Virtual Reality and Its Use in Education

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Ivy Tech Community College

Second Life can provide educators with opportunities to create new learning environments for classes which should enrich learning. In the spring of 2020, Ivy Tech introduced the use of Second Life in many mechanical and electrical engineering classes. Techniques have been developed for translating CAD files from Solidworks to Second Life, presentation of student work (posters) and development of games using Blender and Second Life scripts. This presentation will discuss what we have learned.

A technique has been developed to capture student posters which is inexpensive and easy to manage.

A work flow has been developed to translate CAD files into Second Life up-loadable models.

Background – First steps, ask questions & explore

Our journey into Second Life started in the summer of 2018 when I suggested we get involved with education in a virtual environment. The question was:

What do we want to do with Second Life?

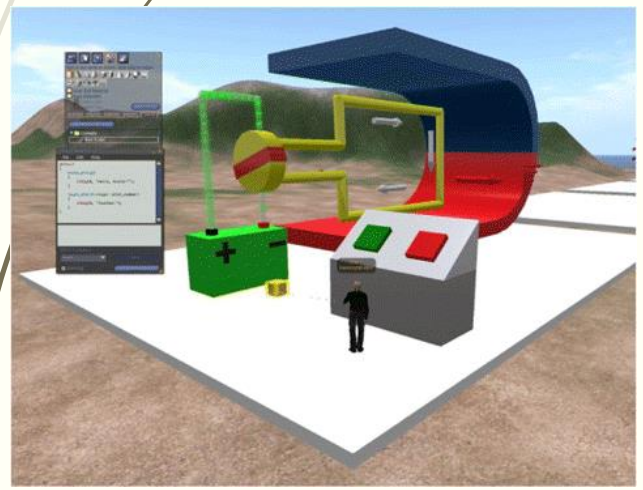
Ans – Build a virtual clean room and labs. Currently we do not have the space or funds to build a clean room (this would cost in excess of 2 million dollars with a sizeable annual budget needed for material, equipment maintenance and supplies ~ 50K per year. But if we build a virtual clean room we could give the experience without the cost.

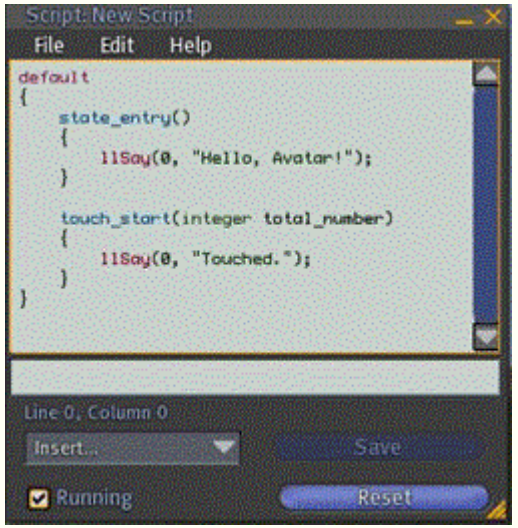
One of the first places visited was Evergreen Island 3 which was owned by Washington State Community College for healthcare education and training[1,2]

Background – Literature & YouTube Reviews

By accident I stumbled upon and article (**Engineering Education Island: Teaching Engineering in Virtual Worlds[3,4]**) that describe using Second Life for Engineering Education and contacted one of the authors. He said – "Good to hear from you and thank you for your interest in our project. Unfortunately we left Second Life when they doubled the cost of educational hosting and never went back." Michael Callaghan, mj.callaghan@ulster.ac.uk

Possibilities included virtual presentation and using CAD files for virtual simulations.

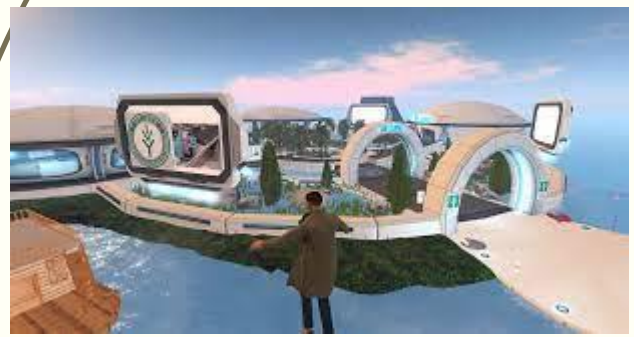




Student Presentations

Initially, posters were uploaded as “jpg” files and then added as textures to the surface of virtual poster boards. Students create a PPT file using a poster template and provide it electronically. The file is then saved as a “jpg” file. The “jpg” file is uploaded at a cost of L$10 to Second Life to your Inventory. This image can then be applied to a 6 by 3 by 0.1 meter poster and placed and used in-world.

Currently, we have over 50 student posters on the IvyTech Engineering Island[5]

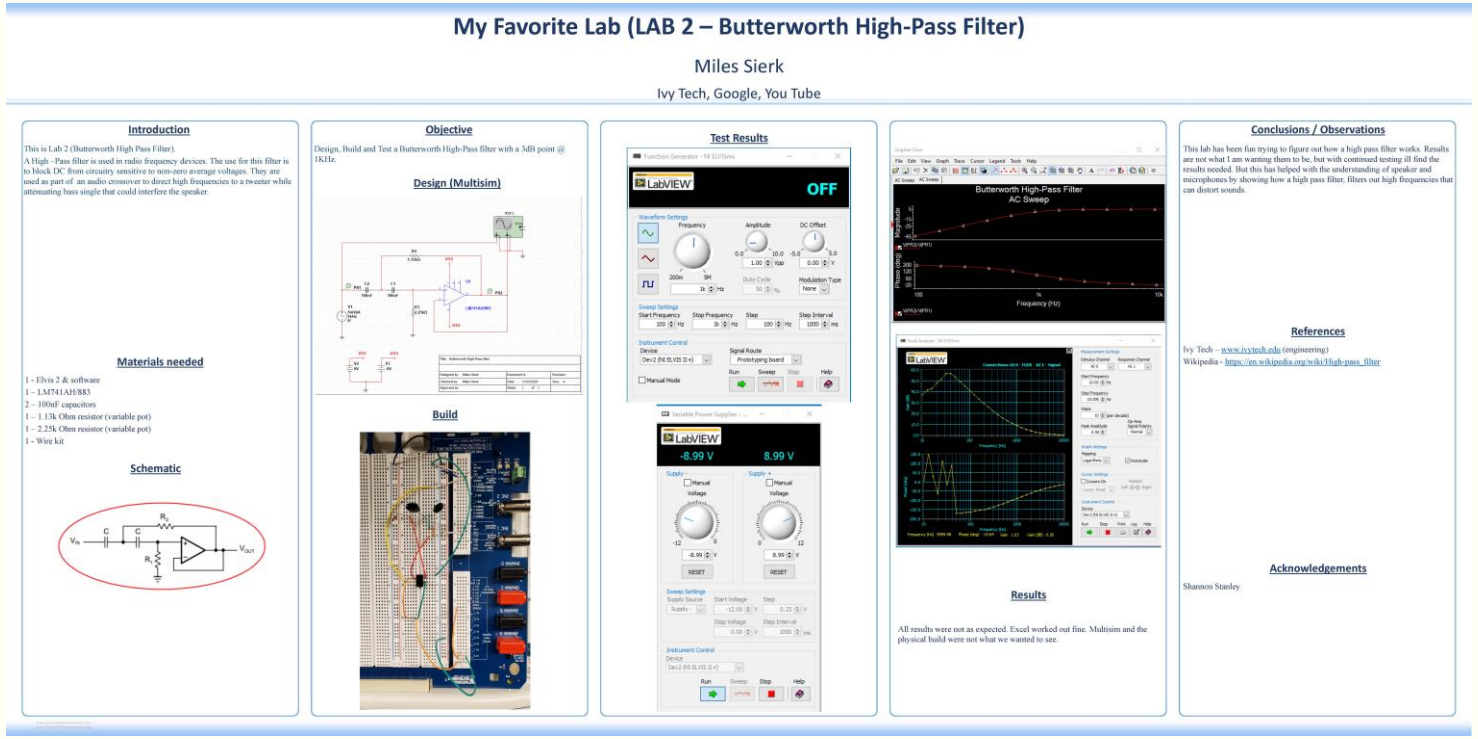


Student Presentations

Another approach was used which is based on the Web on a Prim approach. Again, posters are created by engineering students using Power Point poster templates. The posters are then converted to "jpg" files but uploaded to the www.ivytechengineering.com website. The in-world web browser is then used to access the 6 by 3 by 0.1 meter posters.

This approach doesn't require any image uploads to Second Life and can be easily managed if you have a website or domain.

Example presentations captured and uploaded to YouTube[7]

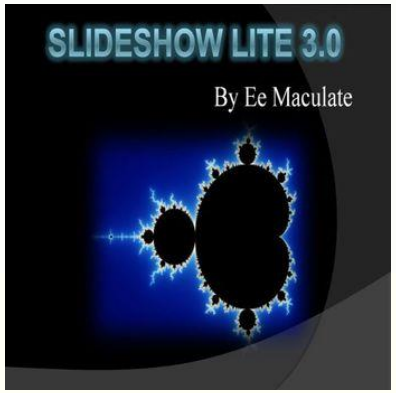


Instructor Presentations

Since I use the "Web on a Prim[6]" approach I can link to any webpage. In our case we can link videos and images but *not* PowerPoint slides. They must be converted to images before they can be used in Second Life. You can use a Slide Show Viewer which you can purchase from the Second Life Market Place[9,10]. This approach will require you to save your presentation files as images and upload them to SL at L$10 per image.

At one point in early versions of PowerPoint is was possible to save presentations as html files but this feature is no longer supported by Microsoft. You can upload your presentation to an online service to convert[11]. Then upload the presentation and get an html file with images.

Another approach is to just use java script and CSS files[12] to create a index.html file that can be uploaded to your website and used in Second Life



Using CAD models in Second Life - Instructor

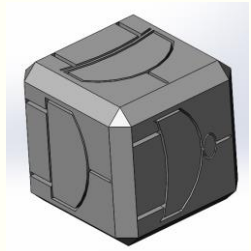
One of the biggest appeals to using Second Life for education is the potential to use CAD Models in Second Life. Many colleges use CAD programs like Solidworks to teach parametric solid modeling for mechanical and architectural objects. Even electrical engineering will use simplified models such as the DC motor model that was used on the Engineering Island[3] to create a virtual learning environment.

