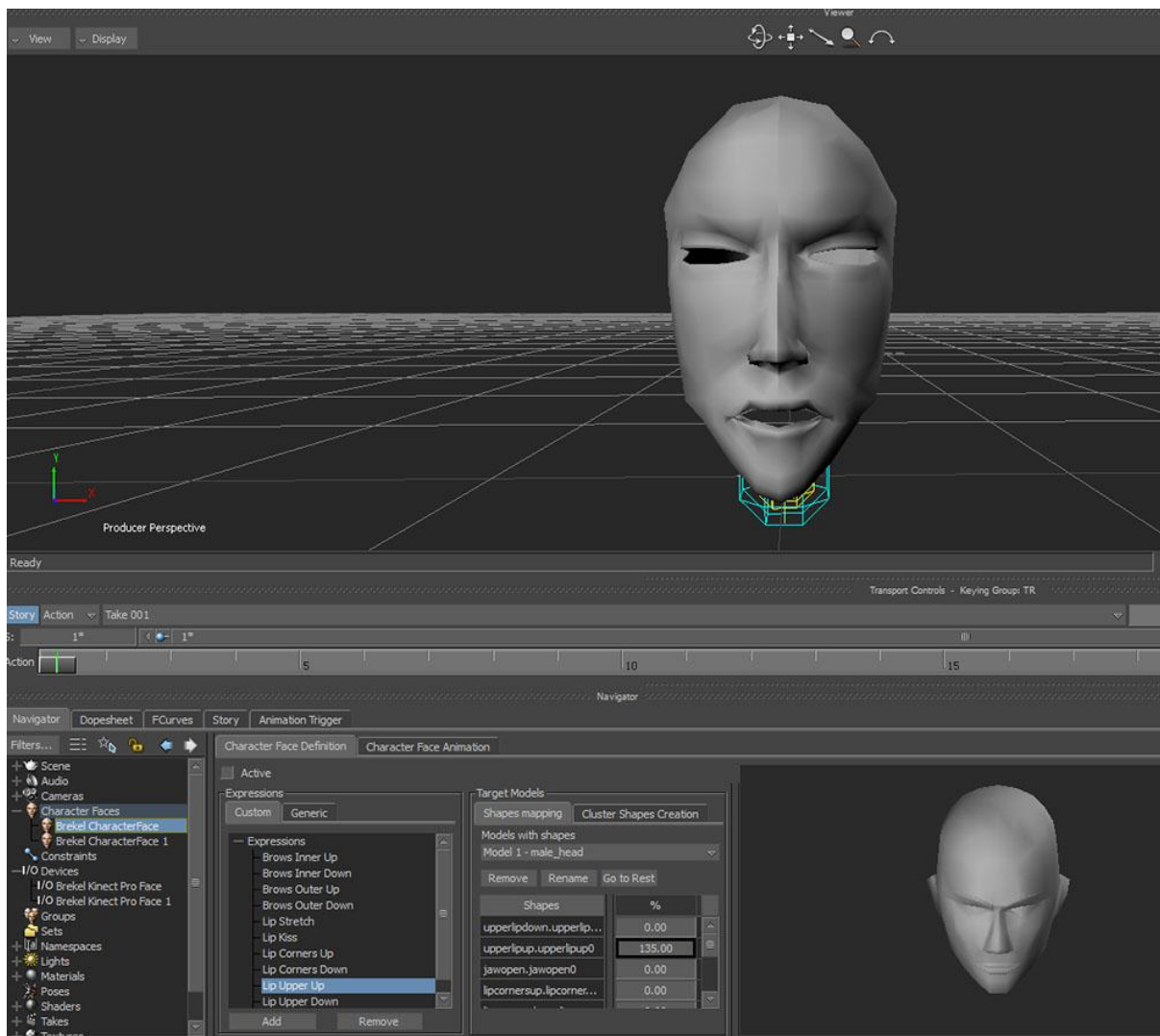
Figure 13. The shapes need to match for mapping the correct expression.

To do this I needed to click on both of the names in each window. In some cases I found that sliding the weight above 150% was necessary to achieve a sufficient amount of expression.

After the shapes were calibrated, the next step was to select "Active" once again.

