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323917

Making Game Engines Work for Engineers

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Learning Objectives

- Learn how to use Unity to help visualize engineering analysis 3D models
- Learn how to get started with game engines by getting the correct hard/software
- Learn how to QA/QC your engineering models using game engineer technology
- Learn how to have fun and play games at work everyday—which is beneficial to all

Description

Game engines are known for their innovative graphics and physics. That would make it seem like game engines are only beneficial to architects. This is just not the case. Game engines provide a wide range of benefits to engineering firms, and this class will explain how to get started using them in a way that is easy, fun, and affordable. Game engines could be used to help QA/QC a project, or to help visualize engineering analysis 3D models, or for real-time interactivity using virtual reality (VR), or even as an interactive game that shows construction sequencing animations, and much, much more. The possibilities are endless. Game engines are fun to use, so it's time to use them in your engineering firm!

About the Speaker

Marcello currently serves as the Director of Advanced Technology at John A. Martin & Associates Structural Engineers in Los Angeles, California. Marcello has worked on many BIM projects over the last 20 years including the Walt Disney Concert Hall in Los Angeles; the Ray and Maria Stata Centre at the Massachusetts Institute of Technology; and the Tom Bradley International Terminal Expansion at Los Angeles International Airport. Sgambelluri is internationally recognized as one of the top BIM leaders and contributors to the education and implementation of BIM technology in the building industry. He continually speaks at Autodesk University and the Revit Technology Conference, and he has received a record total of 15 1st place speaker awards between both conferences. Marcello Sgambelluri received his bachelor's and master's degrees in civil engineering, and he is a licensed civil and structural engineer.

Marcello also has media outlets to reach the AEC industry that includes the following:

Simply Complex Blog Site -

http://therevitcomplex.blogspot.com/

Simply Complex YouTube

https://www.youtube.com/channel/UC7IkO1Bc4PhFKAHEArmQ0jw/videos

Simply Complex Podcast -

http://simplycomplex.sharedcoordinates.com/

AEC Complex Comic -

https://www.aeccomplexcomic.com/

Table of Contents

Introduction

Game Engines in AEC? Finally!

Up until a few years ago the workflow for putting a Revit model into a game engine was not quite as simple as hitting an “Export” button. Although it did technically involve using an export, there was much more manual work to be done, and often required the use of multiple software platforms to get the desired results.

Today’s workflows are much simpler thanks to applications that allow you to go directly from Revit into a game engine environment where materials and object data are translated and applied during the export.

Game engines are very cheap of free with some restrictions. Also, since the demands placed on the game engine software in AEC are not that great compared to the gaming industry. In most cases, computers that are configured to work with Revit is enough hardware to use on game engines.

Game Engines Are Not Just for Architectural Visualization Anymore

Much like the initial appeal of doing BIM was to have 3D geometry, the initial appeal of utilizing a gaming environment was to easily look at a 3D rendered environment. This is especially true in the marketing of projects. Being able to show clients how pretty their new lobby will be, or how much of the atrium is visible from the CEO’s office in a 3D, immersive manner goes a long way.

But this doesn’t have to only apply to the artistic aspects of a building. It can be useful to visualize structure and MEP systems in such an environment as well.

Whether it be for construction coordination or facilities maintenance purposes, understanding how the systems will be installed is of high value. Putting a model into a gaming environment makes it easier to navigate and experience the model than trying to do so in the authoring software, or with printed documents.

You may ask “How does this have any marketing appeal?”. The answer lies in efficiency. Virtual mock-ups of systems can be huge time savers and give the client the opportunity to recognize potential issues or alternatives before any actual construction begins. With a virtual mock-up there is not only time savings, but also with materials. In a short amount of time, one person at a desk can put together a mock-up that might take several workers multiple days to complete. Changes can be easily and quickly applied and seen, without having to waste materials.

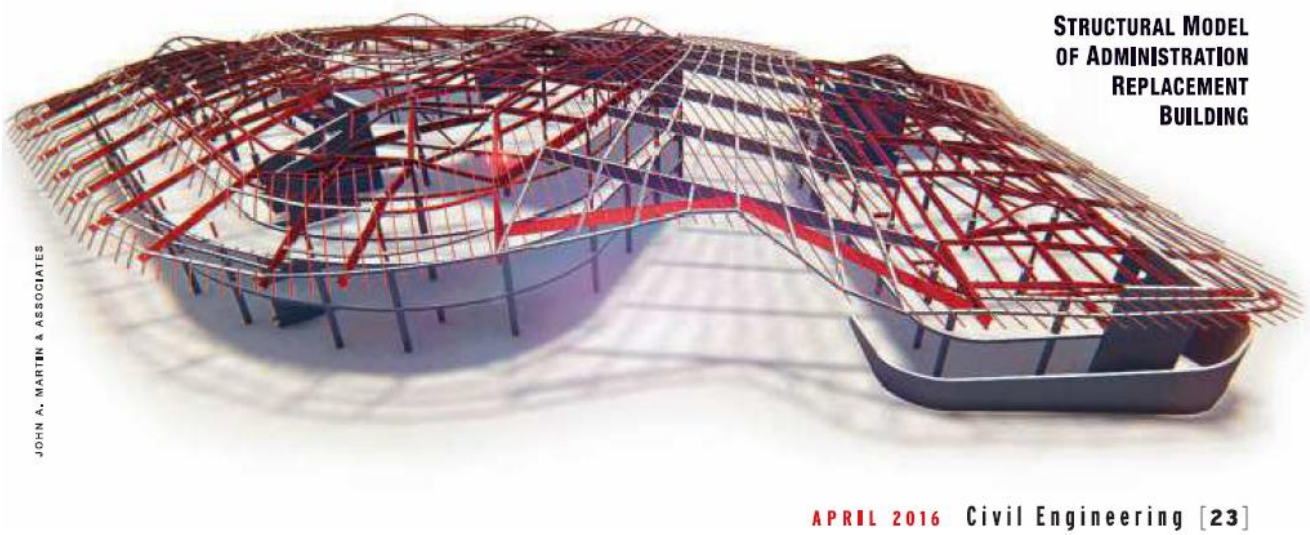
Visualizing systems also reveals prefabrication opportunities, which can result in better safety and expedited construction of key building components. Also using Game Engines is extremely fun. If you are still not convinced after the course and reading through this handout that Game Engineer do not apply to your Engineering practice, then please show other engineers who will use it. This could include engineers outside of your company. I am sure there are no shortage of AEC professionals who would enjoy learning about game engines for engineers.

Presentations and Telling your Story

Render Times = Seconds

Game engines could significantly reduce the amount of time spent rendering still images of projects.

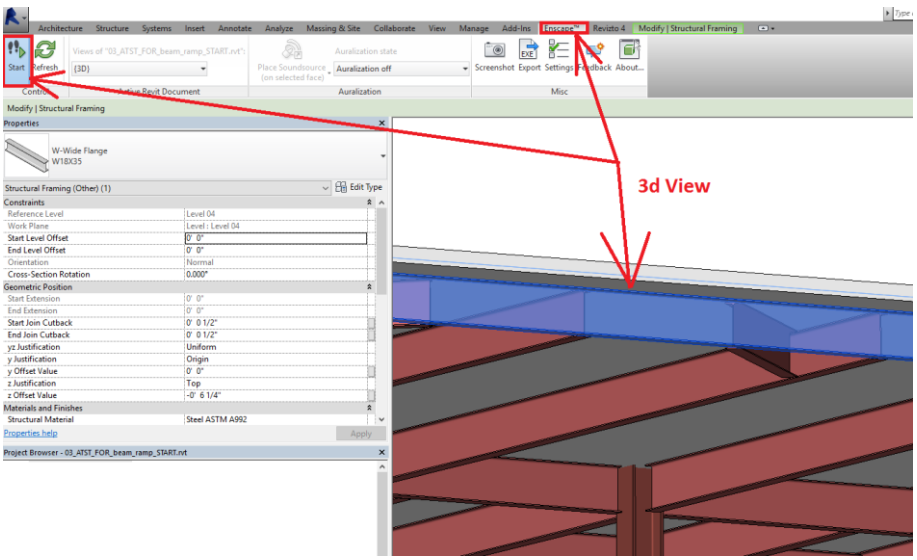
For example, the image below took 30 seconds to render because the model was already inside a game engine and since game engines render in real time it was only a matter of taking a “screenshot” of the view I wanted to create the rendered. This image was used in a magazine article that is referenced in the image.



Deployed Enscape for Story Telling

Forget presentations and “wowing” everyone in the office. These tools are really good at helping you QA and QC your structural model. Simple create your Revit model then use Enscape to move around and look. It’s easy. Then if you want to share that information just export your view or elements to a .exe file (zip it because most emails freak out with exe attachments) and done. The person receiving your .exe file could look at your Enscape model and not even have to own Enscape. How cool is that!

