

MFA Imaging Arts / Computer Animation
Thesis

Chemistry

by

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Abstract

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A description of the creation of a 3D computer animated film, "Chemistry," a project whose goal is to invoke an emotional response in the audience as they watch a reaction between a crystal and a light bulb in a laboratory. Includes thesis proposal, budget, timeline, original story boards, color stills, and a code for a Maya Python tool that helps to create and animate some complex geometrical objects.

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Computer Animation Thesis Report Chemistry

Chemistry is a piece which consists of my 3D CG animation ability, and invaluable suggestions and advice from superb artistic animator Nancy Beiman's. From the planning to the premiere screening, I worked very hard on my thesis film. There were a lot of failures, but I worked constantly to make improvements. I did not create common character animation, but I believe my film represents where I am now at this point with my MFA degree.

While brainstorming for my thesis idea right after my two-quarter film was complete I had the idea to use a mathematical method or theory as the core of my thesis project. Around that time, I mentioned to Nancy Beiman that I intended to use a Fractal principle for my thesis, and she suggested that I watch Chuck Jones' *Dot and the Line*, for which he received an Academy award. Jones' film is a love story between a red dot and blue line. His use of color, shape and dialogue to support a romance suggested to me that I might be able to accomplish some sort of interactive emotions between inorganic objects. His animation is a good example of what I could express in my thesis project as an animator who had learned both the basic principles of character animation and experimental filmmaking. *Dot and the Line* therefore served as my main inspiration and encouraged me to go forward with my thesis idea although I had no idea how to construct it.

I chose Nancy as my thesis advisor for further development of my idea because she was the best animation faculty member in our school of film and animation. Nancy had worked in Disney for years as an animator and producer, and I was certain that she would be able to recognize and help me toward quality animation—a theory that was proven after my thirty-plus meetings with her. Nancy was certainly the correct choice of advisor as my thesis would ultimately turn out to be a compilation of what I learned at RIT and what she would teach me. This combination allowed my final art piece to be a convincing mathematical and technical 3D animation. When I asked her to be my chair advisor, I told her that she was the only one who could give me proper suggestions on my project. I had heard that she required her advisees to draw well, but nonetheless she accepted me. In addition, when I saw her textbook about storyboards I realized I had made a right decision.

It was a rather painful process to make my idea a narrative one as preparation for my proposal. I spent time on research about Fractals that could be seen in nature such as growth of leaves, crystal, and coastal lines, and decided to use crystal growth for my thesis project. The fundamental core of my film was that a simple crystal, like a segment of straight line for further change of shapes, became a complex object with light as catalyst. On the other hand, the shape of the light source was circular, but its shape had to be slightly more complex and unconventional like ¹icosahedrons we found on the web through some research on light bulbs. The basic shapes of the important characters were similar to that of *Dot and the Line* perhaps because I liked the contrast of straight line and curve as the two main shapes.

¹ An icosahedron consists of twenty triangular faces, which are flat plane with straight edges, with five faces meeting at each vertex.

The most important part was how I created a story with a circle and a line without narrating voice-over. Since my idea was abstract in some respects, visualizing my film as a written story was difficult for me. So, I thought it was necessary for me to add something extra to make my film easier to understand and called the crystal 'Chris' and the light bulb 'Sara' as if they were cartoon characters. But, this did not work at my proposal. All of the board members had the wrong impression that my film would be very cartoony with exaggerated shapes and movements. Some of them even told me that it would be impossible to show a love story with inorganic objects in such a way.

My second trial was held two weeks after my first proposal. Charles Bandla proposed for me at the second trial instead of Nancy because she refused to propose again. Despite the tough failure of my first trial the discussion with the board members went very smoothly and was easier than the first one. They seemed to understand from the beginning. I tried to focus on the realism of writing what would be happening between the light bulb and the crystal without using confusing names. My ideas in both proposals were basically the same, but the passion in my second proposal must have been much more as I was determined not to fail again.

