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CS124556

Tools Not Toys: Estimating/Scheduling in Virtual Reality with BIM Data Sources and Stingray

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Learning Objectives

- Learn how we linked an external BIM data source to Stingray
- Learn how we leveraged a data source for visualizing schedules in virtual reality
- Learn how we leveraged a data source for visualizing estimates in virtual reality
- Learn how we exported information from Stingray to an external data source

Description

In this class, students will learn how Skanska created high-quality, interactive estimates and schedules in virtual reality (VR) by linking external Building Information Modeling (BIM) data sources into Autodesk's Stingray interactive engine. First, we will demonstrate how Skanska exported BIM data from Revit software into an external data source. Information in the external data source will be organized and sorted. Then, we will import that information into Stingray in various configurations to create interactive, immersive environments leveraging a repeatable workflow that enables our clients to visualize different design, cost, and scheduling options in VR. As a result, clients will be able to visualize 4D schedules and 5D estimates. They will be able to choose from various design and material options and see the costs associated with them. Finally, they will be able to export the information from Stingray to an external data source. Benefits of estimating and scheduling in VR include realistic design visualization and real-time decision making.

Speaker(s)

Kelsey Stein specializes in BIM-based Preconstruction services at Skanska, where she is helping advance VDC initiatives, especially with regard to AR and VR technologies. She has nine years of industry experience in the USA, Australia, and New Zealand. Prior to joining Skanska, she worked as an architectural designer for Populous where she worked on arenas, stadia and other large scale sports architecture facilities throughout Australia and Asia. She graduated Magna Cum Laude from Drury University with a Bachelor of Architecture and has a Master of International Construction Management from the University of Florida. She is also a LEED Accredited Professional.

Dave Tyner leads Immersive Technology for Customer Success Services at Autodesk. His team is heavily focused on developing interoperable workflows within Autodesk's diverse visualization software portfolio as well as driving awareness/adoption of Autodesk's cross industry VR/AR solutions.

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Introduction
- What is Stingray?
- Why Stingray?
- How is it used for Proposals?

Example – The Linear Accelerator
- Exploration and Interaction
- Excel Schedules
- Materials and Costs
- Cost Updates
- Export Design Options
- Exploration and Interaction - Multiplayer

Example – Big Data
- Exploration and Interaction
- BIM, Schedule, and Cost Data
- Scheduling
- Filtering

Link an external BIM data source to Stingray
- Format BIM Data Source
- Create a Lua Script and Custom Flow Node
- Create Unit Flow
- Create a Tablet

Link a database for visualizing estimates in virtual reality
- Create a Level Flow
- Create a Level Flow for Materials
- Create a Level Flow for the Tablet Model
- Create a Refresh Level Flow

Export information from Stingray to an external data source
- Create a Lua Script and Custom Flow Node

Link a database for visualizing schedules in virtual reality
- Format BIM Data Source
- Create a Lua Script and Custom Flow Node
- Create a Schedule Display

Benefits
- Time and Cost Savings
- Additional Outputs
- Client Involvement

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Introduction

What is Stingray?

Stingray is a game engine and design visualization software. It includes 3D game creation tools, real-time 3D rendering, and virtual reality support. Within Stingray, it is possible to create incredibly complex and detailed environments. Using templates, Stingray offers a quick and easy way to create 3D immersive environments without the need for extensive programming experience. This handout will focus on streamlining the workflow for this process, providing quick turnarounds for pursuits and conceptual estimates.

Why Stingray?

Using Stingray, it is possible to show different design options, cost options, and material changes all with real-time rendering. Stingray offers a high quality level of render for very little time invested. With the addition of LIVE, it creates 3D environments straight from Revit, bypassing traditional rendering software, which is very complex, and can be time consuming to learn and produce deliverables. Stingray also supports a variety of platforms including virtual reality so it is possible to move beyond typical renderings and videos into a fully immersive 3D environment.

How is it used for Proposals?

In order to quickly create 3D environments in Stingray, it is essential to setup project templates and a Level Flow that is simple and repeatable. The project template will be the basis for all pursuits and conceptual estimates. This template will streamline the process for models, materials, and textures within Stingray. Flow is the visual programming system built into Stingray. Creating a repeatable Level Flow file will standardize the programming required within Stingray. This file can be copied into each new project and, with only a few updates, create the interactions within the 3D environment. This Level Flow file can be created in-house by someone with visual programming experience, or by an external party, such as Autodesk.

Example – The Linear Accelerator

The linear accelerator is part of an oncology suite in a hospital. It is an incredibly expensive room, surrounded by 2' thick concrete walls to trap the radiation, and is only accessible by a maze corridor. This can be a very traumatic experience for the patients.

Using this tool, we are able to show the owner how we can transform this cold, sterile environment. We can change materials and show the cost associated with those changes. For a few thousand dollars more, we are able to transform this room, and this experience, for the patient.

The Linear Accelerator

Exploration and Interaction

Using Stingray, you can explore an immersive environment using a virtual reality (VR) headset or using the non-VR computer-based version. Through Stingray, you can explore and interact with this 3D environment using preset navigation buttons. These buttons move and teleport, allowing clients, designers, and construction managers to explore the project.

Excel Schedules

The schedule is created within Excel to show four different scopes of work up for design change. Those four scopes of work are floorings, ceilings, the basic wall area, and finally the feature wall. For each of those areas, there are three potential material types to choose from, as well as correlating square footages from the model, cost per square foot, and the total cost. The working Excel file is directly linked into stingray, which gives the ability to change the data and refresh Stingray to automatically update the tablet.

