

# SYNAPSE | Generative Engineering

Applying Generative Design to Engineering

*January - 2020*

# THE PROBLEM

Design and cost estimating are constraint by



**TIGHT DEADLINE**



**CHANGING INPUT DATA**



**PERSONAL EXPERTISE**

in a highly competitive and low-margin market

Design and cost estimating are **long** and **expensive**

**Differentiating solutions** are missed

# WHICH BENEFITS?

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## Optimal Performance

Explore a whole set of solutions to keep only the best one



## Risk Management

Increase reliability of the results by limiting human errors



## High and Secure ROI

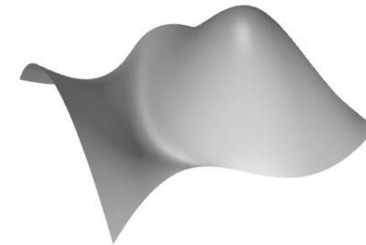
Time reduction of the design and cost estimating processes



# WHAT IS PARAMETRIC DESIGN?

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A method of **making the properties of a model or object parametric** for easy modification.



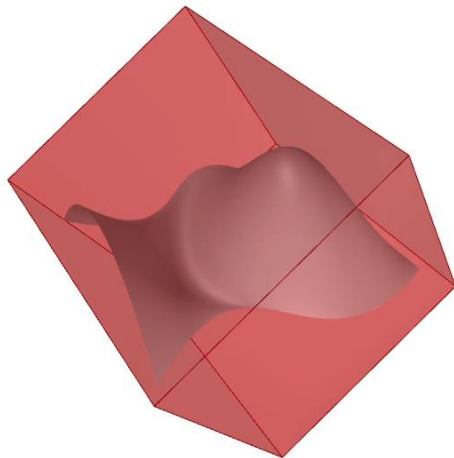
# WHAT IS GENERATIVE DESIGN?

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Parametric Design + Algorithms

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Productivity | Creativity | Savings



# GENERATIVE ENGINEERING

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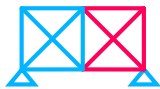
## Geometric Rationalization

3D modelling and advanced form-finding techniques to optimize complex geometries for design intent, constructability and project-specific needs.



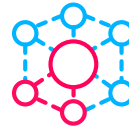
## Custom Software Development

Custom tools that augment, improve or replace the functionality of commercially available software.



## Structural optimization

Optimization tools and techniques use a dynamic structure model to browse through all existing solutions and to choose the best performing one.



## Interoperability

Use software APIs to streamline the design, analysis and documentation processes. Make easier communication between tools.



## Data-driven planning and design

Minimization of earth work, maximization of the positive impact of green areas and water views on inhabitants, etc.



## Data Analysis and Visualization

Provide insight by offering different modes of spatial data representation, mapping techniques and customized visualizations.



# WHO DOES SYNAPSE ADDRESS?

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All design, construction and asset managers



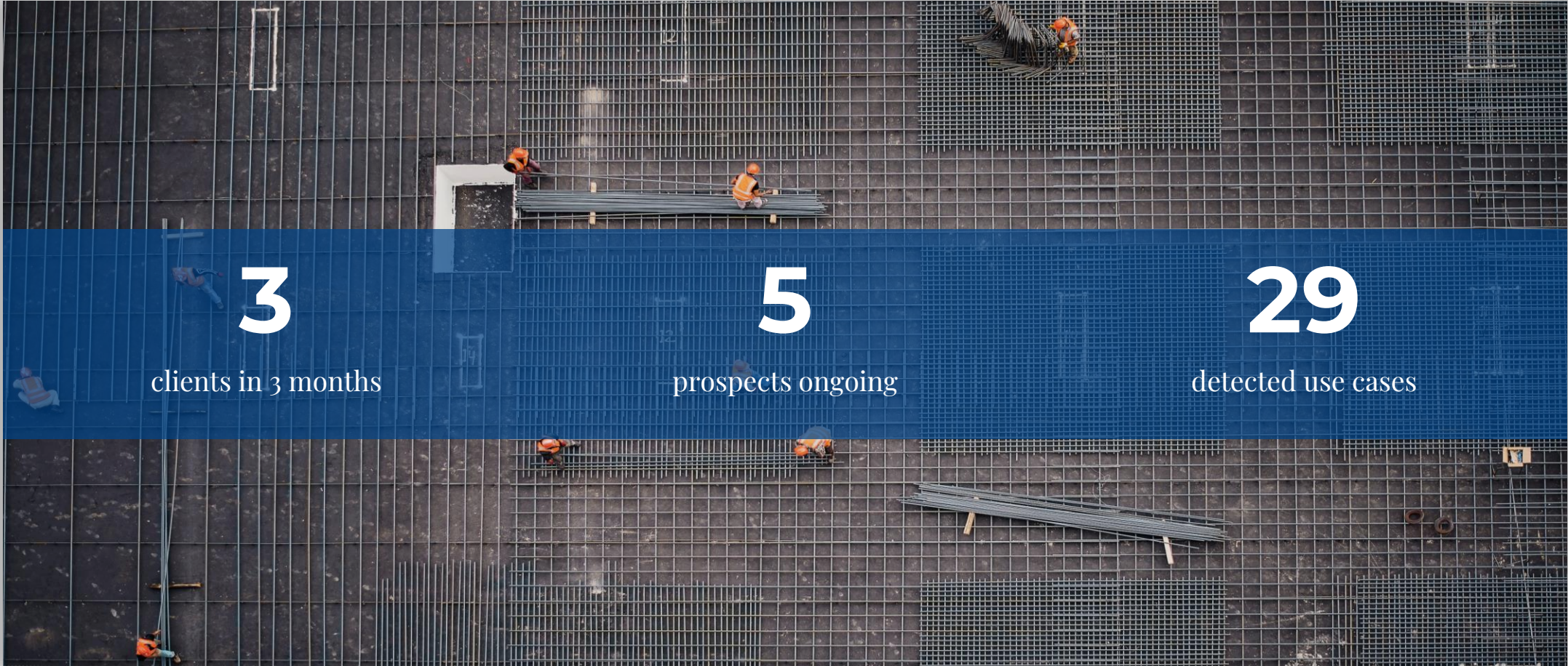
## Design issue

Design exploration, structural calculation, geometric optimization, form finding, planification, iterative process