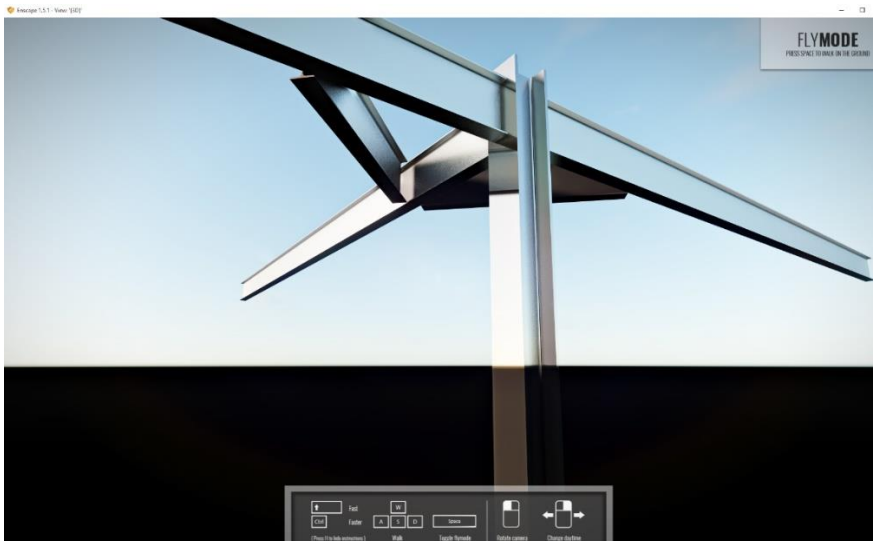
To make an Enscape model just open a 3D view and click the Enscape Start button as shown in the image below



.

The final model in Enscape looks like the image below. If you want to really spice up your experience simply walk around on the structure that you modelled and if you fall… then you have modelled something wrong. It’s fun and enlightening at the same time!

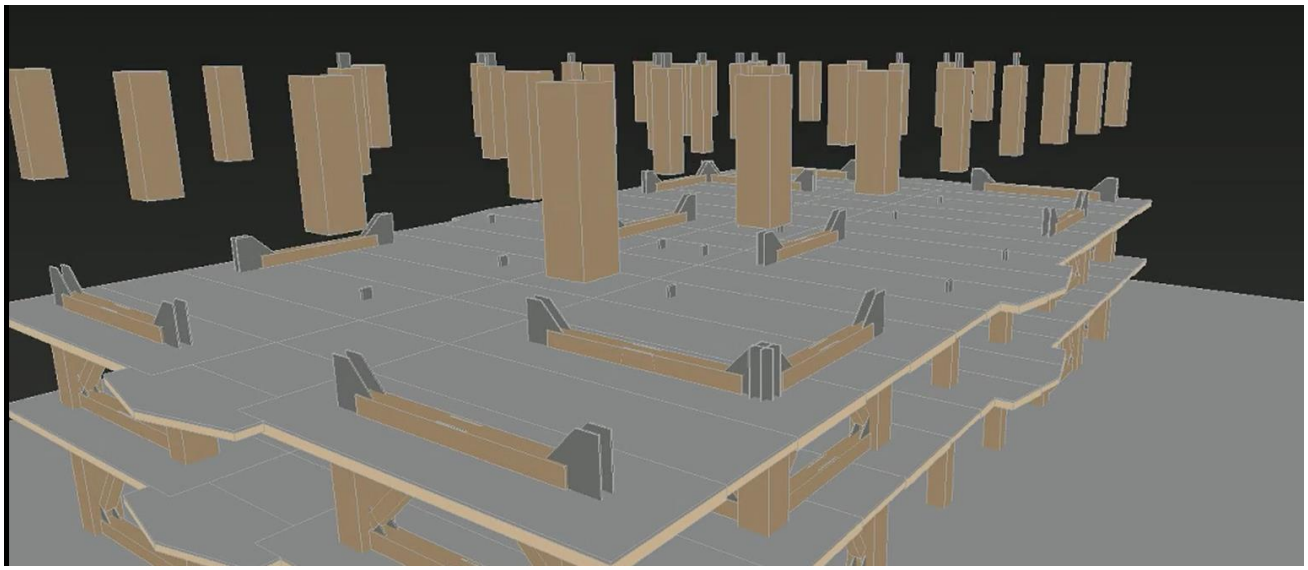
Do you want to isolate any elements? Simply isolate them in Revit then Enscape will update and shown them isolated!



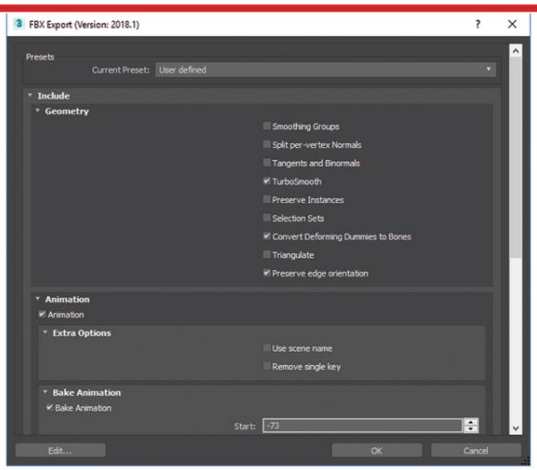
Then if you want to share that information just export your view or elements to a .exe file (zip it because most emails freak out with exe attachments) and done. The person receiving your .exe file could look at your Enscape model and not even have to own Enscape.

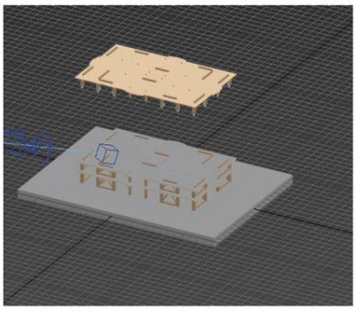
Construction Animation

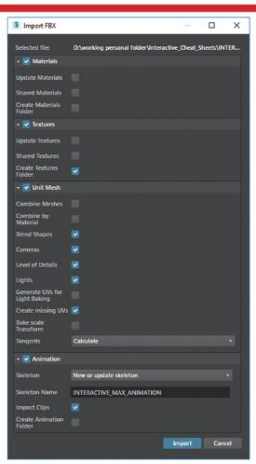
There are many times when you will need to tell the story of how the structural systems need to go together. The problem is construction animations only show the viewer what they are allowed to see based on the present camera positions or positions. What if you could create a construction animation and have the user move anywhere they want while the animation is playing? They could then decide where to look. It is not hard to set something like this up. First, bring your model from Revit to 3DSMax then setup your time steps in, if you want a low resolution animations don't wait for all of the frames to render just simply play the preview animations and record your screen! I do this and it saves me hours of render time! Next bring the animation into a game engine as shown.



INTERACTIVE: SIMPLY CONSTRUCTION ANIMATIONS







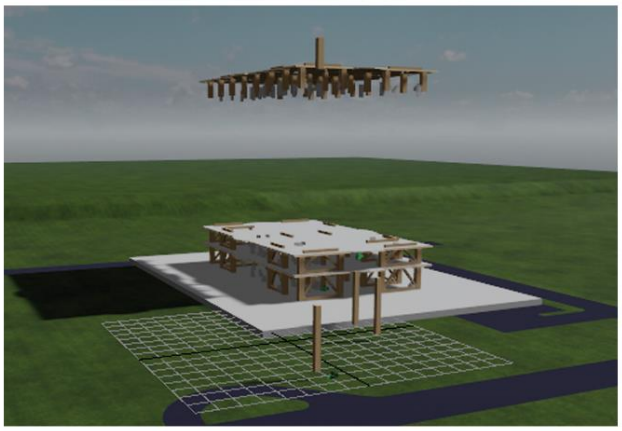
STEP 1

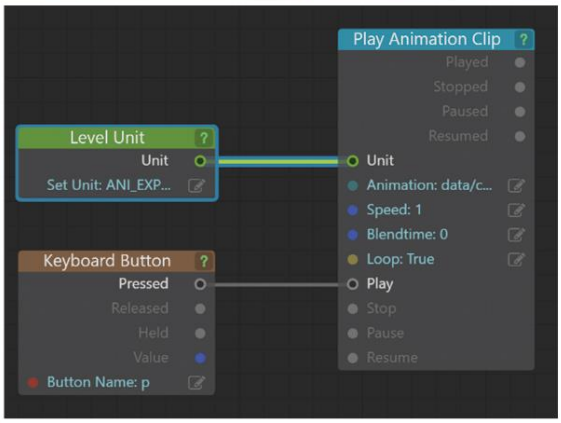
OPEN MAX FILE AND SET UP ANIMATIONS. SELECT THE ELEMENTS AND EXPORT “FBX SELECTED. VERIFY THAT ”BAKE ANIMATION” IS CHECKED

STEP 2

OPEN INTERACTIVE FILE (BEST RESULS WITH LIVE TEMLATE- AND IMPORT THE FBX.

