AUTODESK. UNIVERSITY

CS226303

# Dynamo for Preconstruction: Data Management for Preconstruction Workflows

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## Learning Objectives

- Learn the importance of model-based estimating workflows
- Discover key drivers to success in model-based estimating workflows
- Discover advantages offered from robust model-based estimating workflows
- Learn how to capitalize on existing data in 3D models

## Description

In this material, Skanska USA Building will share one of its approaches to preconstruction workflows on model-based estimating and the benefits of BIM (Building Information Modeling) Data management. We will present case studies on the tools and workflows for data management utilizing Dynamo, Revit and Microsoft Excel. We will focus on describing the workflows for conceptual and schematic design.

## Speaker(s)

**Alvaro Colato** currently work as the Sr. Preconstruction Technology Specialist at Skanska USA building in the greater DC Metro area. As a member of the PPS “Preconstruction Planning Services”, Alvaro is tasked with cost estimating, constructability reviews and value management. At Skanska, Alvaro supports the use and implementation of BIM at the preconstruction phase along with providing training and solutions at a national level. This process includes data management, 3D modeling, AR/VR and tool building for automation through open APIs. Prior to joining Skanska, Alvaro worked in IT, Architecture and the Service Industry. Alvaro graduated from the Catholic University of America of Washington DC with a degree in Architectural Science and has professional certificates from the University of Washington in BIM and from Darden Business School at University of Virginia in Design Thinking.

**Jesse Nelson** is a Civil Engineer working for Skanska USA Building as a Preconstruction Engineer as well as a Cost Engineer on jobsites. In Preconstruction, Jesse is tasked with cost estimating, quantity takeoffs and data management to deliver estimates for Skanska’s clients. Prior to Skanska, Jesse worked abroad in the Oil and Gas sector building the largest Laboratory in South American and infrastructure for the 2016 Olympic Games in Rio de Janeiro. Jesse

graduated from Virginia Tech in 2009 and recently earned his executive MBA with a focus in finance from IBMEC (Brazil).

### Introduction

- What is Dynamo
- How does Dynamo work
- How is Dynamo used to manage data

### Importance of Model-Based estimating workflows

- Faster pricing turnaround
- Common language between designers and contractors
- Visualization (Constructability Reviews, Logistics and Scheduling)

### Example – Virginia Hospital MOB Finish Schedule

- Stablish Objectives
- Gathering Information
    - Narrative
    - Drawings
    - 3D Models
    - Benchmarks, Precedents and Subcontractors' input
- Populate Room Schedule in Excel
- Assess 3D models and identify opportunities for data management (If provided)
- Create 3D model (If not provided)
- Transfer data from Excel to Revit using Dynamo
- Export data from Dynamo to Excel using Dynamo

### Example - Structure (Concrete Frame)

- Stablish Objectives
- Gather Information
    - Narrative
    - Design Requirements
    - Drawings
    - 3D Models
    - Benchmarks, Precedents and Subcontractors' input
- Asses 3D model and identify opportunities for data gathering (If provided)
- Create 3D models (If not provided)
- Export data out to Excel with Dynamo

### Benefits

- Standardization
- Automation
- Centralized data base
- Dynamic and Interactive
- Early constructability and logistic analysis

# Introduction

## What is Dynamo?

“A visual programming tool that aims to be accessible to both non-programmers and programmers alike. It gives the ability to visually script behavior, define custom pieces of logic, and script using various textual programming languages.”

In other words, Dynamo provides users with the tools to model complex geometry and mange Revit element behaviors and its data.

## How does Dynamo work?

Dynamo connects to the Revit API allowing users to create custom tools and unlocking the power of computational design when working with complex geometrical shapes.

## How is Dynamo used to manage data?

Dynamo’s library contains pre-built nodes that allows users to set and/or change element parameters. This data can be easily modified and exported to other platforms.

# Importance of Model-Based estimating workflows

## Faster Pricing Turnaround

The ability to manage data within a 3D model enables us to quantify surfaces and materials faster and more accurately compared to traditional software used for quantity takeoffs.  By using this Approach, we have the ability to create estimates accurately and in a fraction of the time typically required.

## Common Language between Designers and Contractors

3D models enable contractors to clearly understand the design intent and provides the client the opportunity to view and set expectations for the project.

## Visualization (Constructability Reviews, Logistics and Scheduling)

3D Models are also used to visualize space, scope, site logistics, construction sequencing and perform constructability reviews.

# Case Study A

- **The Virginia Hospital Medical Office Building, 95% Schematic Design Level of Development.**

## Interior Finishes

○ Identify what is provided in the RFP (request for proposal) or by the Design team. In the case of the Virginia Hospital, at Schematic Design Level, the following items were provided in the RFP.

○ Narrative sample provided by the design team to be used as a guide to determine interior finishes.

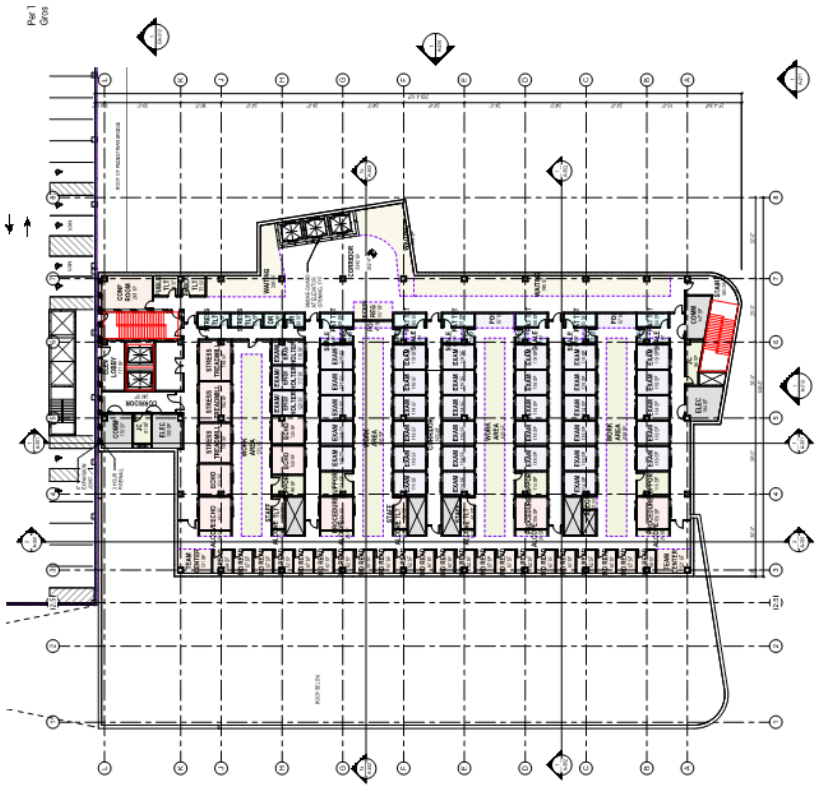
Room Name: **Departmental Waiting and Reception**

| | |
|---|---|
| Floors: | Carpet tile at seating areas equal to Shaw Contract Group, "Park Collection". |
| Walls: | Low VOC latex eggshell paint, with up to two accent colors. Thermoset rubber cove base equal to Johnsonite, "Baseworks". Low VOC latex paint, eggshell finish equal to Sherwin Williams, "Harmony". Natural stone tile accents equal to Crossville, "Yin+Yang". |
| Ceilings: | Dropped gypsum soffit/bulkheads with square lay-in acoustical ceiling tile with NRC of .95 equal to Armstrong, "Optima Open Plan 3252PB". |
| Casework: | Wood laminate vertical surface and solid surface. Decorative resin accent. Stainless steel toe kicks. Worksurface and transaction counter to be solid surface. |
| Lighting: | Semi-recessed LED circular diffuse lensed downlight with 0-10V dimming above reception desk, recessed linear LED 1'x4' fixture with 0-10V dimming for area lighting behind reception desk, and reception desk integrated LED task lighting at counter and casework. |

Specialty Items or Features:

- Etched glass and gypsum board divider walls.
- Specialty lighting as required to support the interior architectural design.