## Cost estimating issue

Tight deadline, many iterations, multi-partyism



3

clients in 3 months

5

prospects ongoing

29

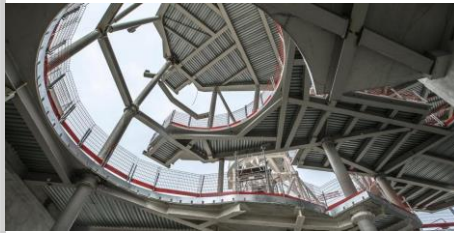
detected use cases



## USE CASES



- Space Management
- Operation cost estimating



- OptiTram
- Energy renovation\*
- Macro planning



- Gravel pit exploitation
- Sewerage system



- Foundations \*
- Retaining wall design (Berlin wall, Diaphragm wall)



- Stay cables
- Suspension cables



- Pipeline design tool \*



- Reinforced concrete box
- Tank



- HV electrical grids
- Cables supports
- Production lines



- Plan logistic
- Student accomodations
- Hospitals



\* Ongoing projects



# OUR TEAM

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Alexandre Cousin

Synapse Founder  
Method Engineer &  
Developer



Nicolas Metge

ISC Director  
Structural Engineer &  
Architect



Antoine Jacottin

R&D Civil Engineer



Romaric Quentin

R&D Mechanical Engineer  
& Computational Design



Tristan Barth

Architect



Sebastien Maitenaz

Laboratoire Navier PhD  
Structural Engineer



**2015**

Parametric Building

Truss Beam

Presidential rostrum design

Form Fiding (shell)

**2017**

Reinforced concrete box

**2019**

Space Planning

Energetic renovation panel

Steel frame robotization

**2016**

Bowstring bridge

Alignment optimization

Optipont

**2018**

OptiTrame

OptiMan

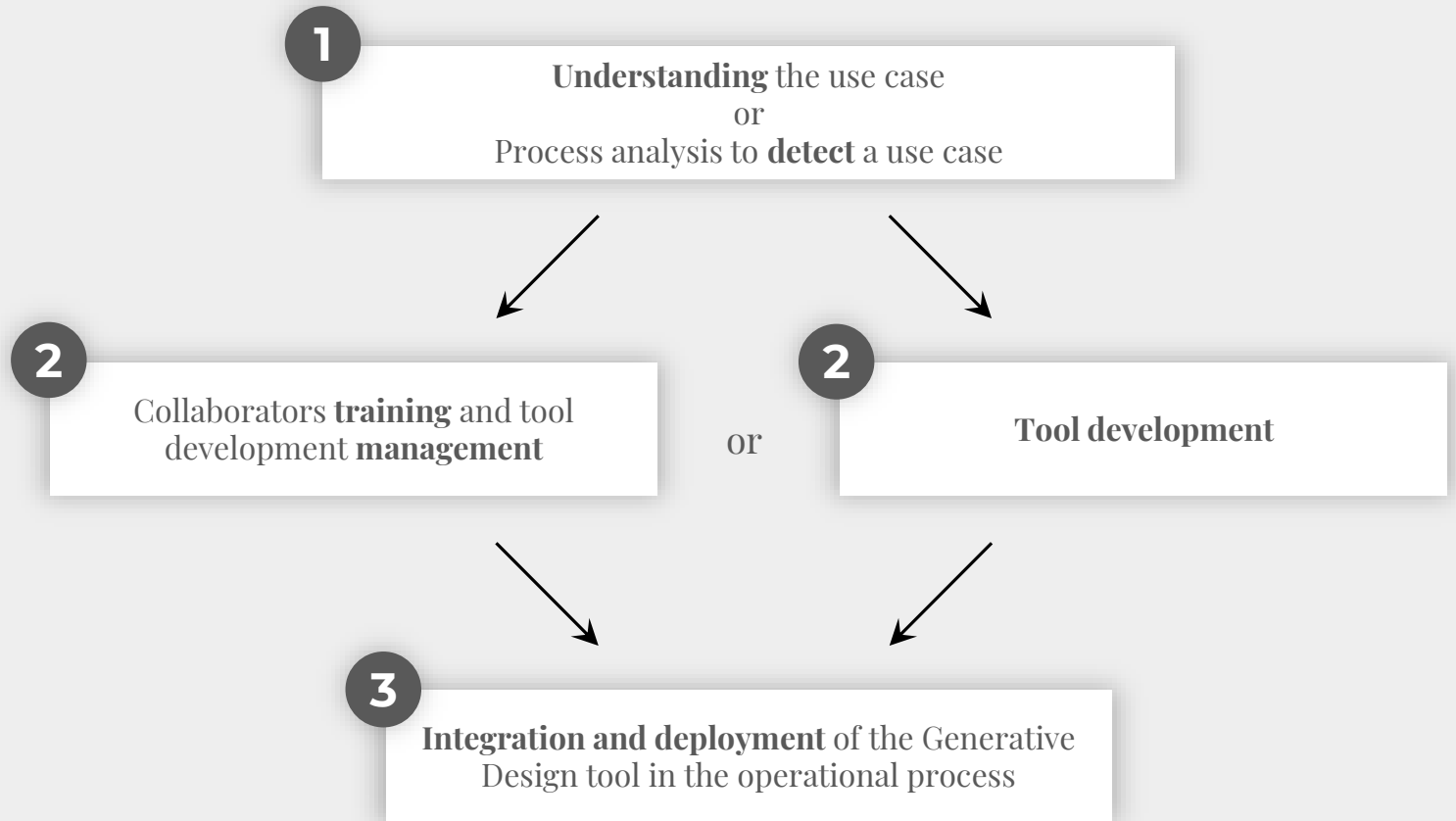
Tunnel ring sequence

Walkway design



# OUR PROCESS

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# OUR SERVICES

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## Consulting

Processes exploration  
Professional training  
Tool development management



## Software development

Understanding the problem  
Parametrization  
Optimization  
Integration



## Financing and exploitation

Investment  
Development  
Exploitation



# WHAT MAKE US BETTER?

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- 01. Technical knowledge**

All our team come from technical world. Structure engineer, method engineer, architect, etc.
- 02. Co-design**

We co-design side by side the solution corresponding with your technical issue.
- 03. Integration**

A tool is made to be used. One of the most important steps the integration into your operational process.
- 04. AI & Optimization**

We master Artificial Intelligence and optimization technologies to create the most efficient tools.