Figure 14 shows the window with everything set up. Last but not least, checking the

"Online" box allowed the system to communicate (refer back to Figure 10). In Figure 14,

the blendshapes were perfected and the model was moving.
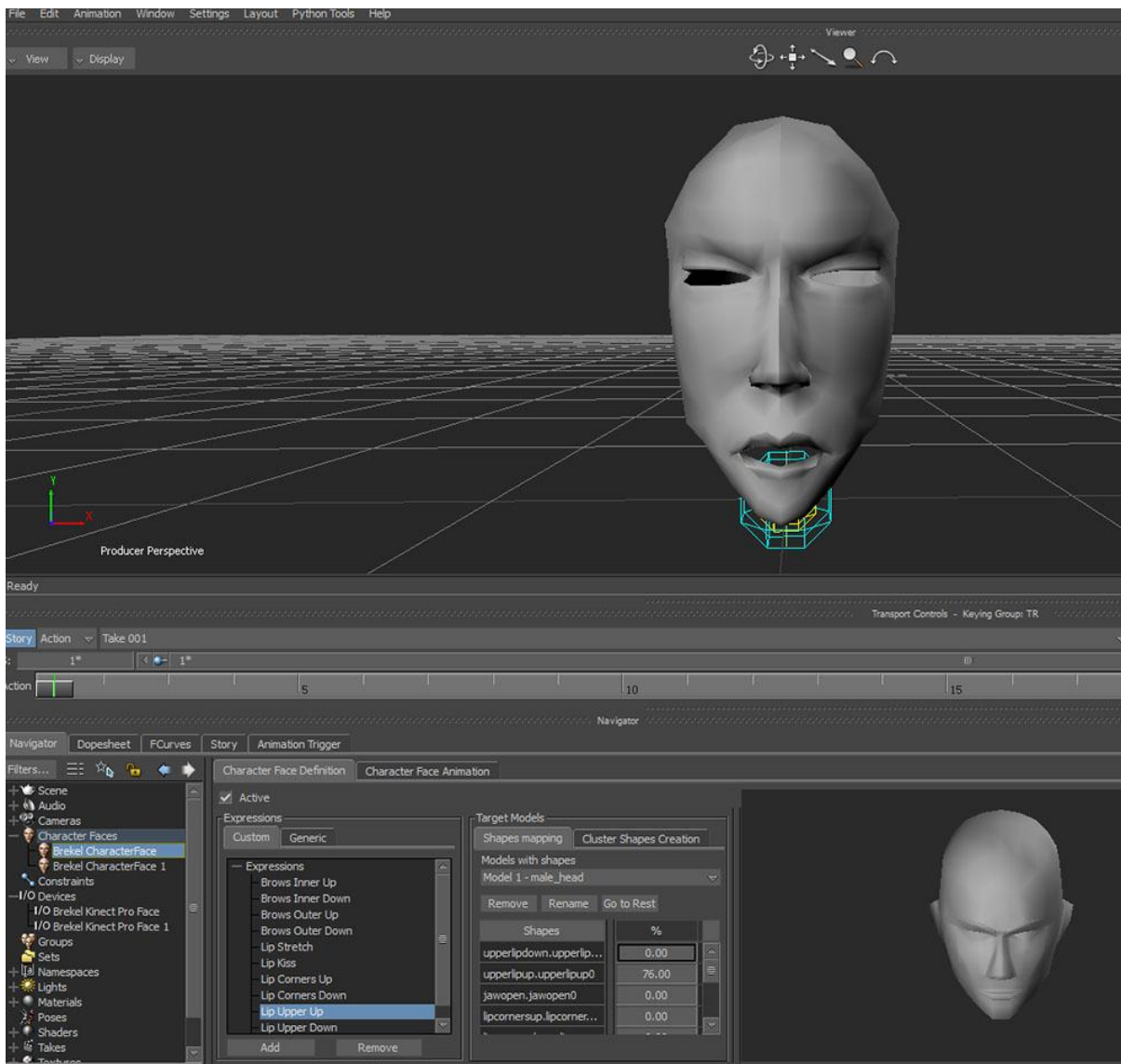
Figure 14. The shapes are matched and the model moves to the expression being read.

Hardware

    To have the setup for this particular project, a computer that runs Windows

Operating System is needed. Windows 7 was the OS that was used. As for the Kinect

Sensor, a basic one specifically for the Xbox 360 can be used. The Kinect for Windows

can also be used with Brekel. (These do not require any adapters). Kinect Sensors can

be bought online individually with no need to purchase a bundle kit/ gaming console.

Typically, the sensors cost around $30-$50 USD used. Another accessory to add is the

Kinect Adapter. These allow the Kinect Sensors to be powered up and communicate to

the PC. The adapter looks like a thick black cord with orange lining the interior of the

ports. This distinguishes the Kinect adapter from a regular USB cable (see Figure 15).

Figure 15. The Kinect Adapter is pictured.