MAX





STEP 3

AFTER FBX IMPORT PLACE THE ASSET IN SCENE. ADD FLOW NODES AS SHOWN TO CONTROL THE ANIMATION (ANIMATION CONTROLER IS NOT NEEDED) CONSIDER ADDING A “STOP” CONTROL AS WELL. TEST AND DEPLOY! NOW YOUR USERS COULD ZOOM AND PAN AS ANIMATION RUNS. NO MORE STATIC ANIMATION CAMERAS

INTERACTIVE

NOTE

FOR ELEMENTS WITH ANIMATION ITS MORE STABLE TO EXPORT VIA FBX AND THEN IMPORT INTO INTERACTIVE THEN TO USE THE MAX TO INTERACTIVE LINK

NOTES

Telehandler Drive And Construction Logistics plan, moving, jumping etc

REVIT TO MAX TO INTERACTIVE: VEHICLE

STEP 1
OPEN REVIT AS SHOWN

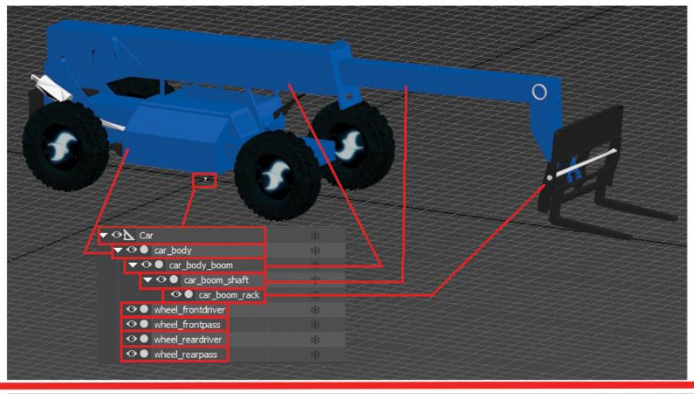
EXPORT AS FBX

REVIT

STEP 2
OPEN FBX FILE IN 3DSMAX

CREATE DUMMY OBJECT AND RENAME PARTS AS SHOWN AND PLACE UNDER DUMMY

MOVE PIVOT POINTS TO CENTER OF TIRES, ETC



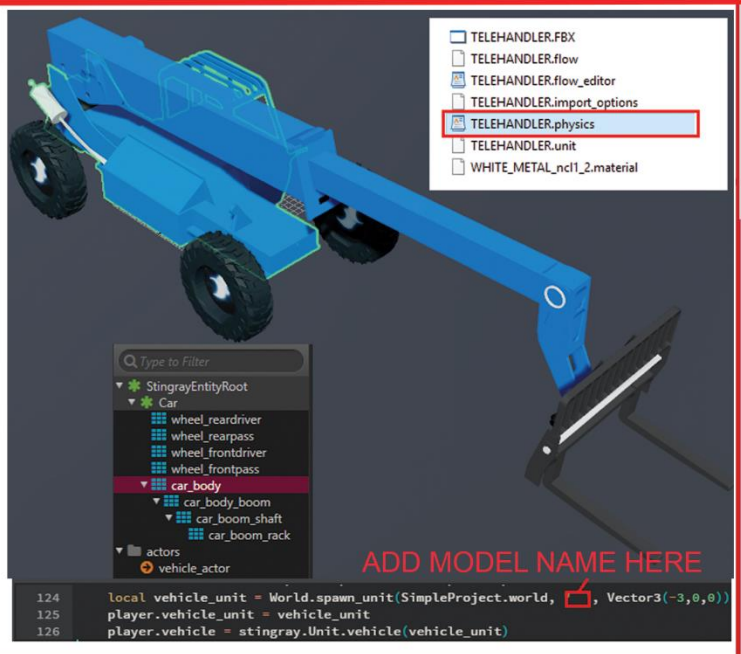
MAX

STEP 3
CREATE OR OPEN EXISTING VEHICLE TEMPLATE IN STINGRAY

IMPORT TELEHANDLER FBX

OPEN IN UNIT EDITOR
CREATE ANY PHYSICS ACTOR

COPY ALL CONTENTS FROM PREVIOUS .PHYSICS CAR TEMPLATE FILE AND PASTE IN TELEHANDLER.PHYSICS FILE



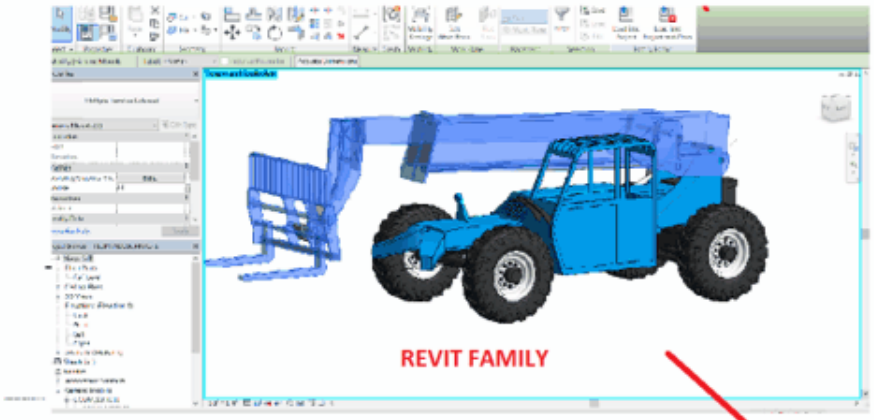
INTERACTIVE

NOTE
THIS METHOD SHOWS HOW TO GET A REVIT VEHICLE FAMILY INTO STINGRAY TO MAKE IT DRIVABLE. MAKE SURE TO MOVE ALL THE PIVOT POINTS OF EACH VEHICLE ELEMENT TO ITS C.G. ALSO NOTE THAT THE DUMMY OBJECT LOCATION WILL BE THE CG OF THE VEHICLE IN STINGRAY

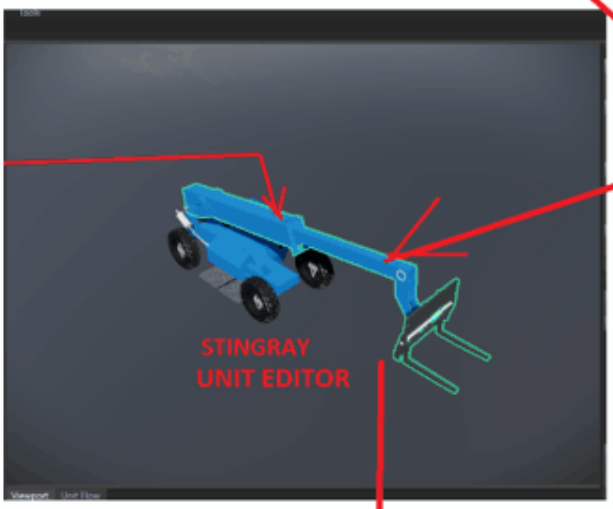
NOTES

LEARN HOW TO GET YOUR REVIT FAMILIES TO MOVE IN THE AUTODESK STINGRAY GAME ENGINE (CLASS PROPOSAL 2017)