○ Schematic design drawings provided by the design team. This sample shows a typical layout floor plan. In this case, the drawing set was in PDF format and used as reference to build an in-house 3D Model (Revit)

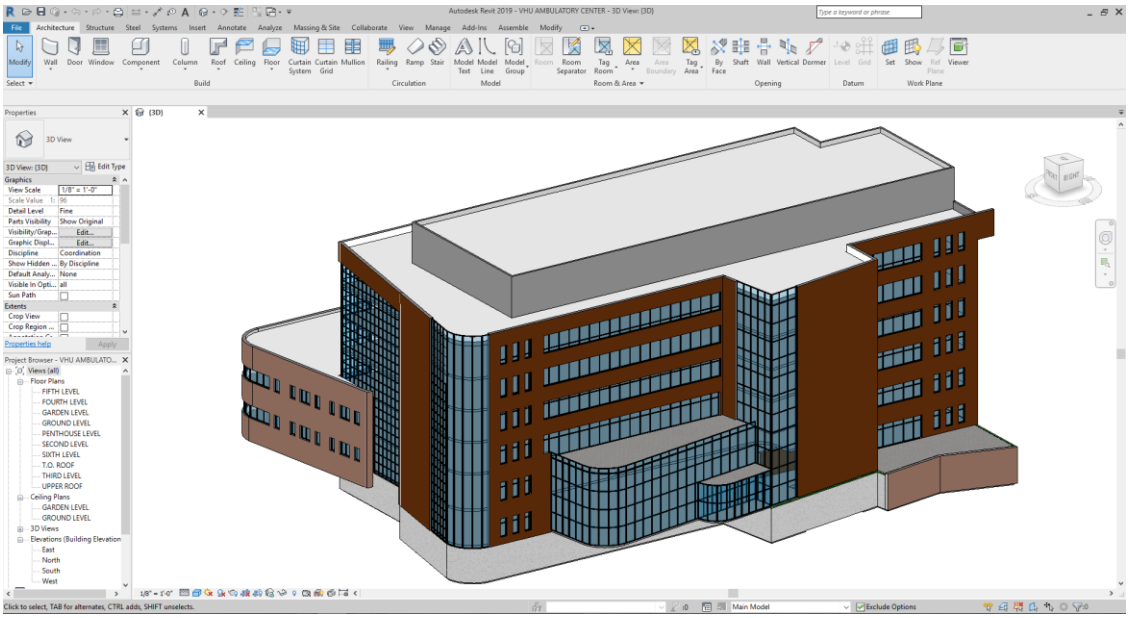


- A door schedule was provided in pdf format. In order to maintain consistency in the document set, we extracted this pdf to excel and as a result we ended up with a spreadsheet with consistent room identification.

**DOOR AND FRAME SCHEDULE - THIRD FLOOR**

| IDENTIFICATION | | | | DIMENSIONS | | | | | PANEL | | | | FRAME | | | | HARDWARE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | WIDTH | | | | | | | | | | | | | | |
| LEVEL | ROOM NO. | ROOM NAME | DOOR NO. | W1 | W2 | TOTAL WIDTH | H | T | TYPE | MATERIAL | FINISH | GLAZING | FRAME TYPE | FRAME MATERIAL | FINISH | FIRE RATING | GROUP | NOTES |
| 3RD FLOOR | | | D3006 | 4' - 6" | | | 8' - 0" | 0' - 1" | | | | | | | | | | |
| 3RD FLOOR | | | D3006 | 4' - 6" | | | 8' - 0" | 0' - 1" | | | | | | | | | | |
| 3RD FLOOR | | | D3152 | 8' - 1" | | | 8' - 1" | 0' - 2" | | | | | | | | | | |
| 3RD FLOOR | | | D3ST01A | 3' - 0" | | | 7' - 0" | 0' - 2" | F | HM | PNT | | 1 | HM | PNT | 180 | | |
| 3RD FLOOR | D3ST01 | STAIR | DST01 | 3' - 0" | | | 7' - 0" | 0' - 2" | F | HM | PNT | | 1 | HM | PNT | 180 | | |
| 3RD FLOOR | D3ST01 | STAIR | D3ST01B | 3' - 0" | | | 7' - 0" | 0' - 2" | N | WD | ST | C8 | 1 | HM | PNT | 90 | | |
| 3RD FLOOR | D3ST01 | STAIR | D3ST01 | 3' - 0" | | | 7' - 0" | 0' - 2" | N | WD | ST | <By Category> | 1 | HM | PNT | 0 | | |
| 3RD FLOOR | D3ST02 | STAIR | D3ST02 | 3' - 8" | | | 8' - 0" | 0' - 2" | N | WD | ST | C8 | 1 | HM | PNT | 90 | | HO |
| 3RD FLOOR | D3002 | JC | D3002 | 3' - 0" | | | 7' - 0" | 0' - 2" | F | WD | ST | | 1 | HM | PNT | | | |
| 3RD FLOOR | D3003 | COMM | D3003 | 3' - 0" | | | 7' - 0" | 0' - 2" | F | WD | ST | | 1 | HM | PNT | | | |
| 3RD FLOOR | D3005 | CORRIDOR | D3001 | 3' - 0" | | | 7' - 0" | 0' - 2" | F | WD | ST | | 1 | HM | PNT | | | |
| 3RD FLOOR | D3005 | CORRIDOR | D3005 | 3' - 0" | 3' - 0" | 6' - 0" | 7' - 0" | 0' - 2" | N | WD | IMP | Glass | 2 | HM | PNT | | | |
| 3RD FLOOR | D3006 | ELEV LOBBY | D3006 | 3' - 0" | | | 7' - 0" | 0' - 2" | F | HM | PNT | | 1 | HM | PNT | 180 | | |
| 3RD FLOOR | D3007 | ELEV LOBBY | D3007 | 3' - 0" | 3' - 0" | 6' - 0" | 7' - 0" | 0' - 2" | | WD | ST | Glass | 1 | HM | PNT | | | |
| 3RD FLOOR | D3011 | CONF ROOM | D3011 | 3' - 0" | | | 7' - 0" | 0' - 2" | F | WD | ST | | 1 | HM | PNT | | | |
| 3RD FLOOR | D3012 | PUB TLT | D3012 | 3' - 0" | | | 7' - 0" | 0' - 2" | F | WD | ST | | 1 | HM | PNT | | | |
| 3RD FLOOR | D3013 | PUB TLT | D3013 | 3' - 0" | | | 7' - 0" | 0' - 2" | F | WD | ST | | 1 | HM | PNT | | | |
| 3RD FLOOR | D3014 | RECEP/ REG | D3014 | 3' - 0" | | | 7' - 0" | 0' - 2" | F | WD | ST | | 1 | HM | PNT | | | |
| 3RD FLOOR | D3015 | CORRIDOR | D3100 | 3' - 0" | | | 7' - 0" | 0' - 2" | F | WD | ST | 0850-window-glazing | 7 | HM | PNT | | | AO, CR |
| 3RD FLOOR | D3025 | LOBBY | D3025 | 4' - 0" | | | 8' - 0" | | | | | | | | | | | |
| 3RD FLOOR | D3025 | LOBBY | D3025 | 4' - 0" | | | 8' - 0" | | | | | | | | | | | |
| 3RD FLOOR | D3025 | LOBBY | D3025 | 4' - 0" | | | 8' - 0" | | | | | | | | | | | |
| 3RD FLOOR | D3025 | LOBBY | D3300A | 3' - 0" | | | 7' - 0" | 0' - 2" | AG1 | - | ST | 0850-window-glazing | 7 | HM | PNT | | | AO, CR |
| 3RD FLOOR | D3025 | LOBBY | D3220 | 3' - 0" | | | 7' - 0" | 0' - 2" | AG1 | - | ST | 0850-window-glazing | 7 | HM | PNT | | | |
| 3RD FLOOR | D3025 | LOBBY | D3130 | 3' - 0" | | | 7' - 0" | 0' - 2" | AG1 | - | ST | 0850-window-glazing | 7 | HM | PNT | | | |
| 3RD FLOOR | D3025 | LOBBY | D3440A | 3' - 0" | | | 7' - 0" | 0' - 2" | AG1 | - | ST | 0850-window-glazing | 7 | HM | PNT | | | AO, CR |
| 3RD FLOOR | D3025 | LOBBY | D3400A | 3' - 0" | | | 7' - 0" | 0' - 2" | AG1 | - | ST | 0850-window-glazing | 7 | HM | PNT | | | AO, CR |
| 3RD FLOOR | D3025 | LOBBY | D3200A | 3' - 0" | | | 7' - 0" | 0' - 2" | AG1 | - | ST | 0850-window-glazing | 7 | HM | PNT | | | AO, CR |
| 3RD FLOOR | D3025 | LOBBY | D3429A | 3' - 6 1/2" | | | 7' - 0" | 0' - 4 1/2" | BS1 | WD | ST | | | ALUM | Clear Anodized | | | |
| 3RD FLOOR | D3025 | LOBBY | D3329A | 3' - 6 1/2" | | | 7' - 0" | 0' - 4 1/2" | BS1 | WD | ST | | | ALUM | Clear Anodized | | | |

