

A Digital Revolution in Resilient Housing – Build Change & Autodesk

Allie Young & Andrés Robles

BIM Technologies – Build Change

About us



Allie Young

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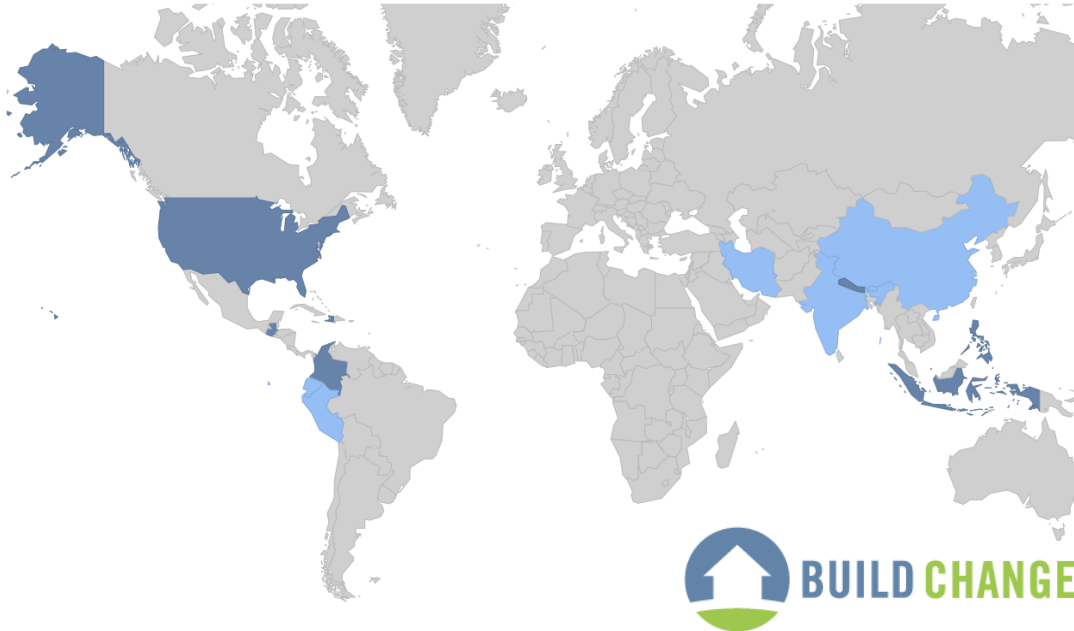


Andrés Robles

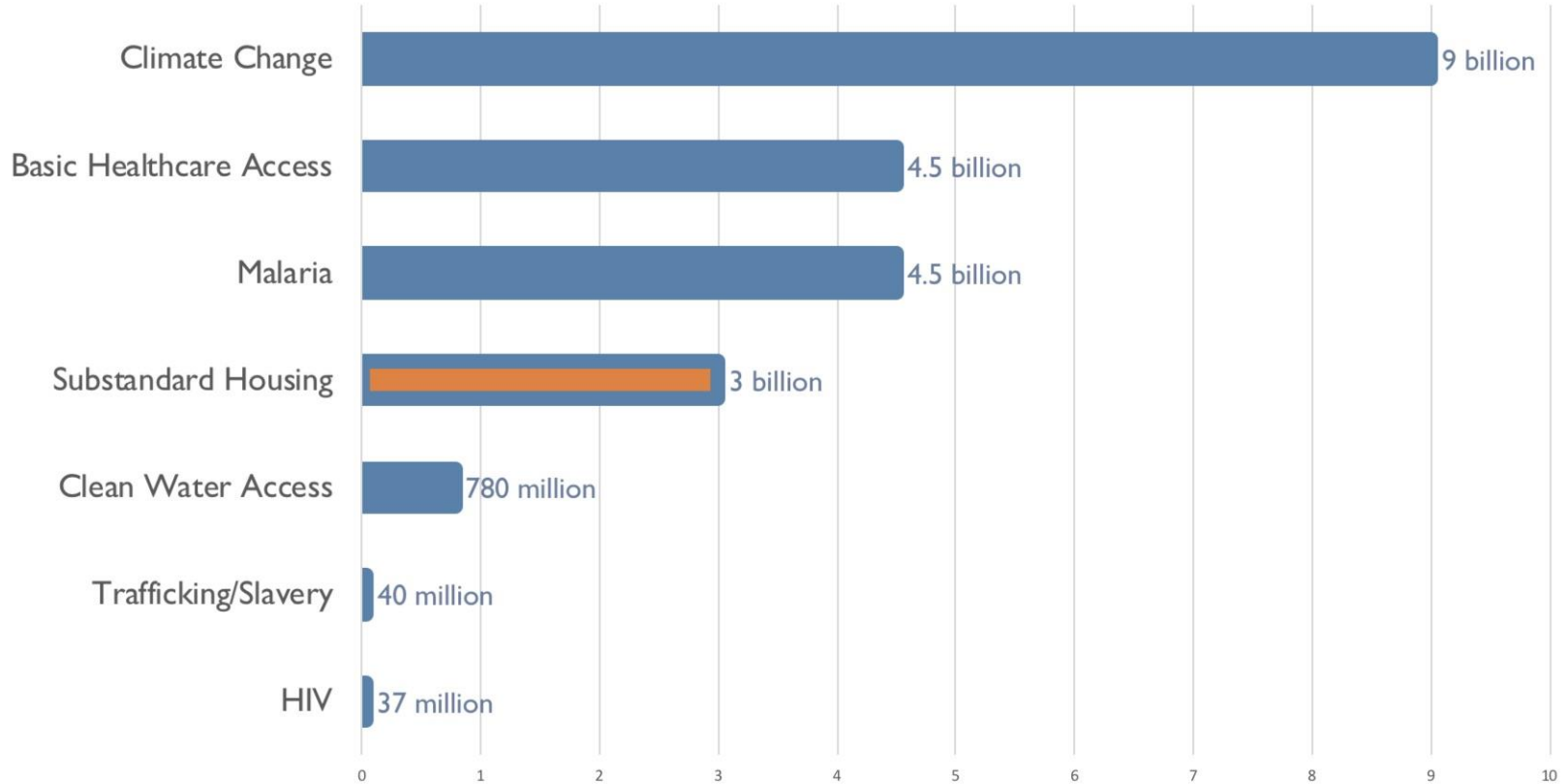
BIM Engineering Specialist
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About Build Change

- Founded in 2004 by Dr. Elizabeth Hausler
- Mission: to save lives in earthquakes and other natural disasters
- Currently in about 6 countries



Global Challenges by Affected Population (2030)