 The adapters can cost between $5-$15 USD depending on the retailer. Popular online

retailers such as Amazon and EBay carry these items. Altogether, the amount spent on

hardware for this project was around $43 USD.

Microsoft also manufactures a Kinect Adapter. The price listed on their website is $49.99 for US buyers. The Kinect Sensor that is compatible with the adapter is listed as $149.99 for US buyers. Buying directly from Microsoft would increase the budget. For this project, the Kinect Sensor for the Xbox 360 was sufficient.

Software

There are many types of software available for motion capture. Brekel, Autodesk Maya 2013 and Autodesk MotionBuilder 2013 were perfect for the live performance. When choosing programs to work with, checking the compatibility with other programs can guarantee a successful workflow. In this case, Brekel was compatible with Autodesk Maya 2013. Jasper Brekelmans, (the founder of Brekel), had replied to one of my forum posts, "The lowest version of FBX files supported is 2006, so you can read them with Maya/MotionBuilder/Max 2006-2015, and pretty much any other 3D app on the planet. The real-time plugins for MotionBuilder are included for versions 2009-2015 (32 and 64 bit where applicable). Since all it needs to do is generate a hierarchy of basic objects and drive their properties it doesn't really need specific features of new versions so the version number doesn't matter much" (Brekel, 2014).

The most important aspect of acquiring the software is timing. It is necessary to put aside a decent amount of time for companies to get back to you. It took Jasper a couple of days to respond to my requests although other companies may take a couple of weeks. Directly emailing the company helps seek out discounts, especially for students.

One last requirement for the setup is installing drivers for the hardware. OpenNi 2 was successful in terms of allowing the Kinect Sensor to be used in Windows 7.

OpenNi 2 is free Open Source Software that provides a driver for the interaction between the devices.

Tier 1 Alternatives

    Tier 1. Tier 1 software that is capable of markerless facial motion capture, using a depth-camera (such as the Kinect Sensor for Xbox 360), is comprised of the following: IPi Soft, NUI Capture, Maskarad, and FaceShift. Although some of these software include a student discount, they still cost more than $500 USD. Many of these programs offer a professional version of their software, but have different features.

    IPi Soft. IPi Soft does make Tier 2 software however its Tier 1 software includes more features. IPi Soft has a standard edition for $1,046.50 USD (after a 30% student discount), which provides all high-end features including multiple person tracking. It supports capture with 2 depth sensors or 3-8 Sony PS Eye Cameras (IPi Soft, 2014). IPi Soft is also compatible with other programs like Poser, Cinema 4D, Maya or MotionBuilder. It can be compatible with other cameras as well, though this is just an example of a Tier 1 option.

    NUI Capture. NUI Capture is another Tier 1 software that costs $817.74 USD altogether, even after a student discount. (It's originally $1168.20 USD). In order to have a successful experience with this software, it is highly suggested that NUI Animate is also purchased, along with NUI Analyze. These work together, transferring information and data. This alternative allows real-time preview. It only runs on Windows 7 Operating System. It can export depth, color, and skeleton, and face data to Matlab, Maya, 3DS Max, and MotionBuilder (Cadavid Concepts, Inc., 2012).

Maskarad. Maskarad is also Tier 1 software. It runs on Windows XP, Vista, and 7. It is also compatible with Maya as well as 3DS Max, Cinema 4D, Lightwave, Softimage and MotionBuilder. This program costs $1,499 USD, although at checkout it reduces to $1,000 USD. Maskarad also processes audio tracks and precisely detects the phonemes timing of the actor speech (Di-O-Matic, Inc., 2014). It would be further useful to see how the model data and audio track data interact.

Vicon. A Tier 1 software that does not have its price listed would be anything from Vicon. Many large productions use software and hardware from Vicon and it is highly safe to assume that Vicon equipment is expensive. A specific program made for facial motion capture is Cara. Cara is the worlds first out of the box, end-to-end facial motion capture system. Each system ships with CaraLive and CaraPost to record capture and export your facial data (Vicon, n.d.). For animators without means of financing available for sensor technology from Vicon, Vicon offers a service called House of Moves, where amateurs can rent equipment and use the motion capture space in the studios. Vicon designs specifically made-for-movies cameras that can digitally simulate 3D environments wirelessly. A company that uses this software and hardware is ILM-Industrial Light & Magic (The Daily, 2011). Industrial Light & Magic (ILM) was the company that did the CGI work for the movie The Avengers. While nominated for an Oscar on their work, their strategy for the film was to be able to recreate a digital body/face double of the actor. A lot of retargeting work was done to achieve the realistic effect.