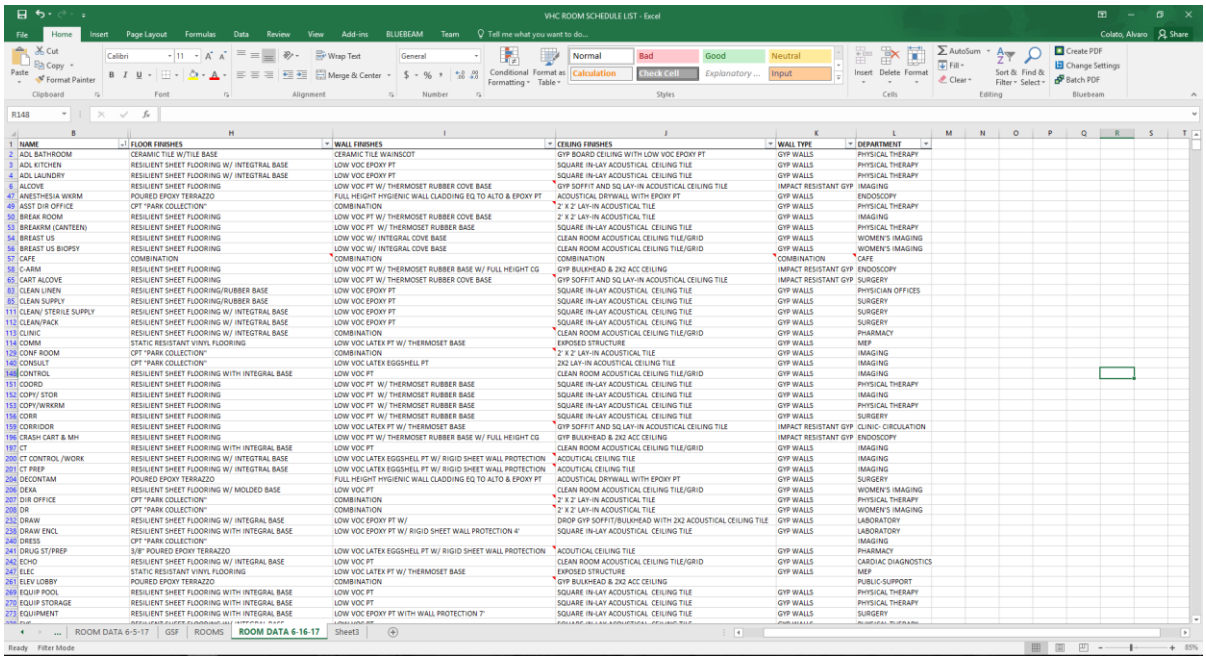
2. Skanska's 3D Model (Revit).
   *A Sketch up model was provided by the design team as visual reference only.



3. Benchmarking – An in-depth study was done to compare similar projects, systems (MEP, Structures, Building Envelope and Interior Finishes)

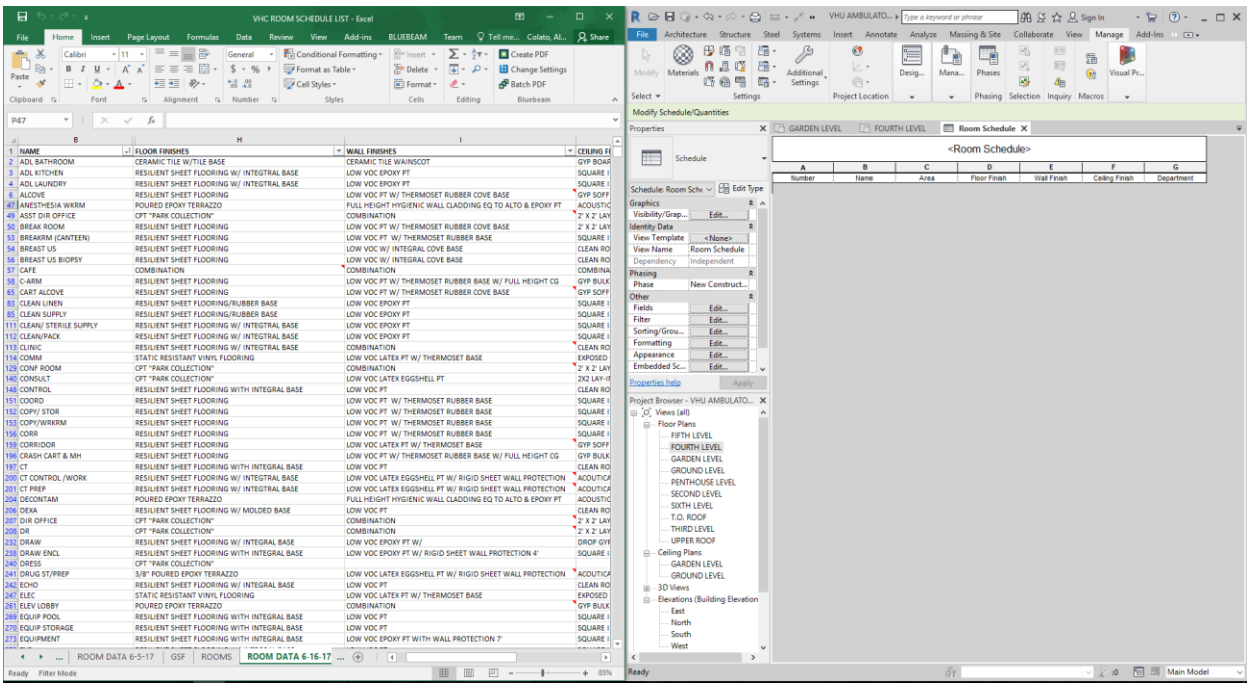
| Benchmark Study<br>**Virginia Hospital Center - Ambulatory Care Center** | SKANSKA<br>**Program Description**<br>200,000 SF **200,000 SF ACC in Virginia**<br>$ 305 /SF **Adjusted PV Cost/SF per below averages**<br>$ 382 /SF **Adjusted PV Cost/SF WITH location adjustment per below averages**<br>$ 76,300,531 **Anticipated construction cost range (SF provided x Adj. PV cost with location adjustment)** 2.0% Annual Inflation Rate | | | | | | **Industry study for peer institutions having built similar programs within the past 3 years. An asteric denotes a Skanska built project.** |
|---|---|---|---|---|---|---|---|
| **Peer *Ambulatory Care Center* Projects** |  | | | | | | |
| **Project** | **PROJECT A** | **PROJECT B** | **PROJECT C** | **PROJECT D** | **PROJECT E** | **PROJECT F** | **Averages** |
| **Location** | Sylvania, OH | Philadelphia, PA | Jacksonville, FL | Oaklawn, IL | King of Prussia, PA | Richmond, VA | |
| **Designer** | | | | | | | |
| **Year Completed** | 2015 | 2014 | 2015 | 2014 | 2015 | 2016 | |
| **SF** | 230,000 | 357,251 | 210,000 | 330,000 | 145,000 | 640,000 | 254,450 |
| **Construction Cost** | $50,000,000 | $62,500,000 | $60,000,000 | $108,000,000 | $65,000,000 | $ 200,000,000 | $ 69,100,000 |
| **Cost / SF** | $ 217 | $ 175 | $ 286 | $ 327 | $ 448 | $ 313 | $ 291 |
| **PV (to 2017) Construction Cost** | $ 52,020,000 | $ 66,325,500 | $ 62,424,000 | $ 114,610,464 | $ 67,626,000 | $ 204,000,000 | $ 72,601,193 |
| **PV (to 2017) Cost / SF** | $ 226 | $ 186 | $ 297 | $ 347 | $ 466 | $ 338 | $ 305 |
| **Location Factor (Adjustment)** | 1.38 | 1.15 | 1.54 | 1.11 | 1.15 | 1.00 | 1.27 |
| ***Adjusted* PV Cost** | $ 72,307,800 | $ 76,274,325 | $ 96,132,960 | $ 127,217,615 | $ 77,769,900 | $ 204,000,000 | $ 89,940,520 |
| ***Adjusted* PV Cost / SF** | $ 314 | $ 214 | $ 458 | $ 386 | $ 536 | $ 338 | $ 382 |
| **Notes** | 4-story facility enhances new care models for the outpatient setting. Interconnecting 23 clinic modules around a spacious central atrium. Design results include; connectivity, expansive use of light and flexibility. | 13-story multi-specialty center. Building houses; clinical, research and office space. Multi-story glass atrium. Use of "super- graphics" to assist with way finding. | 6-story multispecialty ACC designed to provide "value" to both clinicians and patients. Full service D&T facility with offices. Flexibility with "boundaryless" departments. Incorporates new technology. | 9-story LEED Gold facility enhances new care models for the outpatient setting. Collaboration and efficiency based project. Building sets new direction and model of care for campus. | 3-story facility enhances new care models for the outpatient setting. Design based on operational efficiency, enhanced value and a healing environment. | Multi-story ACC dedicated to multidisciplinary care model. Exam, surgery, procedure and radiology space in program (full D&T). Includes space for future retail, connectivity to nature and abundent use of natural light. | **Project costs could be expected to be in the mid to high $300/SF range** - pending program scope, SF efficiencies and level of selected finishes. |