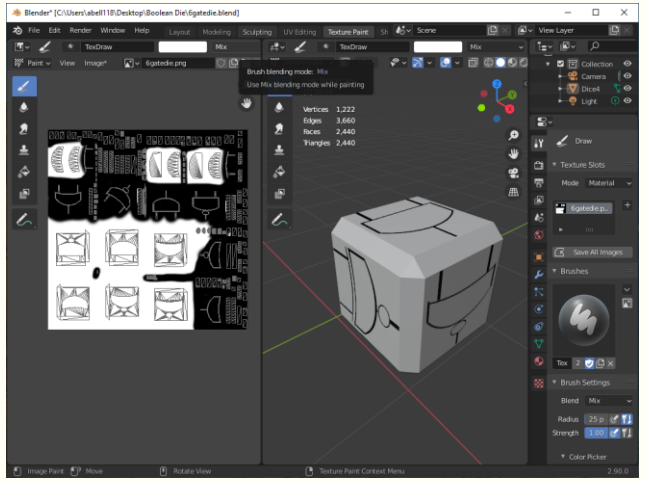
So how do you do that?

Ans – You must either get a 3D model from the web or you can create a 3D model using a CAD program like Solidworks. I have opted to use Solidworks models that I or my students can create or STL files that can be downloaded from websites like GrabCAD[13] or Thingiverse[14].

https://cults3d.com/en/3d-model/tool/gate-die [15]

Built in Solidworks and converted in Blender



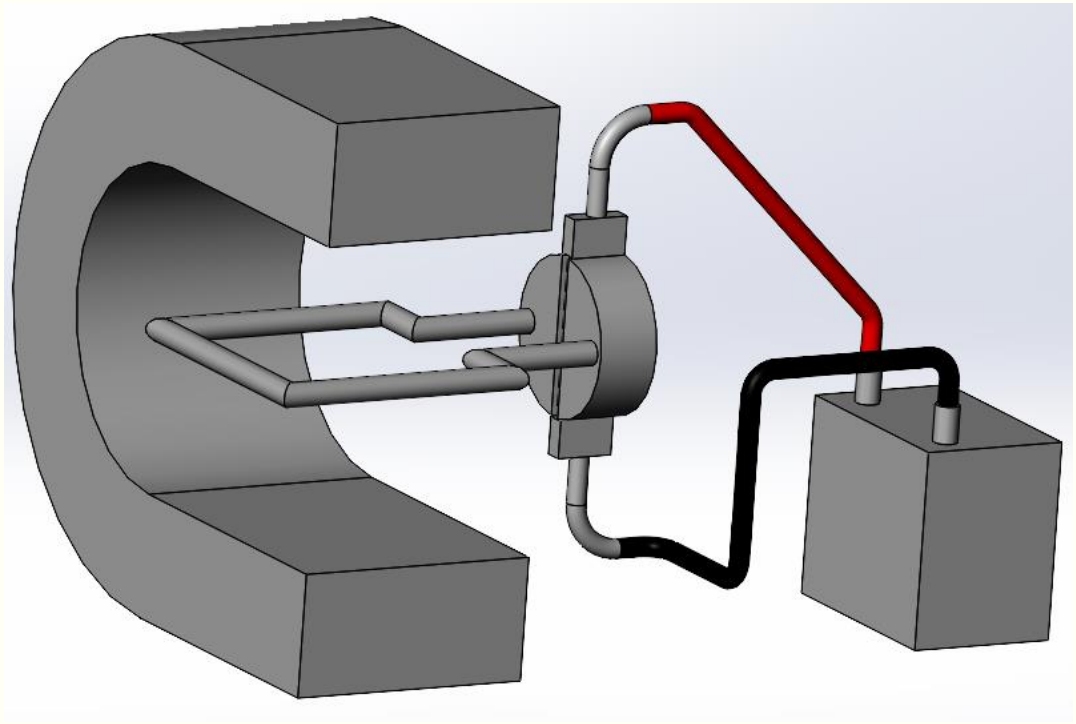


Using CAD models in Second Life - Instructor

Getting back to the original Engineering Island is more complicated and adding LSL scripts to objects to animate adds even more complexity. Consider the DC Motor model.

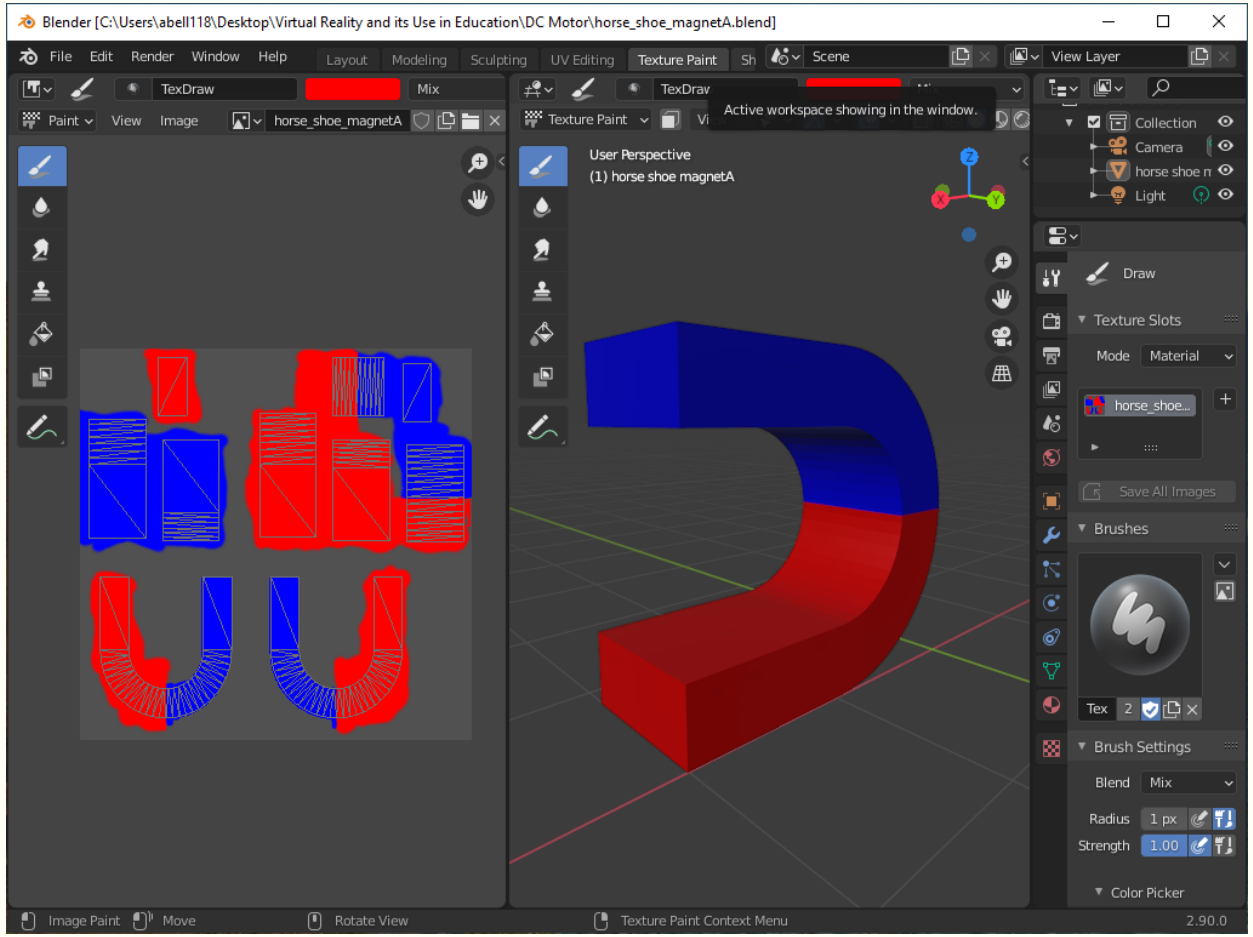
Step 1 – Draw magnet, rotor, battery, brushes and cables in Solidworks.

Conclusion – cables look stiff and brushes are overly complicated. Keep rotor, battery and magnet but redraw cables.



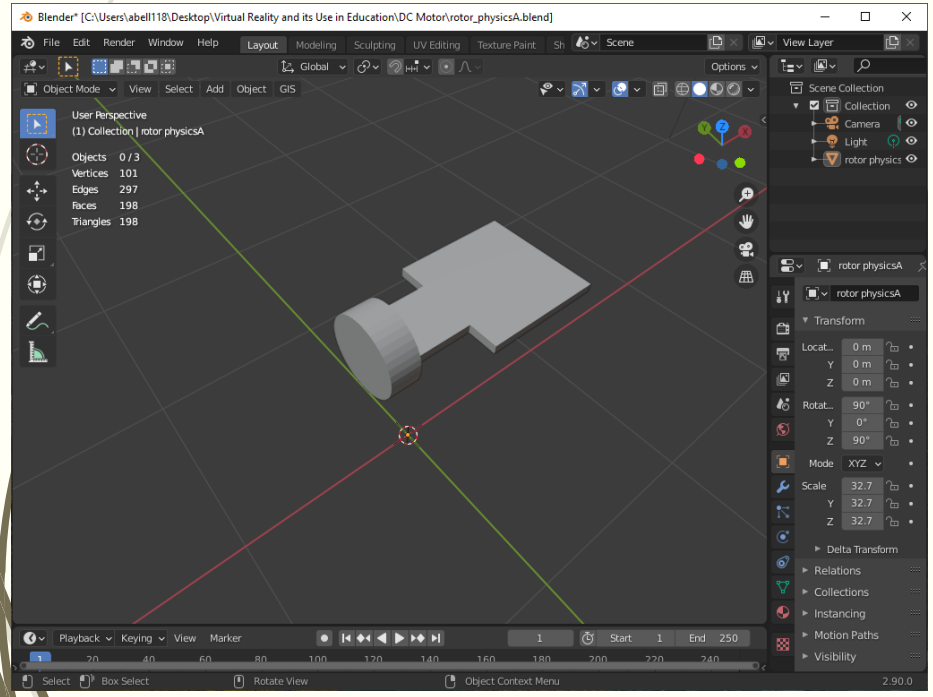
Using CAD models in Second Life - Instructor