Interior Design Options	Area (SF)	Cost/SF	Total Cost
Flooring Options			
Vinyl Tile Flooring	700	$8.00	$5,600.00
Epoxy Flooring	700	$12.00	$8,400.00
Wood Flooring	700	$20.00	$14,000.00
Ceiling Options			
Painted Gypsum	700	$10.00	$7,000.00
Acoustic Ceiling Tile	700	$13.00	$9,100.00
Trespa Ceiling Panels	700	$55.00	$38,500.00
Basic Wall Options			
Painted Gypsum	1500	$3.00	$4,500.00
Vinyl Wall Covering	1500	$8.00	$12,000.00
Wood Wall Covering	1500	$20.00	$30,000.00
Feature Wall Options			
Painted Gypsum	500	$8.00	$4,000.00
Vinyl Wall Covering	500	$12.00	$6,000.00
Wood Wall Covering	500	$25.00	$12,500.00

Screen capture of Excel schedule.

Materials and Costs

Using preset keys it is possible to change materials in the project and see the costs changes associated with those material changes using preset keys or the handheld controllers. The tablet toggles between the scopes of work and the material costs. As the materials and costs are changed and then uploaded, the total cost will sum at the bottom of the tablet in the green row.

Material costs interactive tablet showing the base cost options.

Material costs interactive tablet showing the premium cost options.

Cost Updates

Changing the unit costs in Excel will calculate and update the total cost for that material as well as the sum of the total cost for that design option. Once refreshed, this will show on the tablet. Below is an example of how changing the cost per sf for the wood wall covering is mathematically and visually represented.

Initial Cost Study

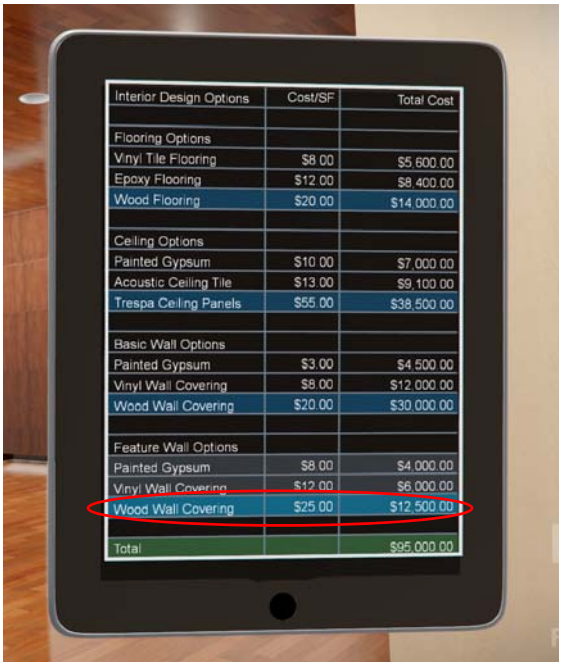
Interior Design Options	Area (SF)	Cost/SF	Total Cost
Feature Wall Options			
Painted Gypsum	500	$8.00	$4,000.00
Vinyl Wall Covering	500	$12.00	$6,000.00
Wood Wall Covering	500	$25.00	$12,500.00

Wood wall covering at a unit rate of $25/sf.

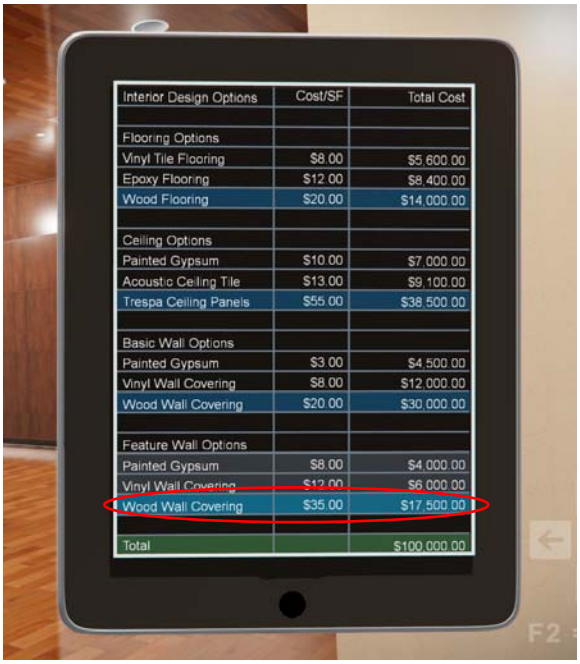
Updated Cost Study

Interior Design Options	Area (SF)	Cost/SF	Total Cost
Feature Wall Options			
Painted Gypsum	500	$8.00	$4,000.00
Vinyl Wall Covering	500	$12.00	$6,000.00
Wood Wall Covering	500	$35.00	$17,500.00

Wood wall covering changed to a unit rate of $35/sf.



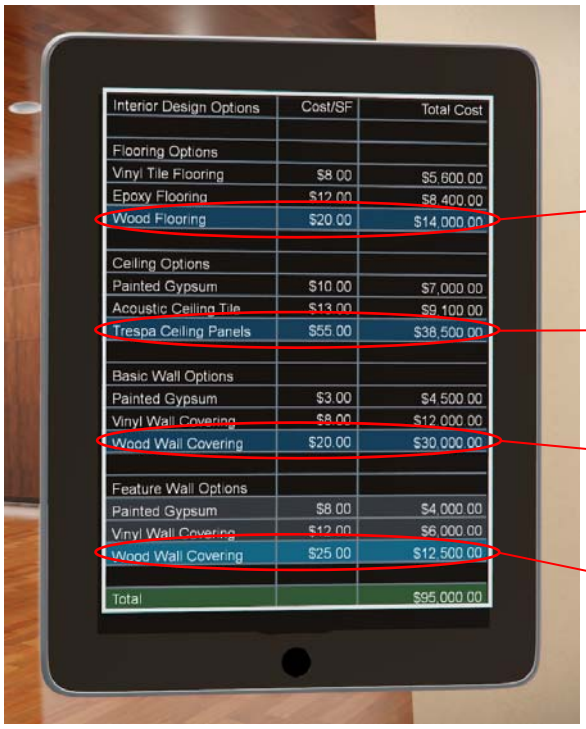
Tablet showing initial price for wood wall covering.



Tablet showing updated price for wood wall covering.

Export Design Options

After design options have been selected in Stingray, it can be exported back out to excel only showing the options that are chosen. Once in excel, the total cost of the final selection are shown as well as the sum of the total costs.