4. Using the extracted Spreadsheet and the provided interior finish narrative, we came up with the room and finish schedule below.



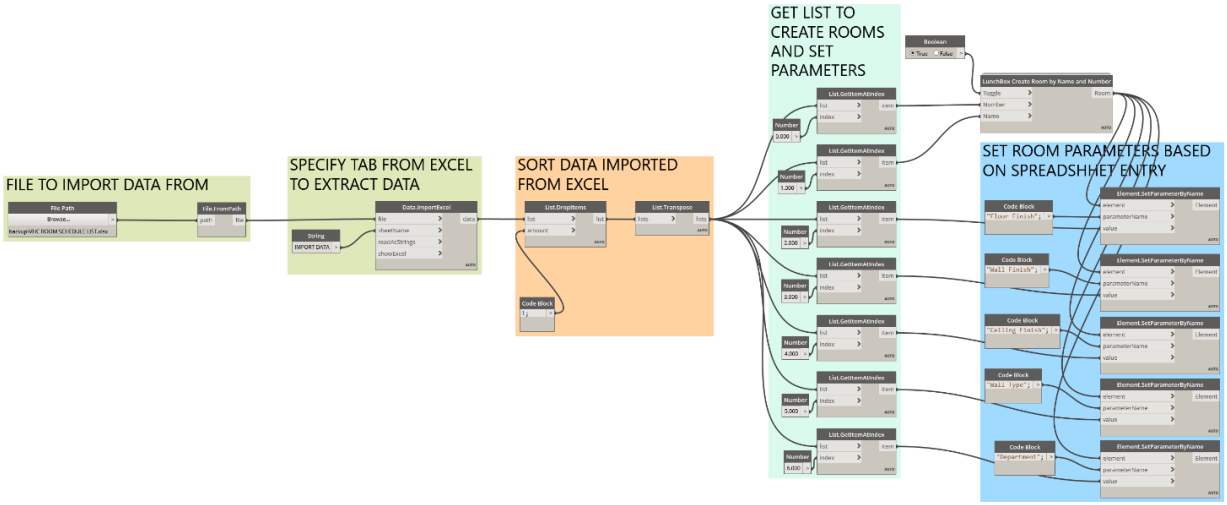
5. The Revit Room tool has the capability to work as a parametric quantity take-off tool, utilizing the room boundaries Areas, Perimeter, Top offset, Volume, Finishes, etc.

    - Create a room schedule in Revit using the same column layout as the finish schedule created in excel and run the Dynamo Script.