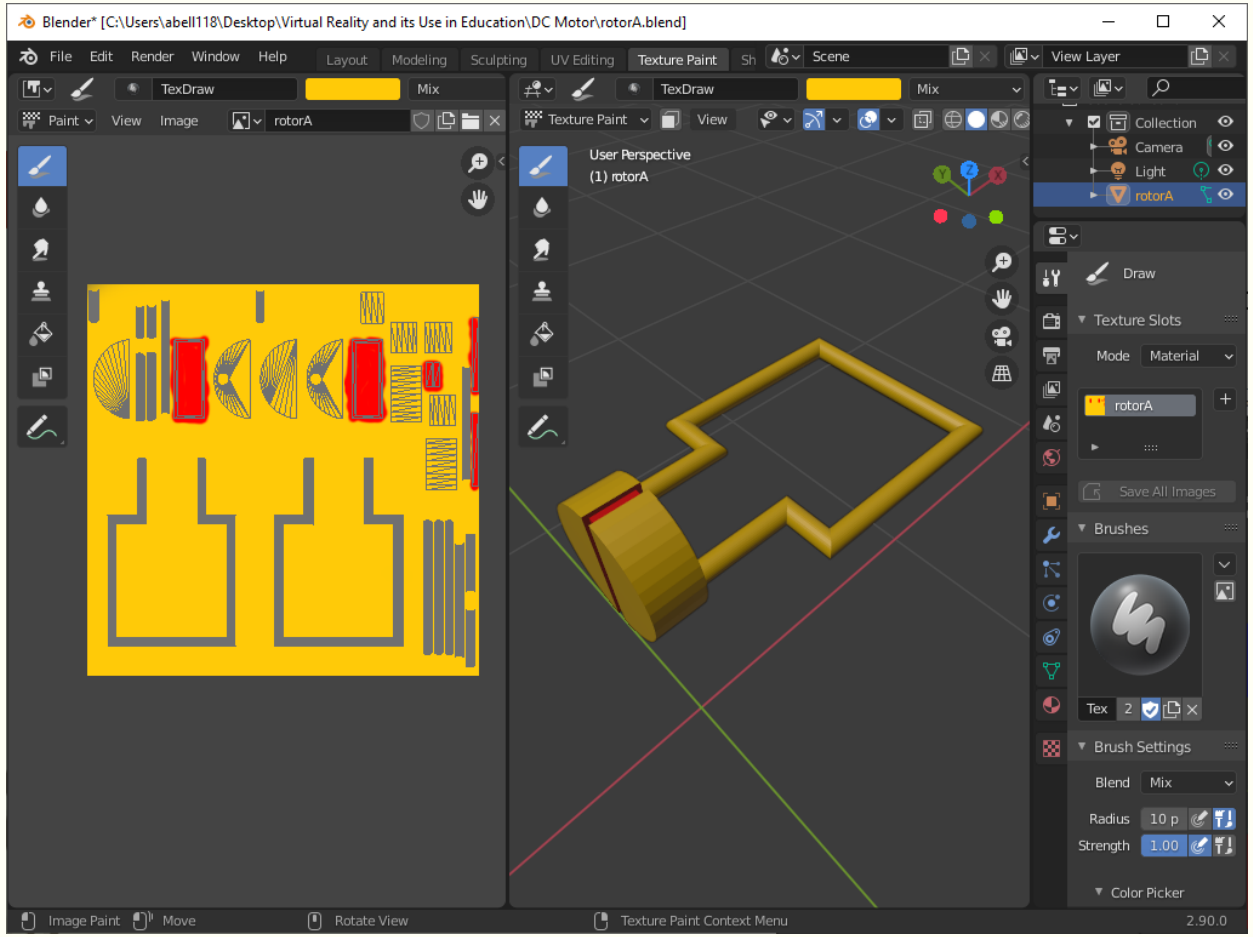
Step 2 – Add texture to horse shoe magnet. This model can now be saved as a "dae" file and uploaded to Second Life. The texture is also uploaded but the physic file can be derived from the model in Second Life.



Using CAD models in Second Life - Instructor

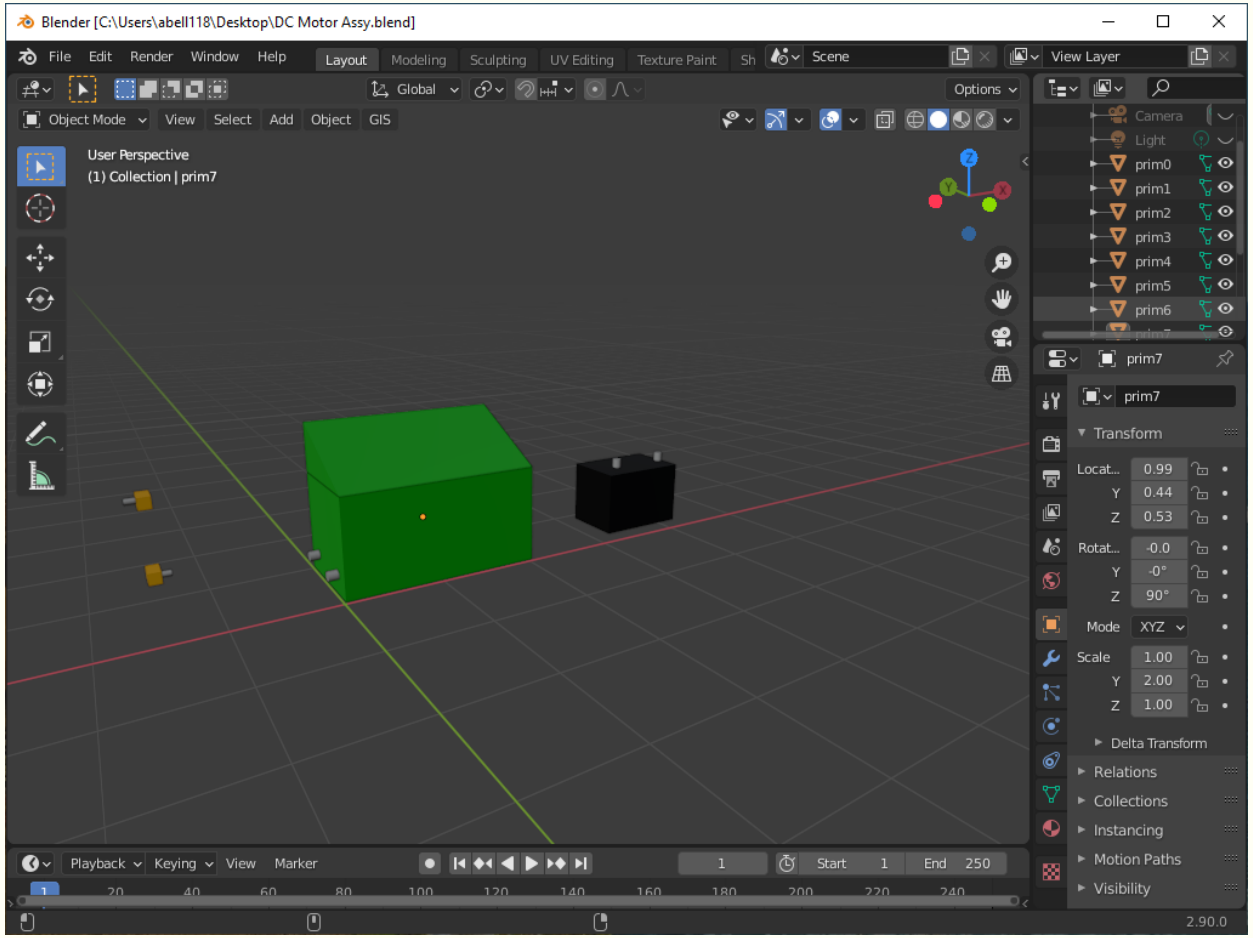
Step 3 – Add texture to the rotor. This model can now be saved as a "dae" file and uploaded to Second Life. The texture and physical model also need to be uploaded.





Using CAD models in Second Life - Instructor

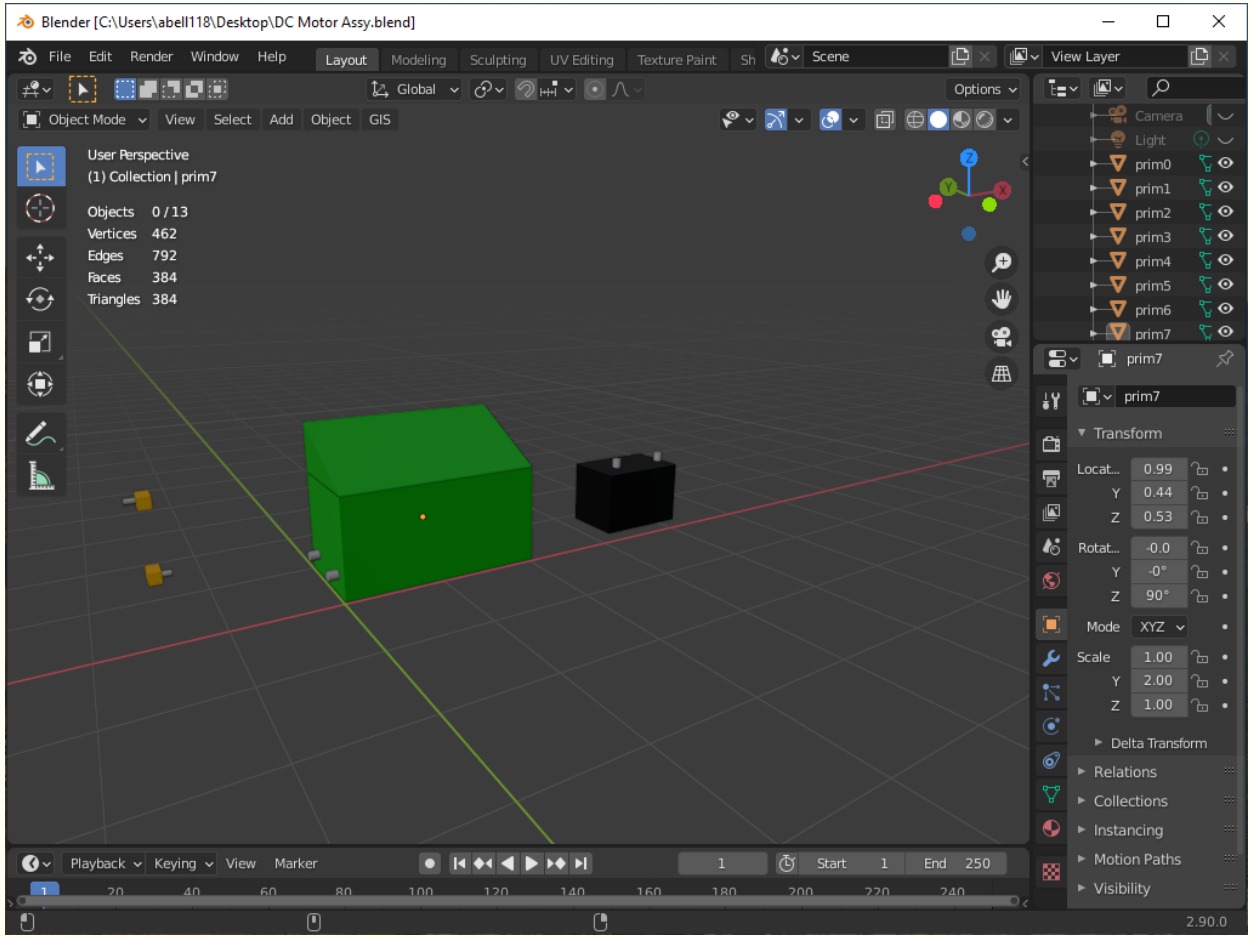
Step 4 – Export the "dae" model for parts built in Second Life (all objects need to be linked to maintain their relative spatial reference). This will provide a reference for where to place the cables.