REVIT FAMILY



STINGRAY UNIT EDITOR



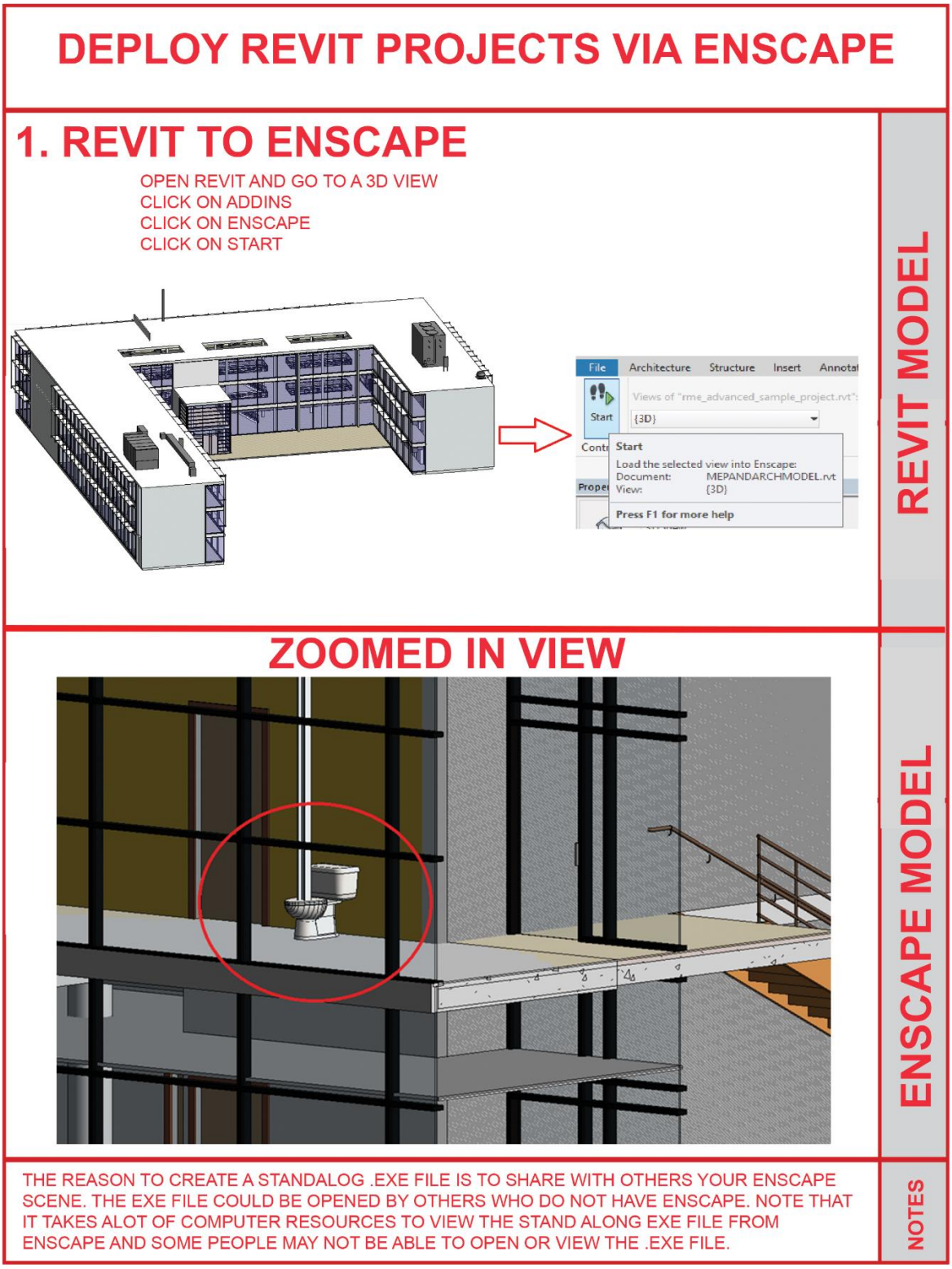
STINGRAY GAME ENGINE

NOTES

NOTE:
THE TYPICAL WORKFLOW IS REVIT TO STINGRAY, SOME FAMILIES REQUIRE REVIT TO 3DSMAX TO STINGRAY

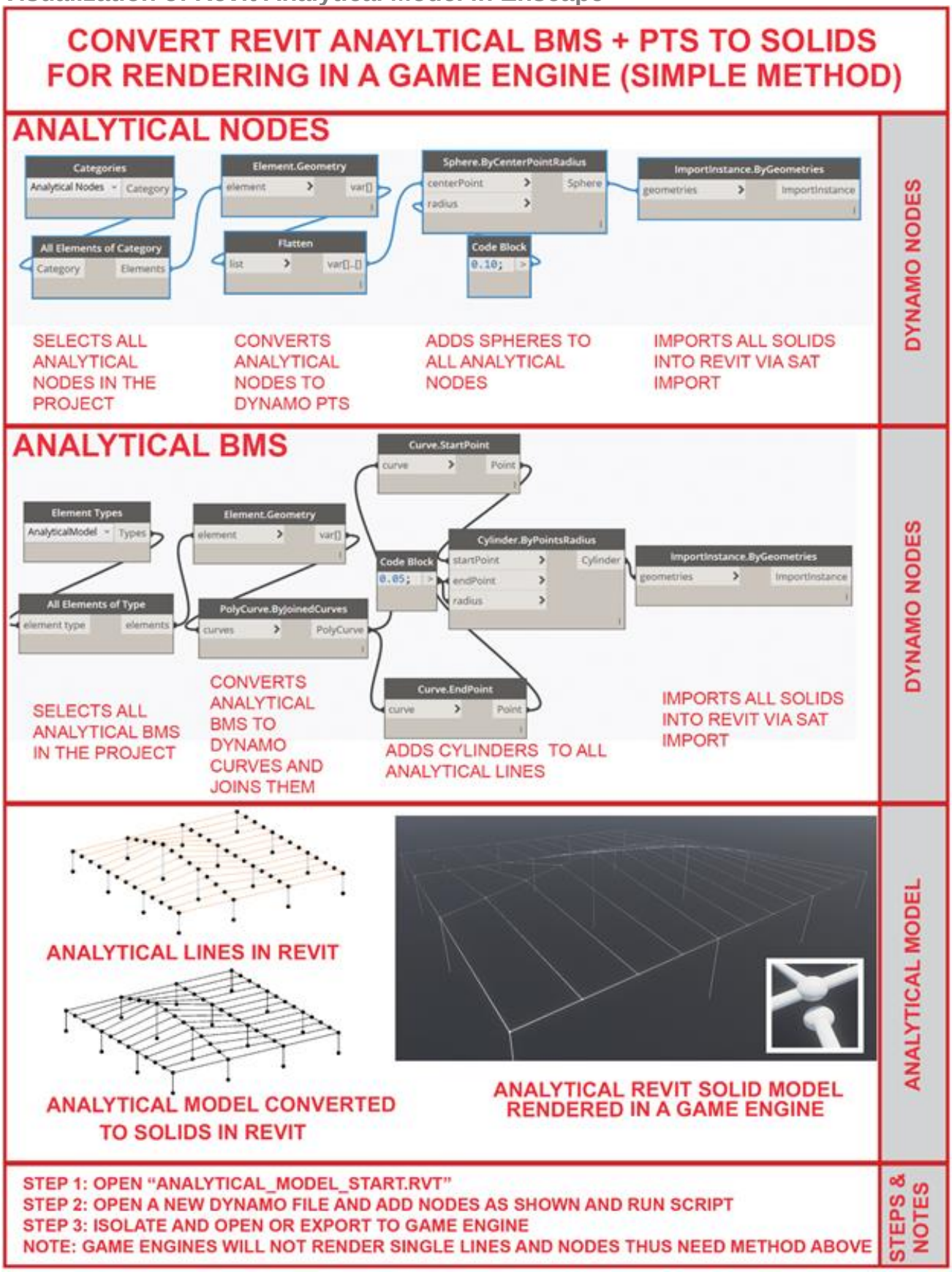
Coordination and You!

The biggest, most underrated, and overlooked technology out in the AECO industry today is YOU! Don't forget to use yourself to make your structural workflow great. Honestly, there are just some tasks that you need to perform in the office that even the latest and greatest technologies could not do. For example, if you ever see something in a model that just does not look "right" or you ever have a feeling that something is making you uneasy about a model you are looking at whether it is your model or someone else's then say something. Take for example the image below.