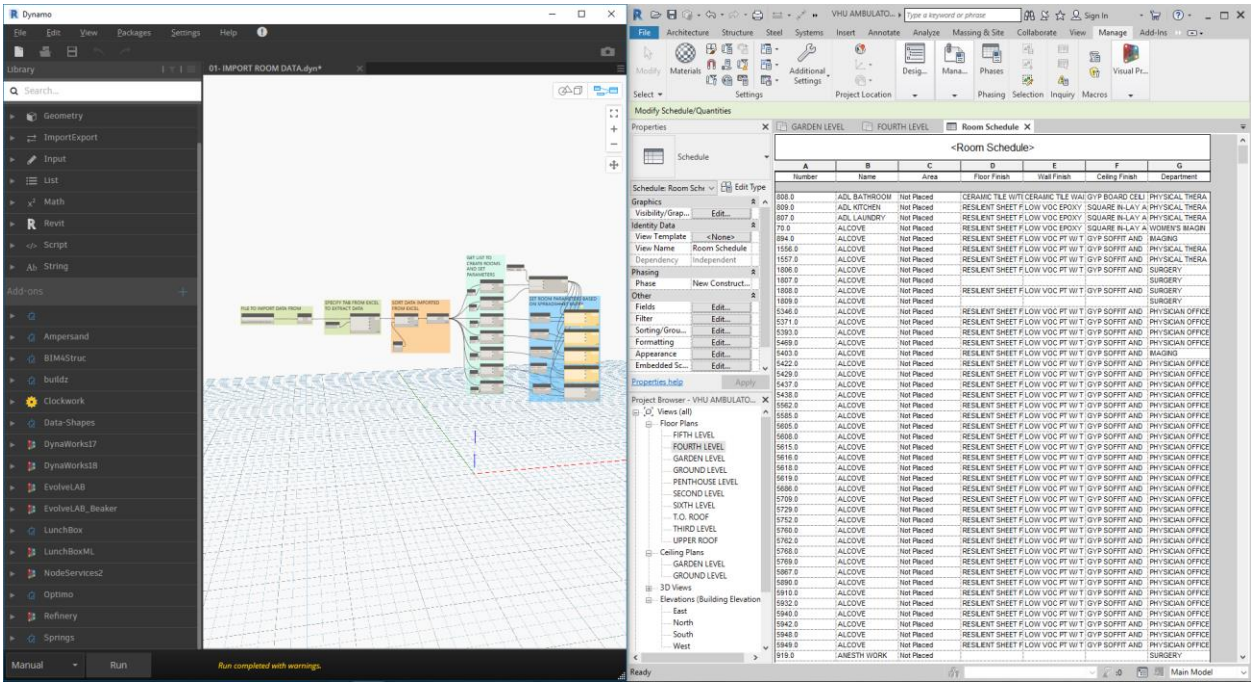


6. The Room Schedule and parameters can be populated into Revit using Dynamo script (provided with the handout).

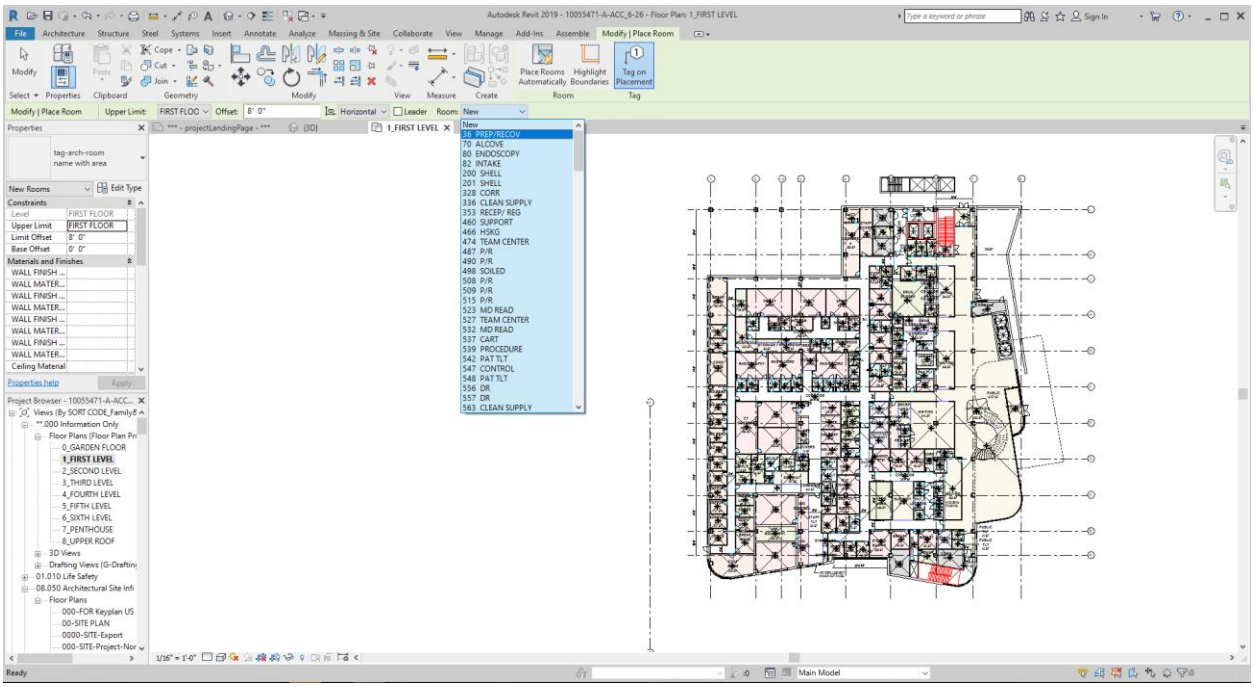
- The image below shows a simple approach to import data from Excel into Revit.



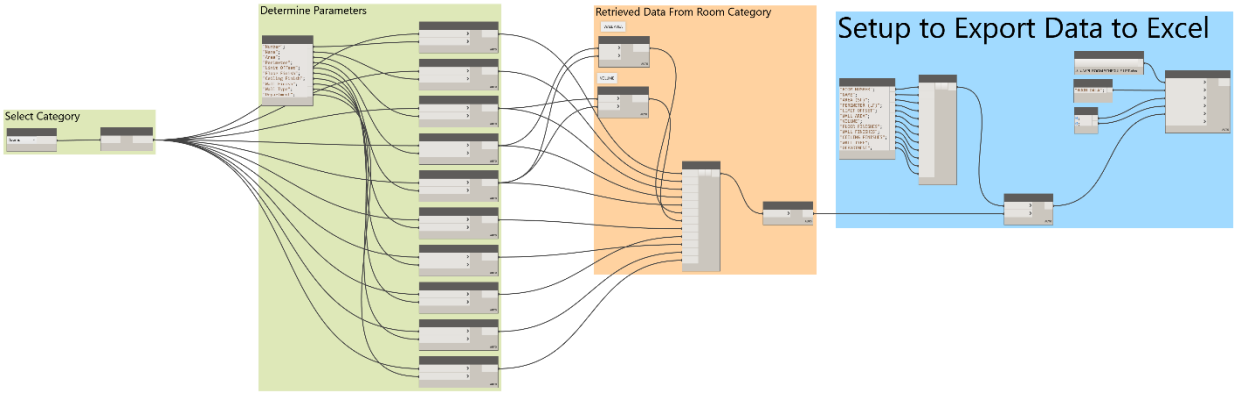

7. The data imported from the spreadsheet is now available in Revit and can now be applied to the rooms.



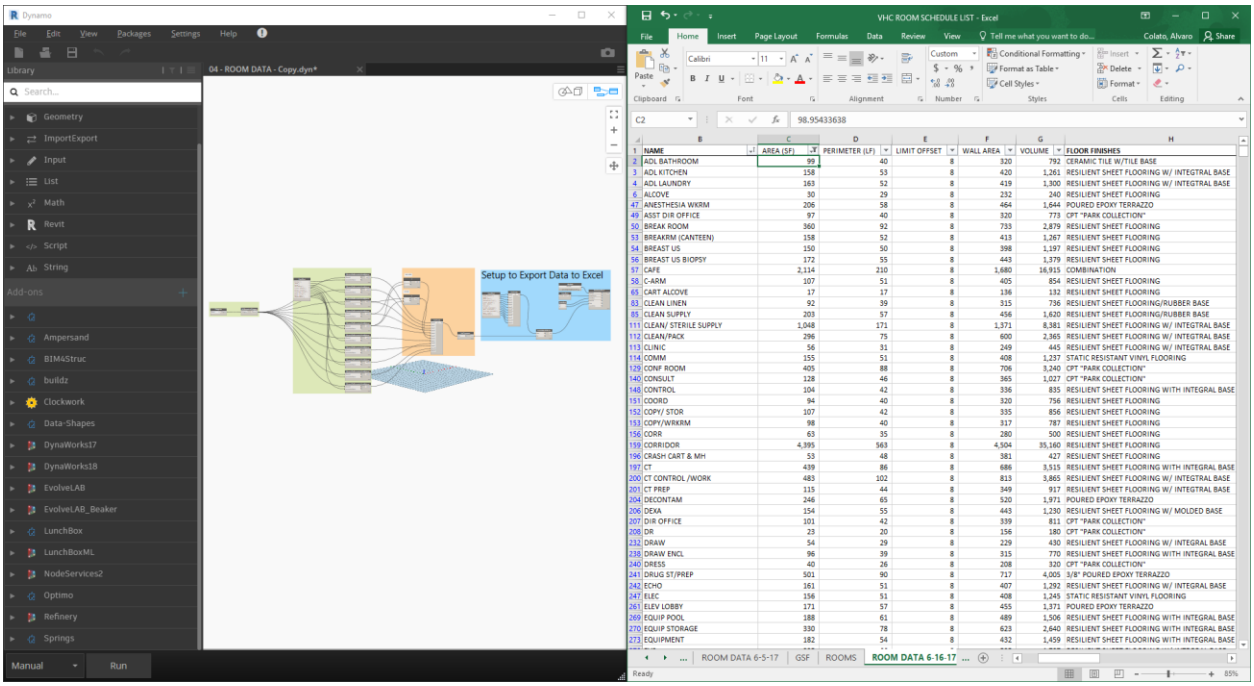
8. Find rooms in the Dropdown Menu and place them accordingly.