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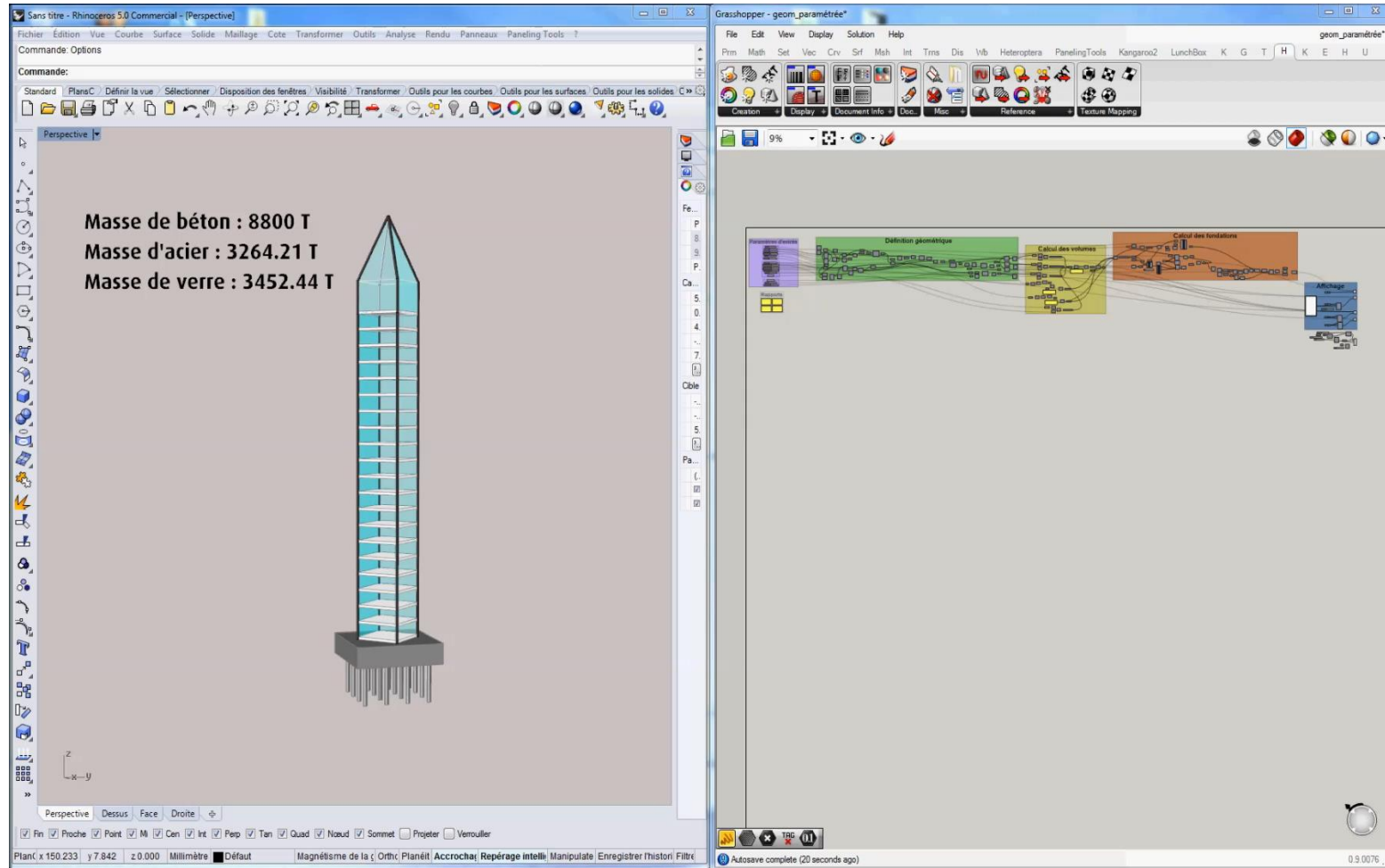
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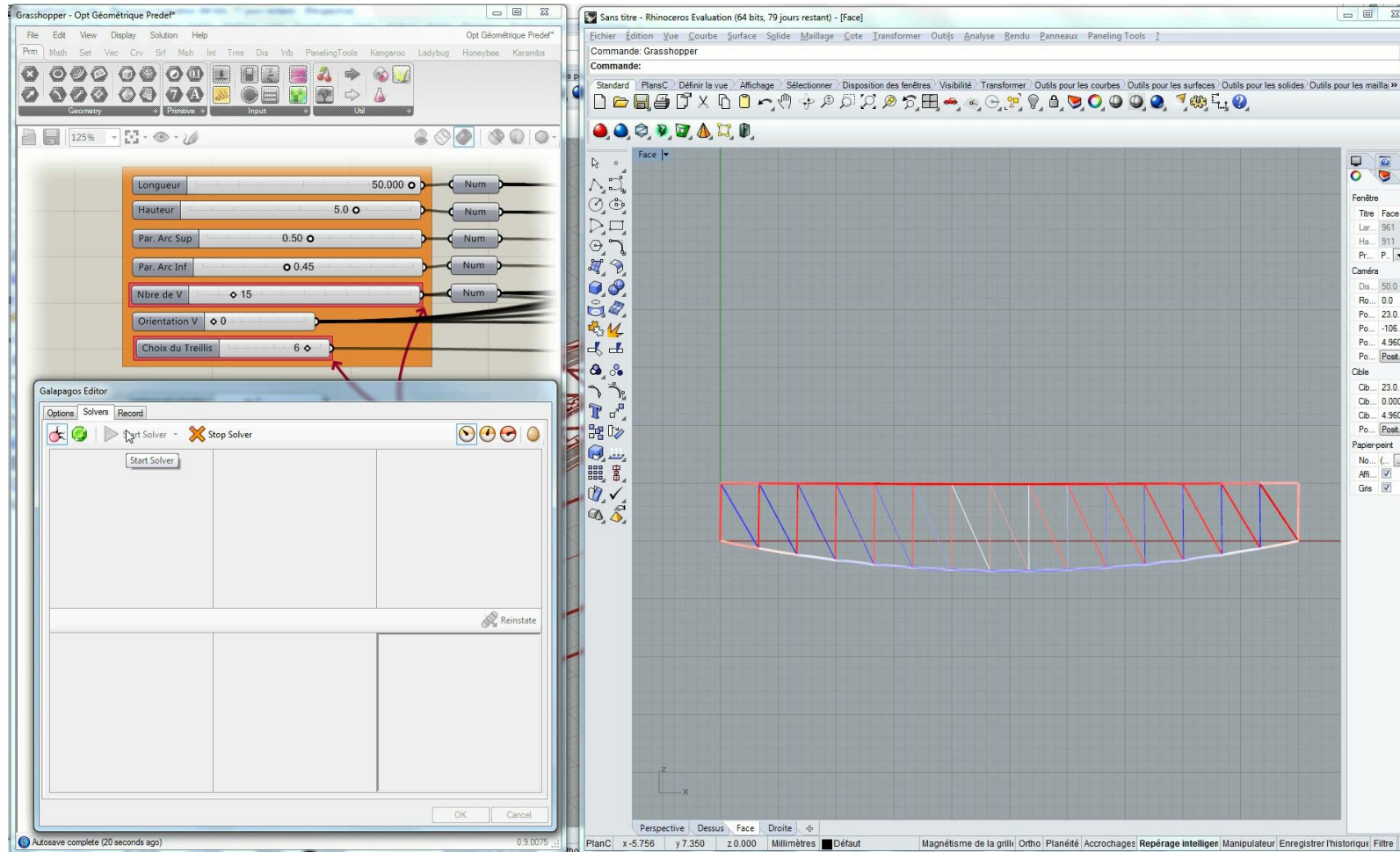
# Annexes



