

BES500010

## Smarter MEP Collaboration and MEP Design Verification by Dynamo

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### Learning Objectives

- Understand the interfaces between MEP models vs Architects/ Structural models and use Revit datas to analyze and verify them.
- Check measurements between two objects or two ranges of specified objects and compare with specific rules and standards.
- How to analyze Revit datas.
- Come up with your own ideas to generate your own automation tools.

### Description

For the last 5 years, Revit become increasingly the popular modelling software in the industry. Every company is using Revit for modelling and coordination. However, this creates a new challenge in terms of increasing hours and efforts that are spent for the projects at the designing stages for construction industry as a whole and MEP world in particular.

Generally, there are two main concerns that every MEP engineer encounters:

1. There are a lot of interferences within various disciplines (*mechanical, electrical, fire protection, acoustics, structural and architecture disciplines*). And the information from these disciplines are very changeable during the design phases.
2. There are numerous engineering rules that an MEP engineer need to verify for MEP designs.

In this class, two Dynamo tool examples will be illustrated to:

- Automatically detect clashes to coordinate the floor penetration locations
- Automatically validate the MEP designs in complianace with building codes and standards. ( namely distances verification).

### Speaker(s)

Trang Chau is a hydraulic engineer working in the building services industry for nearly 5 years. She has been working in various projects in Australia/ New Zealand applying BIM process in every project every day. She has been working with BIM models on a daily basis focusing on models design and coordination. For the last year, she was interested in learning Dynamo and understand how Dynamo work. She has successfully applied a few Dynamo scripts in her projects with good outcomes to provide efficient methods for enhancing projects coordination and verifications for the company.

## Idea 1: Floor penetration coordination

Our first topic covers how a user interprets and understand the interface between MEP model and architectural or structural models. One of the common clashes that structural/plumbing engineers and architects frequently coordinate with is to resolve clashes between plumbing fixtures set out and the structural beams

### 1.1 General:

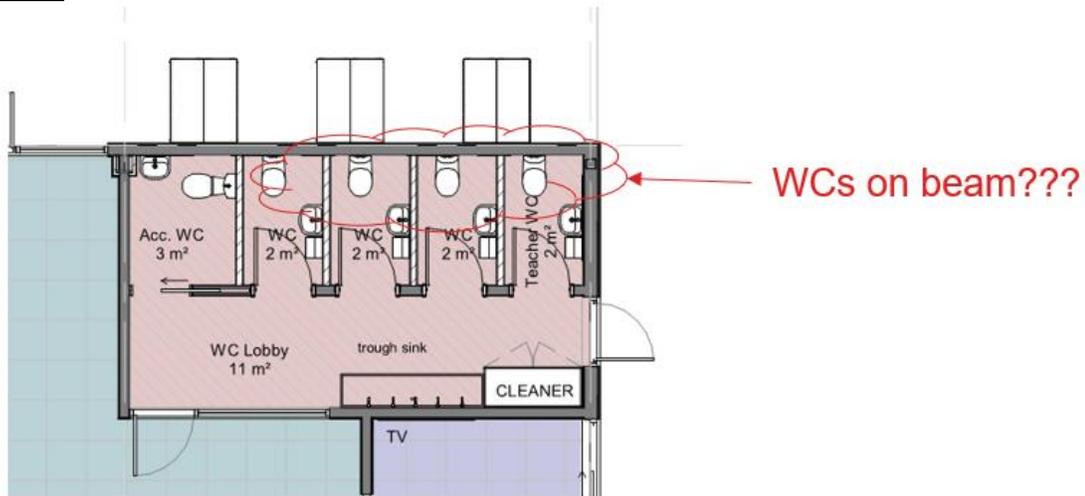


Photo 1: Toilets clash with concrete beam

### Traditional Processes

Normally, the traditional process in an MEP company is as below:

- Step 1: MEP modeller receives the architect, structural models.
- Step 2: MEP modeller starts modelling based on the information in received models.
- Step 3: MEP modeller runs clash detection to check clashes between models.
- Step 4: If there is any clash, MEP engineer/modeller review the clashes (there are some solutions: MEP redraw the pipework or MEP communicate with architects/ structural engineers to change their design). Clash resolved.
- Step 5: If the architectural/ structural models change, MEP engineer repeats steps 1, 2, 3, 4 again.