Main approaches to disaster resilient design

New construction

- Designing and constructing new, earthquake-resilient housing



Retrofits of existing housing

- Structurally reinforcing existing houses by adding new structural elements



Post-disaster vs. prevention

Nepal – post 2015 earthquake



Bogotá, Colombia – 2021

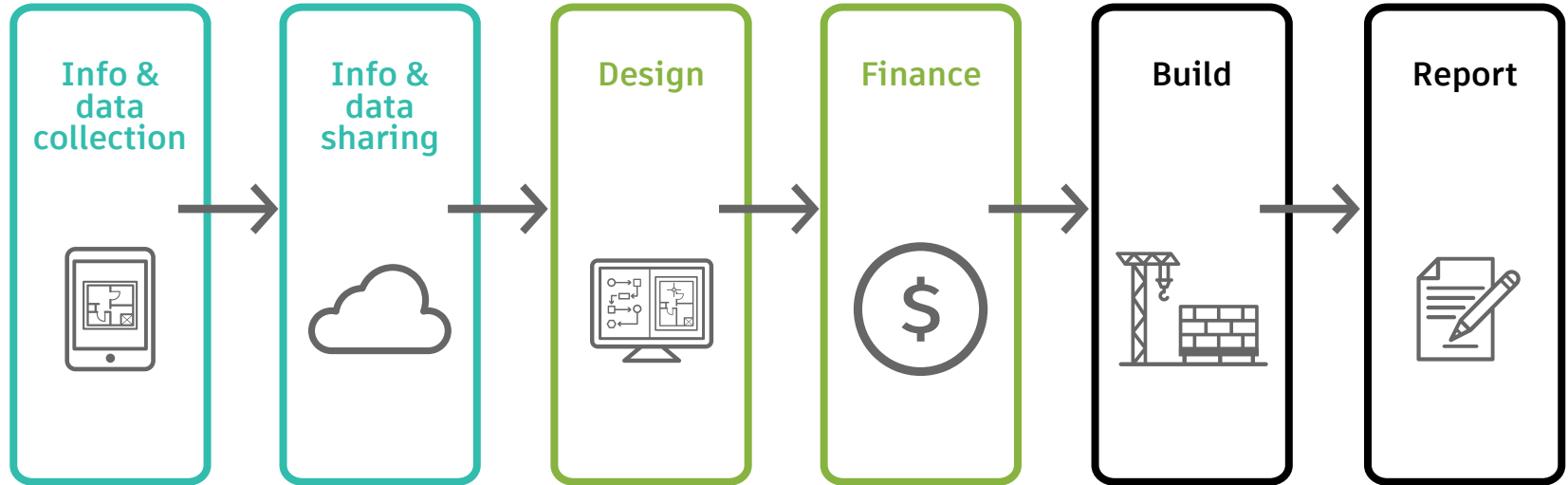


**How can we scale retrofits to
protect thousands of families?**

Autodesk Technology at Build Change

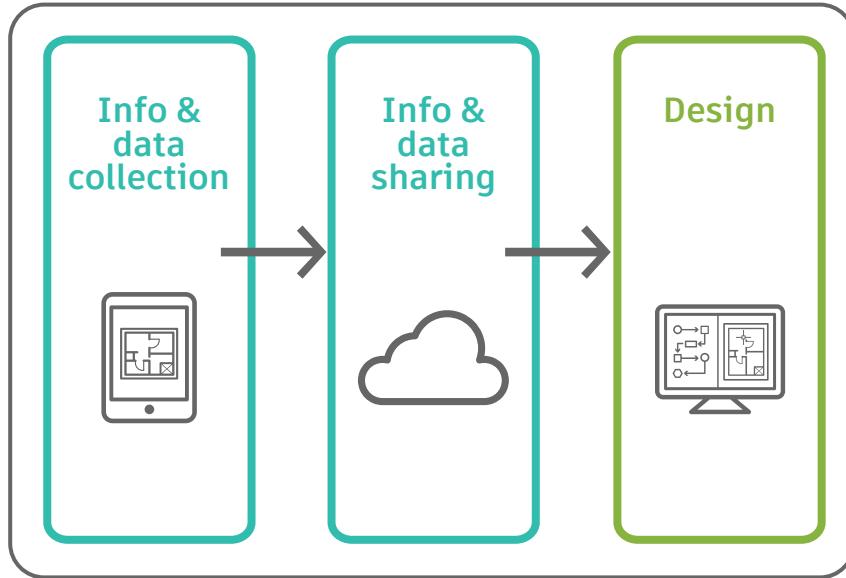
The construction value chain

Steps in the process of retrofitting a house



The construction value chain

Steps in the process of retrofitting a house



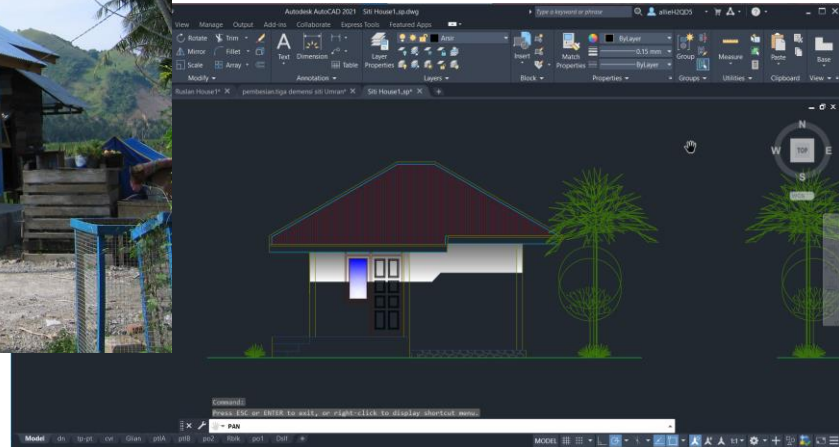
1. Collecting data on the house and its inhabitants, including its floor plan
2. Storing and sharing that data with partners, architects and engineers
3. Developing a retrofit design tailored to that house

In the beginning...

AutoCAD for new construction designs

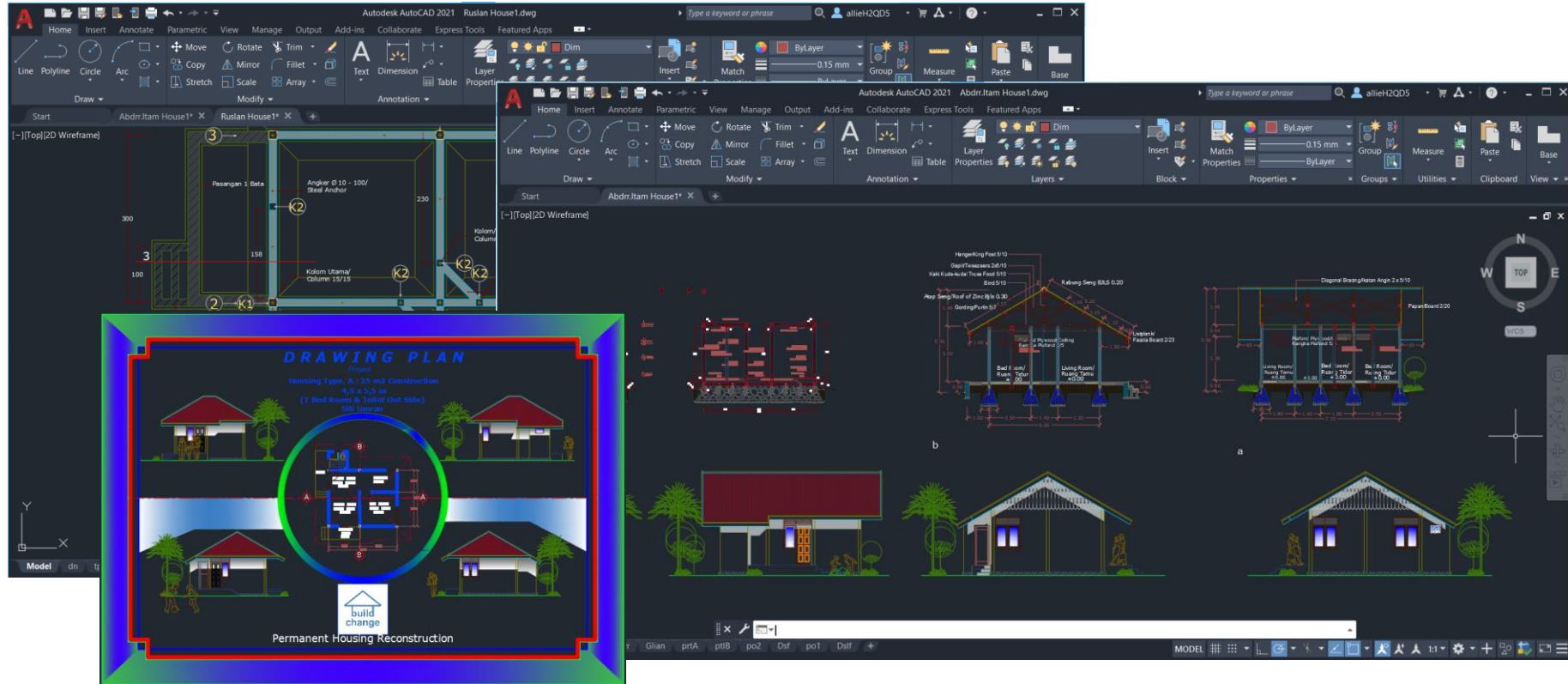


New construction in Indonesia



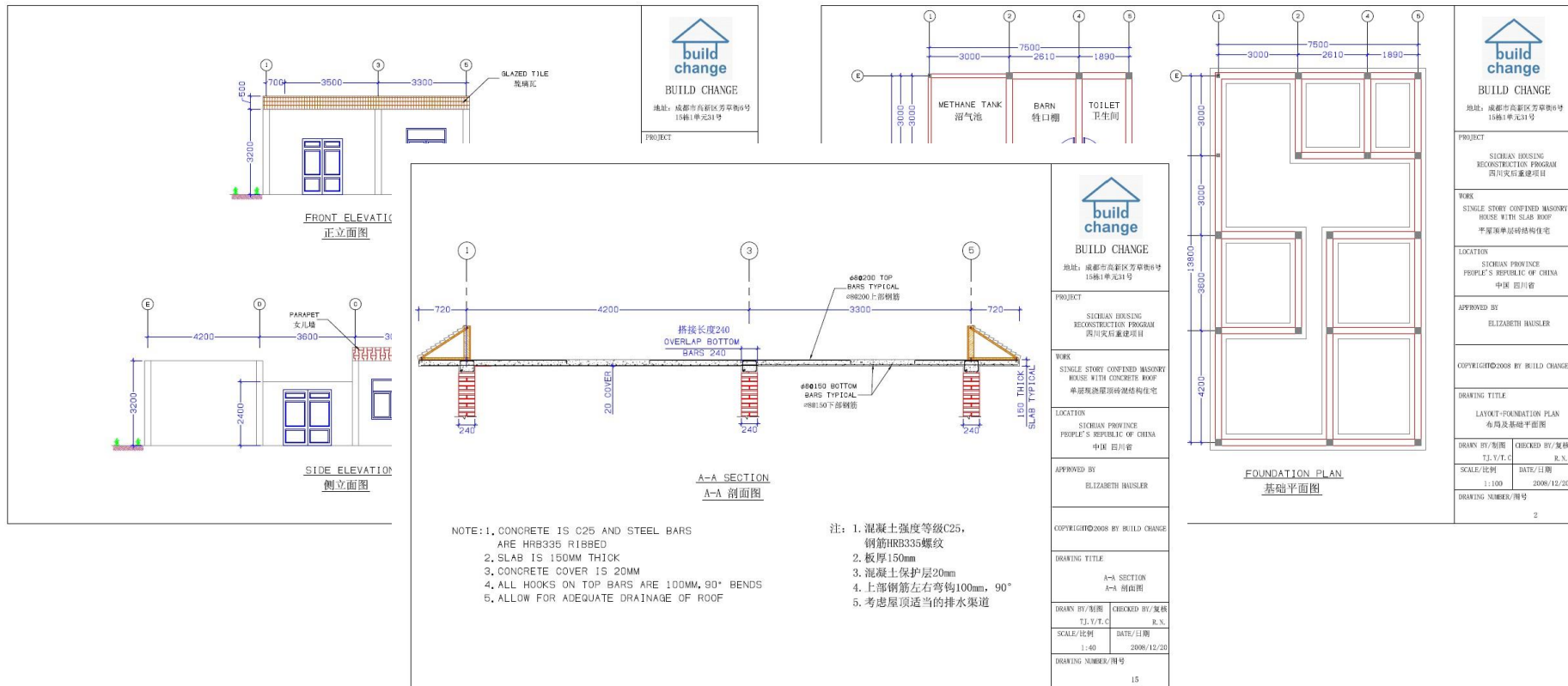
Indonesia, 2006

AutoCAD for new construction designs



China, 2009

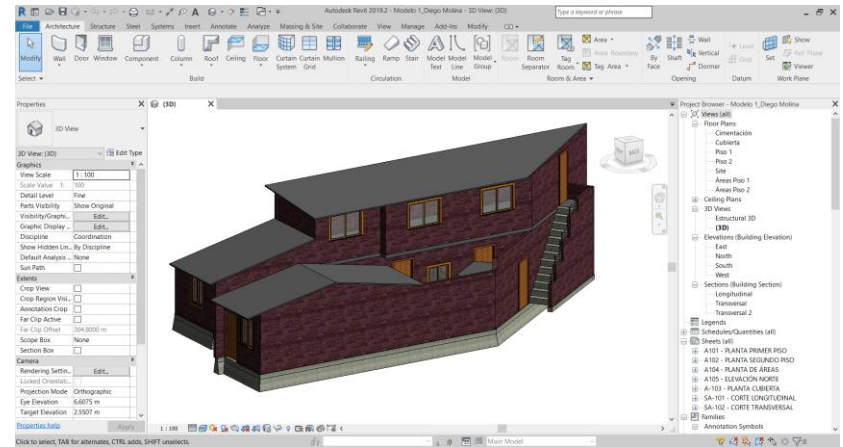
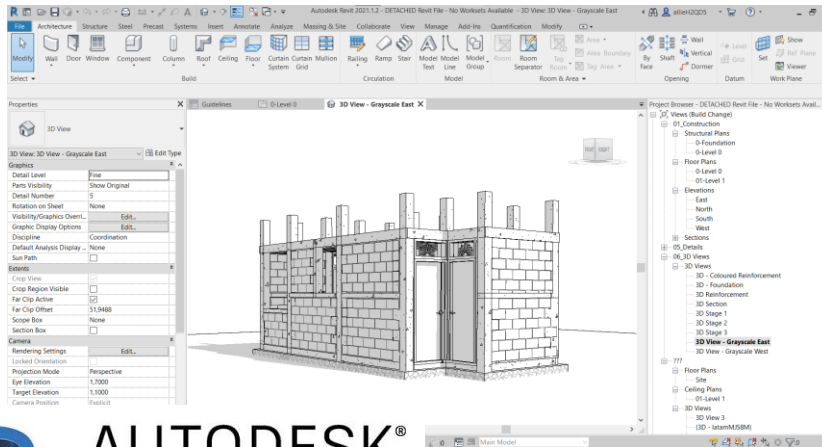
AutoCAD for new construction designs



