A Visualization of a New Conceptual Sustainable Building Using Green Materials

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Title: A Visualization of a New Conceptual Sustainable Building Using Green Materials
By: Tzu-Fang Tseng

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Abstract

The project was inspired by a 9-story building constructed from plastic bottles, which was hailed as a spectacular showpiece for the Taipei International Flora Expo. This building weighs 50 percent less than a conventional structure. It is reconfigurable, energy saving and very low in CO₂. The main intent of the project is to utilize a surreal story in an animation to illustrate the concept of reusing hundreds of thousands of old bottles around the world is a new green method of building which is one way to protect our planet. The resulting product is a short film that can be used for promoting the new conceptual sustainable building.
Problem Statement

The climate has been changing, and our natural resources are being wasted. Therefore, creating value from waste and reducing the consumption of these resources has become two vital environmental issues. This inspired me to plan a project which demonstrates the idea of how trash can be valuable and is illustrated by using a surreal story. I am aware that asking people to change something they are used to doing is difficult. One example is convincing people to reduce the usage of plastic bottles; therefore, the concept conveyed in my project is reusing these materials in building construction.
Literature Review

In order to curb the waste of natural resources, more and more documents, websites and videos have explored diverse green building concepts and designs.

The book, *Green Building, A to Z: Understanding the Language of Green Building* (Yudelson, Jerry, 2007) mentioned that these structures are part of a global response to increasing awareness of the role of human activity in causing global climate change. The book, *Green Building Products: The GreenSpec Guide to Residential Building Materials* (Wilson, Alex piepkorn, Mark, 2008) also suggests that because of the usage of renewable green house materials, the environment could be less damaged.

However, there is little research regarding green building that uses recycled bottles. In this case, I would like to introduce this new construction concept and represent it visually. I used the studies in the books to serve as a starting point; these inspired my story.
In addition, researching literature about motion graphics and animation was necessary for the successful completion of this thesis. The books, *Introduction to 3D Graphics & Animation Using Maya* (Adam Watkins, 2006) and *Advanced Maya Texturing and Lighting* (Lee Lanier, 2008) featured information regarding the techniques and theory of modeling, texturing, rendering and animation. I incorporated some of the knowledge gained from these resources into my thesis. The book *Creating Motion Graphics with After Effects: Essential and Advanced Techniques* (Trish & Chris Meyer, 2005) utilizes tools and skills to guide the readers as they edit the images and text, and work on the 3D effects in their projects. It was quite useful when polishing my film in the end.
Documentation

Concept

The Project is broken into three parts, including writing the story which introduced the concept of building using green materials, developing character designs and creating the final animation. Initially, I mainly focused the research on how plastic bottles can be used as construction. After conducting research on the materials and writing the story, I then created the characters and six different scenes. In my film the characters fly through various scenes throughout the course of the story. I deliberately kept the story simple to keep the concept very clear and concise for the audience.

Software

The whole project is mainly done in the program Autodesk MAYA. The storyboards and some of the textures were made in Adobe Photoshop and Illustrator. Finally, I compiled all of the scenes and edited the film in Adobe After Effects and Final Cut Pro.
Pre-production

Character and sets design

In the film, you see a swarm of flying robots that I call the “Super Recycle Heroes” soar through different cities. They symbolize each human being in the world who collects and recycles the overabundance of plastic bottles. The Recycle Heroes have a sense of justice and a super green thumb. They are diligent in doing everything to treat our environment in a friendly way and know how to reuse waste well, such as building using bottles in construction. The size of the robots and the bottles is much greater than we thought and they can be used as a metaphor for people’s strength and quantities of bottles, respectively. The robot’s style combines the elements of insects and futuristic soldiers (Figure 1), so that they possess the ability to move, fly around and protect the earth.

Figure 1. Final render of the character
Figure 2. First sketch
Figure 3. Wireframe of the model
Sets: Clouds

The Recycle Heroes emerge from clouds in the first scene of the film. The cloud (Figure 4) plays an important role in the film, since it creates the sense of being in a dreamy and surreal world. The first scene also implies that the recycle heroes are eco–friendly messengers who are sent by God. I made this scene in the program Autodesk MAYA and animated with Dynamics. To achieve the visual style I wanted would be challenging, so I used Maya’s scripting language to cause the color and timeline of particles to change slightly and look more natural.

Golden Gate Bridge

Since there are hundreds of billions of plastic bottles produced around the world each year, I chose scenes with different cities to represent the fact that plastic bottles inundate the earth. The first place is the Golden Gate Bridge (Figure 5). There are two reasons that made me decide to put it in the film.