This is a very time-consuming process as the information always change during the design phase. This class proposes an alternative way of using Dynamo to initially check the clashes when receiving the architect/ structural models without implementing the steps 2 and 3 above.

### Dynamo Processes

With Dynamo, the proposed process can be:

- Step 1: MEP modeller receive the architect, structural models.
- Step 2: Run Dynamo to check.
- Step 3: MEP, structural engineers, architects resolve the clashes.
- Step 4: If the architectural/ structural models change, MEP engineer repeats steps 1, 2, 3 again.

## 1.2 Dynamo Graph Summary:

Next, one of the key steps is to understand the relationship between objects, such as the measurements between two objects or two ranges of specified objects and compare with specific rules and standards. This led to the idea to utilize the waste connector inside the toilet modeled by the architect and after that interface with the structural framing/ foundation to identify the clashes. From the waste connector, use Dynamo to automatically draw a 120 dia cylinder that represents for the toilet waste for every single toilet. From the structural model, identify all the locations of structural elements including beams, foundations. Finally, get all identified elements intersected together and export the outcome data to the spreadsheet as a coordination report.

There are 3 main steps to establish the Dynamo graph as following:

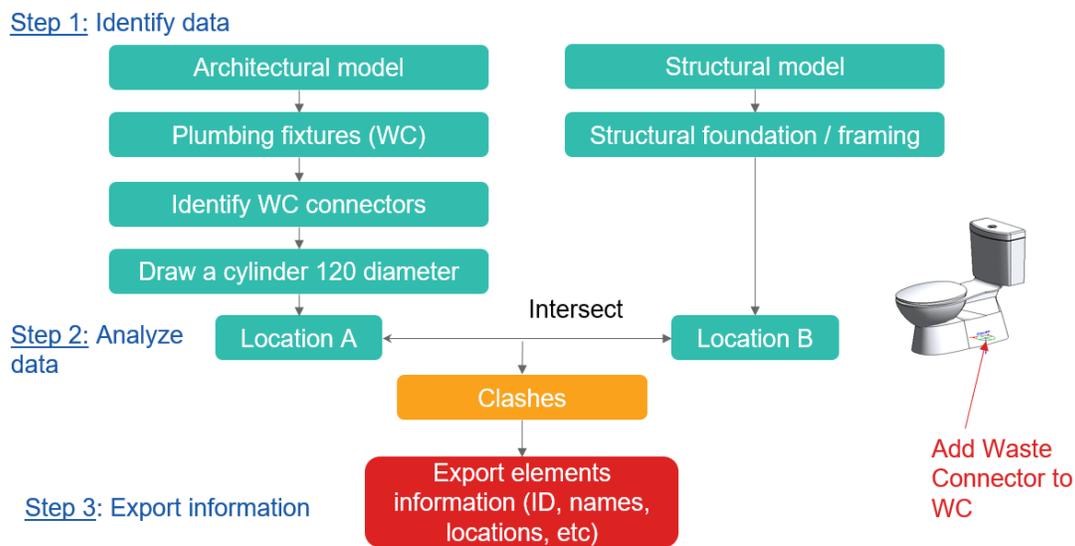


Photo 2: Dynamo Graph Summary – Floor Penetration Coordination

## 1.3 Dynamo Nodes Explanation

Required package: **BimorphNodes, MEPOver**

### Step 1: Identify Input Data

Input data including:

Architectural Model: Plumbing Fixtures -> WC.

Structural Model : Structural Foundation or Structural Framing.

