

BLD124387

Applying Generative AEC Dynamics to a Parking Garage

Jesper Wallaert
MT Højgaard

Sylvester Knudsen
MT Højgaard

Learning Objectives

- Rule based geometry creation in Dynamo Studio
- Connecting Dynamo with FormIT, to explore different design opportunities
- Connecting Dynamo with Project Fractal
- Leveraging Generative Design for optimal design decision making
- Generating Revit models from raw data
- Automating quantity take-off and cost estimation in iTWO based on a Revit model

Description

This presentation will cover how MT Højgaard has automated and optimized the process of designing a parking garage, going from early concept to final estimation and simulation. We will take you through the workflow and show the possibilities in software that includes FormIT, Dynamo, Project Fractal, Revit and iTWO.

Speakers

Sylvester Knudsen

Sylvester is doing a master degree in the field of Building Informatics at Aalborg University, while working at one of Denmark's biggest general contractors MT Højgaard, as part of the Computational Design and Construction group, which goal is to implement and develop computation in the company's daily workflows. Passionatede about BIM, utilizing data and computational workflows, Sylvester strives on making better projects by using data for better decision making.

Jesper Wallaert

Jesper is working as VDC specialist at MT Højgaard. Jesper uses his experience providing Virtual Design and Construction research, and development to share knowledge of digital building solutions. Jesper also manages new implementation and further development of Computational Design and Construction at the MTH organisation.

The Parking garage configurator

The case: MT Højgaards self-built construction of a parking garage for our new headquarters in Søborg Denmark. The Virtual design and construction (VDC) department

was asked to join the project and come up with some cost alternatives by optimizing some of the parameters behind the rule based design of the concept.

The standard Parking garage concept is also developed to address the Danish market regardless of the site. We ended up having a data driven design solution from early conceptual design all the way to construction documents and object based estimation with 4 products connected through Dynamo.

Phase 1 - Parametric concept model:

We decided to use Dynamo for the creation of a rule based parametric concept definition. By identifying the parameters of the standard concept structure such as levels, lengths, number of parking spots and other factors like, total cost and average price per parking spot that all play an important role in the success of the project. We quickly created the foundation for a Dynamo approach. The first phase would focus on the preparation of a proof of concept definition providing the base for the early-stage Conceptual Design model. In phase two we use the base definition from Dynamo Studio and via Dynamo for Revit built a Revit generator. To provide a better end user platform we ended up using Dynamo Studio and the Customizer to bring the design into the FormIt 360. The combination of the two products made it possible for us to meet our client inside FormIt. In order to evaluate the site we use FormIt and creating the site context and try some further options with the dynamic model. We built an output dashboard in the definition to dynamically show outputs for number of parking lots and price estimation in real-time while adapting it to the client's wishes. After finding the best fit for the client the outputs from the conceptual design model (phase one) is then used as input in the Revit generator definition which create the detailed design model in Revit.