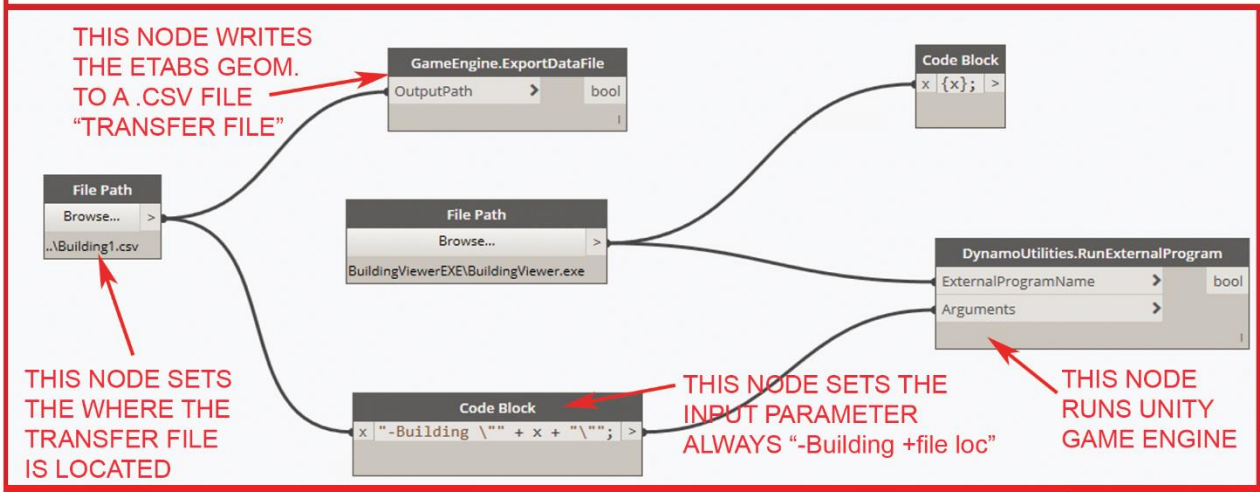
Improving Visualization and Modeling

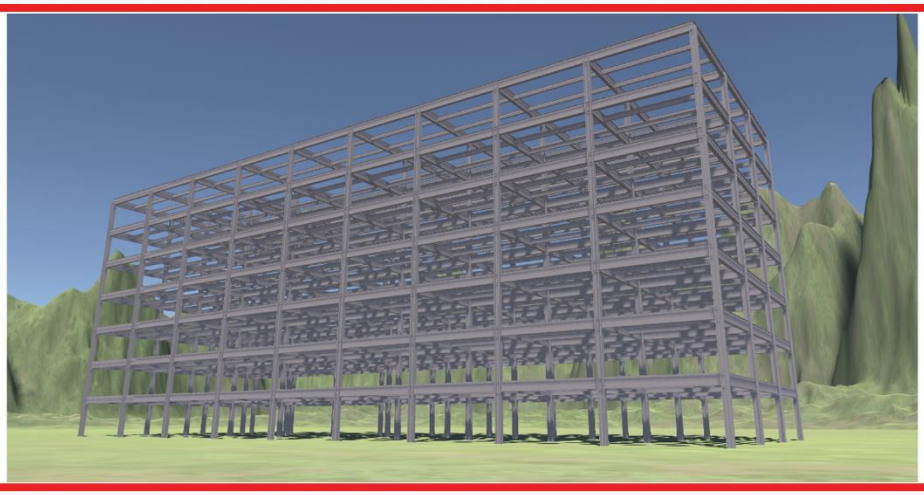
Visualization of Revit Analytical Model in Enscape

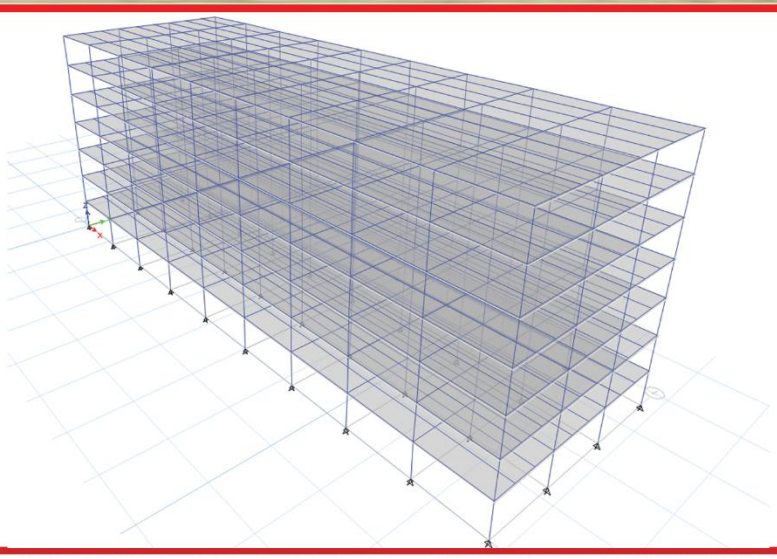


Structural Software into Unity

GET ETABS GEOMETRY TO GAME ENGINE







STEPS: 1. OPEN ANY ETABS MODEL "ETABS MODEL VIEWER.EDB" OPEN DYNAMO
2. OPEN ADD THE NODES ABOVE
NOTES: 1. BEST IF DYNAMO FOR ETABS IS RUN IN MANUAL-
2. ONLY FRAMES ELEMENTS ARE SHOWN IN GAME ENGINE

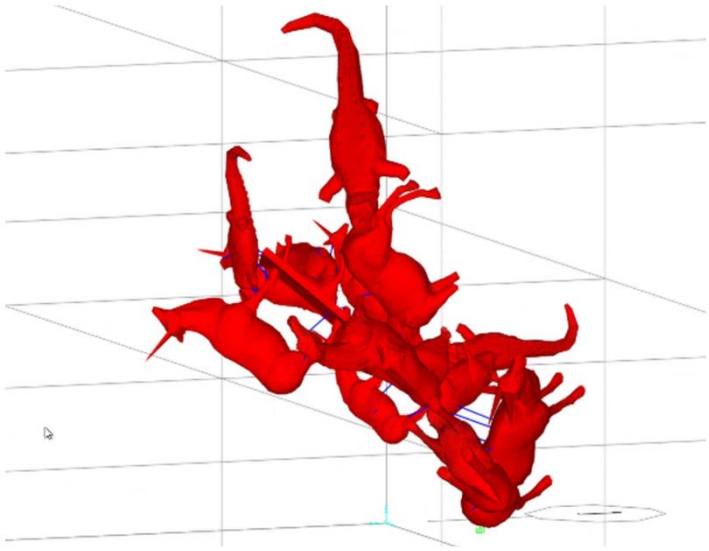
STEPS & NOTES

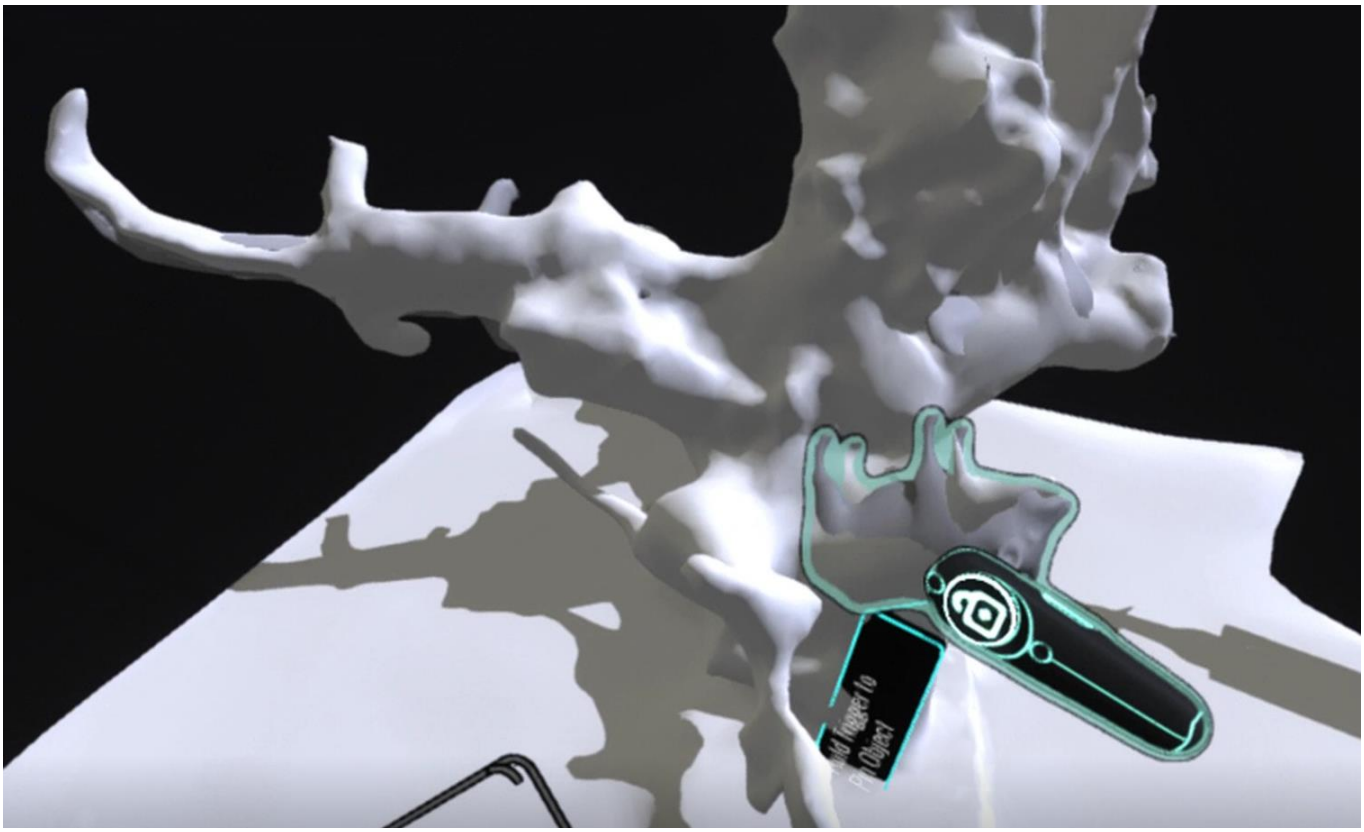
Building Model with VR

Virtual Reality (VR) is a new technology and it could be used in structural engineering modelling. VR drops you into the model and represents scale like no other experience.

The great thing about using a VR high end headset such as the HTC Vive our the Occuls Rift is that you could use your hands to place virtual objects in 3D space. VR 3D placing was used to create complex structural model in SAP shown in the image below.

In the image below, shows how this “animal” shapes were placed in a location using VR. This process was much faster than having to place these “animal” models using a keyboard and mouse.