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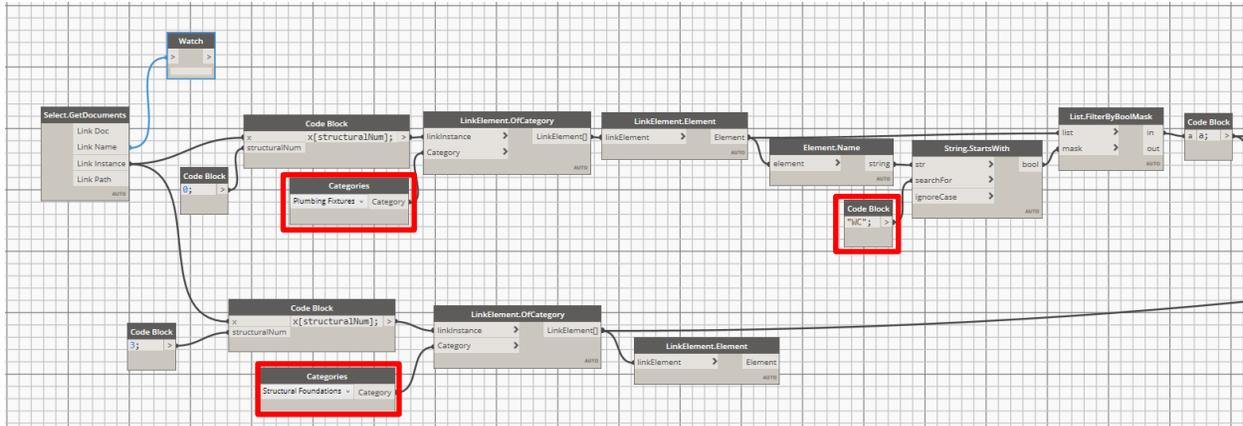


Photo 3 : Dynamo Graph – taking input data from architectural and structural models.

Identify waste connectors from plumbing fixtures:

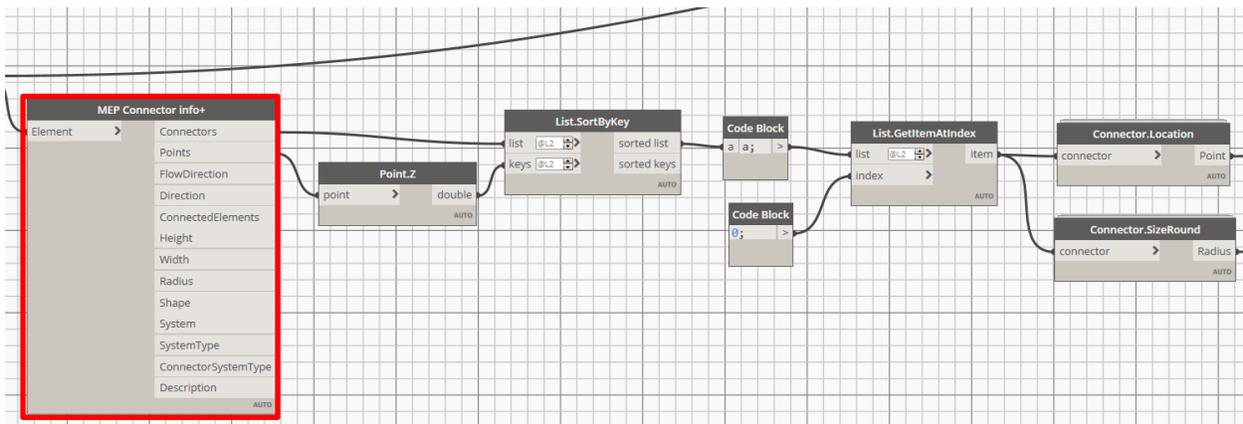


Photo 4 : Dynamo Graph – work with plumbing fixture connector

Draw a cylinder from the waste connectors to -1000 underslab:

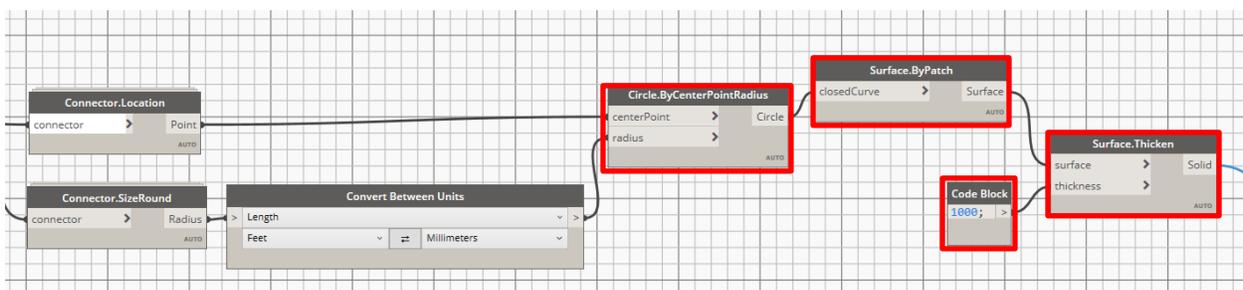


Photo 5: Dynamo Graph – use Dynamo to automatically draw cylinders from WC connector.

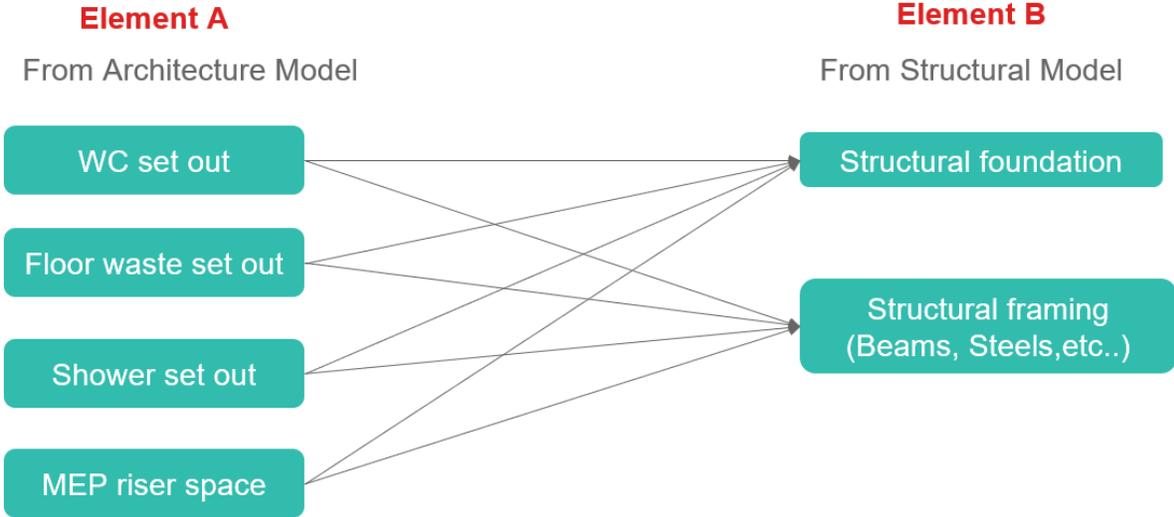


**1.4 Dynamo Application for floor penetration : More ideas, more tools:**

There are many elements need to coordinate for floor penetration coordination. From an MEP perspectives, there are generally some floor set out for plumbing fixtures including WC, basins, sinks, FWGs and MEP risers for hydraulic risers and ductwork risers.

The structural foundation is more with the ground floor penetration coordination while the structural framing is more for the upper ground floor penetration coordination.