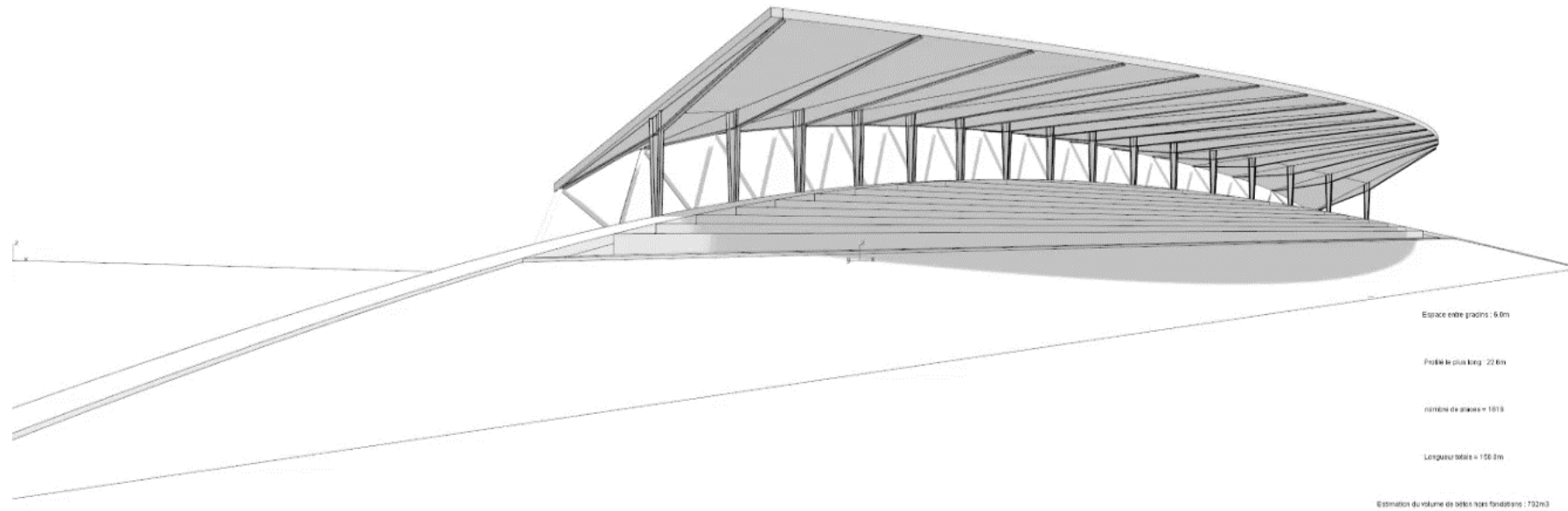
## 2015 – Parametric Building



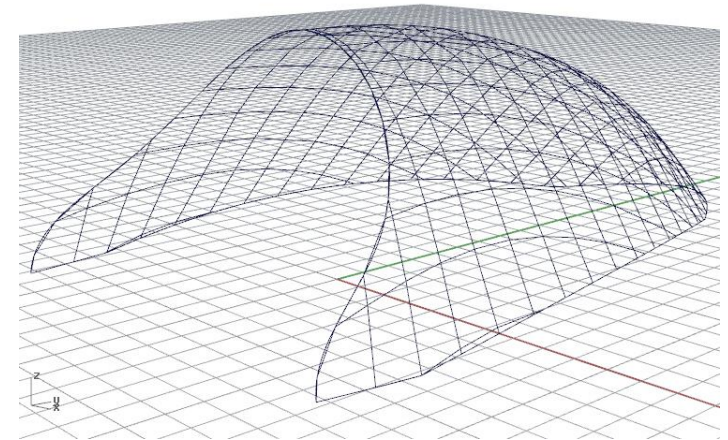
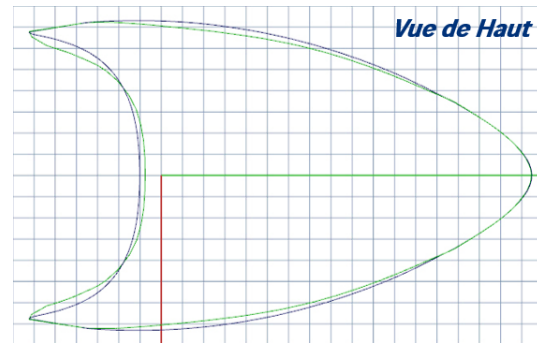
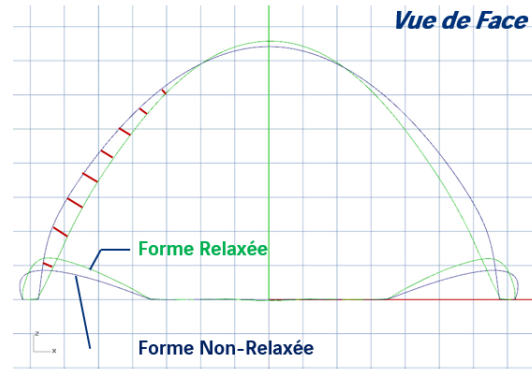
## 2015 – Truss Beam