Tablet with final material selection.

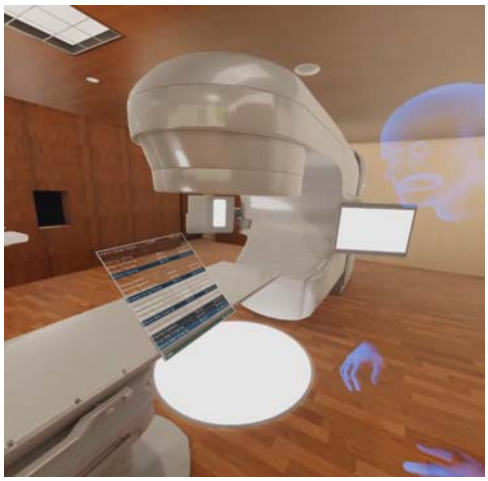
Interior Design Options	Cost/SF	Total Cost
Flooring Options		
Wood Flooring	$20.00	$14,000.00
Ceiling Options		
Trespa Ceiling Panels	$55.00	$38,500.00
Basic Wall Options		
Wood Wall Covering	$20.00	$30,000.00
Feature Wall Options		
Wood Wall Covering	$25.00	$12,500.00
Total		$95,000.00

Excel Schedule with final selection of material with associated costs.

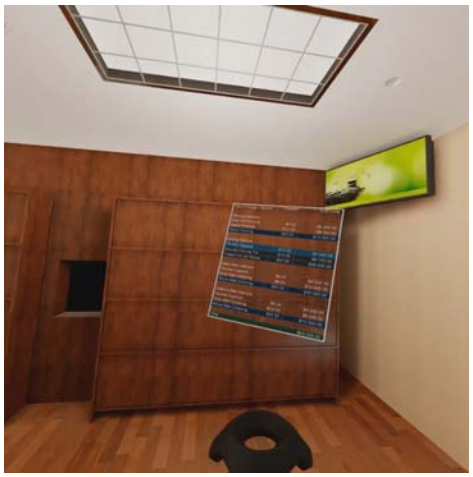
Example – Linear Accelerator VR

Exploration and Interaction – Multiplayer

There are three different viewing options. First is Desktop VR. This is an immersive environment that is viewed through a computer screen without a headset. The second option is the traditional VR headset. The third option is watching one or more users interact in VR on a non-VR computer or screen.



Headset VR: First person view in multiplayer.



Headset VR: First person view in single player.

Lastly, we have multiplayer options in VR. Two or more people can interact in the same virtual environment. Skanska can walk side-by-side with the owner through and explain design options and costs. Skanska can hand the client the tablet and they can change finishes on their own. These two people can be in the same physical room together or in two separate offices in different parts of the country.

Desktop VR: Third party perspective of single and multiplayers in VR

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Example – Big Data

Exploration and Interaction

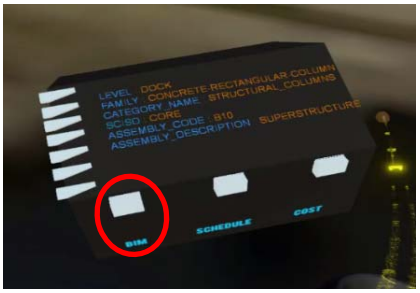
Once the VR session has opened up, there will be three main components (not including the controller). The schedule/cost loaded builiding, wrist viewing menu panel, and schedule wheel. All three are linked to each other, so as filters and dates are selected, changes will show.

Wrist menu panel (top), scheduling wheel (bottom).

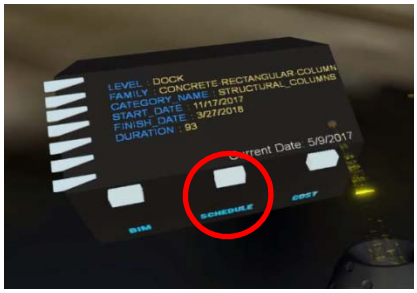
First person view of wrist filtered to curtain walls.

BIM, Schedule, and Cost Data

On the wrist viewing panel, information regarding assembly codes, category names, levels, durations, cost per unit, and total costs are found. The three horizontal tabs are selectable and will rotate to each data sheet, whereas the vertical tabs allow for those categories to be selected or filtered within the model.



Data Sheet 1: BIM Property Data



Data Sheet 2: Schedule View

Data Sheet 3: Cost Data

Scheduling

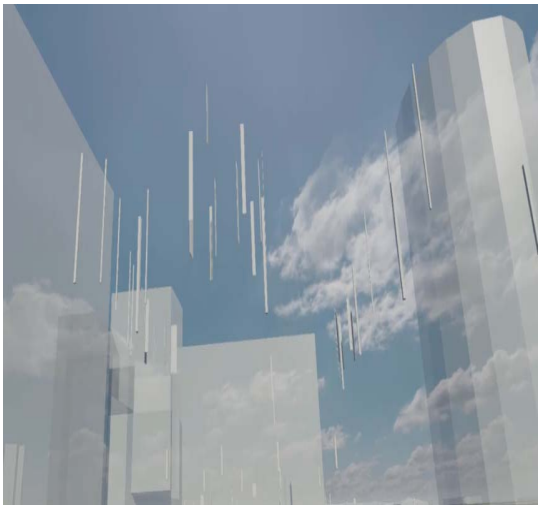
The scheduling wheel provides a visual representation of a calendar, where dates can be specifically selected, the wheel can be turned to show progression, or go into continuous mode. Continuous mode lets the user view the full model growing as the schedule progresses without having to physically turn the wheel.

Wrist schedule showing starting date.