More ideas for the floor penetration coordination can be started from the below examples:



## Idea 2: Validate distances within MEP elements

### 1.1 General:

In MEP designs, there are many distances requirements that MEP engineers need to verify for their designs among all disciplines. For example, one of the distant requirements in the hydraulic design is to check how far the vent termination locations to other objects such as air intake, air opening (windows and doors).

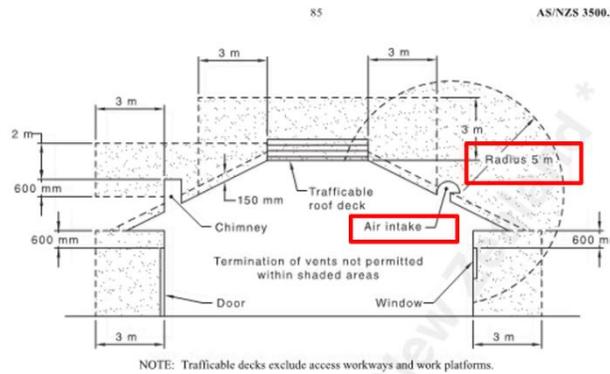


FIGURE 6.9.4 TERMINATION OF VENTS

Photo 9 : Figure 6.9.4 from AS/NZL3500.2, Sanitary Plumbing and Drainage Code – Vent termination requirements

Taking one condition in the figure 6.9.4 between the air intake and vent cowls with 5 meters distance to establish the Dynamo checking tool.

### 1.2 Dynamo Graph Summary:

The idea of this class is to identify all locations of Vent Cowls (A) and Mechanical Air Intake (B) in Dynamo and automatically draw lines from A to B. After that, use Dynamo to automatically measure the lengths of the lines and compare it with the given condition.