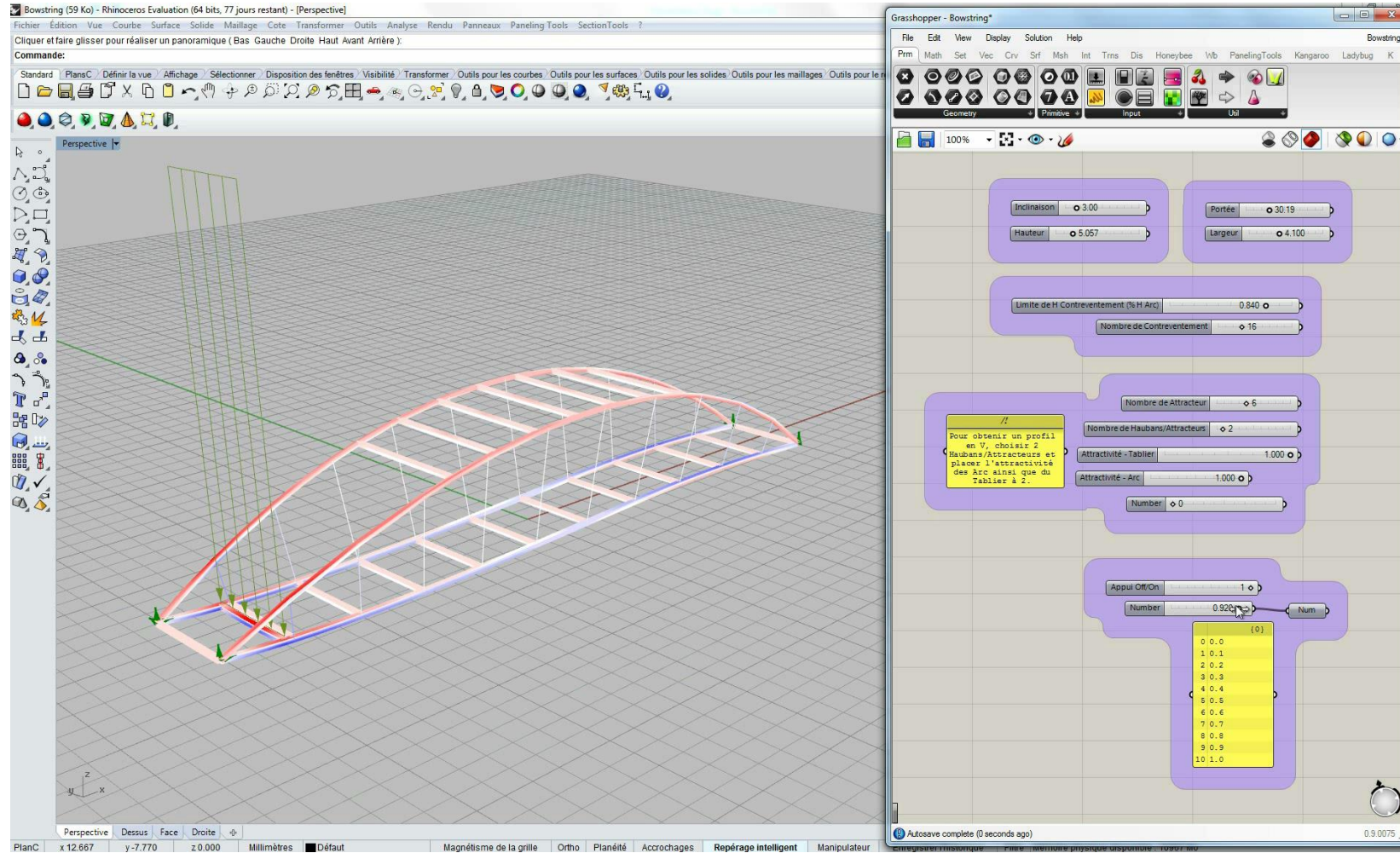
## 2015 – Presidential rostrum design