A shift to Revit

Creating the first templates to make projects more efficient

- Revit was first implemented in Haiti in 2015 and then Colombia in 2017, with the first templates created to make workflows more efficient in retrofit projects



AUTODESK
REVIT®

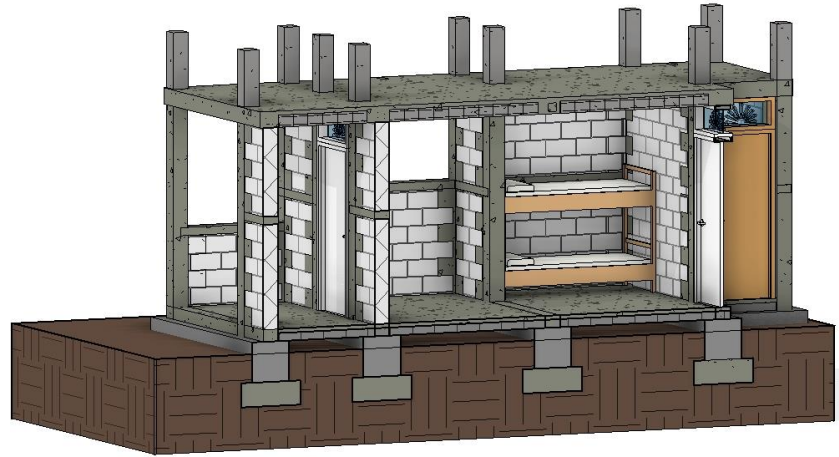
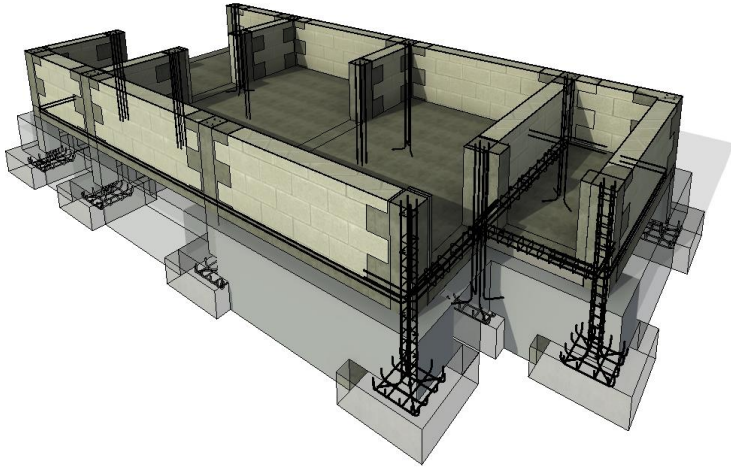
Haiti template

Colombia template

A shift to Revit

Creating the first templates to make projects more efficient

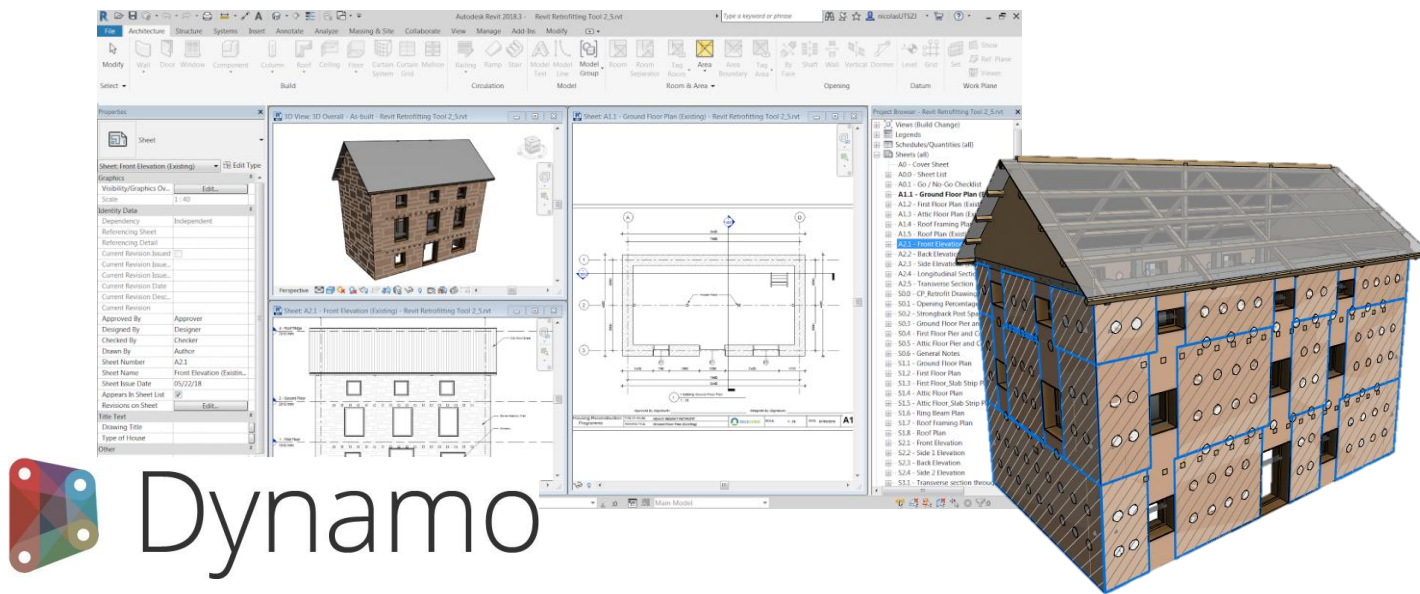
- Revit used for type designs of new construction in Haiti



Nepal, 2017-2018

Automating retrofits in Revit for the first time

- Supported by Autodesk consultants, Build Change first began experimenting with automation in **Dynamo**
- Created our first automated workflows to retrofit houses using specific type designs



Nepal: Methodology meets technology

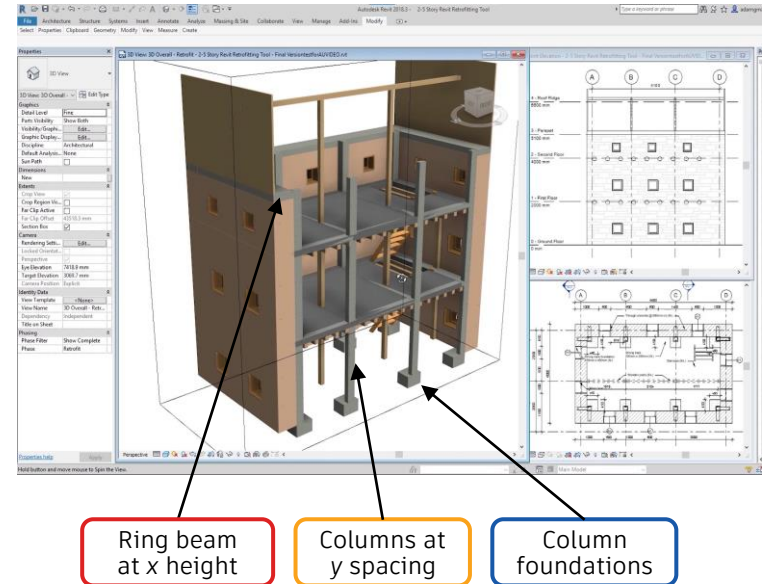
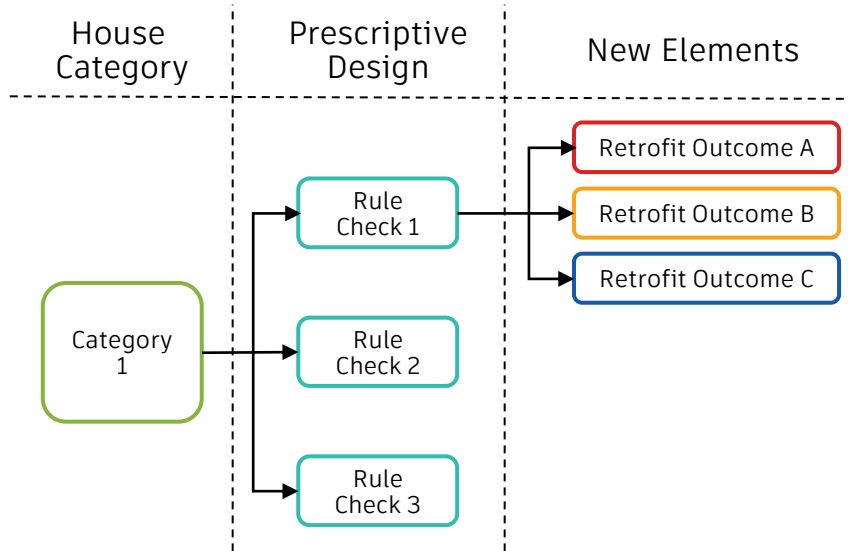
Automating retrofits in Revit for the first time