Firstly, it is one of the best–known landmarks in the world, and a symbol of the beautiful city, San Francisco, and one of my favorite places as well. It also can remind residents there to recycle bottles and protect the environment of the city where they are living.
In this scene, I blend a great deal of elements of Chinese and Japanese style. Since Asia’s population has grown to over half of the world’s current population, and the Chinese are one-third of Asia’s population, I decided to set up the second scene in the Asian style (Figure 6). The lanterns throughout the whole street are based on “Jiufen”, which is a mountainous area of Taipei City. The interesting and richly multi-cultural location gave me great ideas to create this scene. In order to represent the robots flying for many hours from place to place, I designed this as a scene.
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<table>
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<th>Location</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Gherkin</td>
<td>Gherkin (Figure 11) is located in another beautiful city on the European Continent. I researched many landscape photos, and found that not only did the mood of London match up with my surreal story, but Gherkin also is a great choice as a distinctive scene. It always reminds me of a futuristic world where the sunset is shining through the windows of the whole building.</td>
</tr>
<tr>
<td>Palm Jumeirah</td>
<td>Next, the robots arrive in Palm Jumeirah (Figure 10). It is one of the popular man-made islands in Dubai, another paradise in the Middle East. To go with the general concept I previously mentioned, the robots’ flying route leads the line of vision to different places continuously. In addition, to consider the color scheme, I purposely chose places with varied colors. The only thing that does not change is “the architecture”. All the scenes need to somehow connect with the architecture, since the whole topic essentially revolves around bottles and buildings.</td>
</tr>
<tr>
<td>Bottles redesign factory</td>
<td>The final scene is a place that can recycle and redesign all bottles as elements of a building. Instead of the other scenes based on real scenery, the factory (Figure 9) is an original creation. In order to make the scene wrapped in mystery, I tinted the sky with pinkish and purplish colors. Making incredibly huge bottles surround the city buildings, I then added blue lights to give this scene more of a sense of the future.</td>
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</tbody>
</table>
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Figure 9. Bottle redesign factory (up); Figure 10. Palm Jumeirah (down)  
Figure 11. Gherkin
The storyboard (Figure 12) is one of the most important parts in the process of pre-production. It tends to be understood easily by others, and also gives the creator a clear direction to follow. Besides, the more detail and completion included in this step, the less time and effort needed afterwards. Initially, I drew every single frame, which consisted of images hovering in my brain. After setting up everything in the storyboard, I could launch into doing the animatic work and editing the frames easily.
When it came time to animate my characters and other elements in draft form, I decided to render the playblast (Figure 13) in Maya. It was very crucial for me to manage the timeline in the film. I could see the movement of my characters and camera easily and immediately make an adjustment if needed. Once the animatic stage was complete, it allowed me to check if everything had gone smoothly and if it was what I had intended.

Figure 13. Snapshot of the process of animatic
Production

The first action in this process was to explore the procedures of modeling. Overall, I decided to model with the polygon tools available in Maya. For the character, in order to rig it successfully later, I needed to be careful with the line alignment. Also, I had to consider the problem of render time, so I tried to keep the least number of faces as possible. Besides, worthy of note is that it is better to group all the objects of a character instead of combining them together, since it is easier for me to control and shade my character afterward. Next, building up the environment is a bit challenging, since I had a total of six scenes and every one is huge. One thing that deserves to be mentioned is the bottle building in the end of the film. I originally mapped it, and the building completely lost its glitter all along. To make it more realistic, I then used the instance, which is under the Duplicate Special options, to duplicate each of the bottles and build up them into a building. In this way, all the bottles would share the same shape node, which means that the scene could be rendered more efficiently. Again, how I could make Maya work well without consuming too much memory in the computer was always what I needed to consider. Except for keeping all the geometry simple, using the “reference” in each scene was another way to avoid crashing Maya.
Rigging

Instead of using The Setup Machine, I rigged the characters myself, because the structure of my character is simple and the robot’s wings and paw might work incorrectly with The Setup Machine system. This is why I decided to rig it manually. It is faster and more interesting. Rigging the body parts and wings was not that difficult since they did not have to bend. For the leg with paw, I created the IK and FK controllers so that they can be moved more flexibly, such as moving in a curve, rotating, expanding and contracting.