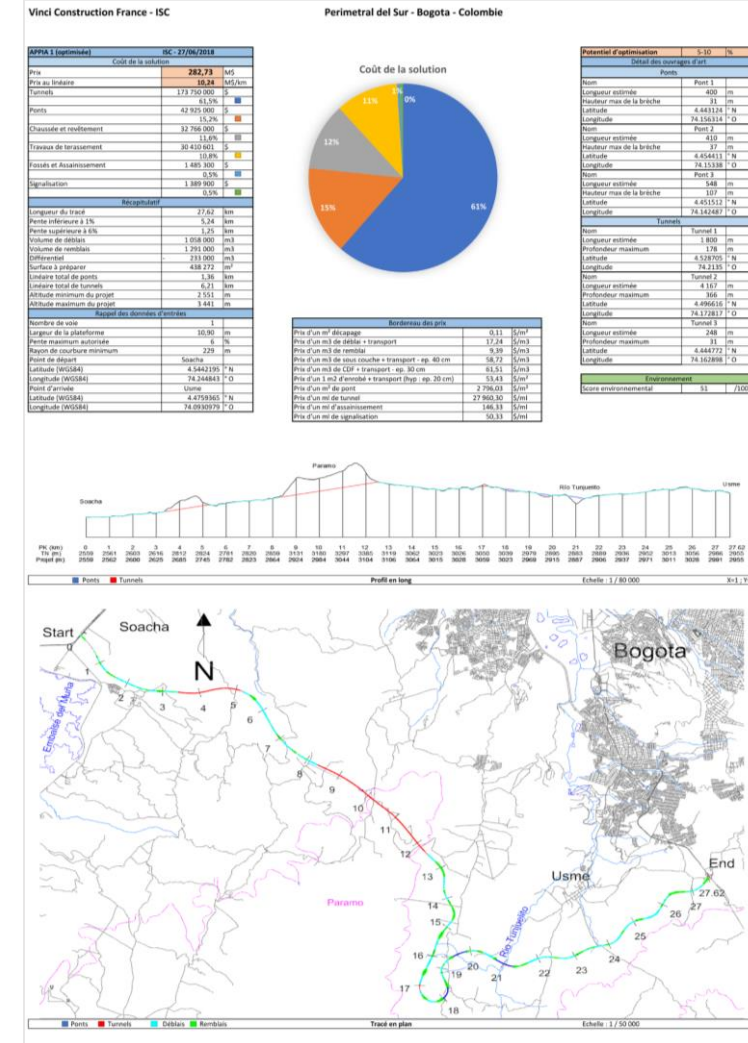
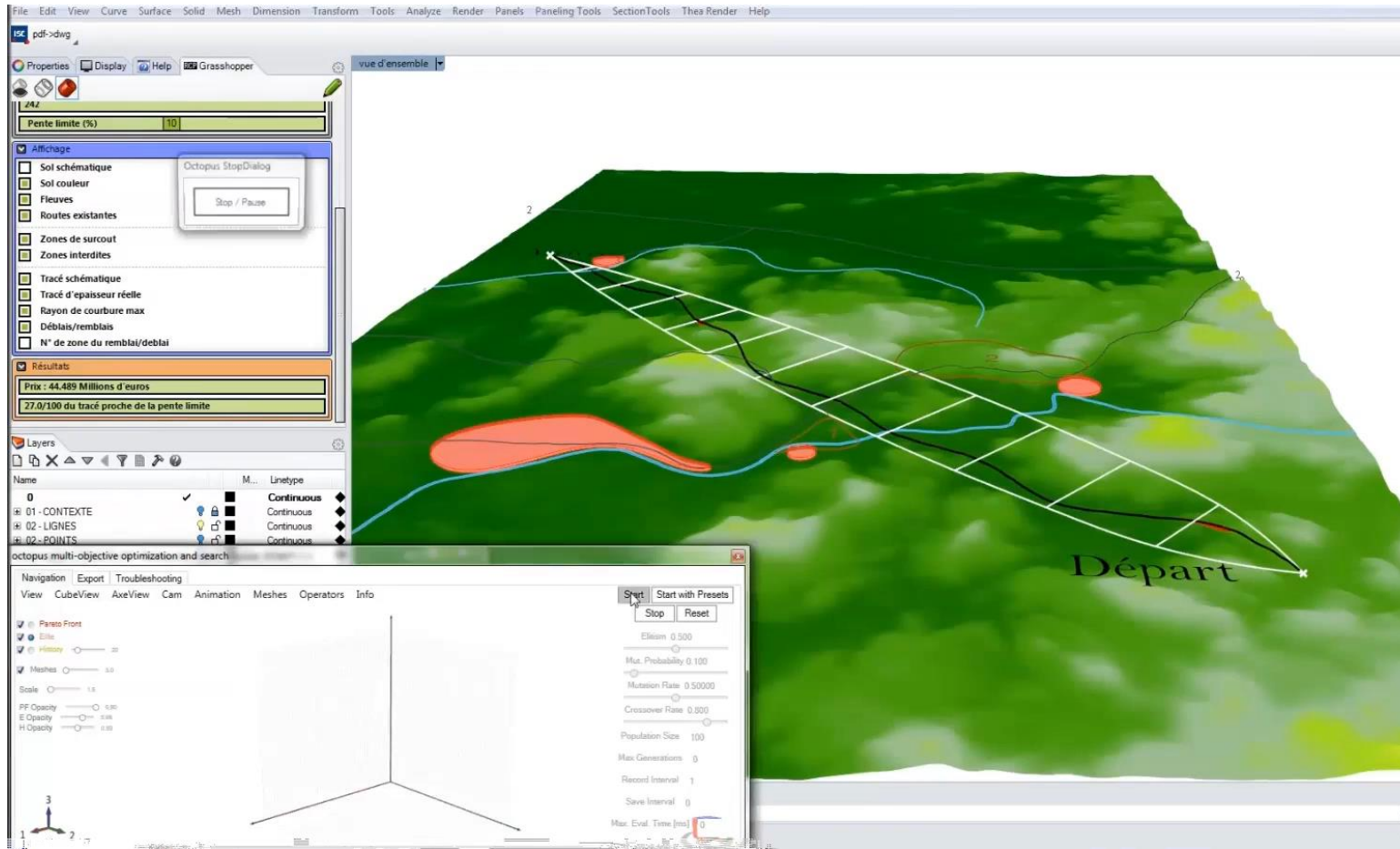
## 2015 – Forme Finding (shell)