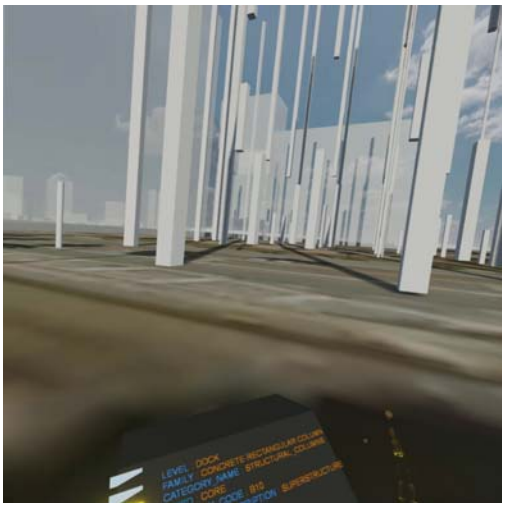
Schedule dates changed by controller.

Schedule progressing in continuous mode.

Schedule by filtered material gives the ability to watch specific materials (i.e. interior materials) grow without the obstructing view of the exterior skin.

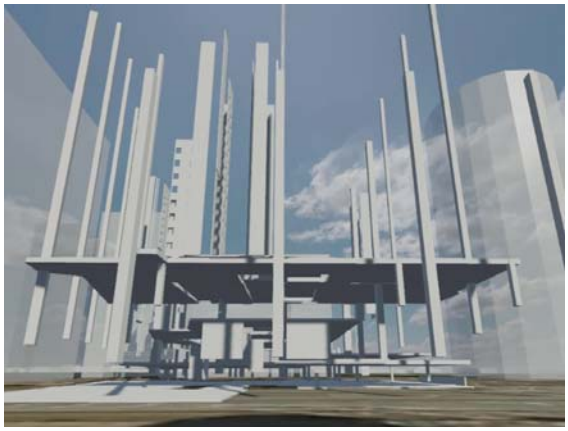


Schedule filtered by structural columns (start date)

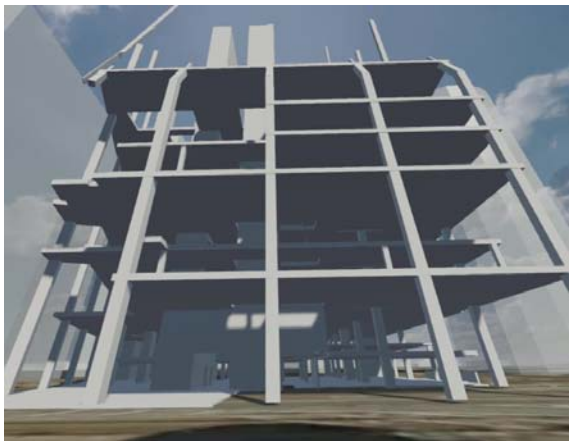


Schedule filtered by structural columns (end date)

As the schedule wheel is turned to the right, the building will grow as it contains the programed schedule dates.



The building starts to grow as the schedule progresses with columns and foundations.

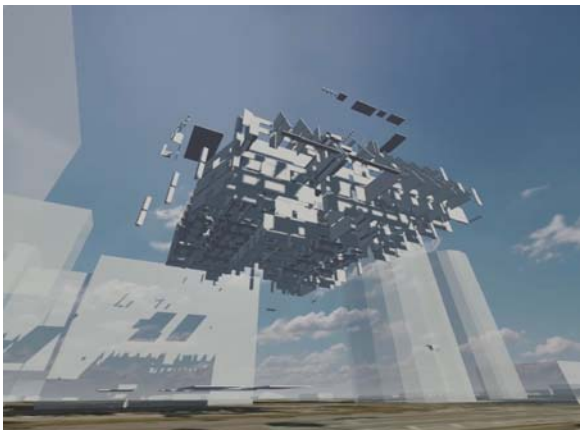


The building continues to grow with floor slabs and shear walls.

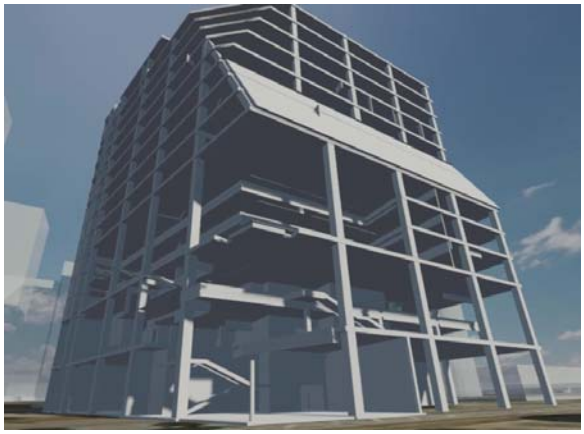
The building grows with exterior curtain wall and precast panels.

Filtering

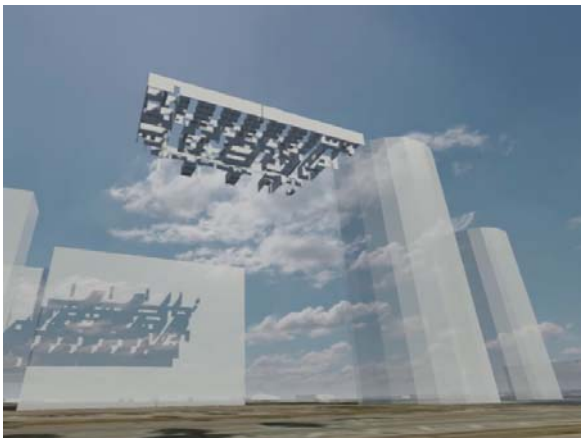
The VR model works well when needing to view specific components of the building such as floors, walls, MEP systems, and exterior skin. Filtering by properties for example can allow the user to view only level four interior walls or the full build out of level six.