9. Use the following Dynamo script to export the data from Revit to Excel (provided with the handout).




10. Once all rooms have been placed, the data can be exported out and made readily available for manipulation through tables and filter.




# Case Study B

## ➢ Structural Concrete Takeoff (Conceptual)

This approach takes advantage of the parametric nature of Revit. Data can be exported into an excel template where the calculations can be done with more flexibility instead of cost loading families into a Revit Model.

1. Stablishing Objectives.
   - Concrete Frame
   - Determine Level of development intended (Concrete Slab Thickness, Post Tension, Rebar lbs/sqft, etc.)

2. Gather Information
   - Narrative
   - Drawing
   - Models (Typically Sketch-up)

- Narrative:

## PLAN NOTES:

1. REFERENCE TOP OF SLAB ELEVATION IS 553.33'.
2. FLOOR AND ROOF SLAB SHALL BE 8" THICK REINFORCED AS FOLLOWS:
   PT = 1.3 PSF
   MILD STEEL = 0.8 PSF

- Drawings:
  Gather all documents made available for the project.


- Benchmarking
- Look at previous/similar projects for structural systems, material and schedule.

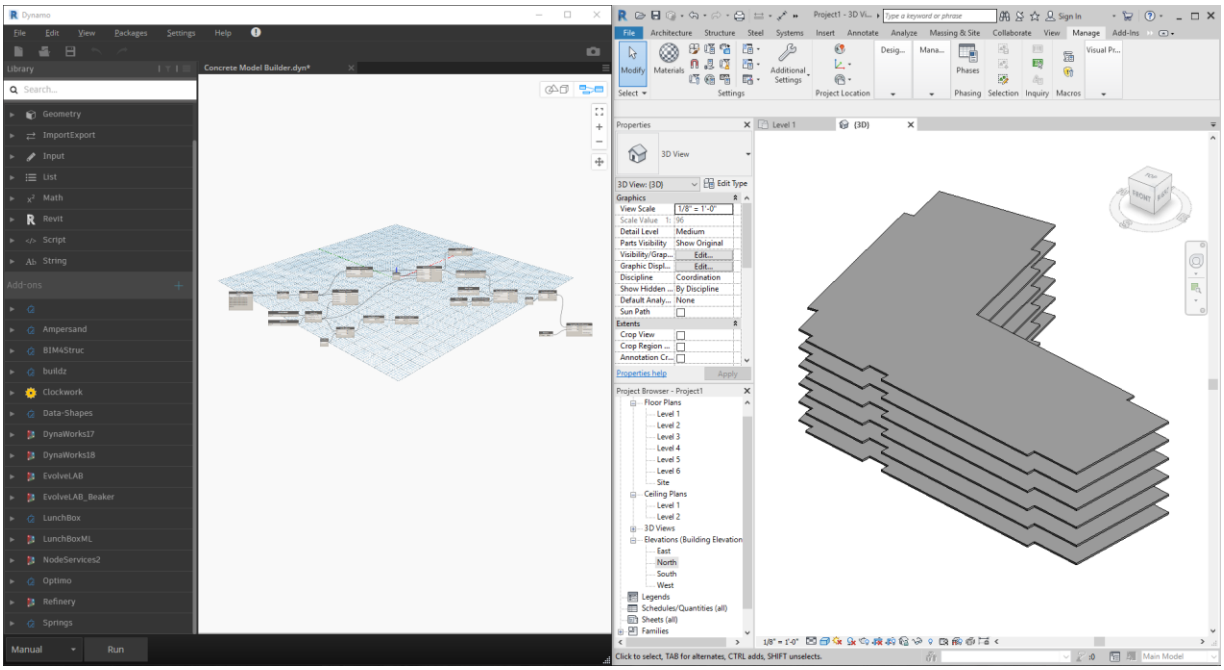
**SKANSKA**

**CORE AND SHELL OFFICE BENCHMARKING (Without Garage & Site Cost)**

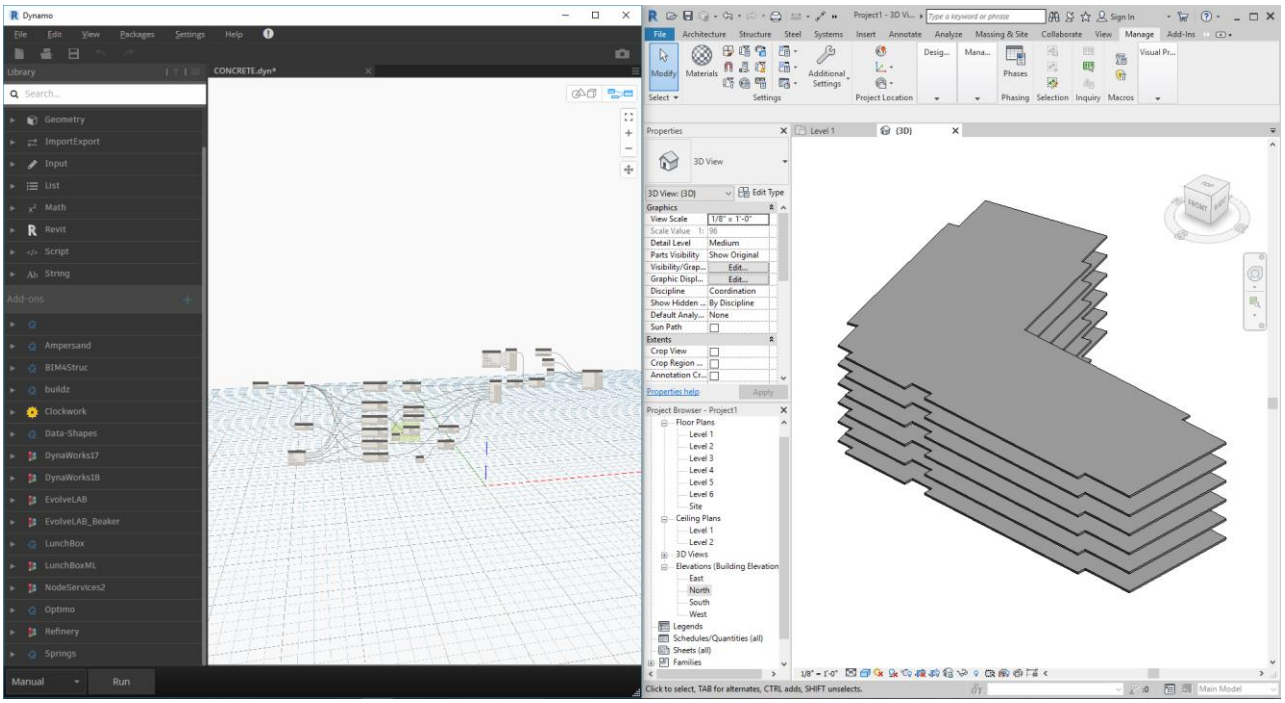
| CSI Div | PROJECT A | | PROJECT B | | PROJECT C | | PROJECT D | |
|---|---|---|---|---|---|---|---|---|
| | 400,716 | GSF | 256,341 | GSF | 243,335 | GSF | 458,290 | GSF |
| 02 Site Construction & Garage (Not Included) | $0 | $0.00 | $0 | $0.00 | $0 | $0.00 | $0 | $0.00 |
| 03 Concrete and Precast | $14,413,515 | $35.97 | $9,592,376 | $37.42 | $9,065,044 | $ 37.25 | $14,173,304 | $30.93 |
| 04 Masonry | $75,000 | $0.19 | $622,413 | $2.43 | $121,344 | $ 0.50 | $308,871 | $0.67 |
| 05 Metals | $2,879,180 | $7.19 | $1,196,809 | $4.67 | $546,241 | $ 2.24 | $1,307,881 | $2.85 |
| 06 Wood & Plastics | $1,871,184 | $4.67 | $471,396 | $1.84 | $375,281 | $ 1.54 | $1,594,407 | $3.48 |
| 07 Thermal & Moisture Protection | $3,126,306 | $7.80 | $1,836,667 | $7.16 | $1,771,297 | $ 7.28 | $1,735,218 | $3.79 |
| 08 Doors & Windows | $23,513,370 | $58.68 | $7,232,415 | $28.21 | $5,966,411 | $ 24.52 | $17,361,405 | $37.88 |
| 09 Finishes | $4,826,086 | $12.04 | $2,402,988 | $9.37 | $2,027,306 | $ 8.33 | $5,562,650 | $12.14 |
| 10 Specialties | $400,716 | $1.00 | $282,261 | $1.10 | $192,997 | $ 0.79 | $434,092 | $0.95 |
| 11 Equipment | $10,000 | $0.02 | $175,889 | $0.69 | $43,384 | $ 0.18 | $902,423 | $1.97 |
| 12 Furnishings | $825,023 | $2.06 | $397,631 | $1.55 | $202,094 | $ 0.83 | $362,981 | $0.79 |
| 13 Special Construction | $0 | $0.00 | $473,550 | $1.85 | $1,159,443 | $ 4.76 | $1,224,385 | $2.67 |
| 14 Conveyance | $3,375,000 | $8.42 | $2,018,618 | $7.87 | $2,105,162 | $ 8.65 | $3,965,400 | $8.65 |
| 15 Mechanical | $12,056,480 | $30.09 | $7,449,930 | $29.06 | $7,122,791 | $ 29.27 | $12,987,369 | $28.34 |
| 16 Electrical | $6,411,456 | $16.00 | $5,270,400 | $20.56 | $3,470,014 | $ 14.26 | $7,665,992 | $16.73 |
| Total Direct Construction Cost | $73,783,316 | $184.13 | $39,423,343 | $153.79 | $34,168,807 | $140.42 | $69,586,378 | $151.84 |
| 12.95% ENR Inflation From 06/2014 to 12/2017 | | | | | | | | |
| 9.80% ENR Inflation From 09/2015 to 12/2017 | | | | | | | | |
| 4.39% ENR Inflation From 09/2016 to 12/2017 | | | | | | | | |
| Total Indirect Construction Cost | $12,651,611 | $31.57 | $7,196,834 | $28.08 | $6,024,413 | $24.76 | $10,561,687 | $23.05 |
| ENR Inflation on Indirect Cost | | | | | | | | |
| Grand Total Cost | *$86,434,927* | *$215.70* | *$46,620,177* | *$181.87* | *$40,193,220* | *$165.18* | *$80,148,066* | *$174.88* |
| Floor Plate Area | 25,044 | SF/floor | 23,304 | SF/floor | 22,121 | SF/floor | 24,121 | SF/floor |