Virtual tour of a retrofitted house, Eklephant, Nepal

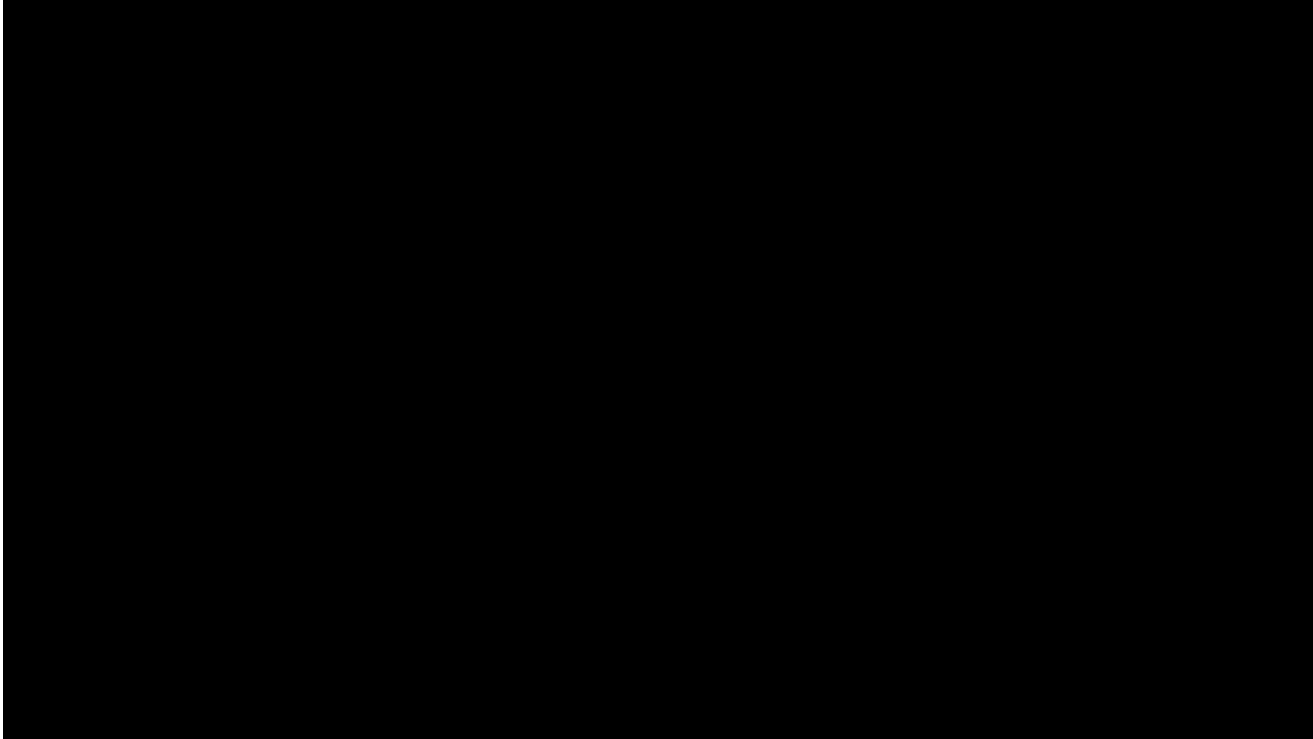
Dynamo in Nepal

Creating retrofit cards for prescriptive design



Dynamo in Nepal

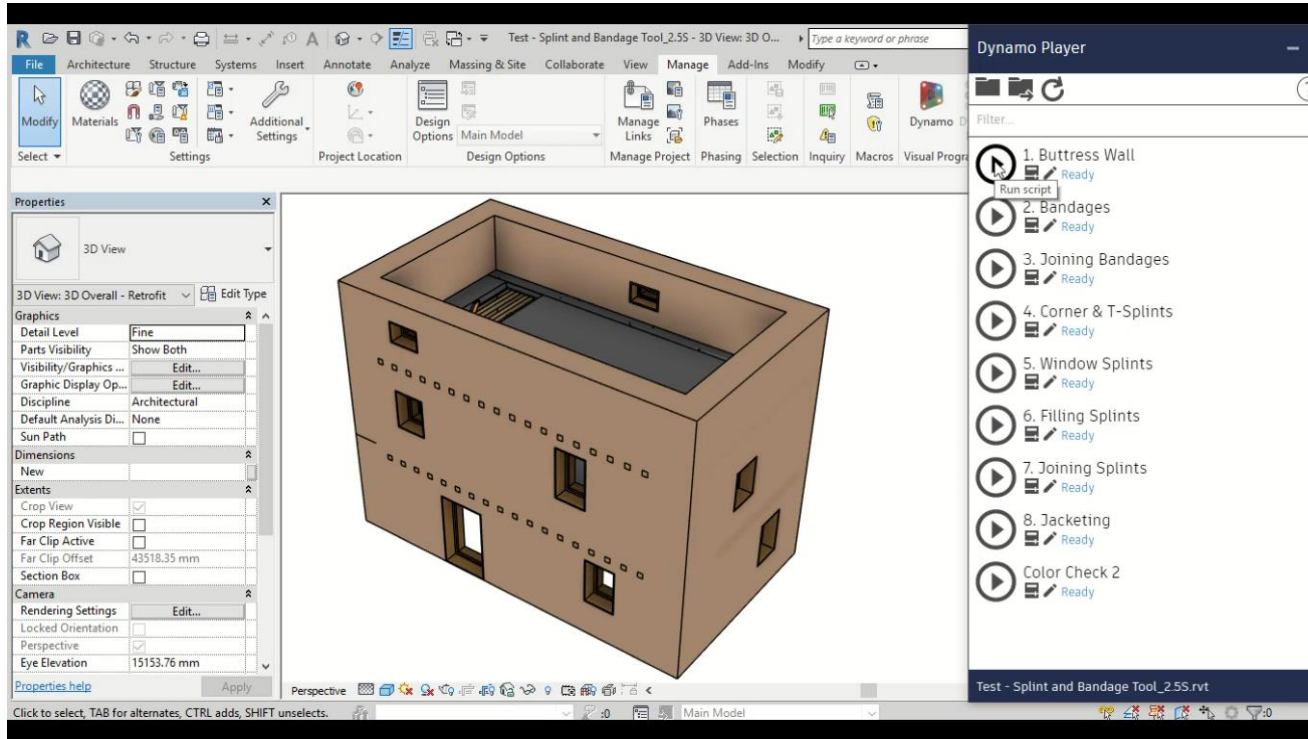
Prescriptive design rules programmed in Dynamo to retrofit houses



Nepal's first type design & automated Dynamo workflow

Dynamo in Nepal

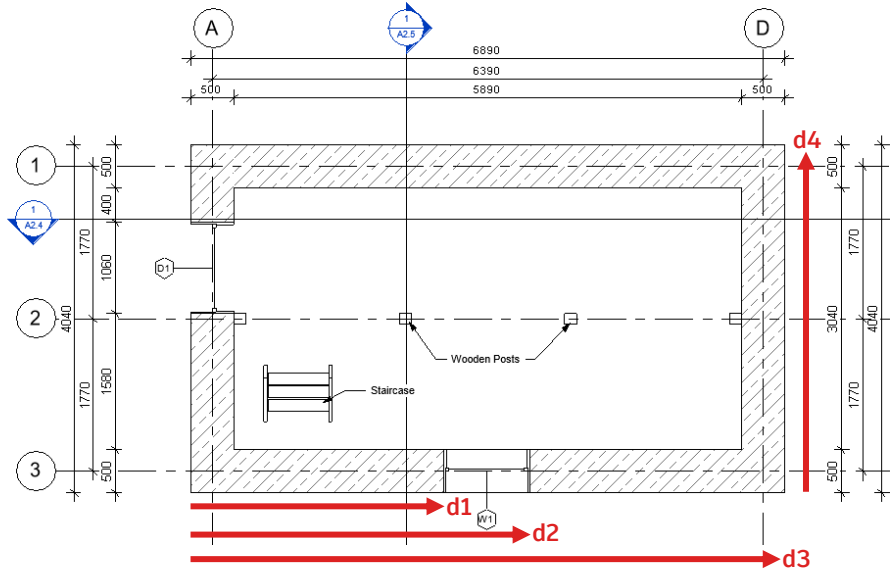
Prescriptive design rules programmed in Dynamo to retrofit houses



Splint and bandage type design, automated Dynamo workflow

Dynamo in Nepal

Model import process



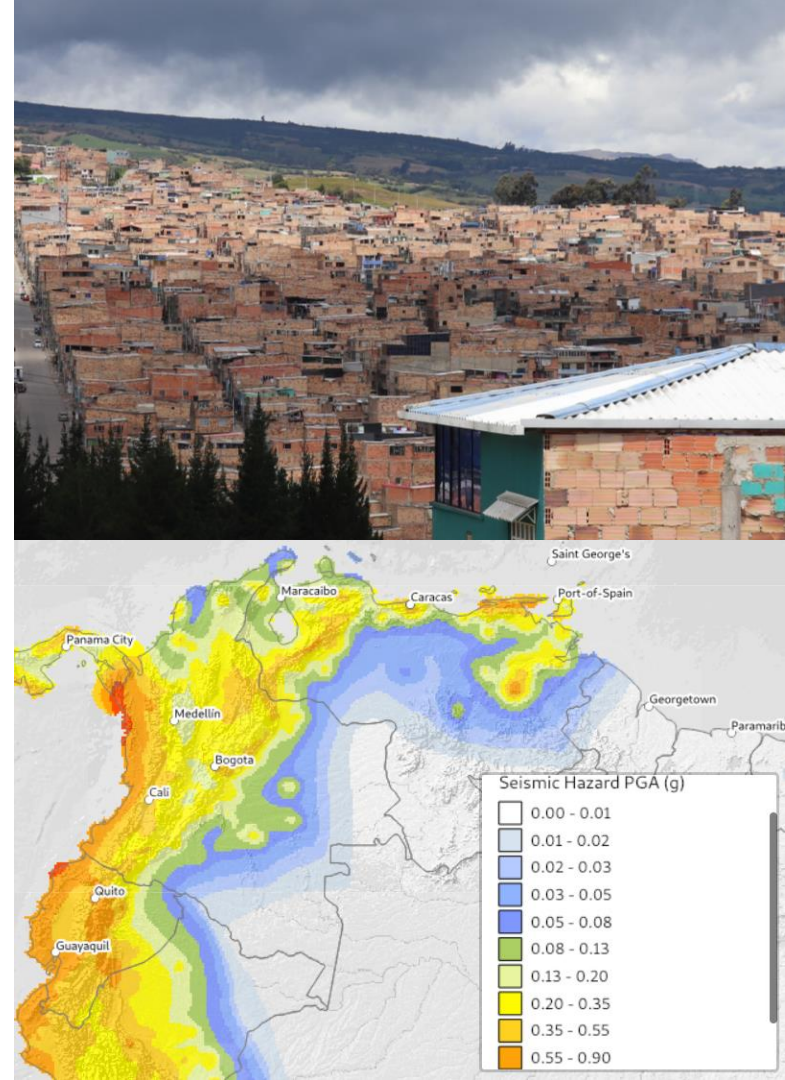


Autodesk Technology at Build Change: Colombia Case Study

Urbanization in Colombia

Colombia has one of the highest rates of urbanization in the world, with almost 80% of its population living in cities.

Growth of informal neighborhoods means an increase in houses constructed without following technical guidelines – taking place in a region with seismic activity.