Using Physics

When we talk about using gaming engine technology for engineering, the conversation goes beyond looking at systems and components. Experiencing and interacting with an environment is a major aspect of a game. Would you buy a game for your PC or console where all you did was walk around and look at things?

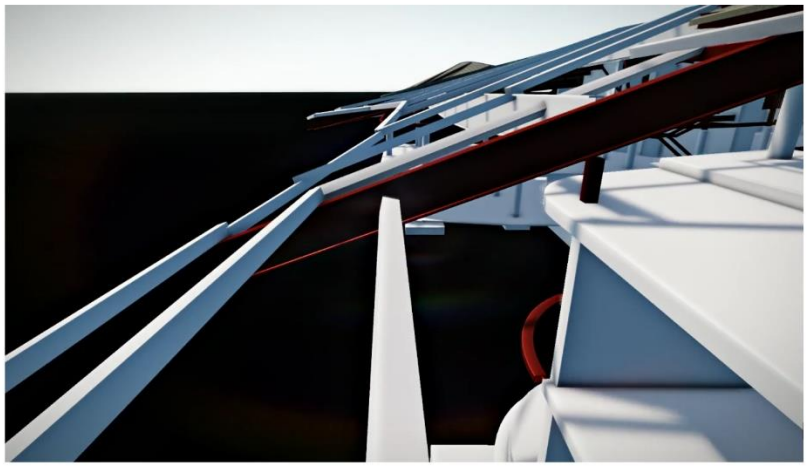
Unlike games for entertainment where you can fly or punch through walls or jump from amazing heights without being compressed into a pancake when landing, a game environment for a building project needs to have real world physics.

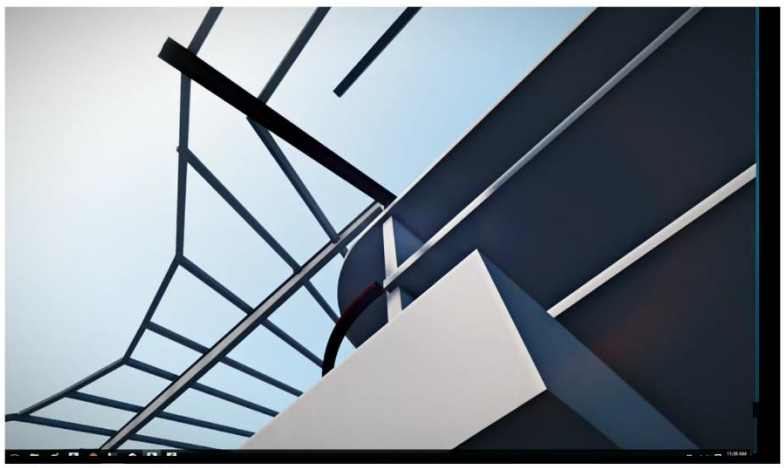
The rapid adoption of VR and AR is driving the need for buildings to be put into gaming environments, and we are early on in discovering the possibilities of making the environments interactive. Basic physics already exist in most game environments. Things like gravity, lighting properties and the fact that you can't walk through walls can all be experienced without much input or programming in the game engine. These even exist in applications like Navisworks, where you can turn on gravity and collisions.

To take things to the next level we want to look at adding physics in the virtual model for engineers. We want experience how objects exist beyond just their geometry and color. The following examples show how to use gravity in game engines to help your project.

Walking the Structure

Want to QA/QC a structure framing model? Simply bring the model into a game engine, in this case Enscape, and turn on gravity. Walk around the structural beams. If you "fall" thru the structure, then you have a disconnected beam in your model, and it needs to be fixed as shown.



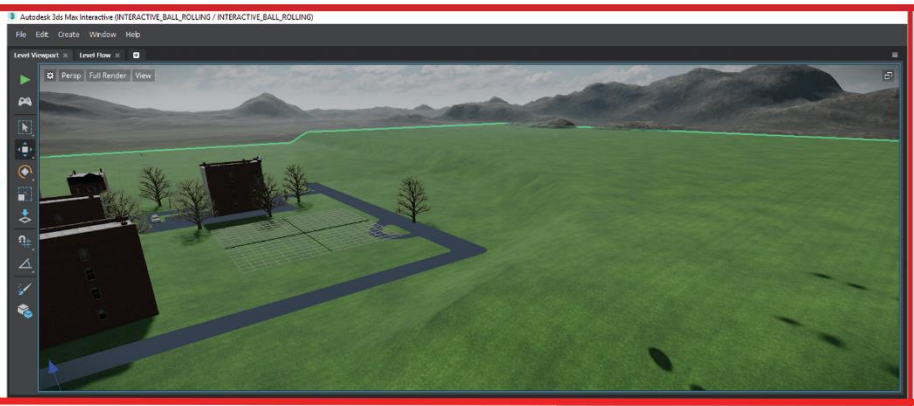


Ball Rolling For Grade

INTERACTIVE: BALL ROLLING PHYSICS

STEP 1

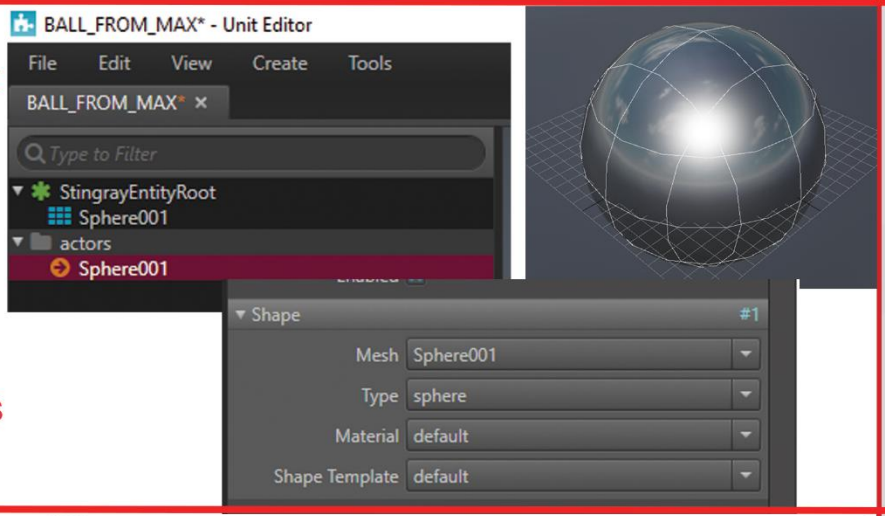
OPEN AN INTERACTIVE PROJECT WITH TOPO, BEST TO CRETE WITH LIVE SERVICE FROM REVIT



INTERACTIVE

STEP 2

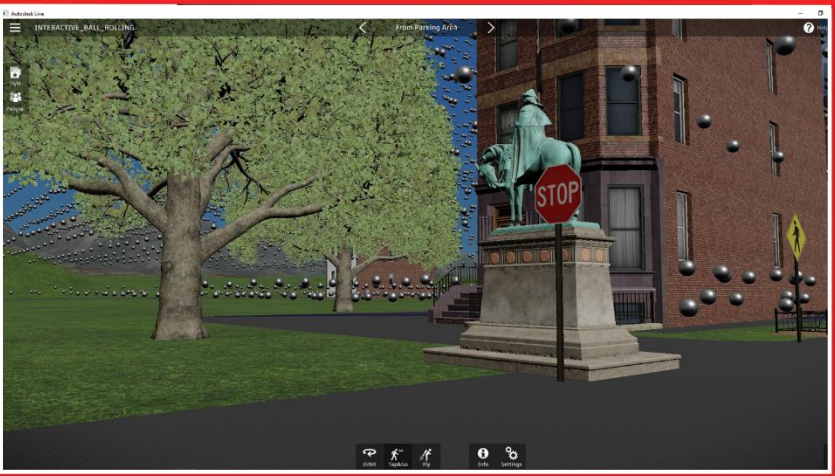
CREATE A SPHERE IN MAX AND IMPORT INTO INTERACTIVE VIA FBX. OPEN THE SPHERE ASSET IN THE UNIT EDITOR AND ADD A DYNAMIC PHYSICS ACTOR WITH A SPHERE SHAPE AS SHOWN



INTERACTIVE

STEP 3

PLACE THE SPHERES IN SCENE ABOVE THE GROUND PLANE AND TEST THE LEVEL IN GAME MODE. THE PHYSICS WILL AUTOMATICALLY ACTIVATE AND SIMULATE FALLING SHPERES



INTERACTIVE

NOTE

INTERACTIVE HAS A PHYSICS ENGINE AND SHOULD BE USED! THIS MEANS ADDING SPHERES TO SCENES TO SEE HOW "RAIN" WATER WILL RUN OFF AND HOW SITES ARE GRADED TO "CATCH" WATER. ALSO, THIS COULD BE DEPLOYED AS A STAND ALONE GAME TO BE SHARED TO TEAM