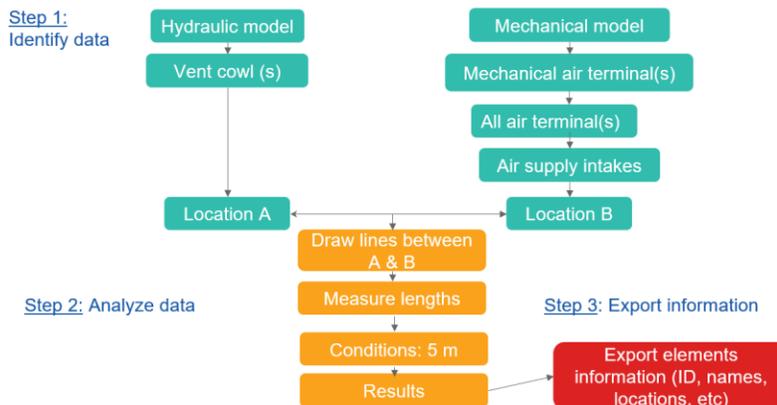


Photo 10 : Dynamo Graph Summary – Distances Requirement

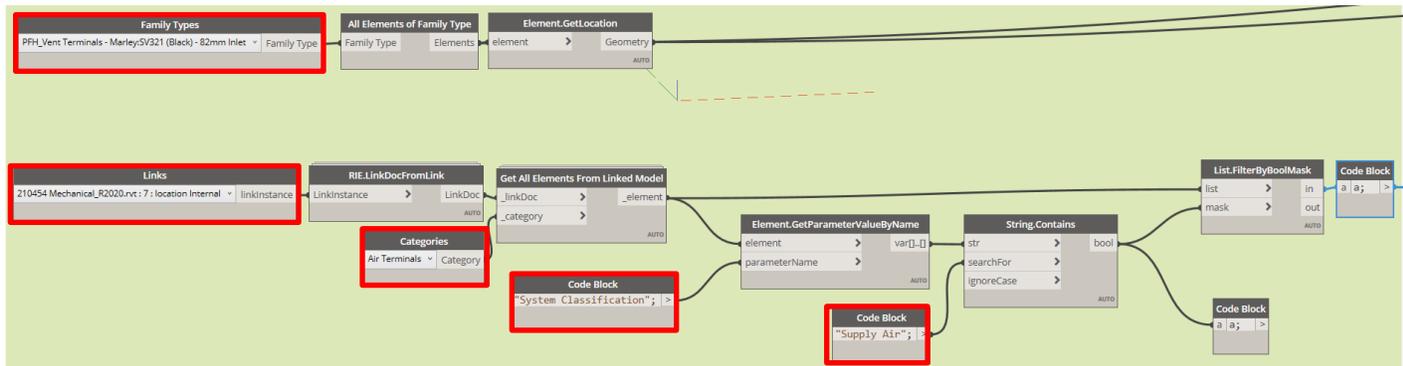
## 1.3 Dynamo Nodes Explanation

Required Package: RIE, Rhythm.

### 1.3.1 Step 1: Identify input data:

The input data here include:

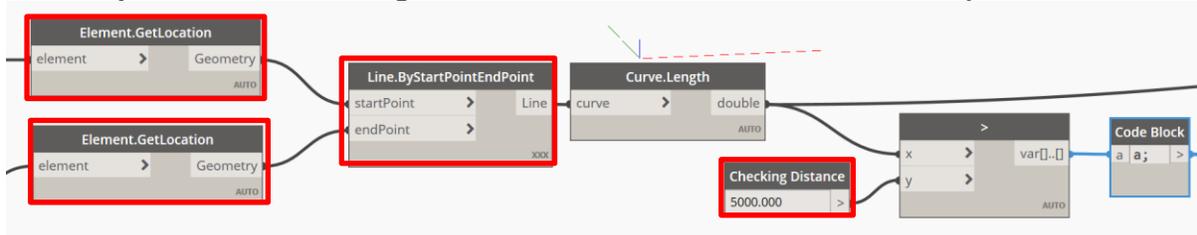
- **Element(s) A:** All vent cowl(s) from the hydraulic model.
- **Element(s) B:** All mechanical fresh air intake from mechanical model.



### 1.3.2 Step 2: Analyze input data:

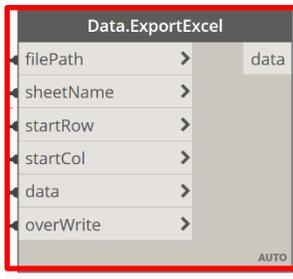
When input data are identified, use Dynamo node **Element.GetLocation** to get all locations of required elements A and B.

Use node **Line.ByStartPointEndPoint** to draw lines between element A and B. Remember to use **crossproduct** under **Lacing** for this node to ensure entire the necessary lines are drawn.