Retrofitting initiatives in Colombia

Funding from multiple government entities to create retrofit designs for houses in Colombia – aim to impact thousands of families in informal housing

- Caja de la Vivienda Popular
- Ministry of Housing

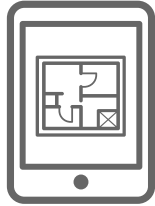


MINVIVIENDA



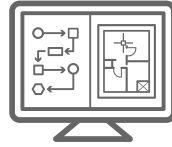
Retrofits, step by step

Data Collection



Capturing the floor plan of the house, importing the house to Revit

Engineering



Performing engineering calculations, generating retrofit design

Construction Package



Outputting final design documentation for construction

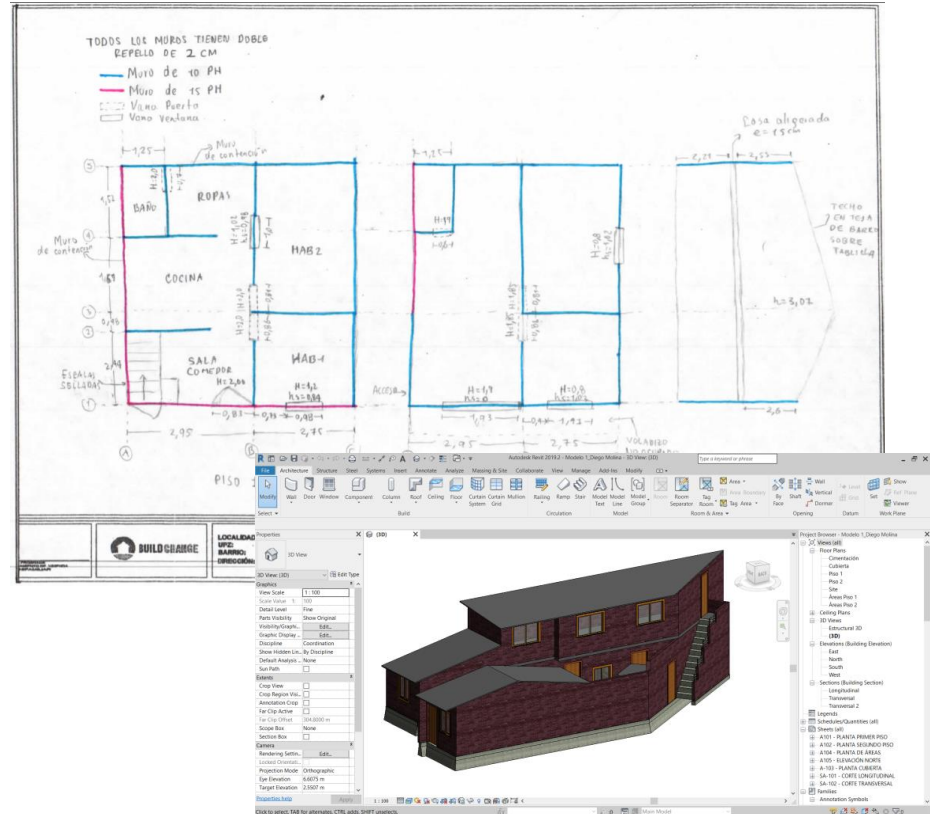
In the beginning...

Gathering data

Existing house plans drawn manually using pen & paper

- At first, these were transferred to AutoCAD
- After 2017 when our Revit template was developed, the plans were transferred to Revit

All plans were drawn twice: by hand and on the computer



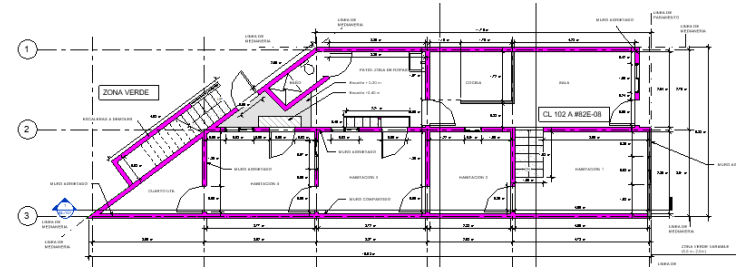
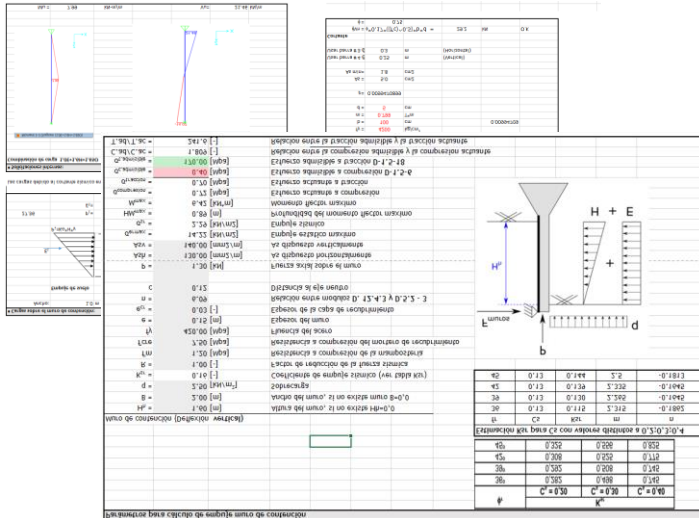
In the beginning...

Engineering calculations

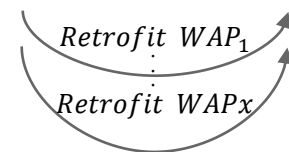
Calculations performed using a series of Excel spreadsheets

Including Wall Area Percentage calculations, requiring many iterations

$$\text{Wall Area Percentage} = \frac{\text{Cross section Wall Area}}{\text{Area of the House}}$$



$$\text{Actual WAP} \geq \text{Required WAP}$$

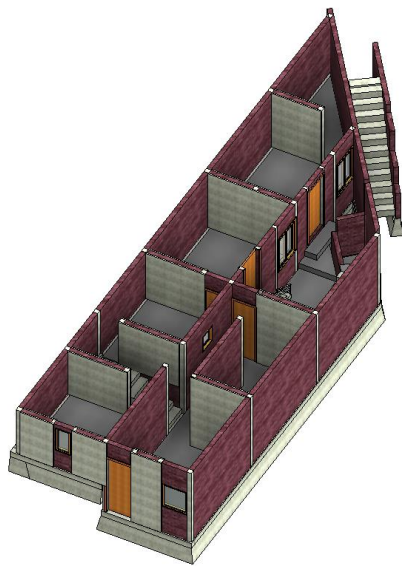


In the beginning...

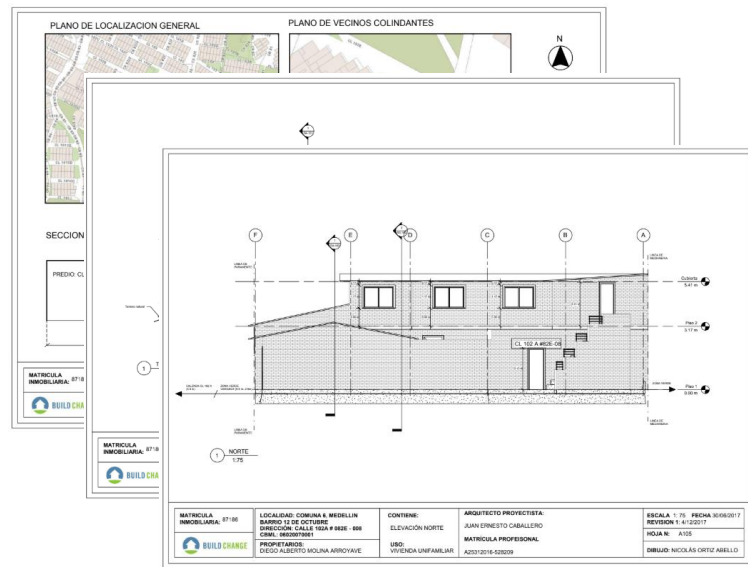
Creating the construction package



Existing Model



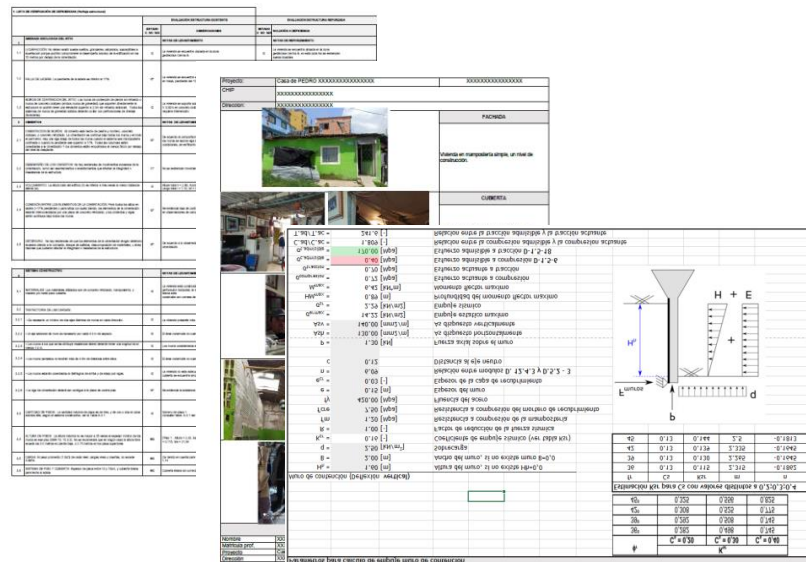
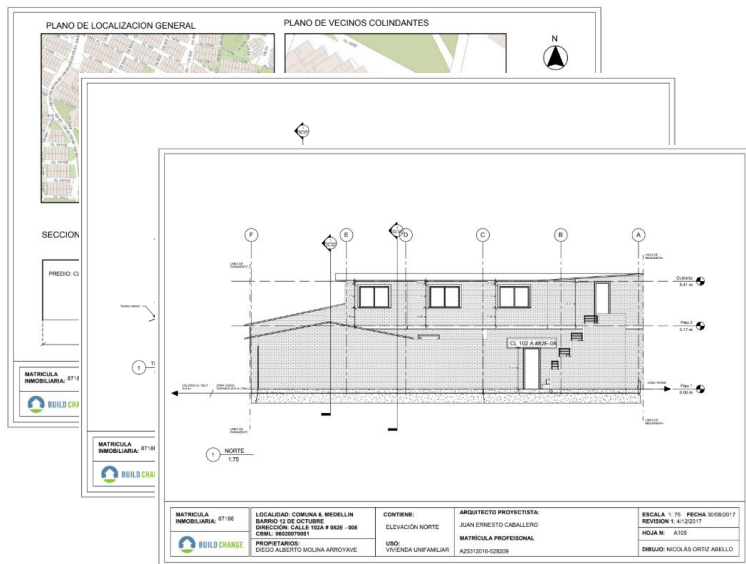
Retrofit Model



Construction Package

In the beginning...