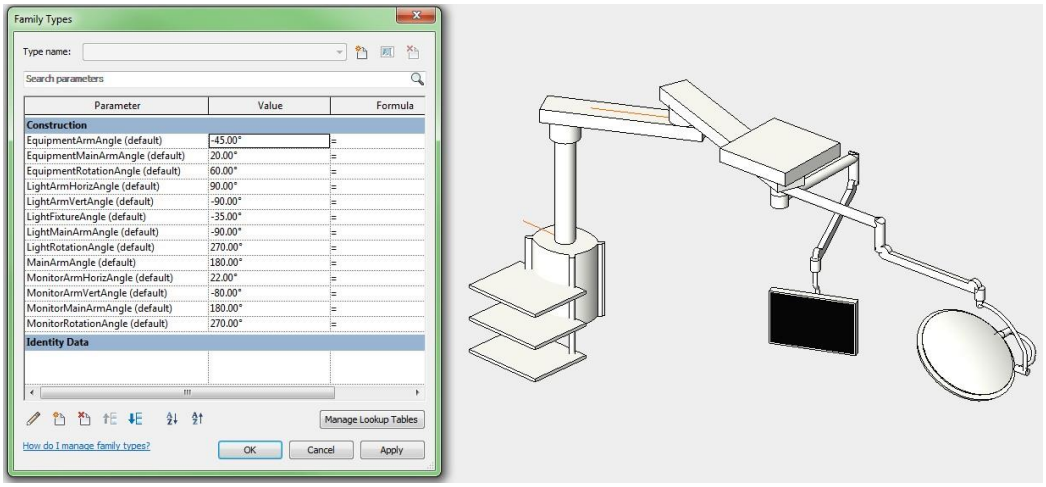
NOTES

Equipment Use Cases

Moving Parts

One key component to this is having objects that are moveable. In Revit, we may not care about the mobility of objects because they just sit in space and on construction documents. But for a gaming experience it may be necessary for objects to move. This doesn't just mean that some objects need to travel across a distance, but also that things need to rotate or change elevation, or that parts of an object might need to move while the assembly stays in place. In general, this can be handled with parameters applied to Revit content, which can later be manipulated by the gaming engine programming.

For example, you may have a light fixture that is on an articulating arm. If the Revit family is a static model, you would only be able to move the whole thing or you would have to edit the family geometry to specific angles for each possibility. Building parametric behavior into the family makes the gaming interaction more realistic and easier to program.

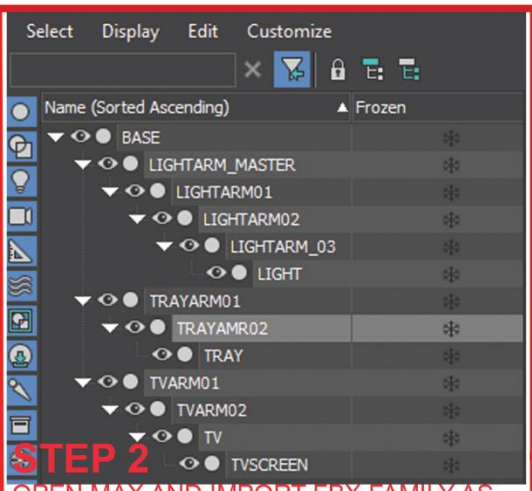


REVIT FAMILY TO MAX: MOVING EQUIPMENT

REVIT

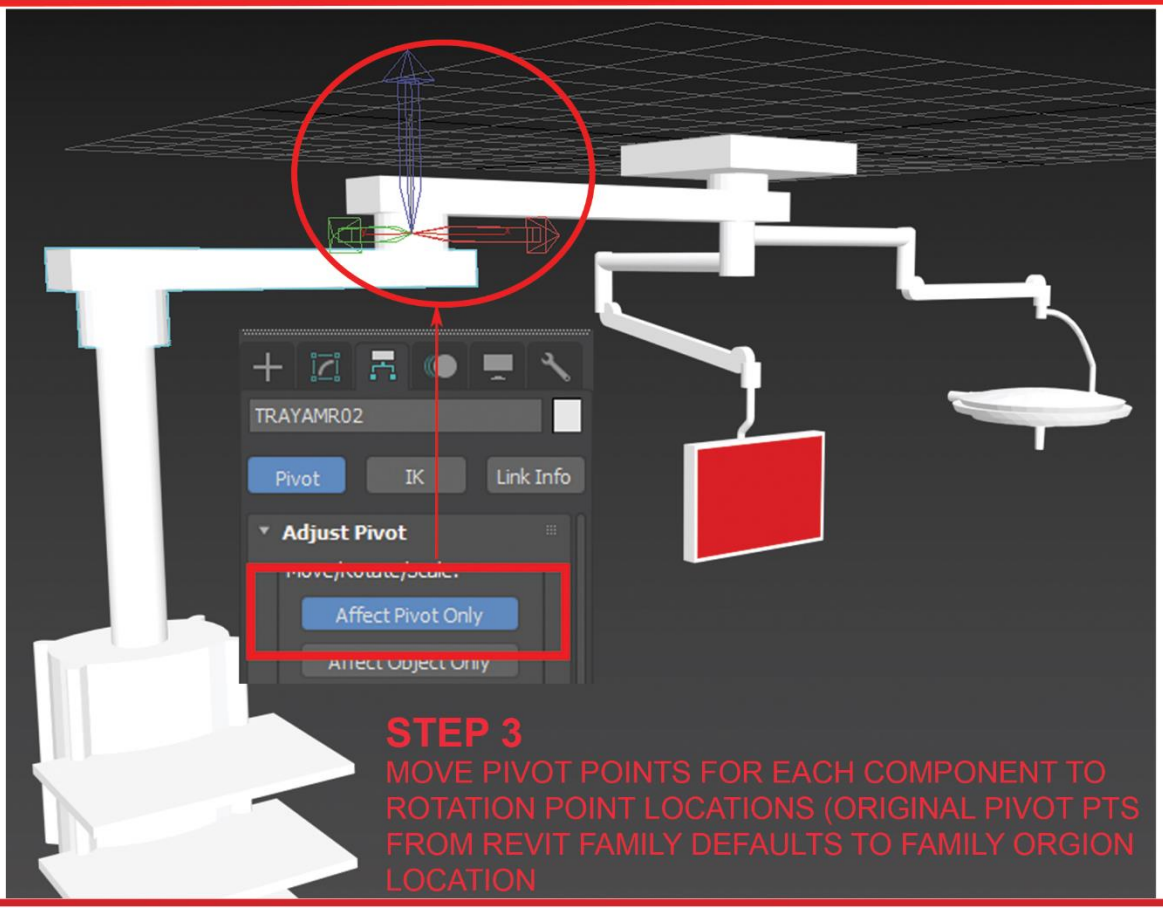
STEP 1
OPEN REVIT FAMILY AND EXPORT AS FBX. AND SAVE TO LOCATION (FAMILY BY DON BOKMILLER)

MAX



STEP 2
OPEN MAX AND IMPORT FBX FAMILY AS FBX AND ARRANGE COMPONENTS HIER-ARCHY SO EX: SHOULDER MOVES ARM, ARM MOVES HAND ECT

MAX

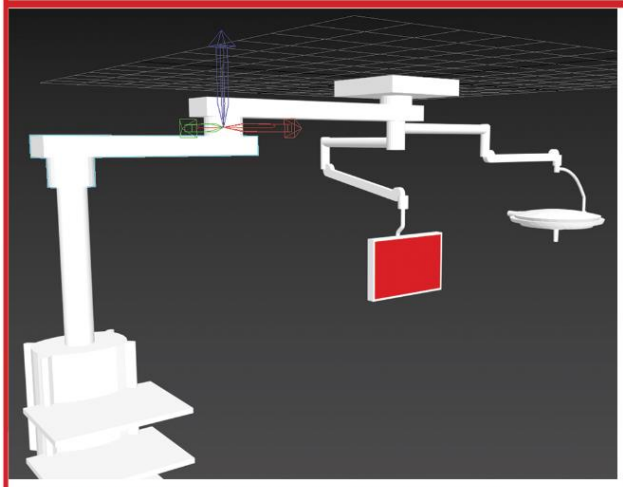


STEP 3
MOVE PIVOT POINTS FOR EACH COMPONENT TO ROTATION POINT LOCATIONS (ORIGINAL PIVOT PTS FROM REVIT FAMILY DEFAULTS TO FAMILY ORGION LOCATION

NOTES

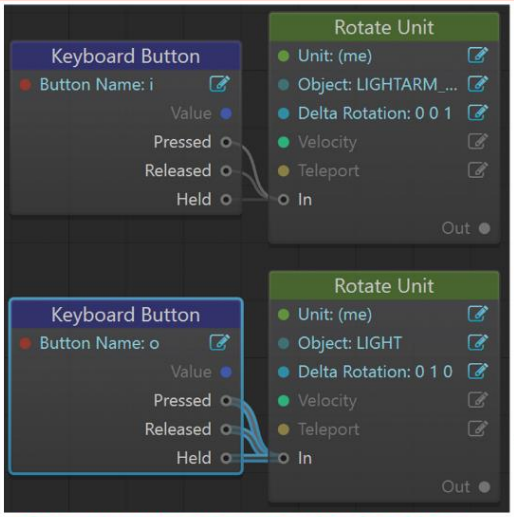
NOTE
IN ORDER TO SKIP STEP 3 (ADJUST PIVOTS) BUILD THE REVIT FAMILY SUCH THAT EACH "ARM" IS NESTED WITHING EACH CONTROLING PART WITH ITS ORIGIN AT ITS PIVOT POINT. THIS MAY NOT BE DESIRABLE TO DO IN A REVIT FAMILY SO IT COULD BE ADJUSTED IN MAX AS SHOWN.