Using CAD models in Second Life - Instructor

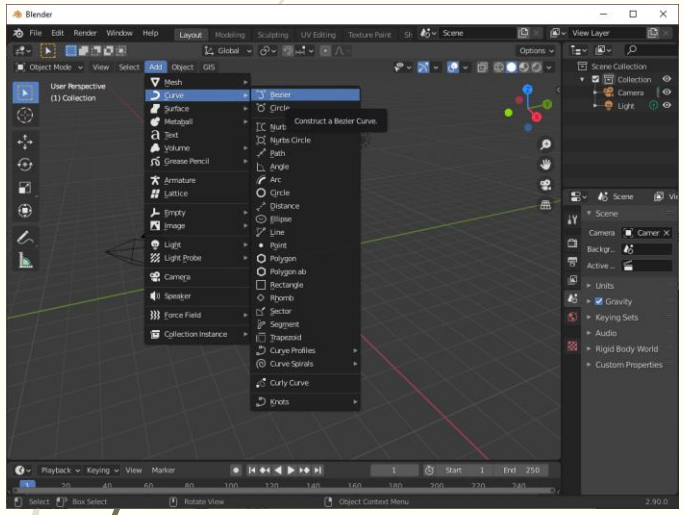
Step 4 – Export the "dae" model for parts built in Second Life (all objects need to be linked to maintain their relative spatial reference). This will provide a reference for where to place the cables.

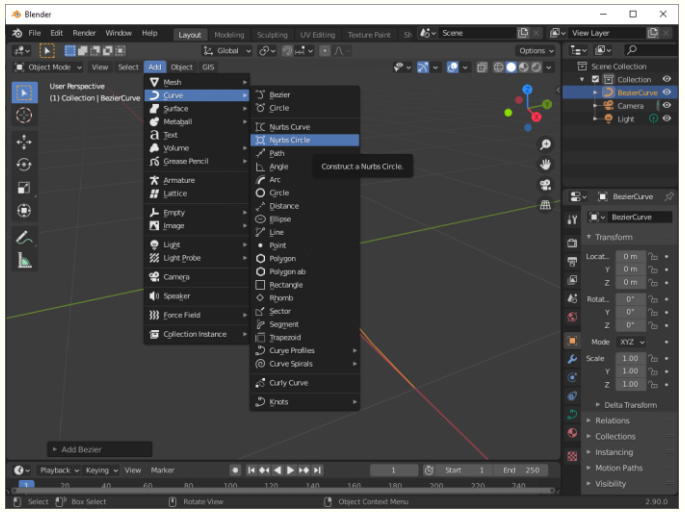
Cable will be built in Blender instead of Solidworks or Second Life. In Solidworks the cables look too artificial and in Second Life they would be too difficult to build.

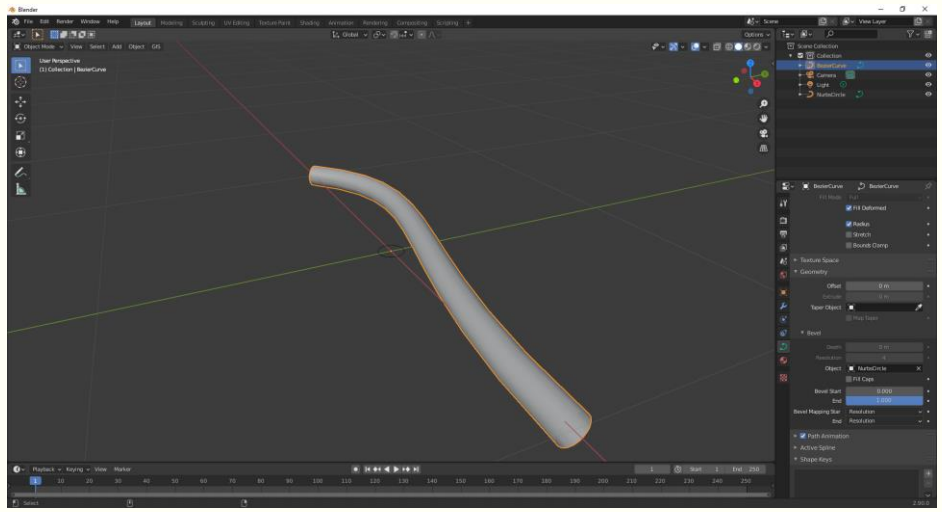


Using CAD models in Second Life - Instructor

Step 5 – Build the cables in Blender. This can be done using “BezierCurve” and “NurbsCircle” as defined in Reference 16.



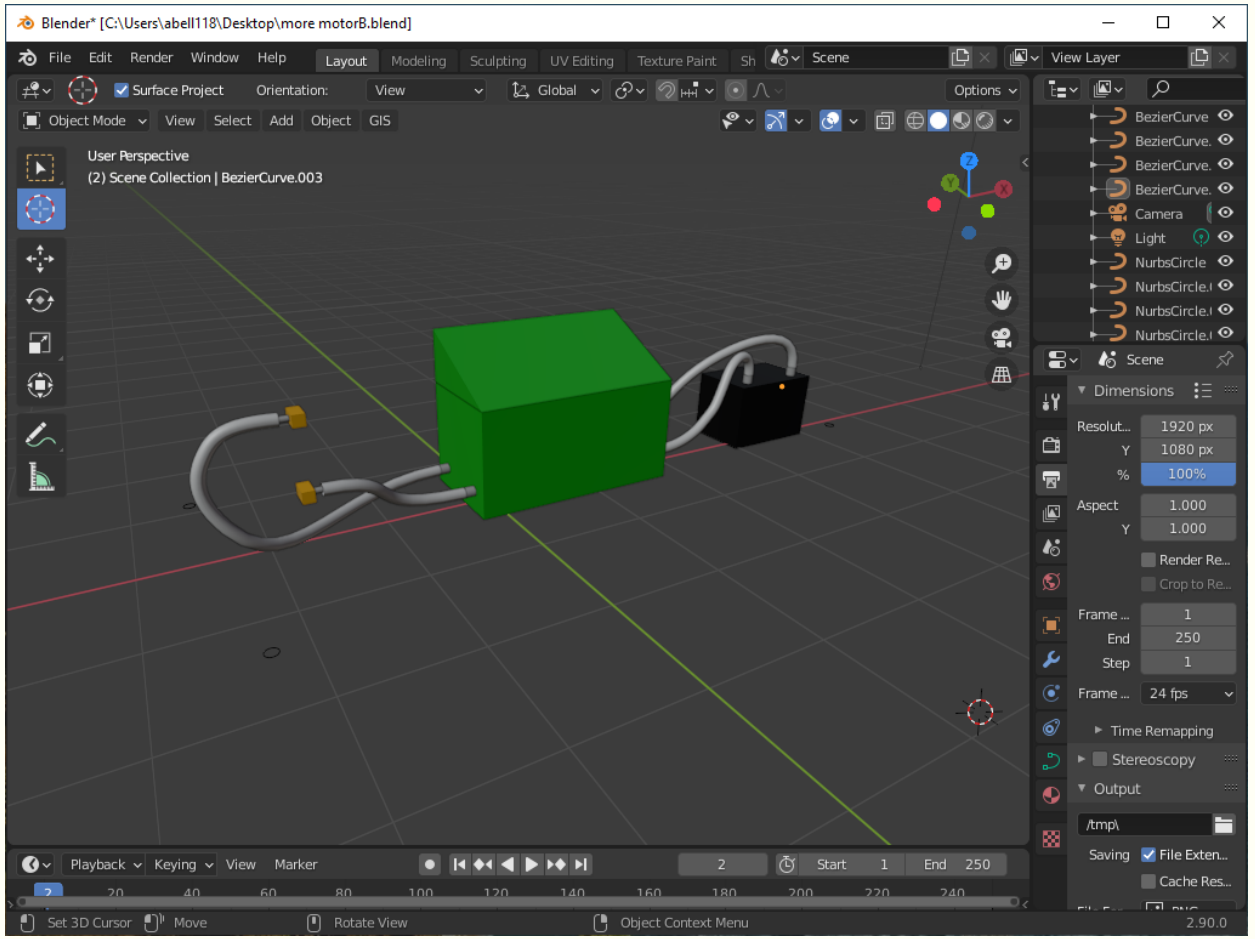




Using CAD models in Second Life - Instructor

Step 5 – You can add additional subdivides to edit the cables. The Handles can be adjusted to provide the curvature you desire. Also, based on feedback from others it was suggested that the NurbsCircle is reduced to “1” and the BezierCurce is reduced to “7”.

NurbsCircle =	12	1	1
BezierCurve =	12	12	7
Vertices	13176	1560	1160
Edges	894	894	894
Faces	12340	1428	1028
Triangles	23860	2388	1588