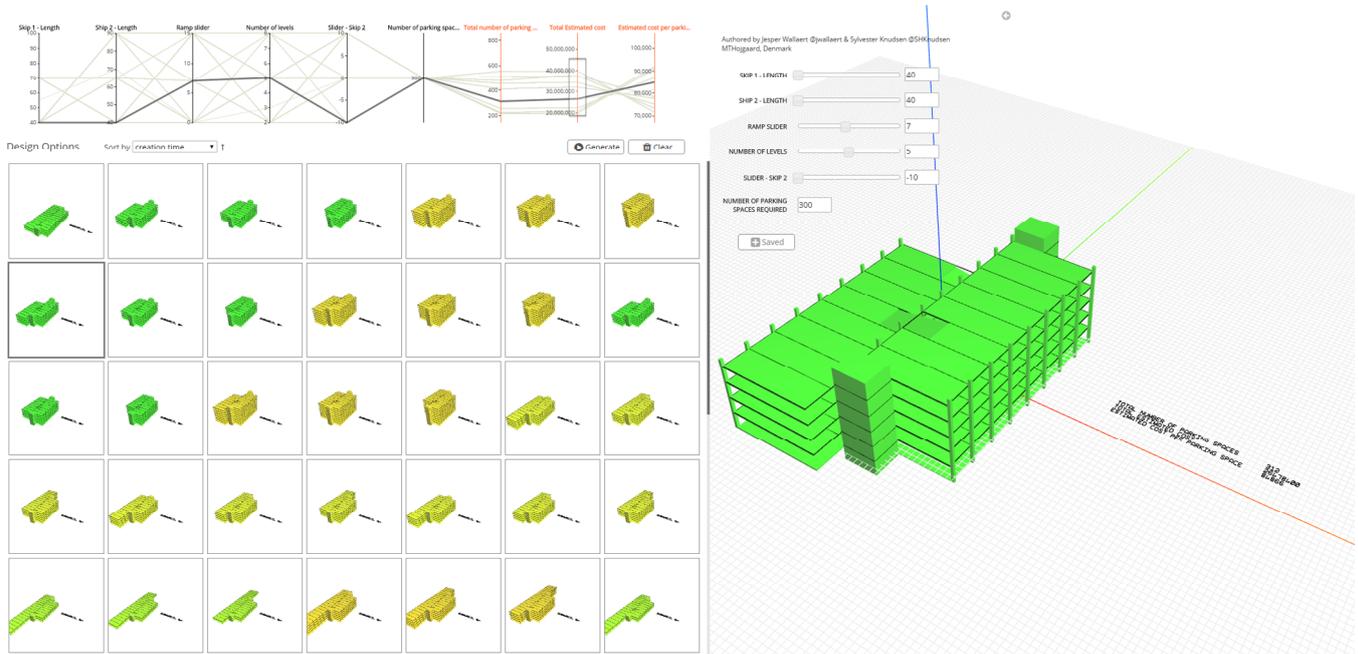
Parametric concept model inside FormIt.

Phase 1.1 - Generative design:

During the development we got access to Project Fractals alpha program and with only little adjustment prepare the definition to work inside Fractal. Project Fractal runs your Dynamo definition through the cloud to analyze a design space of possible inputs and help the designer determine the configurations that best meet the criteria of fitness. Now we had a solution to automate the optimization process of finding cost alternatives. After adding a cost

mechanism and color visualization on top of the original definition we fed it through Project Fractal to see which combination arrives closest to the cost target. From the options generated, we can then refine until we find 5-10 optimal cost alternatives and present it to the client.

While this does not necessarily design the entire parking garage automatically, it is an excellent tool to create thousands of garage scenarios optimized on parameters of our choosing and validate a particular decision in the early stage of a design.



Project Fractal running the Parking garage.

Phase 2 – Parking garage generator:

After locking the conceptual design of the parking garage structure, the next step is to turn the dead geometry created in Dynamo, Formit and Fractal into hardcore BIM objects. The process of converting the parameters identified in the concept model, into a Revit model is based on a Dynamo graph which has the same foundation as the script for generating the concept model. Although the big difference is that instead of making Dynamo geometry, it now creates fully parametric Revit family's, which can be used for estimation, fabrication and so on. Basically the script uses the data that was found in the concept model, and from these data generates the entire structural model of the parking garage. From the data collected from the concept model, the script has built in rules that based on these data defines things like number of column's and beams, placement of structural reinforcement, creates the appropriate amount of levels and much more. From these data we are able to automate almost all of the modeling process.