INTERACTIVE: CONTROLLING MOVING EQUIPMENT



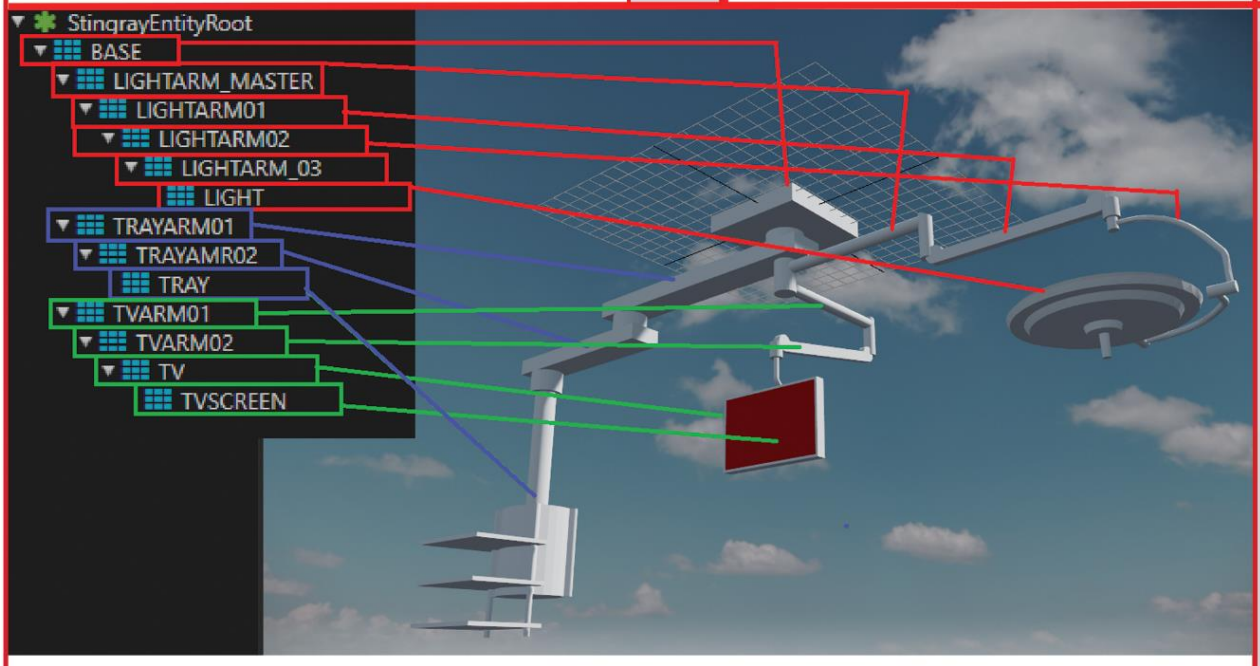
OPEN MAX FILE AND EXPORT VIA MANUAL FBX EXPORT AND SAVE FILE.

MAX



OPEN IN UNIT EDITOR AND ADD CONTROL FLOW NODES

MAX



DEPLOY FROM INTERACTIVE TO A STAND ALONE GAME. THE LIVE TEMPLATE WORKS BEST.

INTERACTIVE

NOTE
GETTING AN ASSET FROM MAX TO INTERACTIVE THAT REQUIRES FLOW NODES TO CONTROL THE MOVEMENT WORKS BEST WITH USING THE MANUAL FBX EXPORT NOT THE LIVE LINK OF MAX TO INTERACTIVE

NOTES

Transformer

Game engines can simulate flow of elements, such as water and electricity. This could be beneficial in exploring how a design handles elements like weather. Suppose you have a roof drain that is part of a piping system. Can it accommodate the amount of water during a heavy rain storm? Does it work well with the roof system (slope, crickets)? If you could show the flow of water into and out of the drain and pipes, you would get a good understanding of how well the system works.

Electrical equipment can be given properties that are consistent with the rating of the equipment. You could set up the gaming environment so that interaction with the equipment would be consistent with what would happen in real life. This has important application in the study of arc flash.

For example, you could define equipment to have a specific arc flash property, where it emits heat, light and concussion during an arc flash incident. You could also equip an avatar (character) with properties consistent with typical arc flash protection, and then simulate an event where the avatar interacts with the equipment.

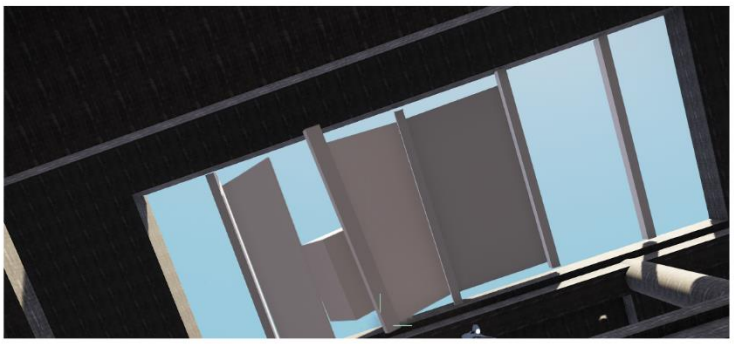
Weight and Mass

Another physical aspect of components to consider is weight and mass. In Revit, we can assign parameters to objects that tell what an object's weight is, but that is simply for reporting. In a gaming environment, we want objects to *behave* per their weight and mass. By programming objects with this information, we can better analyse how they interact with each other and the environment.

Programming structural steel members with their weight, and how much weight they can support would allow us to know the optimal specifications. This is not to suggest that it would replace analysis programs, but rather validate the design decisions we make. Let's face it, as engineers we tend to over-design for the sake of safety and ease.

What if you could have a model where the structural members accept forces like they do in the real world? You could confirm that the structure would act as designed in a manner that is more experiential than numbers on a spreadsheet. You could place a mechanical unit on the structure to *see* if the steel will support it. You could simulate environmental conditions (such as an earthquake tremor) and see the effects.

Applying weight to mechanical equipment would allow you to see how it interacts with the structure.



This can be helpful when changes are made. For example, what if the rooftop equipment specified is not available and another, heavier option is chosen? Will the steel hold it or will it come crashing down? Will it bend the steel just enough to cause problems?

Aside from analytical application, adding weight to objects can be helpful in determining the safety of a design. Being in a game environment and having a character or avatar with weight is a good way to experience the environment. We'll expand on the topic of safety later in this document.

Where do we go from here?

As we explore the horizon of VR and AR in the AEC industry, we realize that there are many applications beyond just visualizing a model.
As we begin to add physics and interaction to the equation, we see that there are some specific areas that VR/AR can be applied that provide critical benefits.
One such area is safety. This is especially important to contractors, many of whom spend lots of time and money making sure that their projects are safe for not only the workers, but those that will occupy the building.

One example of safety is the arc flash example. You could expose an avatar to certain conditions to confirm the correct amount of protection required. You could easily, quickly and more importantly, safely test various scenarios without endangering anyone. This could also be useful in safety training, putting workers in virtual situations to confirm that they know the correct course of action to take.
Another safety example could be with fall protection. It may be easy to see where fall protection is missing from a model, but what about knowing that where it exists is sufficient to protect the workers? Suppose you have a railing modelled around an open area of exposed rebar. You could run your 190lb avatar at a certain speed into the railing to confirm that it will prevent the character from falling through. You could also demonstrate the effects of unsafe environments without anyone actually getting hurt. After all, it's a gaming environment so in a word, SPLAT!

Without all these things, we may have a beautiful, realistic looking model but does it tell the true story? Can those hanger rods support that equipment? How hot does it get in this room with the shades open? Does that heat affect the equipment in the room? The materials?
Yes, there are analysis applications that can give us some of this information, but we are nearing the day when we can experience an environment virtually, which may mean a whole lot more to someone who may not be trained on how to process the data from an analysis program. This session was intended to begin to look at the possibilities and potential applications of adding real-world physics to our models in a gaming environment where different interactions can be explored. We hope that this inspires you to consider the possibilities.