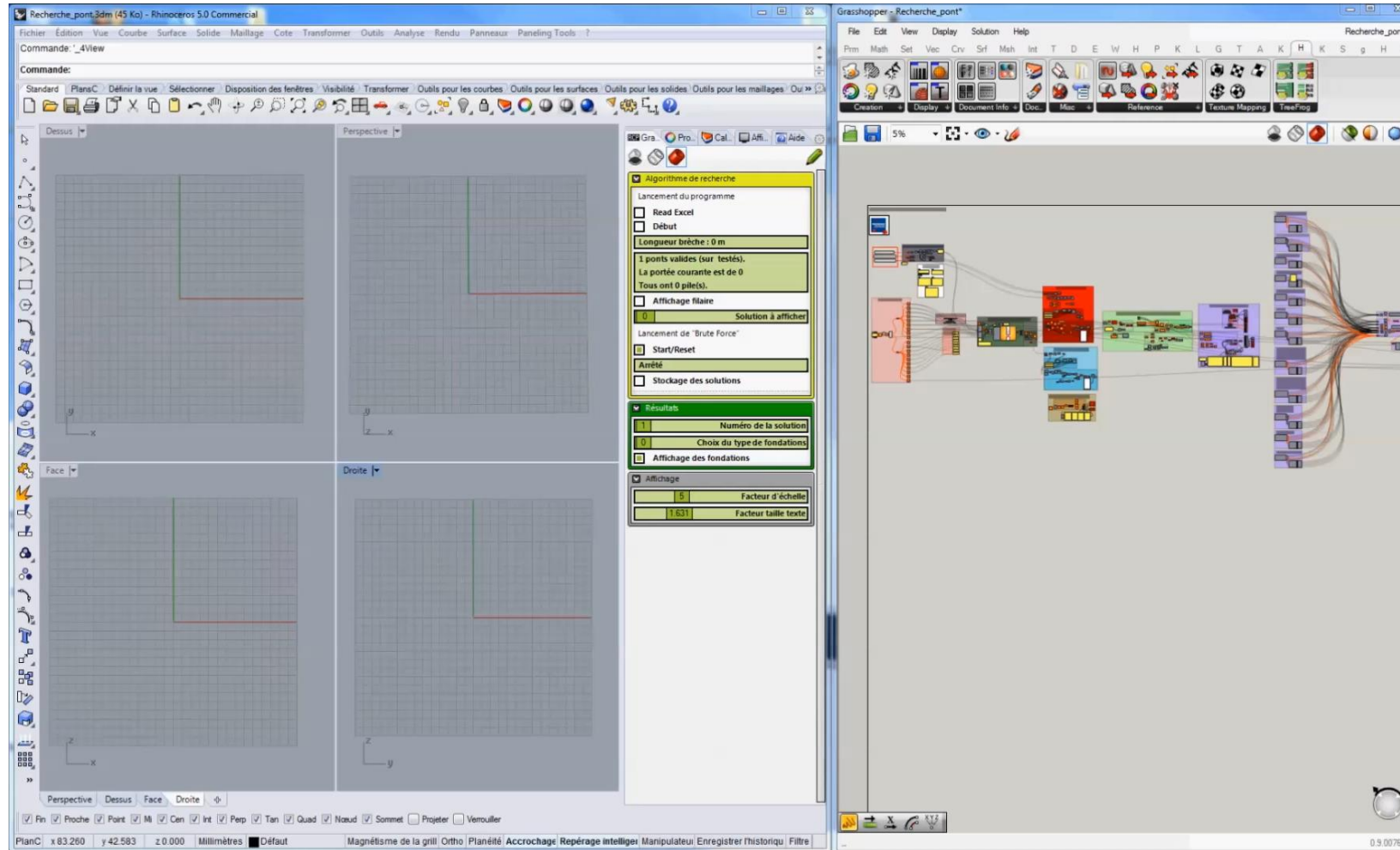
## 2016 – Bowstring bridge



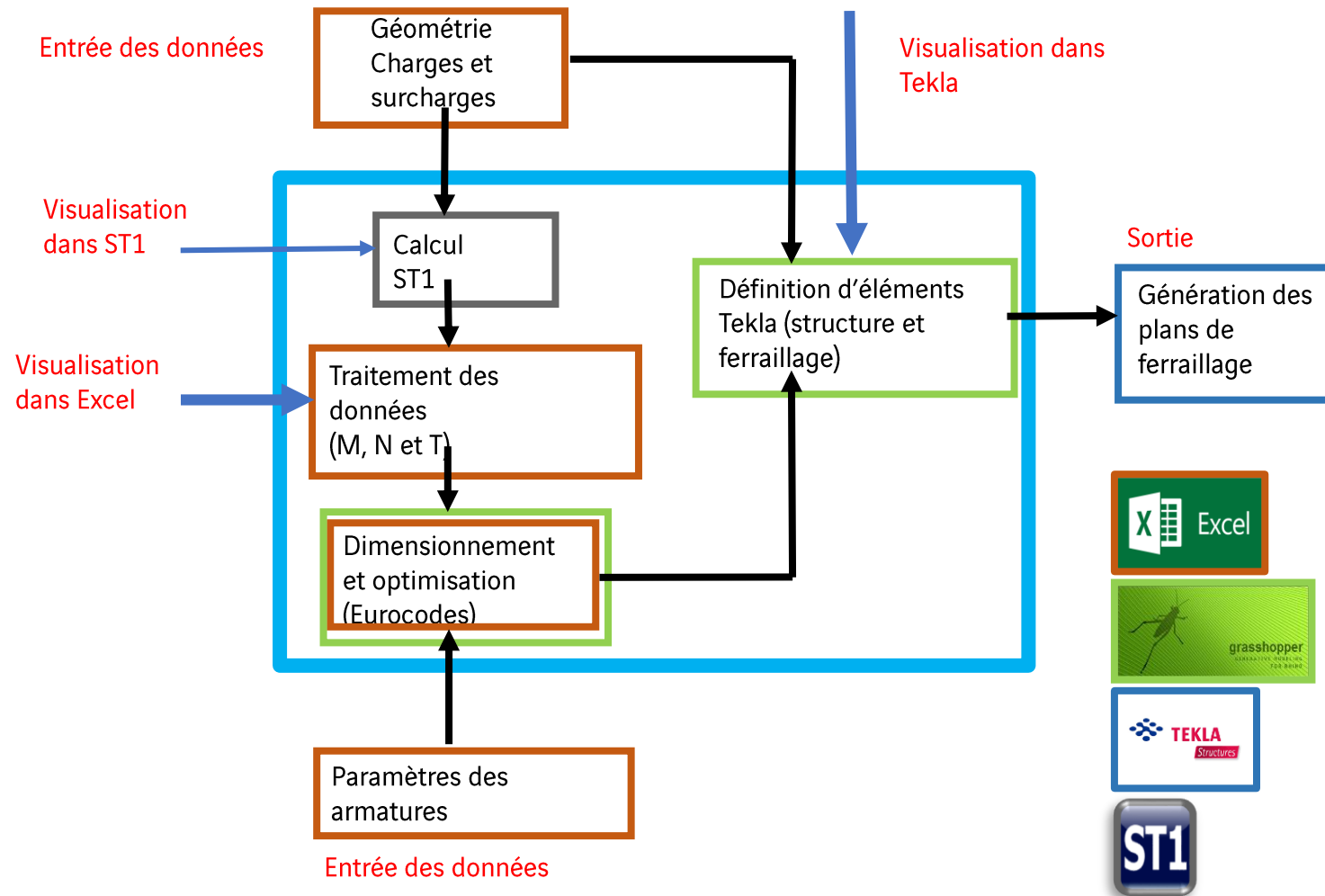
# 2016 – Alignment optimization



## 2016 – OptiPont



## 2017 – Reinforced concrete box





# 2018 – OptiTrame

Microsoft Excel interface showing the OptiTrame software. The window title is "DONNEES D'ENTREE - Excel" and the user is "PEDROSA TORRES Pedro-henrique". The ribbon includes "Fichier", "Accueil", "Insérer", "Mise en page", "Formules", "Données", "Révision", "Affichage", "Développeur", and "Dites-nous ce que vous voulez faire".

The main content area displays the "OptiTrame" interface with several data tables:

- Données matériaux:**

Acier	30 MPa	f <sub>td</sub>	402 MPa
Paroi béton	22 MPa	f <sub>td</sub>	230 MPa