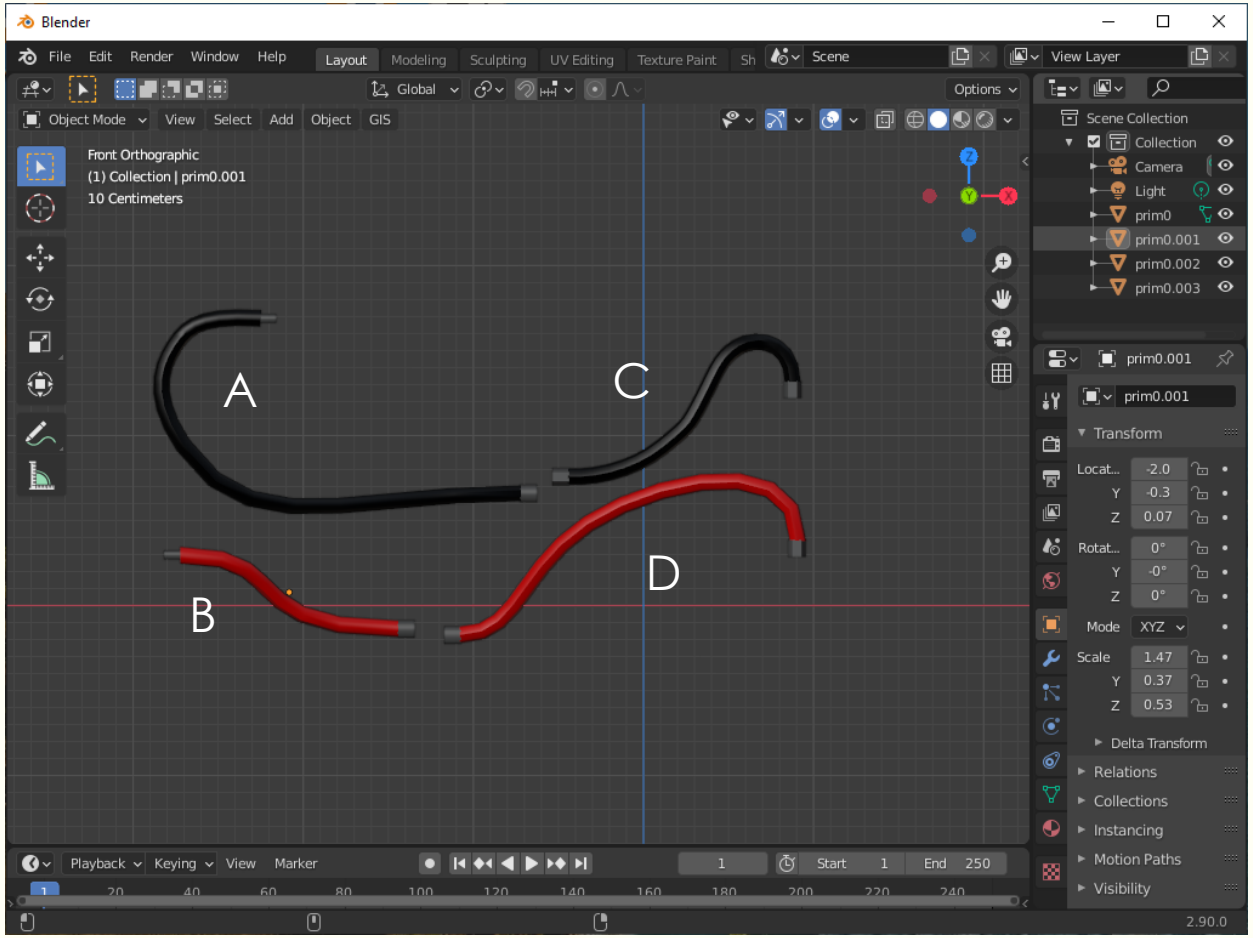


Using CAD models in Second Life - Instructor

Step 6 – Save each cable as a separate "dae" file and assign colors to each cable and the bare metal tips using materials[17].

Cable complexity is based on LOD – Level Of Detail which is based on what the model will look like at a distant. The designer can either create lower detail models or allow Second Life to define the LODs that will be used. The higher the LOD the higher the cost and Land Impact will be.

	Cable A	Cable B	Cable C	Cable D
Triangles =	396	172	496	272
Vertices =	268	144	360	216
LI =	15	6	20	11



Using CAD models in Second Life - Instructor

Step 7 – The final part of the design is to add LSL scripts to your models to make them animate. The strategy used will be to add a button which changes color when it is selected and turns "on" and "off" a light and turns "on" and "off" the motor and turn "on" and "off" a light.

Light Script

SCRIPT: New Script

File Edit Help

```
default
{
    state_entry()
    {
        llSetPrimitiveParams([PRIM_FULLBRIGHT,ALL_SIDES,FALSE]);

    }

    link_message(integer sender_num, integer num, string str, key id)
    {
        if(str=="stop")
        {
            llSetPrimitiveParams([PRIM_FULLBRIGHT,ALL_SIDES,FALSE]);
        }
        if(str=="start")
        {
            llSetPrimitiveParams([PRIM_FULLBRIGHT,ALL_SIDES,TRUE]);
        }
    }
}
```

Line 0, Column 0 Edit... Save

Insert...

Reset Running Mono

Use Experience:

Rotor Script

SCRIPT: New Script

File Edit Help

```
default
{
    state_entry()
    {
        llTargetOmega(<0,0,0> * llGetLocalRot(), 0.1*TWO_PI, 1.0);
    }

    link_message(integer sender_num, integer num, string str, key id)
    {
        if(str=="stop")
        {
        llTargetOmega(<0,0,0> * llGetLocalRot(), 0.1*TWO_PI, 1.0);
        }
        if(str=="start")
        {
        llTargetOmega(<0,0,1> * llGetLocalRot(), 0.1*TWO_PI, 1.0);
        }
    }
}
```

Line 0, Column 0 Edit... Save

Insert...

Reset Running Mono

Use Experience:

Switch Script

SCRIPT: New Script

File Edit Help

```
integer myswitch;

default
{
    state_entry()
    {
        myswitch=FALSE;
        llSetText("Control Switch", <1.0, 1.0, 1.0>, 1.0);
    }

    touch_start(integer total_number)
    {
       if(myswitch==FALSE)
       {

       //Turn Light Bulb ON

       llMessageLinked(LINK_ALL_CHILDREN, 0, "start", NULL_KEY);
       llSetColor(<0.0, 1.0, 0.0>, ALL_SIDES);
       myswitch=TRUE;

       }
       else
      {

       //Turn Light Bulb Off

       llMessageLinked(LINK_ALL_CHILDREN, 0, "stop", NULL_KEY);
       llSetColor(<1.0, 0.0, 0.0>, ALL_SIDES);
       myswitch=FALSE;

       }

    }
}
```

Line 0, Column 0 Edit... Save

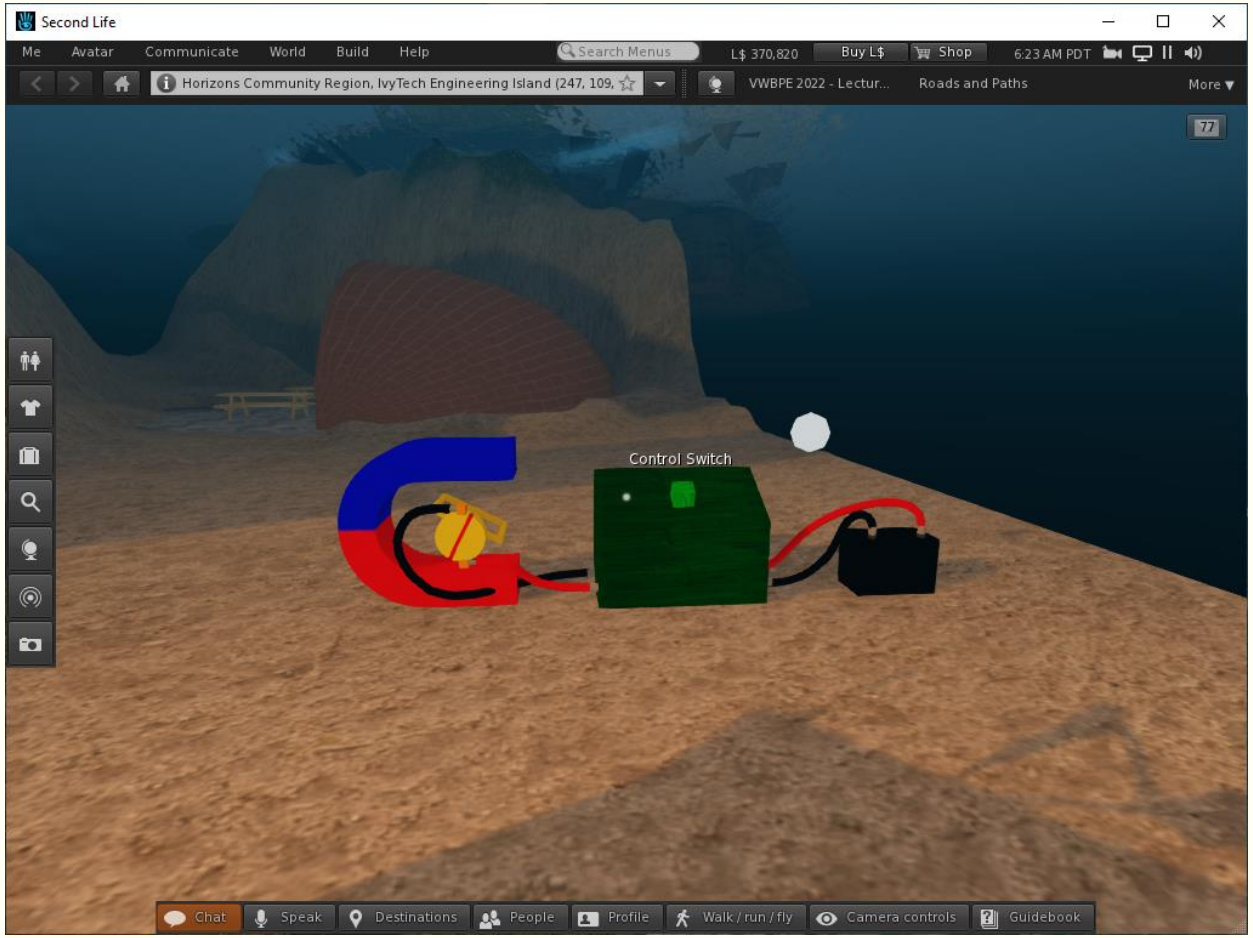
Insert...

Reset Running Mono

Use Experience:

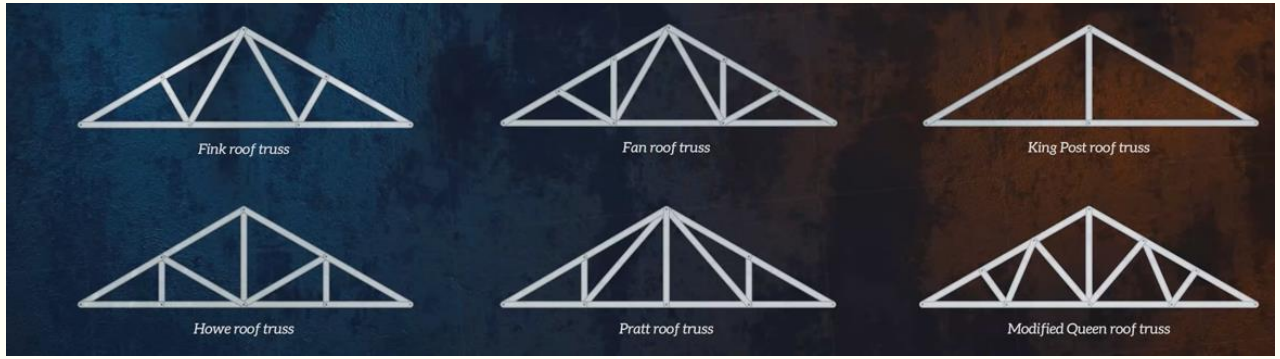
Using CAD models in Second Life - Instructor

Step 7 – The rotor, light and switch are linked together in that order. Which results in an animated DC Motor model that can be turned on and off in-world. The DC Motor model is 95% complete. Only need to add a texture the battery and reroute the negative lead to the rotor. Additional information such as audio, video or text can be added to provide more information to the students that use this model but the basic animated model is done.