After binding the skin, I decided to set two controllers for the whole character as you can see the shape of spade above (Figure 14), so that I could easily control its rotation and movement respectively.
When it came time to animate the character and the camera, I decided to chose the music first. After I made sure of the melody of the music, then the camera movement and all cuts tempo can be on the right track. Following the prior animatic and further adding some more details can save more of your energy and time. In this process, I spent lots of time to learn and implement the camera work in the Maya viewport, so the shots won’t look so odd and aggressive. In the flying scenes, I parented one of the cameras to my character and the other cameras took charge of the mid shots and long shots. In this way, the camera would be able to move along the character’s flying track. I also applied the same procedure of parenting as the other scene, which allowed the robot to grab the bottle. The bottle and the robot were separated originally. To make the robot’s paw connect to the bottle, I chose to split the scene as two parts. The first part employed no grouping and no parenting. The second part starts when the robot touches the bottle, I parented the bottle to the paw so that the bottle would fly with the whole body of the robot.
When I was designing the character, I created a new scene and did most of the initial basic animation, which included wings fluttering; further, I added particles (Figure 16) and a wave handle (Figure 15), which is under the Nonlinear of Create Deformers tab, on the wings. It is an effective way to create ripple on objects by utilizing the wave handle tool so the wings would look softer. I then imported it into the scene that I was animating as a reference. The benefits of doing so is that whenever I want to make some changes on the character, I just need to change my reference file and other scenes will be modified automatically.

In many scenes of robots flying together, I originally grouped them together and attached them on the motion path, but somehow their movement looks unnatural and incorrect. Therefore, I finally took the option of tweaking them one by one.
To make the particle look more organic, I created the expression on both Opacity PP and Radius PP. The Opacity PP could make the particle disappeared gradually; the Radius PP is used to create the random size of the particle. The expression of the Radius PP is as following: “particleshape.radius = rand(0.2, 1)”
To match my surreal story, I mainly rendered with a toon shader. Therefore, my character and scenes would reflect the style of a traditional cell shaded cartoon. In the daytime scene, I applied physical Sun and Sky light, which mimics the look of natural daylight environment. In the night scene, except for some primary lights, I also needed to add lights on the darker part. I find lighting annoying, however, the linking needed to be adjusted for all the lights to prevent the scenes from overexposing or underexposing. Of course, after all of images imported into After Effects, I needed to apply the color correction, curve and photo filter, etc. on them as the final adjustment.

Using render passes is very crucial when having many objects in a scene. It took me a little time to set up in the beginning, but it saved me much more time in the end. The benefits of it is that when I need to modify something like color, light or motion blur in After Effects, adjustments are simple and straightforward. For example, if I separate my characters, background and particles into three render passes, I could easily adjust the opacity of particles and color correction of the background or any other effects on characters without having to rerender everything. Besides, generally we need to at least integrate a Beauty pass and an Ambient Occlusion pass, and they could be done at the same time by setting up render passes.
To solve the issue of creating clouds, I spent a lot of time exploring different methods of generating them. One way is the option of mapping images of clouds to planes, but for my purposes the sense of three dimensionality was not effective enough. The scene lost its consistency using this technique.

The second way is shaded balls (Figure 17). I first created a lot of balls and piled them up as the shape of cloud. Then I used lambert shader with ramp and cloud material on it. The overall effect is not bad, but still can see the slight color on the edge of the ball. Finally, I investigated Fluid Effects (Figure 20) in Maya, and fortunately this method matched the style of the film well. This preset fluid clouds tended to draw attention towards the cloud’s texture, color and light. Thus, I have to change the attributes in the fluidshape node such as the Display, threshold and amplitude of Textures, and Lighting. At the same time, I needed to script the movement time of the cloud. Since it should be rendered by Maya software which is not applied to other objects, I split it into different render passes.
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Documentation

Dynamics

Figure 17.
The following is the way to build up a ball cloud shader. First, create a Lambert shader, a ramp texture, a sampler info and a reverse utility. Then connect the ramp1 to the reverse1, and reverse1 to the transparency of the Lambert node. Third, connect the sampler info facing ratio to the U Coord of the ramp. Next, create a cloud texture and connect it to Lambert color.

Figure 18. This is the final rendered image.
The technique of creating a realistic cloud is a little tricky, but it is not all that difficult. First, go to FluidEffects to create a 3D container. Under the fluidShape tag, check the “texture opacity” which is under the Textures option. You can also adjust the opacity volume that you would like. Then move the “edge dropoff”, which is under the shading option, to control the size of each cloud. Next, go to the Textures option. It might also be helpful for the cloud looking to change the volume of threshold, amplitude, ratio and frequency ratio. It completely depends on how you would like your cloud to look.
Overall the project was almost 80 percent done before this last step, and the structure was developed with desired goals. So it was time to re-organize everything in After Effects and edit them in Final Cut Pro.