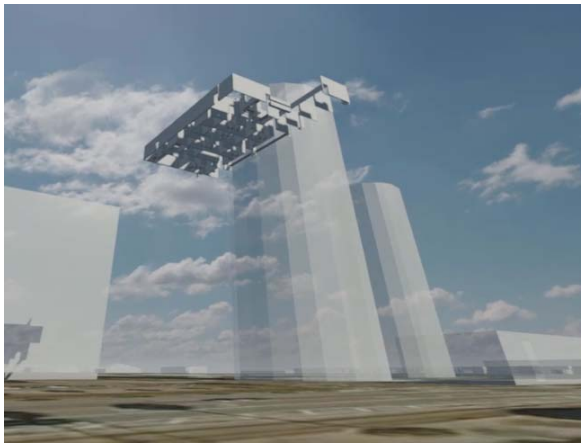
Filtered by all walls on multiple levels



Filtered by structural components



Filtered by interior partions by level



Filtered by walls by level

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How to link an external BIM data source to Stingray

There are multiple data sources that can be linked into Stingray. This tutorial will focus on linking Excel to Stingray.

Format BIM Data Source

First, format BIM data in Excel. This can be done by exporting a Revit schedule to Excel directly from Revit or by using a third-party software. This file can be very simple or very complex. Stingray has the ability to hold massive amounts of data, so whether the BIM information holds a few interior finishes or the entirety of a building, Stingray will run under different conditions.

	Interior Design Options	Area (SF)	Cost/SF	Total Cost
2				
3	Flooring Options			
4	Vinyl Tile Flooring	700	$8.00	$5,600.00
5	Epoxy Flooring	700	$12.00	$8,400.00
6	Wood Flooring	700	$20.00	$14,000.00
7				
8	Ceiling Options			
9	Painted Gypsum	700	$10.00	$7,000.00
10	Acoustic Ceiling Tile	700	$13.00	$9,100.00
11	Trespa Ceiling Panels	700	$55.00	$38,500.00
12				
13	Basic Wall Options			
14	Painted Gypsum	1500	$3.00	$4,500.00
15	Vinyl Wall Covering	1500	$8.00	$12,000.00
16	Wood Wall Covering	1500	$20.00	$30,000.00
17				
18	Feature Wall Options			
19	Painted Gypsum	500	$8.00	$4,000.00
20	Vinyl Wall Covering	500	$12.00	$6,000.00
21	Wood Wall Covering	500	$25.00	$12,500.00
22				
23	Total			$151,600.00

Minimal line item schedule.

1	Category Name	Family	Type	Source	Area
35921	Structural Columns	CIP-Column-Rectangular	28x28	8308627	80
35922	Structural Columns	CIP-Column-Rectangular	28x28	8309724	80
35923	Structural Columns	CIP-Column-Rectangular	28x28	8309736	80
35924	Structural Columns	CIP-Column-Rectangular	28x28	8309748	80
35925	Structural Columns	CIP-Column-Rectangular	28x28	8309822	80
35926	Structural Columns	CIP-Column-Rectangular	28x28	8309952	80
35927	Structural Columns	CIP-Column-Rectangular	28x28	8309966	80
35928	Structural Columns	CIP-Column-Rectangular	28x28	8309982	80
35929	Structural Columns	CIP-Column-Rectangular	28x28	8310240	80
35930	Structural Columns	CIP-Column-Rectangular	28x28	8310247	80
35931	Structural Columns	CIP-Column-Rectangular	28x28	8310253	80
35932	Structural Columns	CIP-Column-Rectangular	28x28	8310259	80
35933	Structural Columns	CIP-Column-Rectangular	28x28	8310265	80
35934	Structural Columns	CIP-Column-Rectangular	28x28	8310717	80
35935	Structural Columns	CIP-Column-Rectangular	28x28	8310777	80
35936	Structural Columns	CIP-Column-Rectangular	28x28	8310787	80
35937	Structural Columns	CIP-Column-Rectangular	28x28	8310797	80
35938	Structural Columns	[illegible]	18x18	10944113	93
35939	Structural Columns	[illegible]	18x18	8138711	49
35940	Structural Columns	[illegible]	18x18	8138713	49
35941	Structural Columns	[illegible]	18x18	8138715	49
35942	Structural Columns	[illegible]	18x18	9322014	49
35943	Structural Columns	[illegible]	18x18	9495719	45
35944	Structural Columns	[illegible]	18x18	9495726	45
35945	Structural Columns	[illegible]	18x18	9495732	45
35946	Structural Columns	[illegible]	18x18	9495738	49
35947	Structural Columns	[illegible]	18x18	9495744	49

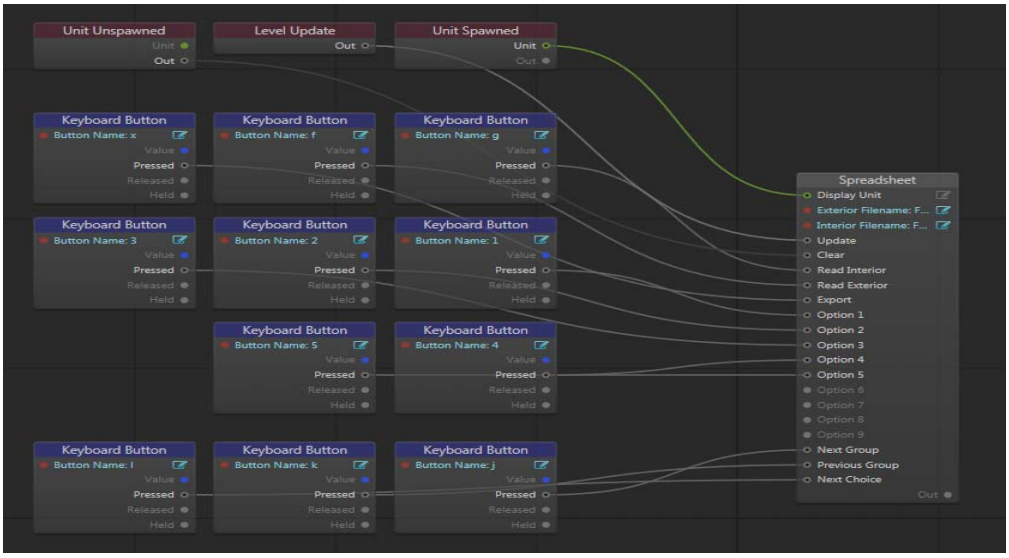
Over 30,000 line item schedule.