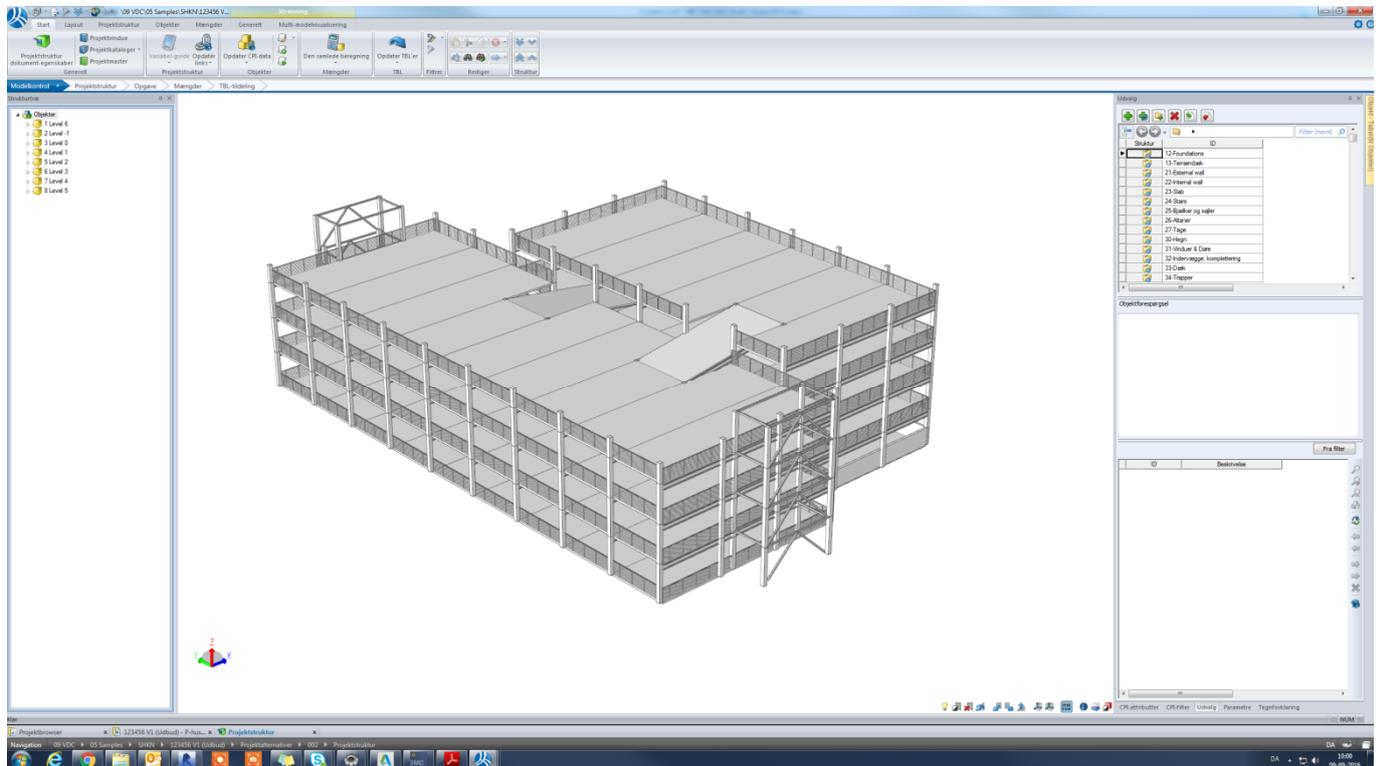
To make sure that objects naming, parameters and classification, is always done in a standardized way, a special Revit template is created for model. This template contains all the parts used in the structure with about 2-3 alternatives to each object. By making sure the naming conventions is always done in the same way, we create a link to our VDC software that enable us to do automated quantity takeoff and 4D simulations.



The automatically generated parking garage inside Revit.

Phase 3 – 4D/5D model:

In the last phase of the project, we go from 3D to 4D and 5D, through our VDC software iTWO. In iTWO we can perform quantity takeoff, estimation and simulation of the building process. By using the generated Revit model, we are able to almost fully automate the process of quantity takeoff, estimation and simulation. By using standard naming and classification, an iTWO template is made so that every time a new model is loaded into iTWO everything is setup and ready to give accurate price estimation and time scheduling. By automating these processes we can present the customer with alternative solutions for the structure, which means he can now see the consequence of every choice he makes, a lot faster. As a contractor we also get a lot of benefits through the simulations of the building process, as we can build the parking garage as many times we want on the computer before we start the actual building process.



iTWO.