My thesis project was completely scheduled by the end of spring 2006 quarter although I was not sure if everything could be planned so precisely at such an early stage. Nancy Beiman explained to me that the production processes up to creating storyboard and an animatic was half of the entire production, but I hardly understood it then. In addition, I originally planned to finish my thesis at the end of the winter 2007 quarter, and therefore this schedule pushed me hard.

A soundtrack was extremely important for my film in order to show emotional reactions between the two inorganic objects, and I started to research music beginning in the spring 2006

quarter. Nancy Beiman gave me a website called UniqueTracks.com for classical music in the public domain, and I was able to find a quality romantic classical piece called Swans Lake Act 3 Pas De Deux (Moderato Andante) by Tchaikovsky by the end of my second proposal. However, I was still looking for some better possibilities. As soon as spring quarter ended I asked a composer, whose older brother was my classmate in State University of New York at Binghamton, to compose music for my film. Since I had Tchaikovsky's music in my mind, I asked my composer to create music with the same feeling, pacing and timing as Tchaikovsky. He seemed to compose without listening to my request and wanted to see some render samples and my older films. It took over a month for him to create the first draft of music, and the sound was similar to contemporary techno, ambient or game music and had feeling completely different from that of Tchaikovsky. I asked him to include something to invoke an emotional reaction in the audience towards the two inorganic objects. I gave an example of a flower growing toward the sun. After three more weeks I received the final draft of music, but I was disappointed with it as it showed little improvement from the first draft. It was the middle of August so I had to move on to the next step of my thesis project. I was desperate, but tried to convince myself that the music was the best I could get given such a short amount of time. My hope was that I would come up with some good ideas to create a persuasive animation with it.

Right after the summer 2007 quarter I showed the music to Nancy Beiman. She frankly pointed out that the music was generic and had no emotion and suggested that I give up using it in my film. I was a bit upset because the composer had worked on the music for free, and I had also spent much frustrating and stressful time receiving and explaining the music, but I was also optimistic because I knew that it would be hardly possible to evoke romantic emotional reactions

with the original music. I eventually decided to use the Tchaikovsky piece. This attempt at a collaboration was a failure, and I would have to make up the time as I proceeded with my thesis.

My thesis work during the summer quarter was crucial for my production period later. I learned Python programming and developed a tool to help the animating process for my project. Obtaining music had ended up an unsuccessful venture, but developing Python programming skills and tools for my animations was extremely helpful though I only realized this in hindsight. From June 4th to August 15th I stayed in the 3D Lab at RIT every day for more than fifty hours per week mostly working on my thesis. It was unhealthy but was necessary as a part of my choice to complete my degree as soon as possible. Furthermore, at that time I was not quite sure if my Python tools were adequate.

My thesis project included a section where I used shapes of fractals - geometrical shapes constructed by recursions. What I planned to do, which was basically replacing curve segments with geometries, was complex because fractals can be generated infinitely. This process required machine power and was not really suitable as a Maya project because Maya is a complete software package to create animation and not something through which we draw a picture from scratch. Python programming supported a powerful list structure, which allowed me to use any kind of objects, and was helpful for my idea, and was therefore the obvious choice. I studied MEL in Duane Palyka's Programming for Artists class, but was new to Python programming. There was nobody in our school who could teach it to me, so I was on my own to learn it. First of all, I decided to master only the Python basics in a month. I knew there was compatibility between MEL and Python in Maya, so I assumed it would not be too difficult to make the switch to Python. I started with a fundamental online tutorial supplied at python.org. It covered

comprehensive knowledge enough for me to be able to script for Maya, from how Python could understand line break to some common useful methods and packages. At the beginning, the most difficult thing for me to get used to was that Python uses a white space as the end of a statement or new line when a white space usually means just a space between words. I also did not know how to see the white space in text editor, which had an impact on my tool development plan. My plan was to create a tool with MEL and translate it to Python. When I tried to translate about 1400 lines of MEL codes into Python I could not eliminate errors called index errors, i.e. Maya gave me an error whenever there was an unnecessary white space. I had to start writing a Python script from the beginning and test it as often as I typed a line. This way of programming was tedious for a while until I found an editor called jEdit that can show the end of a line and the white space with a dot. After installing jEdit in my hard drive programming was a matter of how much I learned about Python and logics.