Create a Lua Script and Custom Flow Node

It is necessary to create a script in Lua that reads and writes to the Excel file. This Lua script will also create a custom flow node that can be used in the Unit Flow of the cost tablet.

Create Unit Flow

Next, it will be necessary to create a custom flow node. Our custom flow node contains links to two Excel files, Read, Update, Clear, and Export options. It also contains tabs for nine different design options.



Unit flow with custom spreadsheet node

Create a Tablet

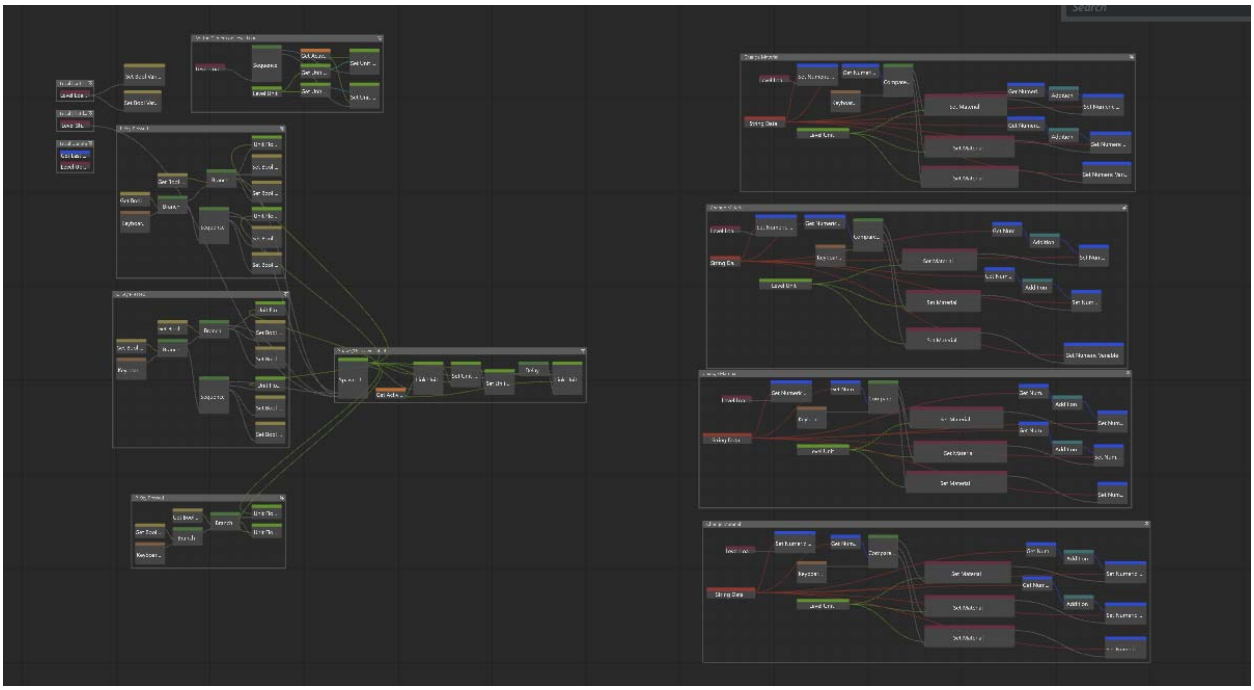
Create a tablet to display the cost. This can be a single plane, a tablet, or even a wrist-mounted device. It is important to keep all of the 3D objects, materials, and textures associated with this display device in the same folder.

Simple tablet or complex on the wrist schedule (either allows for a range of views and property data).

How to use a linked database for visualizing estimates in virtual reality

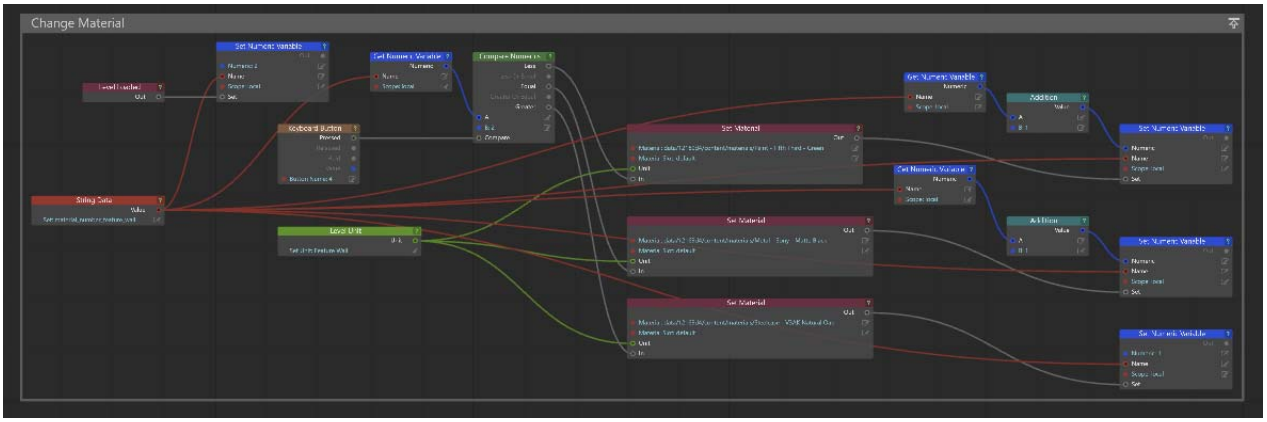
Create a Level Flow

Create a Level Flow that links the materials with the cost updates. Using the same buttons in the Level Flow and the Unit Flow ensures that the costs and materials will update at the same time. This Level Flow includes flow for the materials, tablet, and a tablet refresh.