Creating the construction package



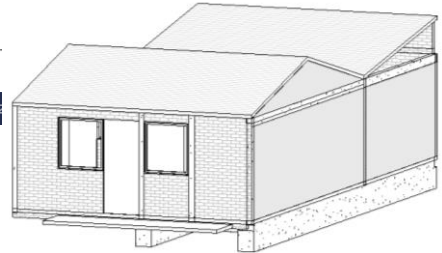
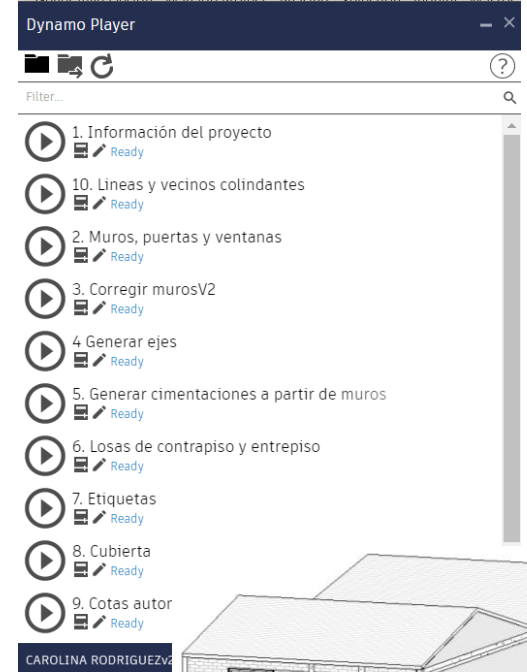
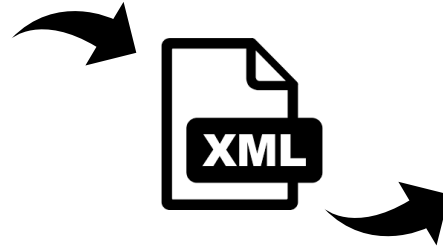
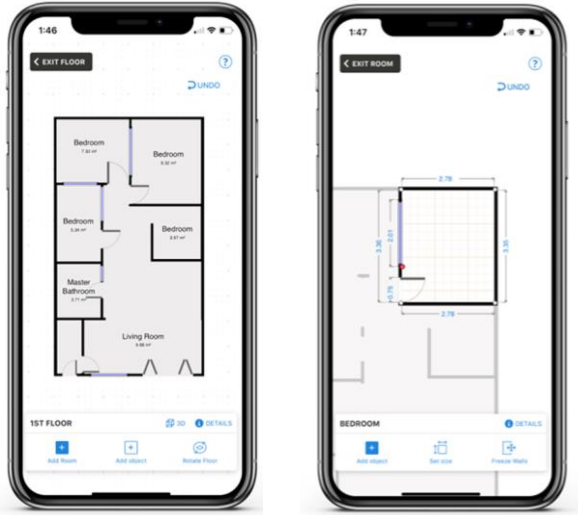
Construction Package

Floor plan capture to import



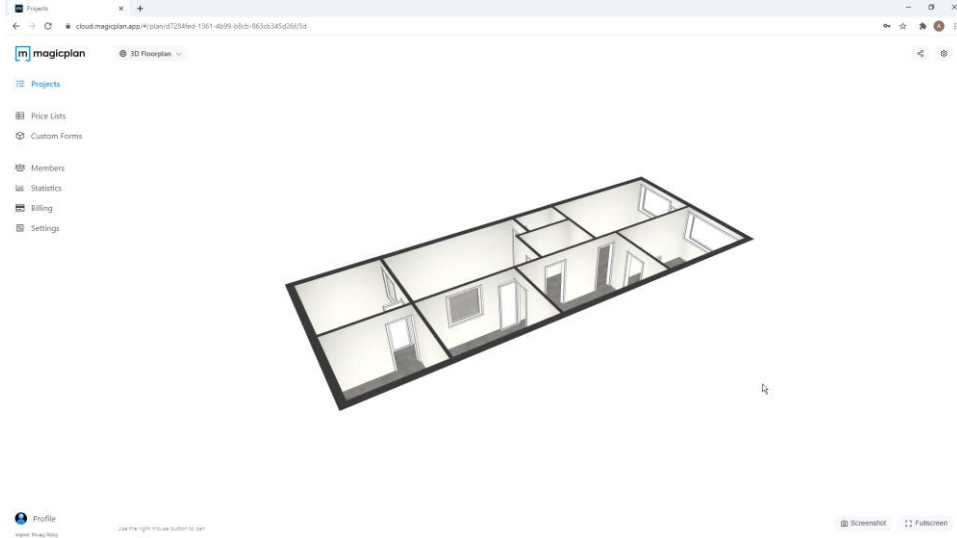
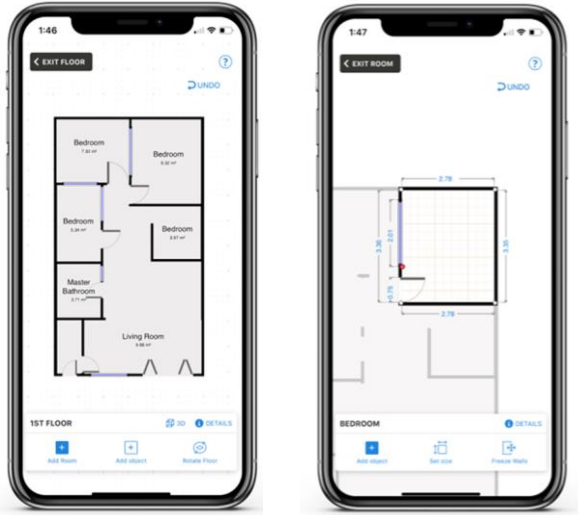
Automated workflow: importing to Revit

Floor plan capture to import



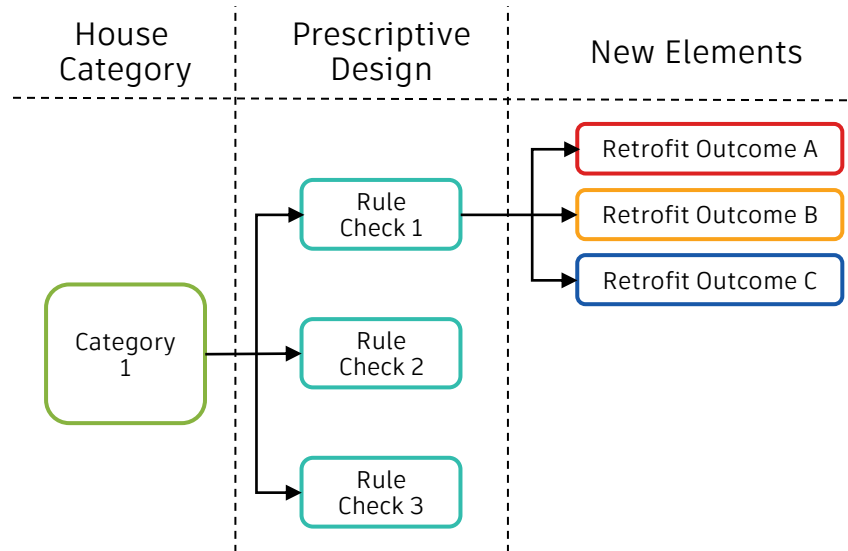
Automated workflow: importing to Revit

Floor plan capture to import



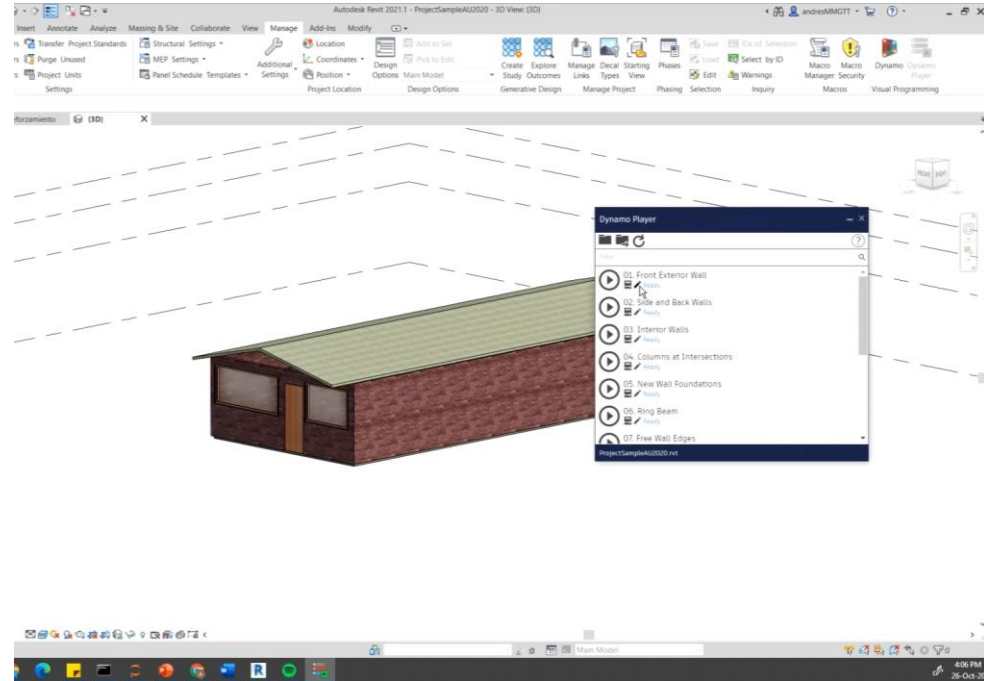
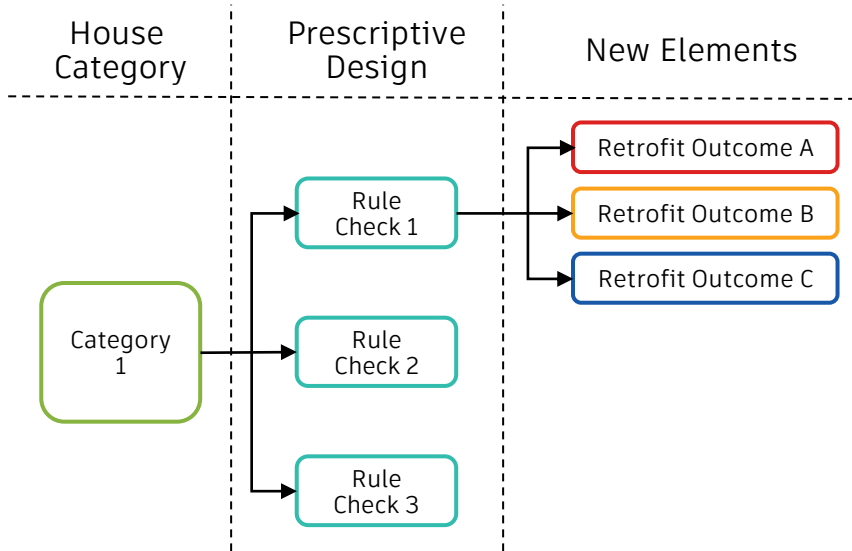
Automated workflow: retrofitting the house