NOTE: Below grade garage and site have too many variations, garage and site were not included on this comparison

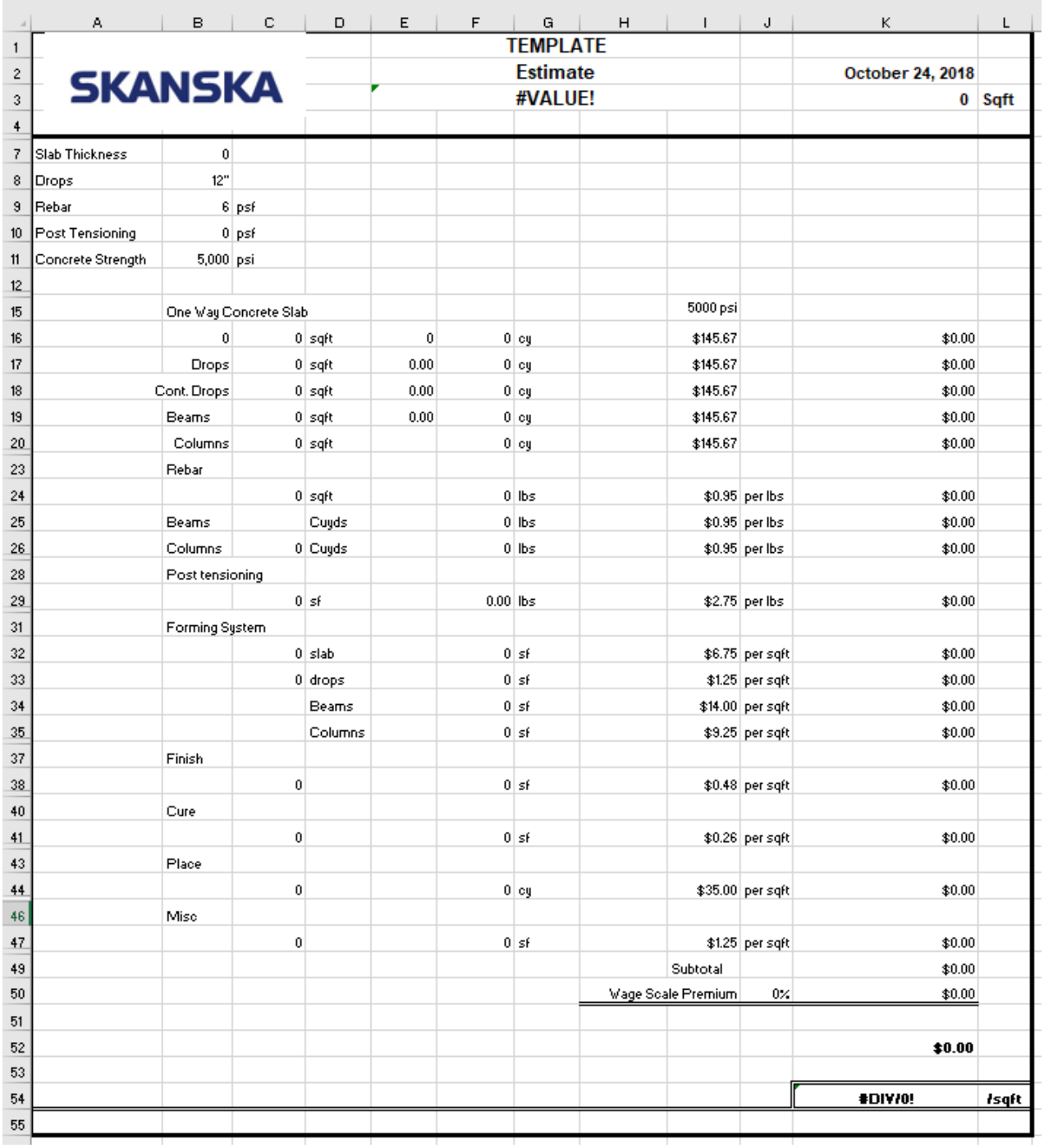
- 3D Model (Revit) Create 3D model using Dynamo and the provided drawing set.