Using CAD models in Second Life - Student

In our METC 111 Statics I decided to use Solidworks and Second Life to design and analyze 5 basic roof truss desian. Students were told to pick a roof truss configuration and analyze and draw the roof truss in Solidworks. The model would then be saved as an STL file and converted to a "dae" file using Blender and uploaded to Second Life. In Second Life the roof trusses would be placed in a sandbox and students would need to add their trusses to a 28 foot by 28 foot garage. A basic pitch and overall roof width were defined as well.

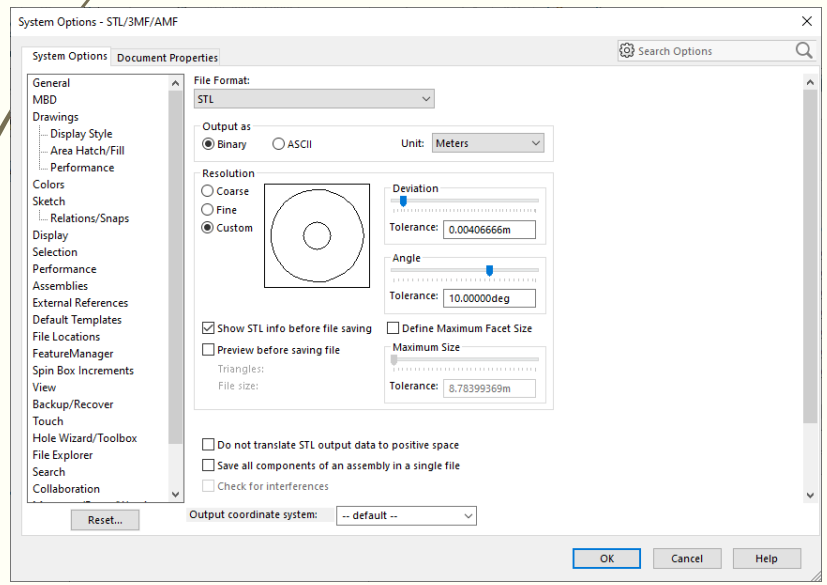


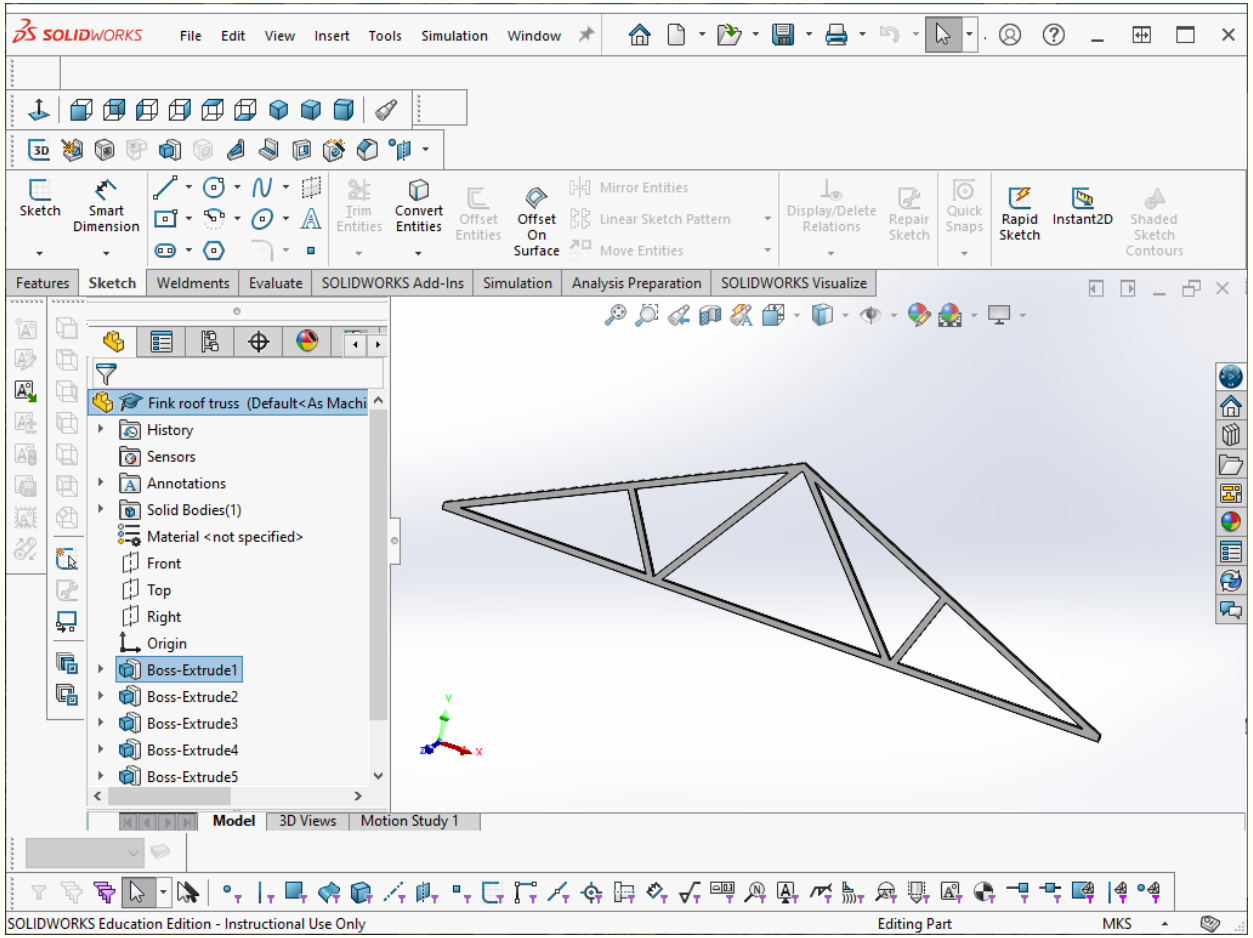
Understanding and Analysing Trusses[20]

Assignment - Using Solidworks design and analyzes a Fink roof truss for a garage of 28 foot width and a 25 degree pitch. Assume the garage is square and the is a 20 lb load per square foot and the trusses are on 24 inch centers. Assume a point load and evaluate using Solidworks each member to determine whether it is compression or tension. Document your results in a PowerPoint and verify your results with your partner.

Using CAD models in Second Life - Student

Step 1 – Each student draws their roof truss in Solidworks base on the dimensions provided. This requires a conversion to the metric system. The drawings are done to scale and saved as SLDPRT and STL files. Make sure STL file options are selected and the STL units are set to "meters or else there could be scaling issues when you upload to Second Life.

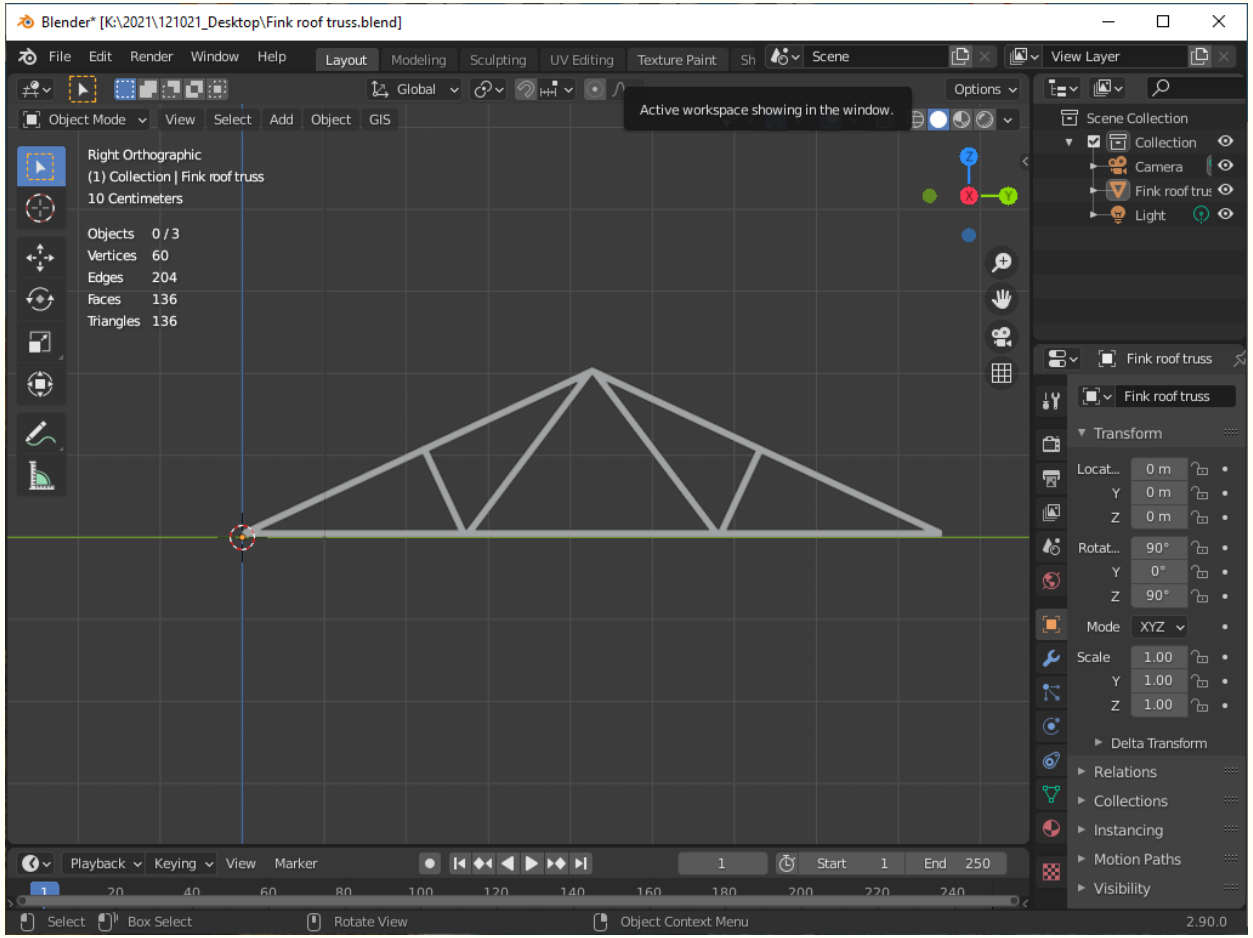




Using CAD models in Second Life - Student

Step 2 – Import and verify design in Blender. No textures will be added but the mesh will be checked for complexity. The more complicated the mesh the more problems Second Life will have when the model is uploaded.