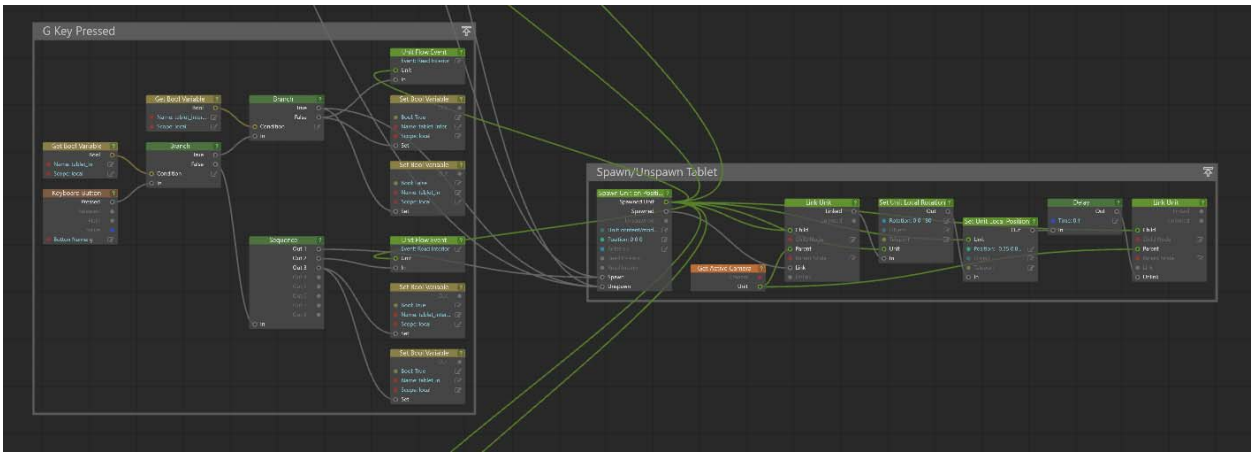
Create a Level Flow for Materials

Creating a Level Flow is necessary to change the materials on the different design options. This example cycles through three different materials.



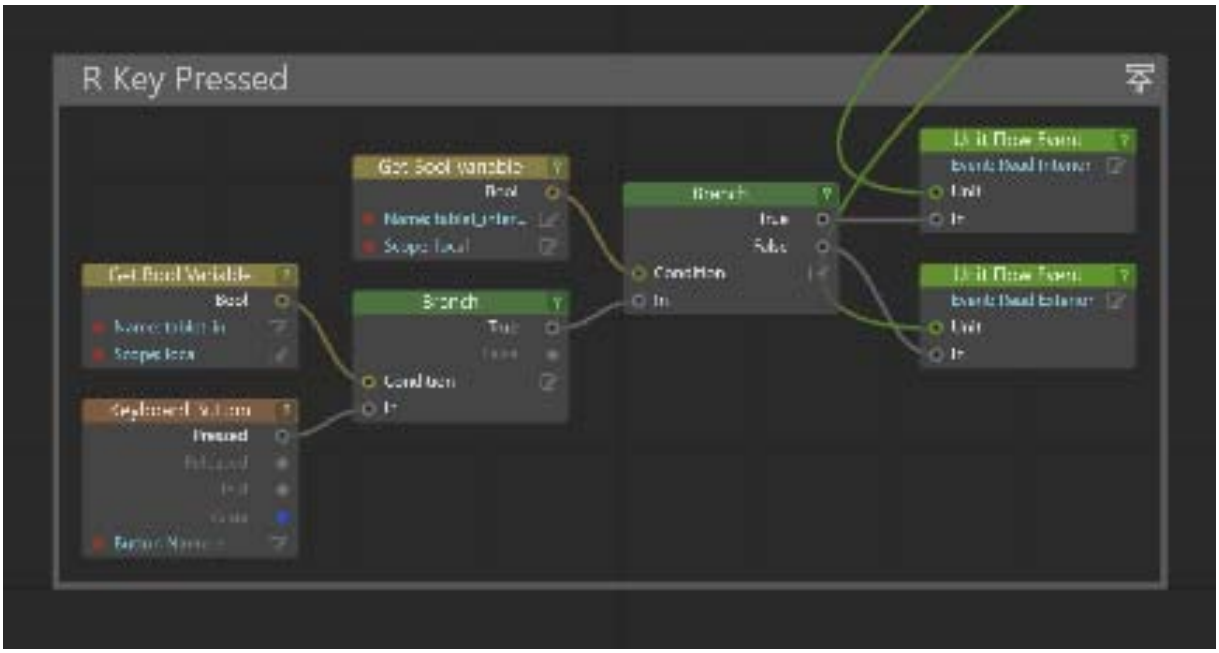
Create a Level Flow for the Tablet Model

It is also necessary to create a Level Flow for the cost tablet. In this example there is a flow for spawning and unspawning the tablet and for activating the cost data on the tablet.



Create a Refresh Level Flow

This Level Flow also includes a refresh button. If information is updated in Excel, it will be updated in Stingray using the refresh button.



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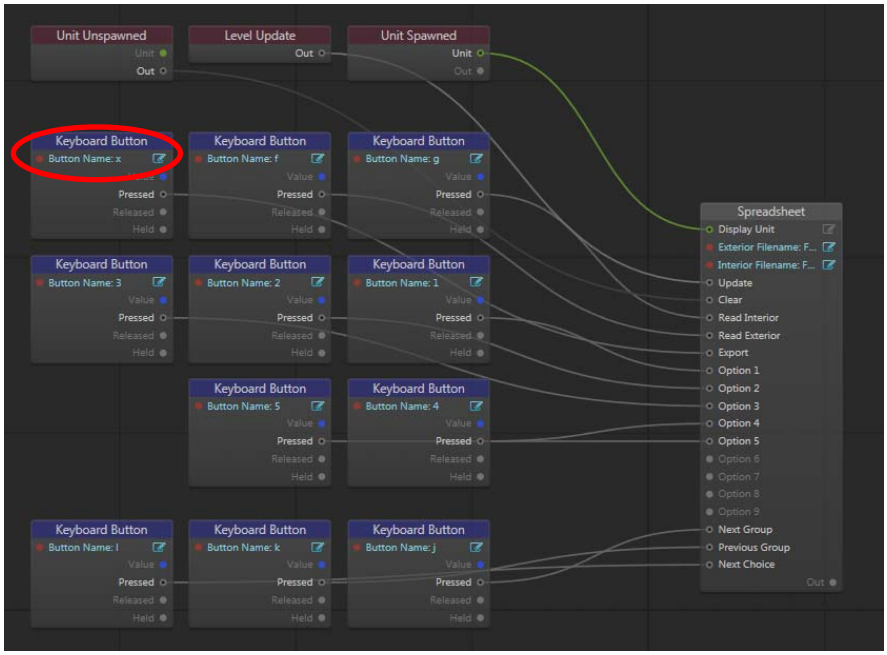
Export information from Stingray to an External Data Source