Initially, I had to import all my rendered images into After Effects and named them well. It is very important to name each file well when having four to six layers of each shot. I then edit the music in the rough rendered video in Final Cut Pro, since it was not convenient to listen and monitor the screen simultaneously in After Effects. I then imported back the edited music into After Effects for ensuring high quality for the film.

Typographic design is another challenge, because I had to insert appropriate quantities of information into the limited space and time. In order to make the words stand out, I put them in the negative space on the screen. At the same time, I also considered the lines of visual direction, and combine the words and the video together smoothly. Also to make the information more readable, I removed most of the effects on the words and just left over subtle changes on them.

After Effects provides so many fancy functions that could help us to edit our films better and easier, and so this process made me understand that the special effects could definitely be seen as a glorification of a film.
Much research is currently exploring the relationship between eco-friendliness and construction, such as wind power or water saving system, but few studies mentioned the benefit of employing resuable plastic bottles in construction. I then began to conduct deeper research. Through the extensive research of most kinds of green building and motion, I found that a story about construction with bottles might be a great trigger for people to go green. A success of eco-friendly related motion will arouse people’s eagerness to be involved in going green, and that is also the intention of my story. However, I still met some difficulties with the execution.

Initially, the project management was the difficult part for me. I am actually not used to building up a project step–by–step with a concise plan, and that resulted in the delay of my plan, since I spent lots of time creating useless objects. This finding let me circle back to examine the core of my project, then redo the whole plan from specific to general. The project eventually went off without a hitch.
The other important thing I have learned from the process of the project was how to benefit from critiques. Generally, I would first give it a shot and solve problems by myself. And the next step was to get critiques and learn from my advisors or others, and go fix the film back and forth. For instance, there were several problems with the clouds in the beginning, such as the speed of their movement and the shadow they cast. They should have floated slightly, instead of distracting people too much. Also the same problem happened with the camera movement. I then learned how to adjust the appropriate speed for the camera, and the best way to transit from one scene to the next so that the whole story could go smoothly. The fluid effects learning and camera movement was the most important technical development for me in the project. I think the process of seeking solutions has helped me grow professionally.

Overall the whole process was a great experience and challenge of creation. It brought me some new perspectives on creativity; also it could be an advantage to any of my further research and works. Mostly, though, it made me reconsider and find the meaning of design.
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Appendix: Thesis Proposal

Situation Analysis
Currently, the global climate has changed a lot. Scientists and many other people are trying different methods to improve the environment. Building a green house, which is a kind of green design applied to sustainable construction and is built with specific materials that could save more energy and reduce the waste of resources, is exactly the way to respect the value of natural resources and keep our planet from becoming worse. The green house is not only a new architectural style, but also a new attitude toward the earth. In order to make more people realize the advantages of the green houses, I plan to make a 3D motion title using Maya and After Effects to promote a novel concept for people that green houses are safe to live in and less damaging to our environment.

Target audience
I expect that more house owners will be interested in building a green house based on my motion title. Also, all the teenagers could have some general concept about the sustainable building. Based on the two reasons above, my target audience would be those who are between the ages of 12 and 70. No matter if they own a house already, they all could be my potential audiences.
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<th>Survey of Literature</th>
<th>Introduction to 3D Graphics &amp; Animation Using Maya (Graphics Series)</th>
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<tbody>
<tr>
<td></td>
<td>Adam Watkins</td>
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<tr>
<td></td>
<td>Publisher: Charles River Media; 1 edition (April 6, 2006)</td>
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<tr>
<td></td>
<td>Language: English</td>
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<tr>
<td>ISBN-10:</td>
<td>1584504854</td>
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<tr>
<td>Written for aspiring designers, modelers, animators, texture artist, and those new to 3D graphics, Introduction to 3D Graphics and Animation Using Maya explores the fundamentals of 3D. There are a variety of practical tutorials, including the techniques and theory behind modeling, rendering, UV editing and layout, texturing, lighting, animation, and character animation.</td>
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<table>
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<tr>
<th>Creating Motion Graphics with After Effects: Essential and Advanced Techniques</th>
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<tr>
<td>Publisher: Focal Press; 5th edition</td>
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<tr>
<td>ISBN-10: 0240814150</td>
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<tr>
<td>Subjects: Animation techniques; layer management; modes, masks, and mattes; mastering 3D space; text animation; effects &amp; presets; painting and rotoscoping; parenting, nesting, and collapsing; color management and video essentials; motion tracking and keying; working with audio; integrating with 3D applications; puppet tools; expressions; exporting and rendering; and much more. Creating Motion Graphics 5th Edition has been thoroughly revised to reflect the new features introduced in both After Effects CS4 and CS5. New chapters cover the revolutionary new Roto Brush feature, as well as mocha and mocha shape.</td>
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</table>
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The 3D section has been expanded to include working with 3D effects such as Digieffects FreeForm plus workflows including Adobe Repoussé, Vanishing Point Exchange, and 3D model import using Adobe Photoshop Extended.