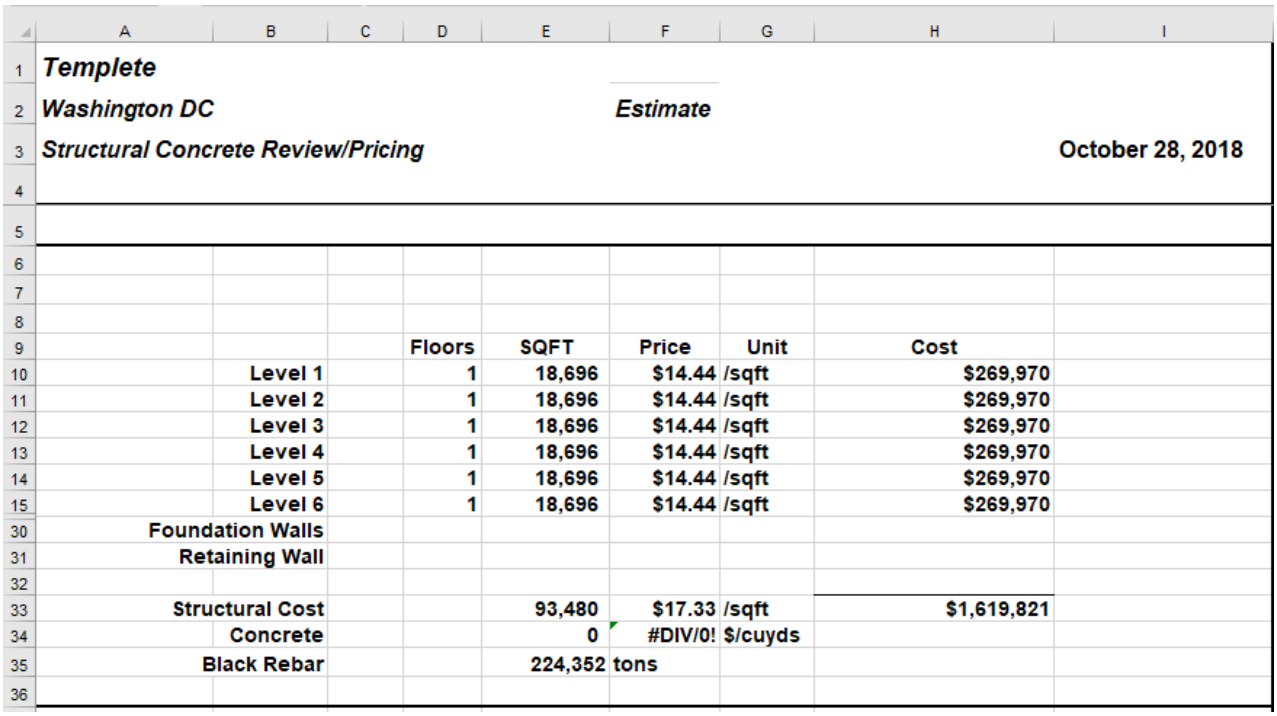
  - Use Dynamo script to export data to a spreadsheet template (provided with the handout).



- Data gets extrapolated into a spread sheet. Where each slab uses an individual form to break the cost down.



| | A | B | C | D | E | F | G | H | I | J | K | L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | TEMPLATE | | | | | | |
| 2 | SKANSKA | | | | | Estimate | | | | | October 24, 2018 | |
| 3 | | | | | | #VALUE! | | | | | 0 | Sqft |
| 4 | | | | | | | | | | | | |
| 7 | Slab Thickness | 0 | | | | | | | | | | |
| 8 | Drops | 12" | | | | | | | | | | |
| 9 | Rebar | 6 | psf | | | | | | | | | |
| 10 | Post Tensioning | 0 | psf | | | | | | | | | |
| 11 | Concrete Strength | 5,000 | psi | | | | | | | | | |
| 12 | | | | | | | | | | | | |
| 15 | | One Way Concrete Slab | | | | | | | 5000 psi | | | |
| 16 | | 0 | 0 | sqft | 0 | 0 | cy | | $145.67 | | $0.00 | |
| 17 | | Drops | 0 | sqft | 0.00 | 0 | cy | | $145.67 | | $0.00 | |
| 18 | | Cont. Drops | 0 | sqft | 0.00 | 0 | cy | | $145.67 | | $0.00 | |
| 19 | | Beams | 0 | sqft | 0.00 | 0 | cy | | $145.67 | | $0.00 | |
| 20 | | Columns | 0 | sqft | | 0 | cy | | $145.67 | | $0.00 | |
| 23 | | Rebar | | | | | | | | | | |
| 24 | | | 0 | sqft | | 0 | lbs | | $0.95 | per lbs | $0.00 | |
| 25 | | Beams | | Cuyds | | 0 | lbs | | $0.95 | per lbs | $0.00 | |
| 26 | | Columns | 0 | Cuyds | | 0 | lbs | | $0.95 | per lbs | $0.00 | |
| 28 | | Post tensioning | | | | | | | | | | |
| 29 | | | 0 | sf | | 0.00 | lbs | | $2.75 | per lbs | $0.00 | |
| 31 | | Forming System | | | | | | | | | | |
| 32 | | | 0 | slab | | 0 | sf | | $6.75 | per sqft | $0.00 | |
| 33 | | | 0 | drops | | 0 | sf | | $1.25 | per sqft | $0.00 | |
| 34 | | | | Beams | | 0 | sf | | $14.00 | per sqft | $0.00 | |
| 35 | | | | Columns | | 0 | sf | | $9.25 | per sqft | $0.00 | |
| 37 | | Finish | | | | | | | | | | |
| 38 | | | 0 | | | 0 | sf | | $0.48 | per sqft | $0.00 | |
| 40 | | Cure | | | | | | | | | | |
| 41 | | | 0 | | | 0 | sf | | $0.26 | per sqft | $0.00 | |
| 43 | | Place | | | | | | | | | | |
| 44 | | | 0 | | | 0 | cy | | $35.00 | per sqft | $0.00 | |
| 46 | | Misc | | | | | | | | | | |
| 47 | | | 0 | | | 0 | sf | | $1.25 | per sqft | $0.00 | |
| 49 | | | | | | | | | Subtotal | | $0.00 | |
| 50 | | | | | | | | Wage Scale Premium | | 0% | $0.00 | |
| 51 | | | | | | | | | | | | |
| 52 | | | | | | | | | | | $0.00 | |
| 53 | | | | | | | | | | | | |
| 54 | | | | | | | | | | | #DIV/0! | /sqft |
| 55 | | | | | | | | | | | | |



| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | ***Templete*** | | | | | | | |
| 2 | ***Washington DC*** | | | | ***Estimate*** | | | |
| 3 | ***Structural Concrete Review/Pricing*** | | | | | | | **October 28, 2018** |
| 4 | | | | | | | | |
| 5 | | | | | | | | |
| 6 | | | | | | | | |
| 7 | | | | | | | | |
| 8 | | | | | | | | |
| 9 | | | **Floors** | **SQFT** | **Price** | **Unit** | **Cost** | |
| 10 | **Level 1** | | **1** | **18,696** | **$14.44** | **/sqft** | **$269,970** | |
| 11 | **Level 2** | | **1** | **18,696** | **$14.44** | **/sqft** | **$269,970** | |
| 12 | **Level 3** | | **1** | **18,696** | **$14.44** | **/sqft** | **$269,970** | |
| 13 | **Level 4** | | **1** | **18,696** | **$14.44** | **/sqft** | **$269,970** | |
| 14 | **Level 5** | | **1** | **18,696** | **$14.44** | **/sqft** | **$269,970** | |
| 15 | **Level 6** | | **1** | **18,696** | **$14.44** | **/sqft** | **$269,970** | |
| 30 | **Foundation Walls** | | | | | | | |
| 31 | **Retaining Wall** | | | | | | | |
| 32 | | | | | | | | |
| 33 | **Structural Cost** | | | **93,480** | **$17.33** | **/sqft** | **$1,619,821** | |
| 34 | **Concrete** | | | **0** | **#DIV/0!** | **$/cuyds** | | |
| 35 | **Black Rebar** | | | **224,352** | **tons** | | | |
| 36 | | | | | | | | |

## . Benefits

- Standardization
  Creating workflows allows teams to have a cohesive approach toward looking at a 3D models and data.

- Automation
  Creating Dynamo Graphs and Templates eliminates manual data entry and it streamlines the process. In addition, this approach provides team with more time to evaluate projects and add value.

- Centralized data base
  All data comes from the same places making easier when sharing information or working with teams

- Dynamic and Interactive
  Taking advantages of Revit's parametric nature, allows users to interact with clients and designers in real time.

- Early constructability and logistic analysis
  Handing off Preliminary 3D models, Data and Design Intent allows for early coordination, logistics and constructability reviews which in turn informs the preconstruction team with potential cost drivers and value engineering options.