Modifying and adding new structural elements to the house



Automated workflow: retrofitting the house

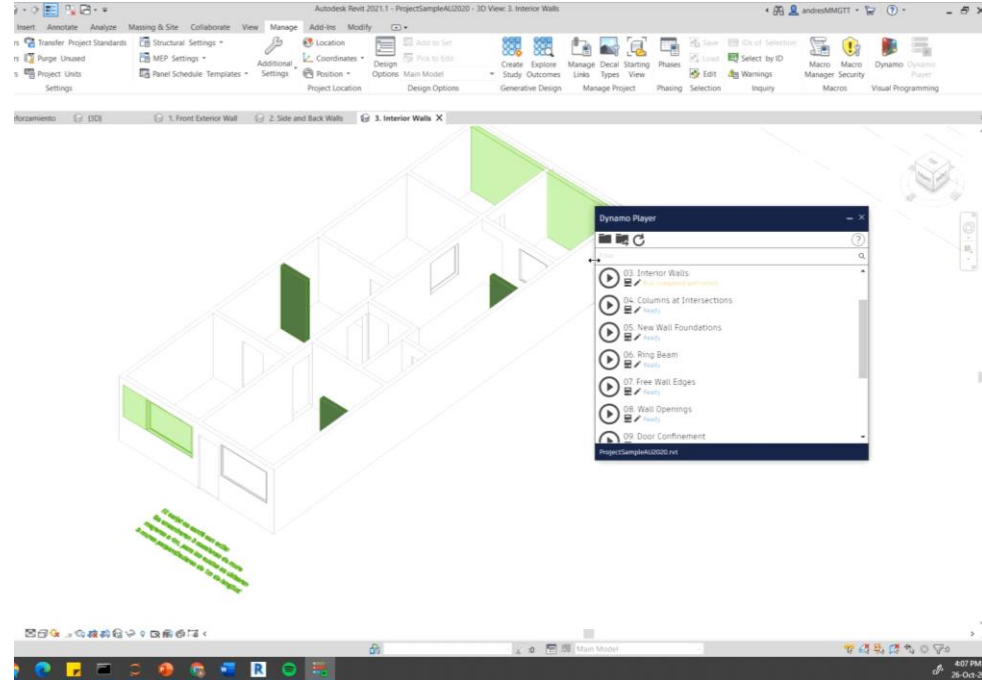
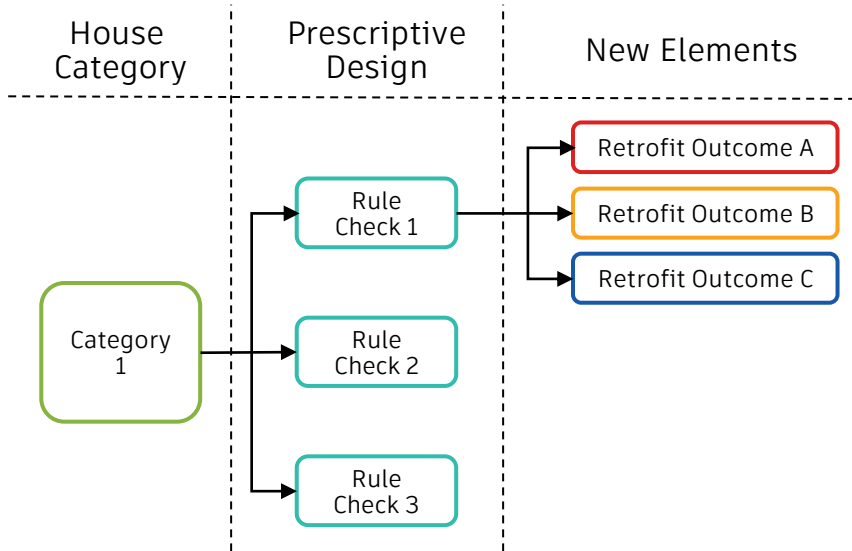
Modifying and adding new structural elements to the house



Front exterior wall script

Automated workflow: retrofitting the house

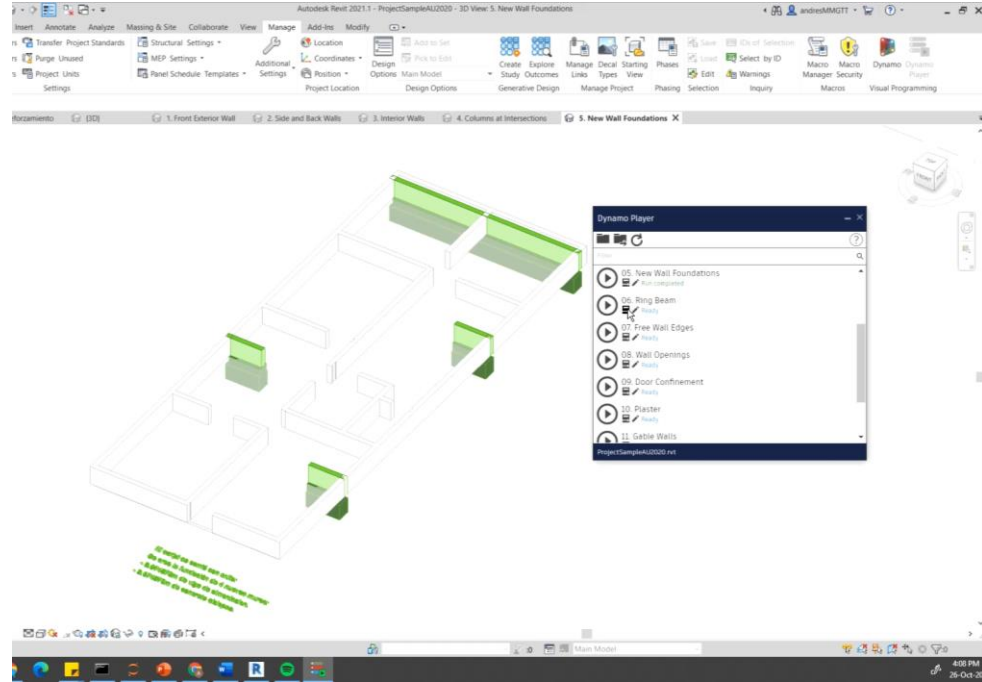
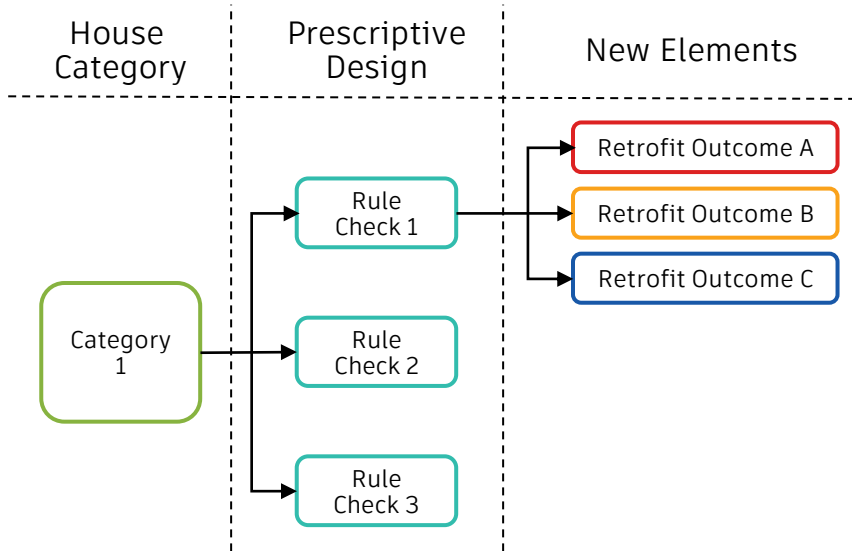
Modifying and adding new structural elements to the house



Columns at intersections of new walls script

Automated workflow: retrofitting the house

Modifying and adding new structural elements to the house



Ring beam and free wall edges scripts

Automated workflow: retrofitting the house

Interoperating with other platforms & performing calculations automatically

The screenshot displays the Autodesk Revit 2021.1.2 interface for a project named "RITO ANTONIO ROJAS - NEW TEMPLATE". The main view is a sheet titled "M100 - Registro fotografico". The Properties panel on the left shows the sheet's identity data, including its name, issue date, and author. The Project Browser on the right lists the project's structure, including the sheet and a Dynamo Player window.

The Dynamo Player window, titled "Dynamo Player", shows a list of five tasks:

- 01. Import Photos Fulcrum
- 02. PAM existente
- 03. PAM reforzamiento
- 04. LMIN y SIMETRIA
- 05. LVD

Each task has a "Ready" status. The Project Browser on the right also lists the project's structure, including the sheet and a Dynamo Player window.

The main view of the sheet, "M100 - Registro fotografico", contains a table with the following columns: Foto 1, Foto 2, Foto 3, and Descripción. The table is divided into three sections: FACHADA, CUBIERTA, and VENTANA. The FACHADA section contains a table with 4 rows and 4 columns. The CUBIERTA section contains a table with 4 rows and 4 columns. The VENTANA section contains a table with 4 rows and 4 columns. The table is divided into three sections: FACHADA, CUBIERTA, and VENTANA. The FACHADA section contains a table with 4 rows and 4 columns. The CUBIERTA section contains a table with 4 rows and 4 columns. The VENTANA section contains a table with 4 rows and 4 columns.

Foto 1	Foto 2	Foto 3	Descripción
			FACHADA
			Vista de la fachada de la casa existente. Se muestra la fachada de la casa existente. Se muestra la fachada de la casa existente. Se muestra la fachada de la casa existente.
			CUBIERTA
			Vista de la cubierta de la casa existente. Se muestra la cubierta de la casa existente. Se muestra la cubierta de la casa existente. Se muestra la cubierta de la casa existente.
			VENTANA
			Vista de la ventana de la casa existente. Se muestra la ventana de la casa existente. Se muestra la ventana de la casa existente. Se muestra la ventana de la casa existente.