Survey of Literature (Continued)

After Effects Apprentice
Publisher: Focal Press; 2 edition (January 20, 2009)
Language: English
ISBN-10: 0240811364
Subjects: Animate, edit, layer, and composite video and still images. Manipulate keyframes and the way they interpolate to create more refined animations. Use masks, mattes, stencils and blending modes to add sophistication to your imagery. Create and animate shape layers and text. Place your layers in 3D space. Use tracking and keying to create special effects, such as replacing screen displays.
This book provides a “missing link” for those who need to master essential After Effects techniques but also want to improve their overall grasp of broad motion graphics and VFX principles and methods.
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Survey of Literature (Continued)

How to Cheat in Maya 2010: Tools and Techniques for the Maya Animator
Publisher: Focal Press; Pap/DVD edition (December 29, 2009)
Language: English
ISBN-10: 0240811887
Take the animations to the next level with this essential guide to Maya 2010. Packed with character animation techniques and the secrets of professional animators, How to Cheat in Maya 2010 provides the tips and tools to help people create high quality animation in the most efficient way possible.

Green Building, A to Z: Understanding the Language of Green Building
Yudelson, Jerry
Publisher: New Society Publishers Released: 2007
ISBN: 9780865715721
1) Green buildings are part of a global response to increasing awareness of the role of human activity in causing global climate change.
2) My biggest challenge was not only to train a new generation of thinkers but to find many more, as the market demand for green building know-how was beginning to explode, along with the rapid growth of our own business.
Appendix: Thesis Proposal

Survey of Literature (Continued)

Wilson, Alex Piepkorn, Mark
Publisher: New Society Publishers
Released: 2008
ISBN: 9780865716001
Subjects: Building materials–United States–Catalogs.
Building–Environmental aspects–Handbooks, manuals, etc.
Author’s opinions:
1) A green house that respects the value of our planet’s natural resources, that protects its occupants, and that recognizes the impact and legacy it will leave for future generations.
2) Green homes are safe to live in, affordable to operate, and less damaging to the local, regional, and global environments.

Emerald Architecture: Case Studies in Green Building
Kolleeny, Jane Linn, Charles
Publisher: McGraw-Hill
Released: 2008
ISBN: 9780071544115
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Author's opinions:
1) Scientists have issued a series of urgent reports putting us on notice that global climate change threatens human life on earth, and have identified buildings as the single largest contributor to climate change.
2) GreenSource magazine has played an indispensable part in making the point that environmentally responsible architecture is necessary and achievable.

Sustainable Energy Systems in Architectural Design
Gevorkian, Peter
Publisher: McGraw-Hill Professional Publishing
Released: 2005
ISBN: 9780071469821

Author's opinions:
1) Most consumption of fossil fuel energy is a result of inefficient and wasteful transportation and electric power generation technologies. Due to lack of comprehensive energy control policies and lobbying efforts of special interest groups, research and development funds to accelerate sustainable and renewable energy technologies has been neglected.
2) In order to curb the waste of fossil fuel energy, it is imperative that our nation, as a whole, from politicians and educators to the general public, be made aware of the dire consequences of our nation's energy policies and make every effort to promote use of all available renewable energy technologies, which is new solar power systems, so that we can reduce the demand for nonrenewable energy and safeguard the environment for future generations.

Green BIM: Successful Sustainable Design with Building Information Modeling
Krygiel, Eddy Nies, Brad McDowell, Steve
Publisher: Sybex
Released: 2008
ISBN: 9780470239605
Author’s opinions:
1) The future of BIM and our willingness to learn from nature can help us move more quickly to a sustainable future: a restored world and healthy planet.
2) Much of the focus of sustainable design is geared toward reducing energy use.
Appendix: Thesis Proposal

Technical Tool

Windows 7/ Mac osx 10.6
Adobe Creative Suite 5.5 Collection
Autodesk Maya & Mudbox

Timeline

Sep
• Research
• Thesis planning

Oct
• Concept
• Storyboard

Nov
• Proposal
• Begin character design

Dec
• Environment design
• Modeling

Jan
• Shading & lighting
• Animatic

Feb
• Revise
• Animatic

Mar
• Render Testing
• Animation
• Rendering

Apr
• Editing & compositing
• Revise

May
• Editing & compositing
• Defense

Jun

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College of Imaging Arts and Sciences
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