Dynamo Studio “Quick” Start

Dynamo Studio is a stand-alone programming environment that enables designers to create visual logic to explore parametric conceptual designs and automate tasks.

Getting started with Dynamo can't be covered in this Hand out. But here's some few guidelines:

1. Less is more, start with small time saving script, which can automate and enhance your daily repeating design tasks. The time saved can then be used for more Dynamo exploring.
2. The Dynamo Primer is your friend: www.dynamoprimer.com
3. Use the community: www.forum.dynamobim.com
4. Read the guidelines for getting help the right way: www.forum.dynamobim.com/t/how-to-get-help-on-the-dynamo-forums/4677

Project Fractal Quick Start

Project Fractal enables you to explore parametric design space of models created in Dynamo Studio with the automatic generation of a wide sampling of options.

1. If you want to create your own Fractal content, install the latest released version of Dynamo Studio 2017
2. Login to Project Fractal with the Autodesk ID that you want to whitelist (this will fail but will put you on the whitelist request list).
3. Contact the Project Fractal team with the email address associated with your Autodesk ID so that we can whitelist your address for access to Project Fractal.
4. Review guidelines below about what Dynamo nodes work with Project Fractal.
5. Publish a Workspace from Dynamo Studio to Project Fractal. File Menu > Send to Web...
6. Visit a list of Dynamo workspaces published to your Autodesk ID directly by accessing Project Fractal.
7. Once you've selected and opened a workspace in Project Fractal, you can generate options, save custom options, and/or sort and filter all of the options in your Dynamo workspace.
8. Contact us at Fractal.Dev@autodesk.com and tell us what you think!

Guidelines

1. Only native Dynamo nodes are eligible to run in Project Fractal - same rules as the Dynamo Customizer described here.
2. Slider inputs will vary automatically in Project Fractal after pressing "Generate", combining min max and median values for each input.
3. Numerical inputs will not vary but can be set to different values and saved manually as different options.
4. Thumbnails created on save or generate are derived from the position of the model in the main view.
5. Nicknamed watch nodes that contain a number or a boolean value can be used for outputs (these will show up orange in the parallel coordinates graph).

FormIt + Dynamo Quick Start

Autodesk® FormIt and Autodesk® Dynamo Studio work together to create a Generative Conceptual Design workflow

Publish a Dynamo Customizer and place it in FormIt

1. Start Dynamo Studio 2016 and open or create a new script
2. Go to File, Share Workspace then title, describe, and publish your script
3. Start FormIt for Windows
4. Log into A360 with the same account used for Dynamo Studio
5. Go to the Dynamo tab in the FormIt panels
6. You should see the Dynamo Customizer you just published, if not then refresh
Drag and drop the Dynamo Customizer into your FormIt sketch

Flex the Dynamo Customizer parameters inside FormIt

1. Double click a placed Dynamo Customizer to edit the Group
2. Go to the Properties tab in the FormIt panels
3. Adjust the slider or number inputs available in the script
4. After a pause, the script will be sent to Dynamo for evaluation
5. You can exit the group and continue working in your sketch while you wait for the updated geometry
6. When the updated geometry is ready, your sketch will be updated automatically

Tips for Dynamo Customizers in FormIt

1. Dynamo Customizers behave like Groups in FormIt, you can copy, make unique, ungroup, delete, undo, redo, etc
2. Any manual adjustment made inside the Dynamo Group will be overwritten when the geometry is updated
3. Edits made outside the Group (like rotate, scale, etc) are preserved when the geometry is updated
4. FormIt will use the units of the current sketch to interpret the values in the Dynamo Customizer
5. Published Dynamo Customizers can be downloaded as DYN files for enhancement in Dynamo Studio
6. To control which inputs are visible in FormIt, right click and un-check 'Is Input' in Dynamo Studio