Create a Lua Script and Custom Flow Node

The previously created Lua Script and Custom Flow Node read and write to the Excel file. The Export option is activated by pressing X in the Unit Flow. This function is only designed to export the selected option. Variations of these export options are possible through editing the Lua script.



Unit Flow showing where the keyboard button x is located.

Interior Design Options	Cost/SF	Total Cost
Flooring Options		
Wood Flooring	$20.00	$14,000.00
Ceiling Options		
Trespa Ceiling Panels	$55.00	$38,500.00
Basic Wall Options		
Wood Wall Covering	$20.00	$30,000.00
Feature Wall Options		
Wood Wall Covering	$25.00	$12,500.00
Total		$95,000.00

Result of pressing x in the Unit Flow.

How to use a linked database for visualizing schedules in virtual reality

The processing for linking a data source for scheduling is very similar to the process for linking a data source for estimating. This tutorial will focus on linking Excel to Stingray.

Format BIM Data Source

First, format schedule data in Excel. This can be done by in the same Excel file as the estimating data. This example contains start date, end date, and duration.

Format of VR data displayed on wrist viewer.

Category Name	Family	Lev	Start Dat	Finish Da	Duration
Structural Columns	Concrete-Rectangular-Column	Dock	2/20/2018	3/20/2018	20
Structural Columns	Concrete-Rectangular-Column	Dock	11/17/2017	3/27/2018	93
Structural Columns	Concrete-Rectangular-Column	Dock	11/17/2017	3/27/2018	93
Structural Columns	Concrete-Rectangular-Column	Dock	11/17/2017	3/27/2018	93
Structural Columns	Concrete-Rectangular-Column	Dock	11/17/2017	3/27/2018	93
Structural Columns	Concrete-Rectangular-Column	Dock	11/17/2017	3/27/2018	93
Structural Columns	Concrete-Rectangular-Column	Dock	11/17/2017	3/27/2018	93
Structural Columns	Concrete-Rectangular-Column	Dock	11/17/2017	3/27/2018	93
Structural Columns	Concrete-Rectangular-Column	Dock	11/17/2017	3/27/2018	93
Structural Columns	Concrete-Rectangular-Column	Dock	5/20/2018	6/26/2018	27
Structural Columns	Concrete-Rectangular-Column	Dock	5/20/2018	6/26/2018	27
Structural Columns	Concrete-Rectangular-Column	Dock	7/15/2018	7/24/2018	7
Structural Columns	Concrete-Rectangular-Column	Dock	7/15/2018	7/24/2018	7
Structural Columns	Concrete-Rectangular-Column	Dock	7/15/2018	7/24/2018	7
Structural Columns	Concrete-Rectangular-Column	Dock	5/20/2018	6/26/2018	27
Structural Columns	Concrete-Rectangular-Column	Dock	5/20/2018	6/26/2018	27
Structural Columns	Concrete-Rectangular-Column	Dock	2/20/2018	3/20/2018	20
Structural Columns	Concrete-Rectangular-Column	Dock	5/20/2018	6/26/2018	27
Structural Columns	Concrete-Rectangular-Column	Dock	5/20/2018	6/26/2018	27

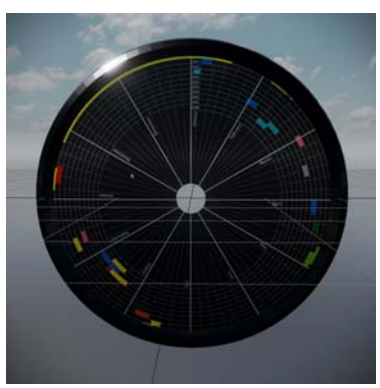
Data displayed in Excel.

Create a Lua Script and Custom Flow Node

It is necessary to create a script in Lua that reads the Excel file. This Lua script will then parse the dates. The dates are reordered by Year, Month, Day. This Lua script matches the Revit ID in the Excel file to the corresponding 3D object in Stingray.

Create a Schedule Display

Create a display for the schedule. This example uses a wheel. The schedule could be a slider, arc, or circle. It is important to keep all of the 3D objects, materials, and textures associated with this display device in the same folder.



VR Schedule Wheel.

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Benefits

Time and Cost Savings

Benefits include increased owner involvement, cost, and time savings. Time savings are achieved through a streamlined workflow, which bypasses traditional rendering software, and results in high quality projects being created in a short amount of time. This workflow can result in projects being produced in a shorter amount of the time as compared to traditional rendering methods. Cost savings are directly associated with these time savings.

Additional Outputs

In addition to traditional rendering and videos, real-time rendering provides the additional output of 3D immersive environments. These virtual reality environments enhances the client experience by allowing them to visualize their project. It also allows for client greater input during the early design phases of the project and enables them to make real-time design decision. This benefits all parties involved.

Client Involvement

Additional outputs lead to increased client, designer, and contractor involvement. Using Stingray, it is possible to explore and interact with a 3D model, providing a better understanding of the project. Decreased time and effort to produce high quality projects can also result in a greater number of design options. This results in a stronger project overall and benefits all parties involved.

The benefits of using gaming in construction include increasing owner involvement, reducing the time and effort it takes to produce an attractive proposal, and facilitating bidding on smaller projects with a quality offering only affordable by larger projects today. Visualizations in the Stingray game engine ultimately lead to winning more work