Faceware. A similar company that once again, does not have prices listed is Faceware Technologies. The company offers software and kits that include hardware to

motion capture artists. Faceware Analyzer™ is used for capturing the motion from the camera. Faceware Retargeter™ is a plug-in for Autodesk which helps Autodesk progams read and interpret the data for animation. There are two types of camera systems available: GoPro® Headcam Kit and the professional headcam kit created by Faceware Technologies. The GoPro® is for smaller budgets whereas the professional headcam kit is targeted towards larger productions (Faceware Technologies, 2013).

FaceShift. The last software that could be classified under Tier 1 is FaceShift. The studio version is $1500 USD a year and the freelance version is only $800 USD a year. Both of these versions have many features for efficient facial motion capture. Also, FaceShift is markerless which eliminates an added step. A potential problem could be the subscription fee of paying yearly for the program. If there were a larger budget, the studio version would be most compatible for this project because it offers offline plug-ins for Maya and MotionBuilder. This program also runs on both Mac OSX and Windows (Faceshift, 2014). There were countless tutorials with this software as well as helpful resources in markerless facial motion capture. I had contacted Faceshift for a trial version and the company had sent me a key for a 3-month trial. The software was very detailed and had a lot of motion capture capabilities. I would choose this Tier 1 software over the others because it would be a great beginning entry into Tier 1 software.

Tier 2 Alternatives

IPi Soft Express. The express edition for IPi Soft costs $206.50 USD (after a 30% student discount). The basic edition itself costs $416.50 USD (after a 30% student discount) and includes all basic features needed for high-accuracy motion capture. It

supports capture with 1 or 2 depth sensors or 3 to 4 Sony PS Eye cameras (IPi Soft, 2014). Again, capture is not limited to just Sony PS Eye cameras with this program. Unfortunately this program is not a real-time program.

   FaceCap. FaceCap is a software that is marker motion capture and for use on a webcam although it is integrated with Autodesk Maya. FaceCap was developed in Xantus S.A. Animation Studio (d3cker, 2012). There are no jitters; quick easy setup, no calibration really required (Ascensi, 2013). The problem with this software is that you need to set up markers. Some other downsides of this program are that it works only on Mac OS and it doesn't use a depth-camera. The software gets its visual data from a regular camera such as a webcam. Some positive information about this software is that it is capable of real-time capture and it is OSS. To run FaceCap, you would need to operate using Linux, (a separate operating system), and Autodesk Maya 2011. This software uses OpenCV features to capture, filter and track markers from camera. Data is sent to Maya using external server techniques. This is more Proof-of-Concept than useful tool (d3cker, 2012). All in all, the possibility of considering this as a resourceful tool for this motion capture project was low, though this program would make a decent test for markered facial motion capture.

   Zign Track 2. Another webcam-based Tier 2 software is Zign Track 2. It is a relatively affordable program that costs around $200 USD. However, it tracks dot-markers and does not use infrared light as the Kinect sensor uses. Livestream and real-time make the tracking of those dots inefficient, as there may be some bugs in the software (DSW, 2012). Again, this program is not markerless which does not comply with this production's standards however it is important to include it in the list of facial

motion capture software. After testing this system with the trial, I was unsuccessful getting live motion capture. Contacting the company, I requested a more in-depth trial or perhaps a discount but there was no response.

Fast Mocap. Fast MoCap on the other hand, is another Tier 2 software that is a motion capture program that is markerless. It is compatible with other programs like Maya, MotionBuilder, 3DS Max, Poser, and Cinema 4D. The basic edition sells for $149 USD while the professional edition is $199 USD. Both types of the program are also capable of running on Mac OSX and Windows partitions. An unfortunate detail about this software is that it is mainly geared towards skeletal motion capture of the body and not for facial mocap.

CHAPTER 4

CONCLUSIONS

Technological Achievement

Markerless facial motion capture is a recent trend in computer graphics and animation. Setting up a motion capture system for under $500 USD is very possible. Using this project's setup, markerless facial motion capture could be performed live in a large format. With the large format capability, this project proves that projection art can be achieved with motion capture. Being able to access a setup like this allows more individuals to learn about motion capture without having an abundant source of financial means. This creates a widespread growth of knowledge in which the industry can potentially have a greater selection of animators. Not only is the markerless technology gaining popularity but eventually it may become the new means of motion capture.

Discussion of Response

Once the project was completed, the final part was seeing how close friends and family reacted to it. Setting the markerless facial motion capture system up in my apartment, I had a private get-together to show my work. The conversation between my real-time system and my audience was casual. I had asked questions and told stories to keep the interaction going. My friends were very engaged by this piece and there were many laughs. The level of comfortability seemed mixed. When asked if they felt comfortable interacting with the piece, nine people told me they felt comfortable while two people did not have a solid opinion.