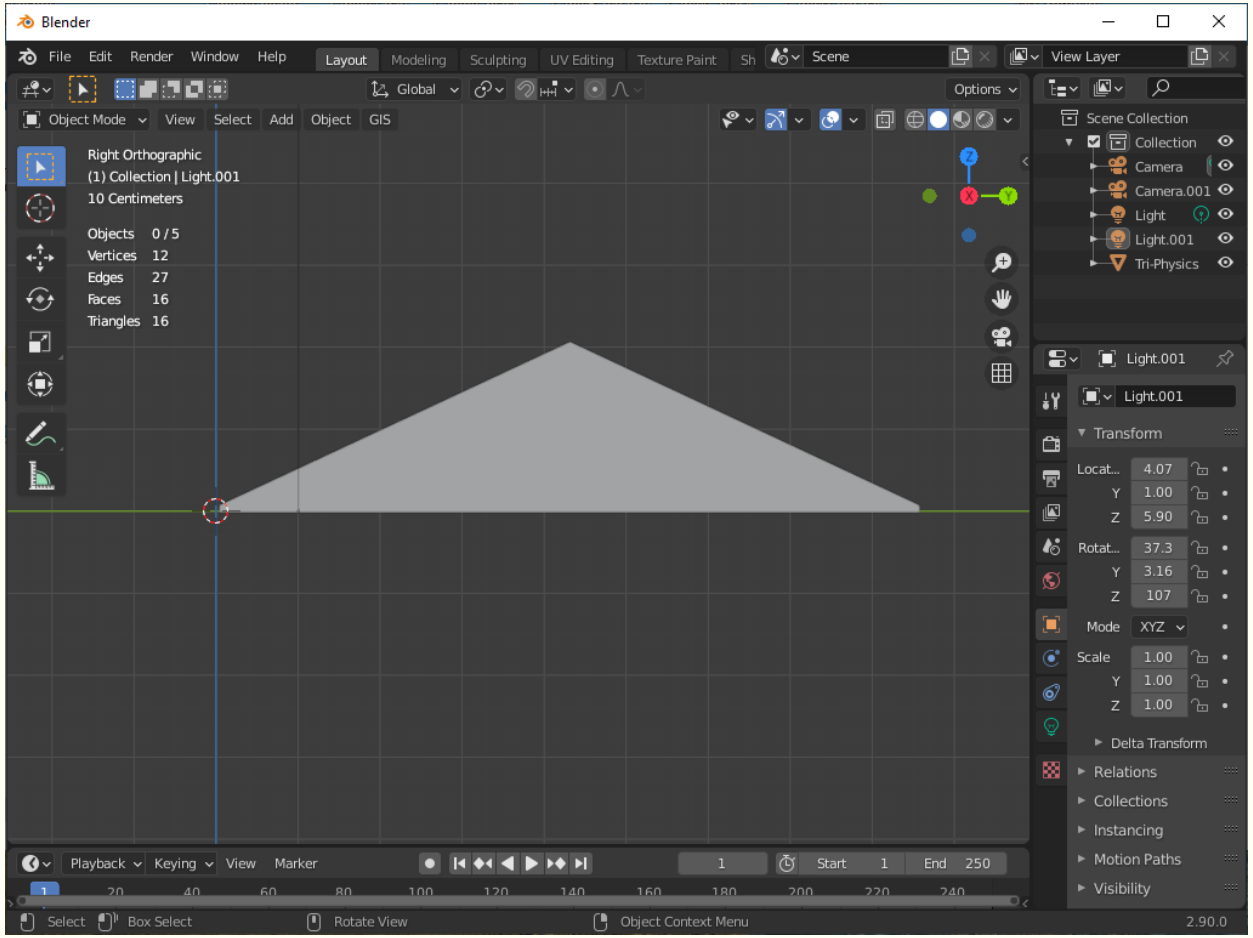
Vertices =	60
Edges =	204
Faces =	136
Triangles =	136



Using CAD models in Second Life - Student

Step 3 – A physics model can also be used. This model can easily be drawn in Blender or Solidworks and should have very low impact on the Second Life model. Physics models are typically created to prevent avatars from moving through objects. After all the models have been exported from Blender as "dae" files they can be uploaded to Second Life.

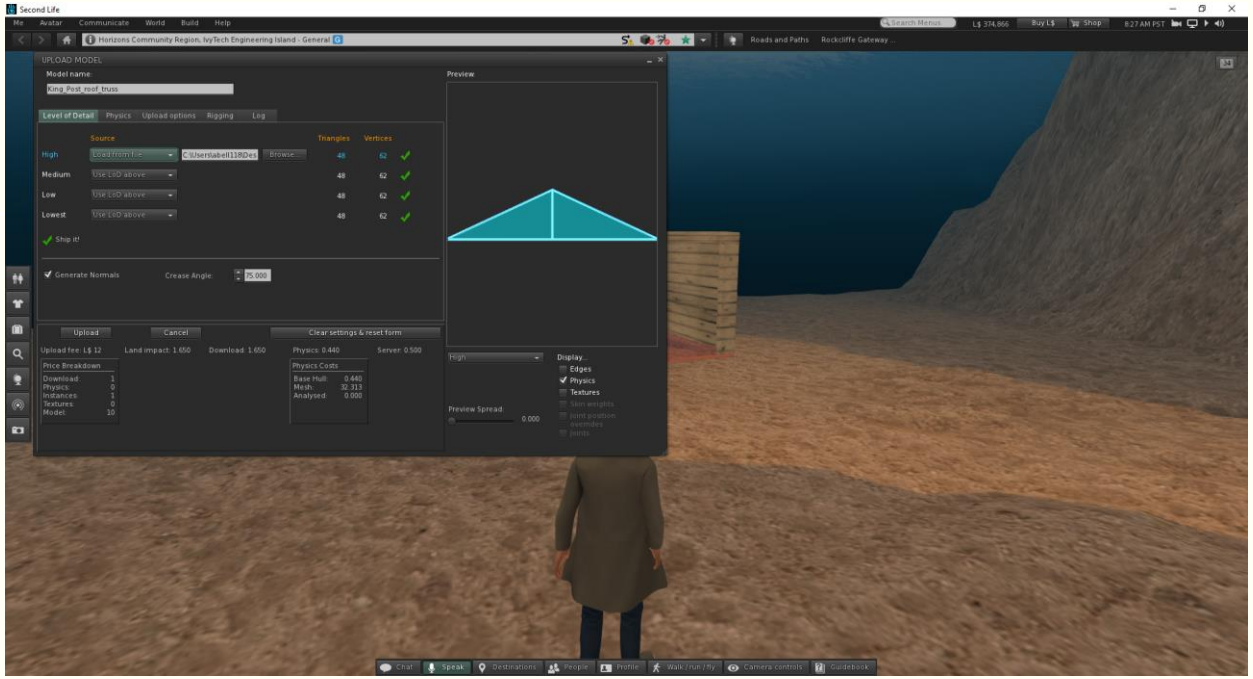
Vertices =	12
Edges =	27
Faces =	16
Triangles =	16



Using CAD models in Second Life - Student

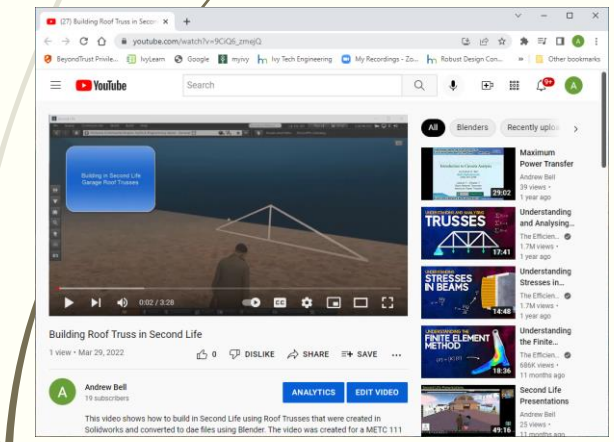
Step 4 – Upload models to Second Life. As an example consider the King Post Roof Truss - Upload both the model and physics file. L$ 12 is pretty good cost. This object (model) will then go in your inventory and shared with the students in the sandbox.

Instructor example of King Post Roof Truss design on 28 ft by 28 ft garage.

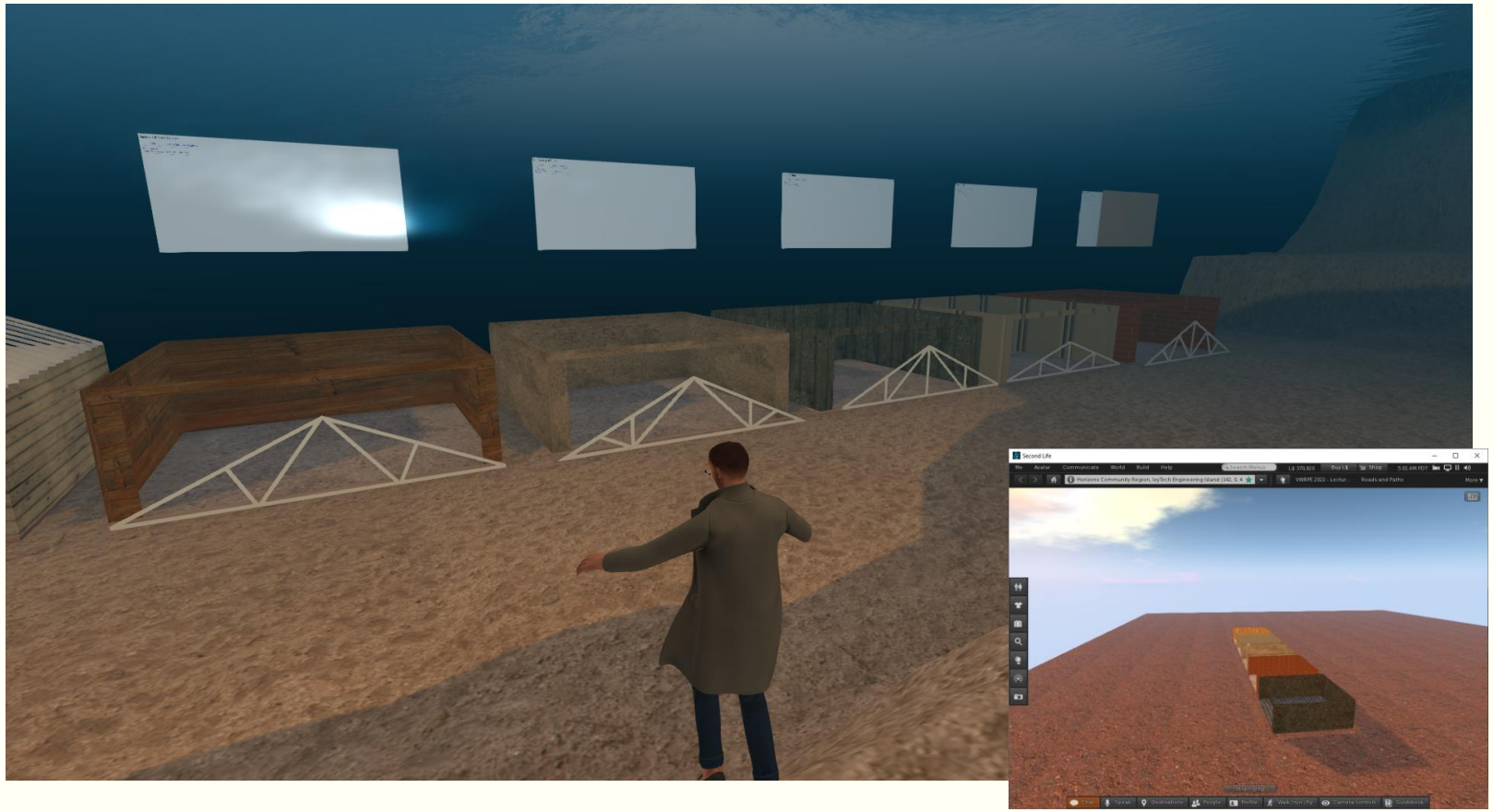


Using CAD models in Second Life - Student

Step 5 – Setup all roof trusses and garages for students to build with in Second Life. This is done by the instructor. In my case I created 5 virtually identical garages in-world and added textures to each of them.
An instructional video[21] was also provided that explains how to add the trusses to their garage.