Although I did not have any books to learn basic Python, I read some books about fractals. Fractals could be constructed by replacing a shape with a homologous shape using certain ratio or rules, and also by putting points infinitely in a complex plane (two dimensional plane). I approached my film employing mainly the former method, using homologous shape, because I wanted to use a continuous change of shapes. Since my main crystal had the shape of a line segment I planned to start crystal growth from a basic classical fractal, such as the Koch Curve or Sierpiński Triangle, and into something more complex. I was reading fractal theory books and studying shapes, and tried to think how I could obtain shapes generated by fractal theory. With the Python script I wrote I was able to create about twelve different shapes generated by different kinds of formulas at the end of July 2007. I could not include three-dimensional fractal shapes because they were too complicated for me to figure out formulas

given such a short amount of time but could cover things elaborate enough for my production phase.

Although it was not very difficult for me to think how I could get a specific shape by calculation, my constraint was machine power. The number of object were defined with power functions and depended on how many times I ran the calculation in my program. As I used machines in the RIT 3D Lab I had to check how many numbers of objects could be in a scene file. This process was experimental by try and fault, i.e. I tried a number, and would lower it if the computer crashed. I also needed to guess how much environment I would have to have in shots in my film for other production processes. When I designed my environment after this testing I tried to make the environment simple enough to be rendered out. As it turned out only one specific scene file containing approximately 9000 crystal objects took 20 minutes to open, while fortunately the other files opened and processed fairly quickly.

My summer had ended with some accomplishments, but it was still only a small part of my pre-production. As my fall 2007 quarter began I started weekly meeting with my thesis chair advisor Nancy Beiman and worked on other aspects in pre-production. Nancy made herself readily available and met with me every week during the quarter.

As I noted before, Nancy Beiman insisted that making a good storyboard was the first half of the entire production of animation. I worked on storyboards for the entire quarter, while also designing props and environment. My meetings with Nancy in this quarter were lectures about experimental and narrative animations, which used sound well. For example, we watched *Boogie Doodle* by Norman McLaren, *Colour Box* by Len Lye, *Mars and Beyond*, Oscar

Fischinger's movies, and *Fantasia*. She explained the films to me and also showed me videos from either her own collection or online sources.

As she knew my project was not a regular character animation and required me to animate colors, she suggested that I create a color script consisting of only abstract color panels. She recommended some websites of Hans Bacher, a production design artist with Disney's animation studio. Bacher's websites had a color analysis of the emotion of shots on Chuck Jones's *What's Opera, Doc?* During this quarter, Nancy loaned me a book called *Dream Worlds* by Hans Bacher, and this book gave me many ideas about camera angles, effective and interesting compositions, and also great art works from Bacher's own previous pieces.

Since I had an edited version of the Tchaikovsky music already I did not draw my storyboards on paper but instead worked directly with Photoshop so that I could import the image sequences easily into After Effects. This proved to be a very efficient approach, particularly on my project that required animating colors. The alternate method, scanning, would take a very long time and need some post-scanning color corrections. As I intended to work more quickly on making storyboards I estimated that I could move to the modeling process while modifying my animatic. At the end of fall 2007 quarter, I had finished my animatic and already animated a couple of shots.

My animating process was not particularly challenging because I had already created a helper tool during the summer. I needed to modify my Python script that fitted to the actual scene files I had for production – scene files such as defining names of variables or adding more functions. The job was fairly easy aside from having to correct a few logical errors for the saving/reloading function. When I animated the most intensive scene file with about 9000

objects I was amazed that the script worked almost flawlessly except that I had to restart Maya whenever I inserted a keyframe three times. This process might seem inefficient because of the procedural method instead of controlling everything with expression or script, but it was not available as I used mental ray renderer. Furthermore, I manually animated some of them to create a gradation look with the crystal objects, so the procedural method could be the only way to animate my film.