Many knew that I was the 'man behind the curtain', but some still engaged as if I were mechanical. Further responses revealed that eight people thought of the piece rather as a "whom" than an "it" while four others thought the other way around. Given the varied responses, a social paradigm of motion capture may be a direction for further research.

Project Review

Markerless facial motion capture is possible for under $500 USD. This project helped prove the technology's capabilities while exploring different methods of motion capture workflow. From experience with the Brekel and MotionBuilder interfaces, I would infer that they become user-friendly and actions seem intuitive after learning the tools. I believe that my Quick Start Guide will propel others' workflows faster than my own when initially researching different mo-cap methods. It would not be fair to think this is the only method of markerless motion capture. There are always newer versions of technology coming out, but I feel that this is a stepping-stone into markerless motion capture. Since the project's presentation and with the turn of the new year, Brekel has come out with a second version of Brekel Pro Face with more features; however it only supports Windows v2 Kinect Sensors and the Xbox One Sensor. Microsoft has also recently released a newer Kinect for their latest Xbox One console. I would regard Brekel software as a more attainable learning tool for mo-cap and see it becoming increasingly popular within the motion capture community.

CHAPTER 5

RESEARCH CONTRIBUTIONS

Project Accomplishments

The goal of this project was not only to test the motion capture setups but also to create footprints that other animators could follow. From the Quick-Start Guide to my online blog, the intentions for these pieces are to aid future animators, or perhaps help those that are currently working. Another accomplishment was being able to do a live markerless facial motion capture performance through projection.

Potential for Future Research

What I have done within the realm of motion capture is examine the field of options and use the techniques as tools to animate a character's face. I chose the face over the body because I'm very interested in facial expressions. Sculpture, linguistics, and anthropology courses have helped mold my interest in this area. I feel that these specific paradigms have aided me while I observe facial structure and muscle movements. Other researchers from different fields may use markerless motion capture for other intentions as well. Programs in Nurse-Aide Testing have used the Kinect Sensor to help train students how to properly lift and put down a patient on a bed. Other fields like Kinesiology may use the Kinect Sensor to test an athlete's range of motion. Linguists and speech pathologists may look into this specific system for facial tracking. Many fields beyond entertainment and media can use markerless motion capture.

Another aspect of facial motion capture to explore would be social response. Collecting data on how people react to an avatar would benefit researchers studying

sociology, psychology and media. Today, society is engrossed with digital graphics and avatars throughout the surrounding environments. More people are using digital media and this has transformed worldwide communications. These are all factors to be considered when people interact with avatars. Facial motion capture can help explore this significance.

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APPENDICES

Quick Start Guide

Preparing for Motion Capture (Intermediate Animators):

1. Create face model in Autodesk Maya 2013
2. Check that all of the vertices are symmetrical
3. Check for border edges
4. Create facial rig
5. Paint weights
6. Create Blendshapes
7. Bind Rig
8. Export FBX file

Save as .mb

Delete border edges if present.

Setting Up Motion Capture

1. Connect Kinect Sensor to computer with adapter
2. Open Brekel Pro Face
3. Set the network setting to "UDP"
4. Open MotionBuilder UI
5. While in the MotionBuilder UI, open the FBX file under the "Open" tab
6. Drag the Brekel Device from the Asset Browser onto the character/model
7. In the Navigator Window, under "Devices", click on the Brekel Device
8. Under the "Model Binding", use the scroll tab to select "Create". In the same window, under "Character Faces", click on the "Create New" tab
9. Going into the "Character Faces" filter, click on "Brekel Character Face" to open the tab
10. While in the "Brekel Character Face" window, make sure the active checkmark is marked
11. Going back into the "Brekel Kinect Pro Face" in the "Devices" filter, make sure the "online" and "live" boxes are checked and that recording remains off
12. Ensuring the network is able to connect, go back into "Brekel Character Face"
13. Deselect Active.
14. Hold [Alt] and drag the model from the stage into the "Shapes Mapping" tab below.
15. Use the sliders to determine the amount of movement in each expression.
16. When the shapes are completely mapped, click on active one last time.

[x] Active

Protocol should read "UDP" to match Brekel network settings. If it is not on "UDP", correct the setting by clicking on the scroll tab.
[x] Online
[x] Live
[ ] Recording
Protocol [UDP]

[ ] Active

Make sure the slider being weighed is matched to the name of the expression.

[x] Active

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