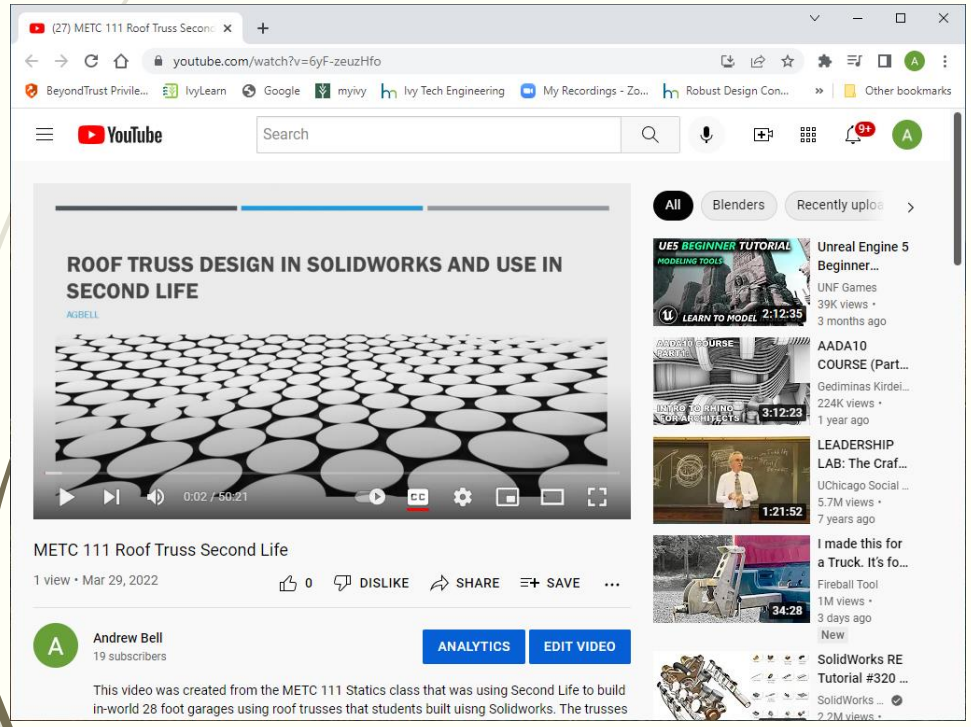


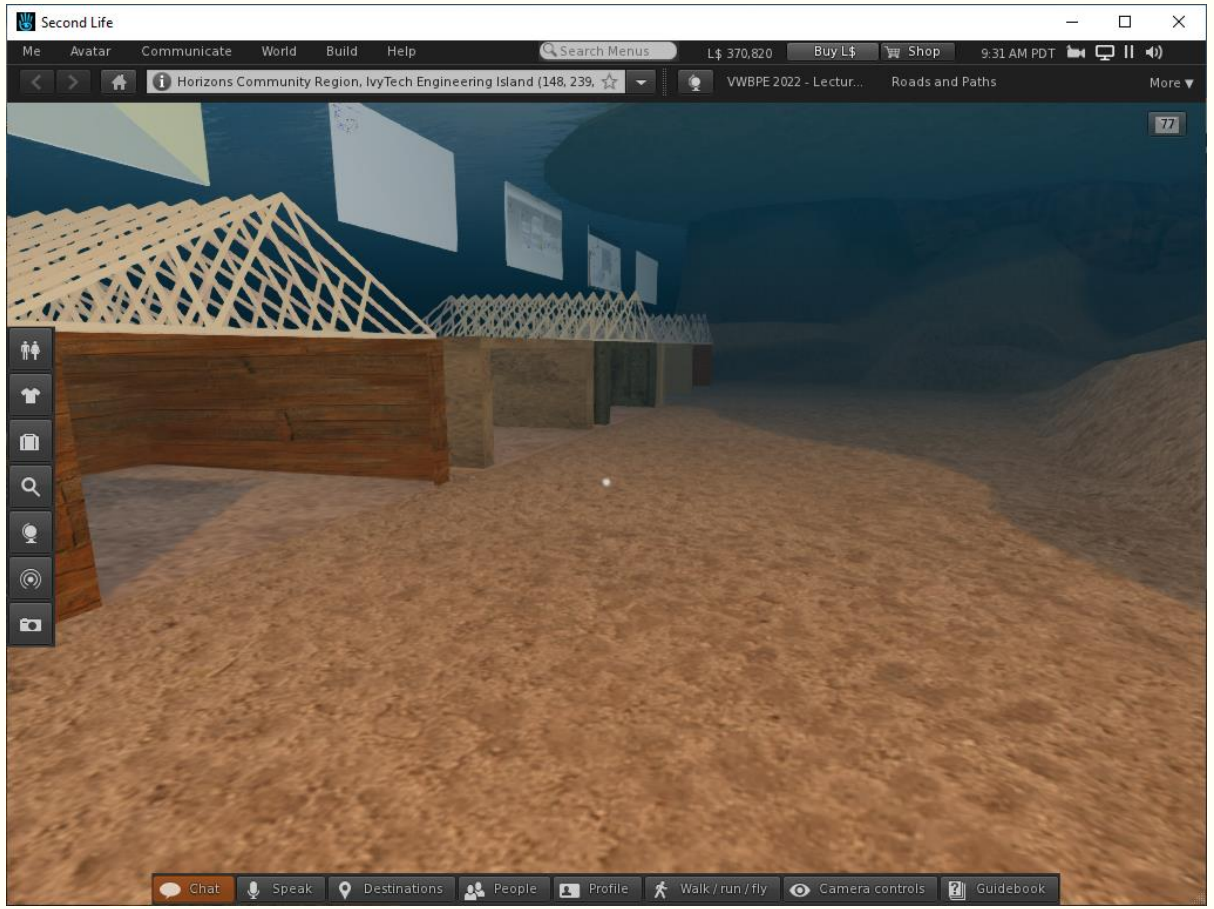
See reference 21 for more info



Using CAD models in Second Life - Student

Step 6 – Students built and presented their garages in Second Life. This included a poster and they added the trusses they designed to the top of their assigned garage. Some found the build challenging and it was recorded and posted on YouTube[22].





See reference 22 for more info

References

1 – Evergreen Island 3(no longer active)
https://maps.secondlife.com/secondlife/Evergreen%20Island%203/37/146/30
https://community.secondlife.com/forums/topic/451042-healthcare-education-and-training/

2 – MUVE Market - Virtual Patient Care Simulation Lab by pookymedia, YouTube posted Jul 16, 2010 https://www.youtube.com/watch?v=LNpOfDEh9Ds

3 – **Engineering Education Island: Teaching Engineering in Virtual Worlds** [2]
which was published in 2009 in ITALICS, Innovation in Teaching And Learning in Information and Computer Sciences by MJ Callaghan, Kerri McCusker, J Lopez, JG Harkin, Shane Wilson
https://www.tandfonline.com/doi/full/10.11120/ital.2009.08030002

4 – Engineering Education Island Second Life Project by harmonyhill, YouTube posted June 29, 2009 https://www.youtube.com/watch?v=_gcb8GJBOOw

References (continued)

5 – IvyTech Engineering Island
http://maps.secondlife.com/secondlife/IvyTech%20Engineering%20Island/59/51/2

6 – **Web on a Prim in Second Life** by David Taylor, YouTube posted Oct 31, 2016
https://www.youtube.com/watch?v=safGo9qMYJk

7 – Second Life Presentations by Andrew Bell, YouTube posted Apr 27, 2021
https://www.youtube.com/watch?v=o3S8sou4oUQ

8 – **Virtual Worlds Teaching Manual** by Gregory Perrier, August 2020
https://online.nvcc.edu/it/docs/sl/Virtual-Words-Teaching-Manual.pdf

9- Second Life: Slideshow Viewer Lite Acquistion and Set Up by David Taylor, Feb 11, 2019 https://www.youtube.com/watch?v=_HJ5TwOzNAg

10 – Ee's Slideshow Viewer LITE 3.0 in Second Life Marketplace for L$0 at
https://marketplace.secondlife.com/p/Ees-SLideshow-Viewer-LITE-30/290095

References (continued)

11 – PPT to HTML Online Converter - https://convertio.co/ppt-html/

12 – Javascript Image Slider with Next and Prev buttons | Html, Css and Javascript slider YouTube posted Mar 21, 2020 https://www.youtube.com/watch?v=uAAD3mmQGRQ

13 – GrabCAD at https://grabcad.com/library

14 – Thingiverse at https://www.thingiverse.com/

15 – Six Sided Boolean Die at https://cults3d.com/en/3d-model/tool/gate-die

16 - Blender Quick Tip: making Wire/Hoses and more by Blender Cubed, YouTube posted Dec 29, 2018 https://www.youtube.com/watch?v=BCp_b2y4mmc

17 - Understanding Materials - Blender 2.8 Tutorial for Beginners (Eevee) by chocofur, YouTube posted Apr 25, 2019 https://www.youtube.com/watch?v=nBdGm_d_8XE

References (continued)

18 – Part 1 Scripting a Light Switch in Second Life by Michael Lively, YouTube posted Mar 20, 2008 https://www.youtube.com/watch?v=kHb8WBtyKQg

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Questions

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