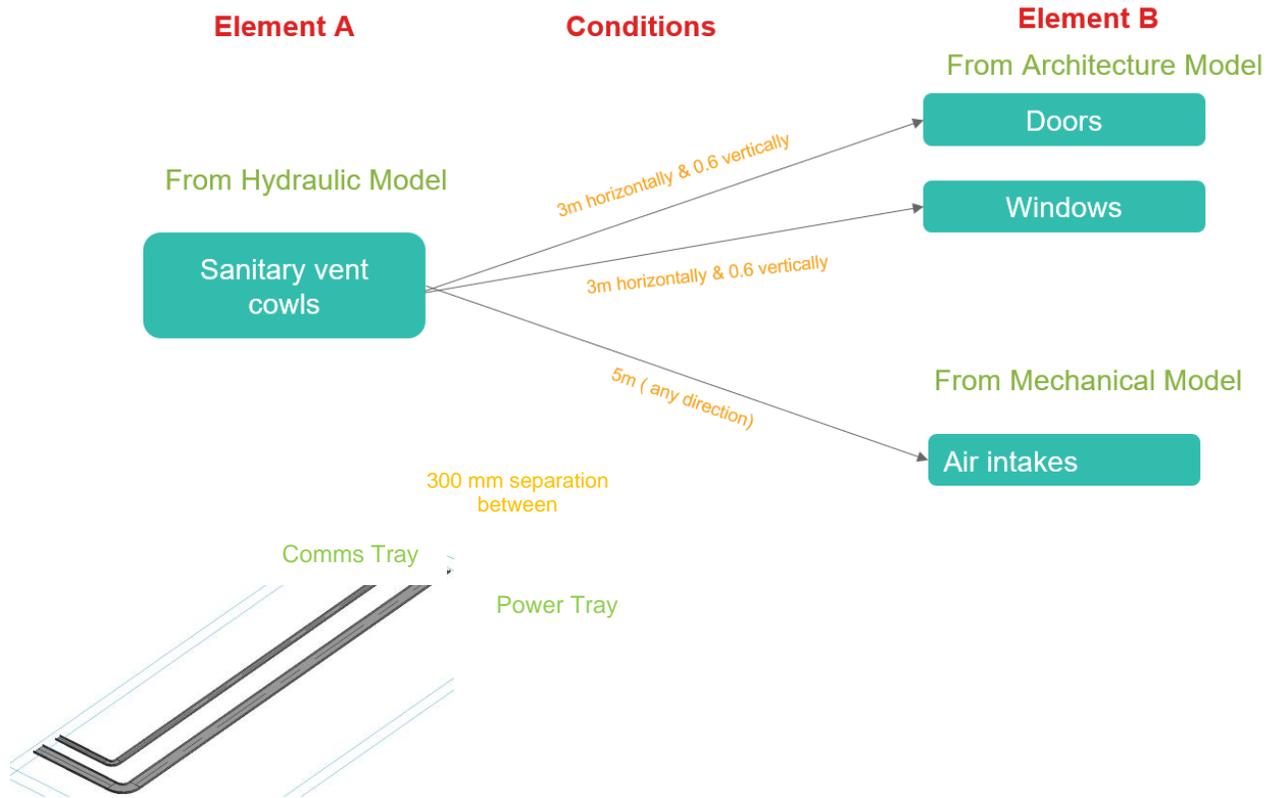


### Step 3: Export Data:

Use Node **Data.Export Excel** to export information to excel file.



## 1.3 Dynamo Application : More ideas, more tools:



Some examples can be developed from this application:

### **Point vs Point:**

- Mechanical Air Intake vs Mechanical Exhaust.
- Boiler Flue vs Mechanical Air Intake.
- Boiler Flue vs Air Opening ( Windows, Doors).
- Vent Coil vs Air Opening ( Windows, Doors, Mechanical Air Intake).
- Electrical Fixture vs closet nearby door.
- Electrical Socket vs closet table.
- Sprinkler vs Sprinkler.

### **Point vs Curve:**

- Sprinkler vs Closet wall.
- Sprinkler vs Closet Ducting.

### **Curve vs Curve:**

- Communication Tray vs Power Tray : 300 minimum separation.
- Water Pipe vs Cable Tray: 100 minimum separation.

### **Notes:**

- Be always specific with your rules because it helps you to write the Dynamo scripts easier.

- Don't be complicated about your ideas because it helps you make the Dynamo scripts simpler.
- Think how to give the most exact result with the less time spending for creating the tool.

## What are the advantages of the Dynamo Tool?

### Advantages



- No need to model simple elements from Revit (e.g idea 1).
- Identify clashes at the beginning of the project (e.g. idea 1).
- Quickly update when input data or conditions change.
- Especially suitable for large-scale projects with numerous elements.
- Can apply to many similar projects when the script is written.
- Export results to spreadsheets and record documents automatically.

## How we can develop these automation tools?

Your ideas are important. Start from your own disciplines.

Divide ideas into smaller ideas, start with baby steps first.

Start with common ideas first, then specific ones.

Look beyond traditional ideas and workflows.

Work closely with the digital team to optimize your ideas.

Your involvement and commitment to implementing ideas is important..

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