The animating process was relatively simple for almost all shots, but there were three challenging parts. The first was when a ring of objects faded and fell down. When I worked on the shot, I misunderstood Nancy Beiman when she suggested that the crystal objects become like a hand and try to hang on to the light bulb. So, I first created hands and animated them. I then replaced the hand geometry with crystal objects. It took three days to rig the hand and animate, so probably I wasted about a week with the shot. What Nancy really suggested was simply that crystal objects, which were not like the shape of a hand, try to hang on to the light bulb. The second part was when a flower shape changed to wing in order to fly. I modeled a wing with nurbs curves and rigged it for placing crystal objects on all the curves with my Python tool. But deforming the nurbs curves was not an option in Maya and I ended up creating a nurbs plane with curves and left the construction history there. As we deformed planes, curves on the plane followed the deformation. The third part was tough because of a miscommunication with Nancy Beiman. I had animated a shot of the crystal objects transforming to a ring at the beginning of the animating process and she had congratulated me at that time. However, it looked different from the animatic I made and therefore, Nancy changed her mind and suggested that I animate again to make it look the same as my animatic. The time I spent on this first animation proved to be more time wasted. These miscommunications seemed a waste, but whenever they occurred I

tried to take advantage and make things better than before. In the end all of the misunderstandings or mistakes were not so bad for learning and improving my film if time allowed us to do it.

Probably the most important part of production was the lighting in my project. My film would still be able to work if the animation was not good but certainly not if the color was wrong. Nancy Beiman insisted that lighting on many 3D films was incorrect. I did not understand her theory at the time because I had not seen many 3D feature animations, but agreed with her when she pointed out problems on *Bee Movie* by Dreamworks. In some shots, both the background and main character were yellow, therefore, the audience could not see what should be significant in the scene because there was no clear contrast between the two. Nancy also showed me an animation called *Moonbird* by John Hubley. The film had a very clear contrast between characters and environment and successfully showed of the important parts of the frame to the audience even though the scene was lit only by the moon in the night. It was not very easy for me to control lighting because I used glassware in my film. I had to make different settings for each different shot in order to make sure that the reflections and refractions on materials made sense. 3D software can simulate things in the real world very well including how materials reflect light, but this does not mean we were able to let it render out without making sure of all the individual settings. Nancy told me that I had an artistic problem because I did not know that we had to change the settings on materials for all shots depending on what was important. This process was very tedious in Maya. If I did not combine all of the basic light / texture settings into a single file it would take much more time. Using one file for changing the settings worked relatively well because I had to animate procedurally on light colors, too.

Luckily colors and lighting had been decided when I worked on my animatic, so I just followed it for lighting and texturing. I eventually agreed with Nancy Beiman about the importance of storyboards and an animatic. In addition, I tried to work on lighting / texturing for my thesis proposal and over the summer, mainly because I wanted to get an idea of how they would look. Nonetheless, I had to redesign from scratch again as Nancy's suggestion changed my conceptual thought about lighting and because I needed more control over colors and details.

My film was screened on May 19th at Carlson Auditorium. I got nervous before the screening, but I was very happy when I earned applause from the audience. There was some feedback from faculty. Prof. Thomas Gasek congratulated me that my film was beautiful, and he also enjoyed that lots of unexpected things happened there. Prof. Duane Palyka said that he liked colors and space-filling curves, which transformed shapes, but he complained that I should employ a real hand instead of a CG hand in my film. Prof. Stephanie Maxwell pointed out that DNA shape did not work for her because it was too literal. Prof. Malcolm Spauld told me that he enjoyed listening to the music of my film and made sure the license of the music was fine. When Malcolm said that, Nancy Beiman, who recommended me to explore an online music store called UniqueTracks.com, broke in and told him instead of me that the music was public domain and that I bought the license.

I really would like to thank Nancy Beiman as my thesis chair. I did not necessarily need technical advice on Maya but rather artistic suggestions, thoughts and inspirations to make my thesis project possible. She also pushed me hard to finish the project on time. My thesis really encompasses everything that I have learned while studying in the US. It is likely that my study

materials and exercises were actually more sophisticated than the technique applied in my film, but my film still represents the maximum that I was able to apply on a practical level. I definitely need to and am willing to learn more to be a better filmmaker, and hopefully can continue film / animation. Just as my crystal objects eventually reached the light bulb, I would like to make my life brighter in the future.