The table is divided into three sections: FACHADA, CUBIERTA, and VENTANA. The FACHADA section contains a table with 4 rows and 4 columns. The CUBIERTA section contains a table with 4 rows and 4 columns. The VENTANA section contains a table with 4 rows and 4 columns.

Future Developments

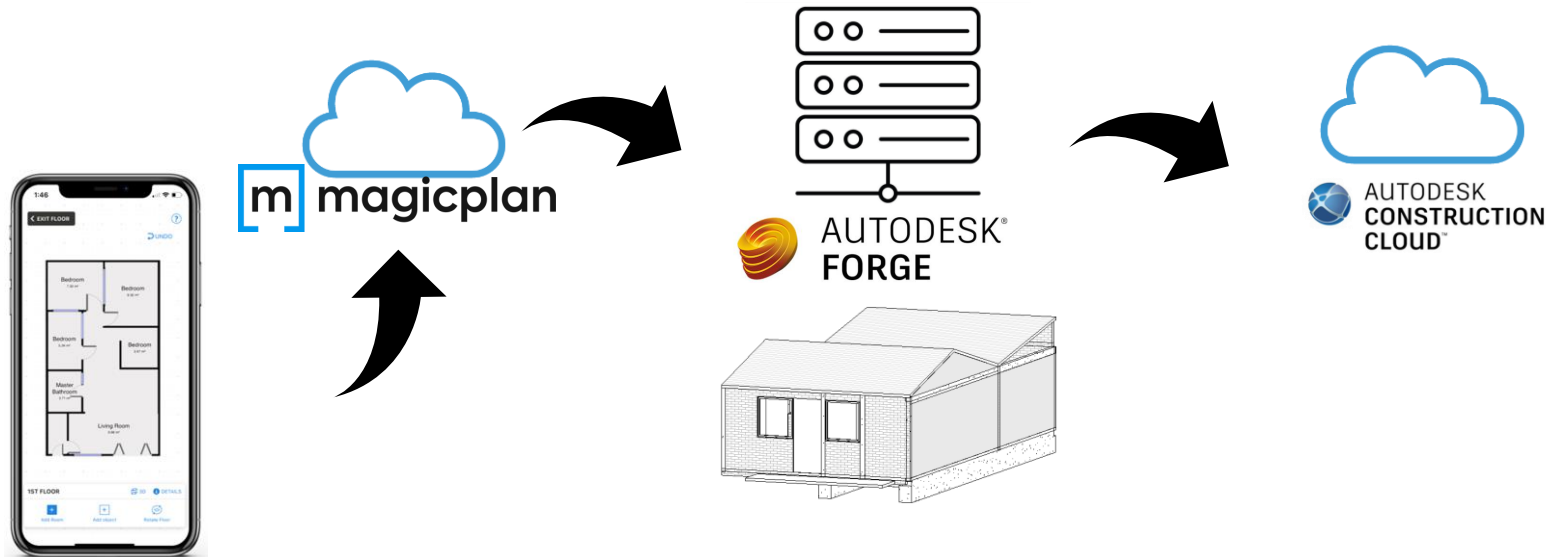
Goal:

A workflow that is automatic and accessible to users with limited Revit experience.

Current developments

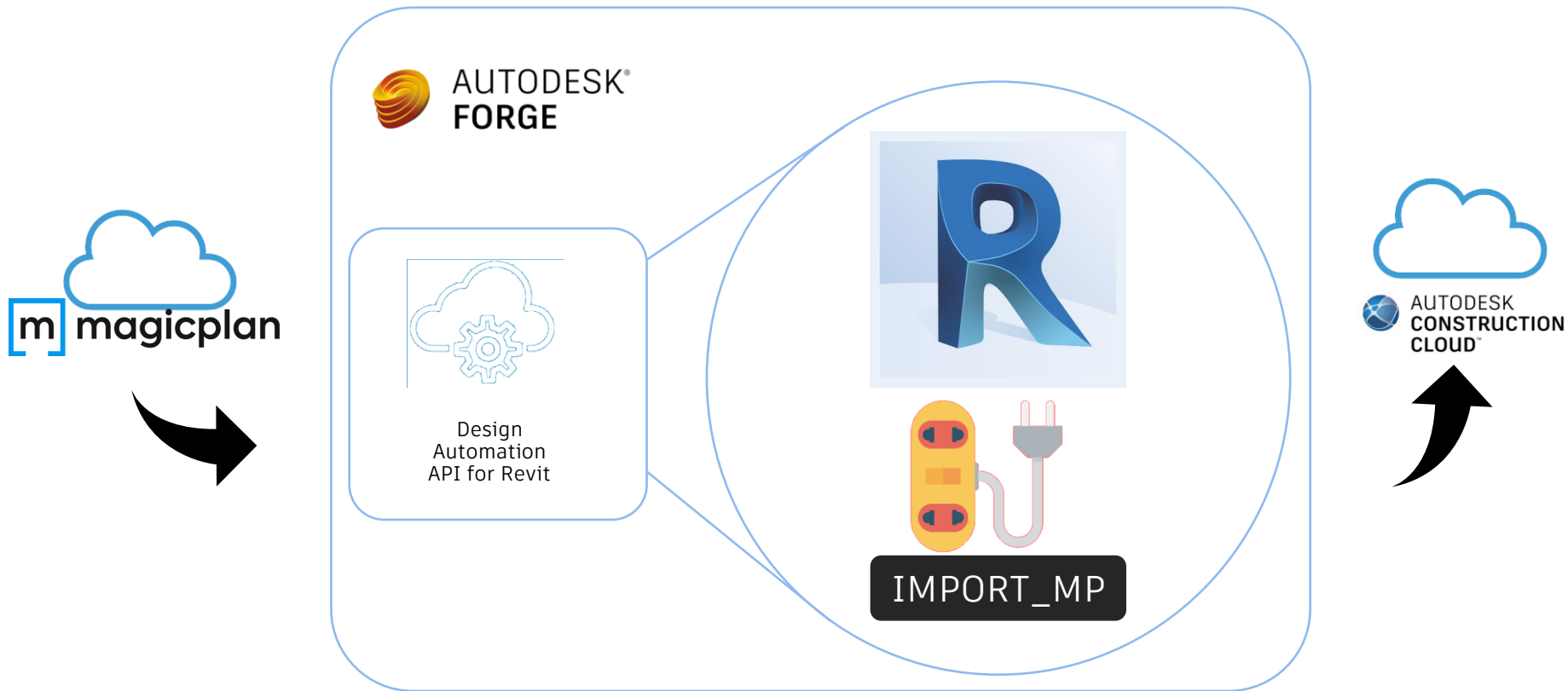
Moving the import process to the cloud

- First implementation of Forge – moving our import process to the cloud, allowing the user to catch errors in the Revit model in the field



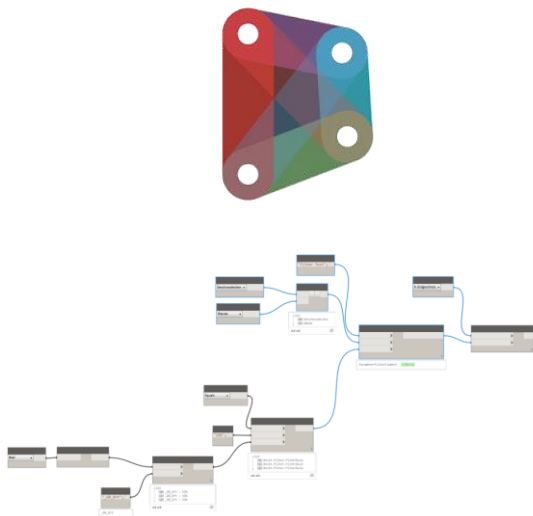
Current developments

Moving the import process to the cloud



Current developments

Moving the import process to the cloud

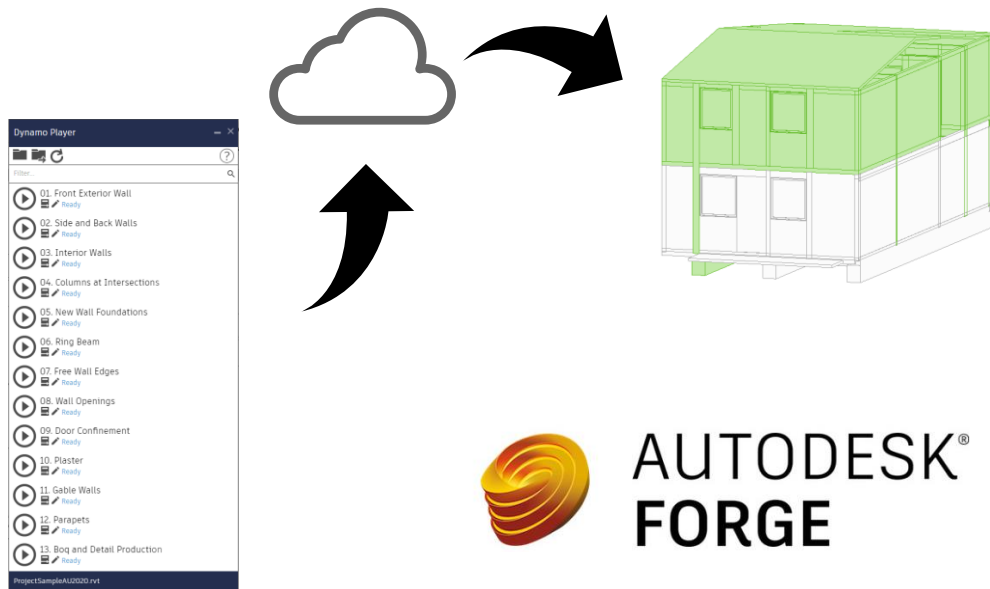


```
Program.cs
1 using System;
2
3 namespace DotnetBot {
4
5     public static class Program {
6
7         public static void Main(string[] args) {
8
9             string message = "";
10             if (args.Length < 1) {
11                 message = "Welcome to .NET Core!";
12             }
13             else {
14                 foreach (string item in args) {
15                     message += item;
16                 }
17             }
18         }
19     }
20 }
```

Next steps...

Moving more to the cloud

- Moving the automated retrofit workflow into the cloud – allowing users to run the workflow without needing to use Revit



The background features four abstract, dark, metallic-looking geometric shapes in the corners, resembling stylized computer monitors or architectural elements. They are arranged symmetrically, with two in the top corners and two in the bottom corners, all pointing towards the center.

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