Acier	30 MPa	f <sub>td</sub>	402 MPa
- Chargement:**

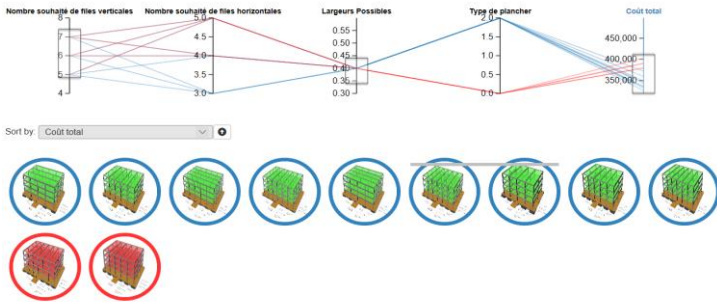
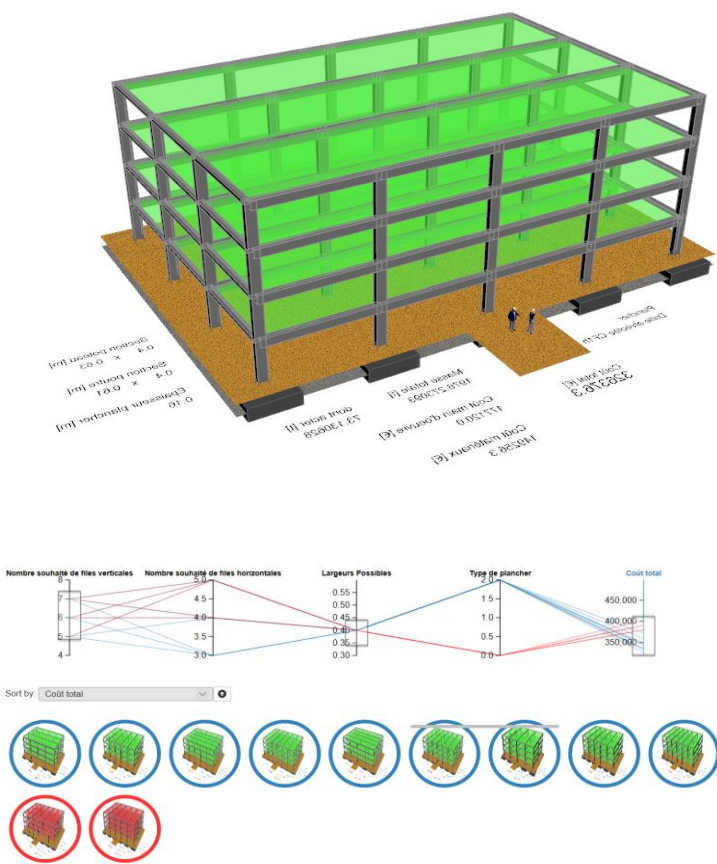
Chargement	2.0 kN/m²
Chargement	2.0 kN/m²
- Planchers:**

Epaisseur min	8.0	cm
Epaisseur max	10.0	cm
Epaisseur min	8.0	cm
Epaisseur max	10.0	cm
- Poutres:**

Epaisseur min	18.0	cm
Epaisseur max	24.0	cm
Epaisseur min	18.0	cm
Epaisseur max	24.0	cm
- Poteaux:**

Epaisseur min	18.0	cm
Epaisseur max	24.0	cm
Epaisseur min	18.0	cm
Epaisseur max	24.0	cm
- Fondations:**

Epaisseur min	18.0	cm
Epaisseur max	24.0	cm
Epaisseur min	18.0	cm
Epaisseur max	24.0	cm



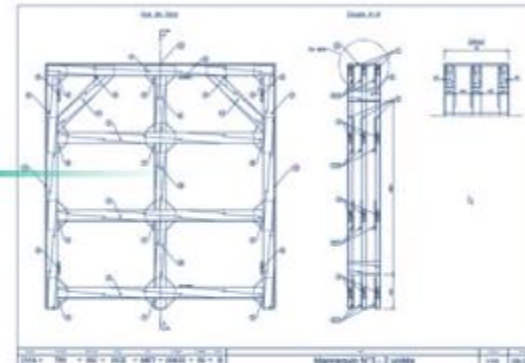
## 2018 – OptiMan



1. Récupération des dimensions des mannequins depuis la maquette BIM

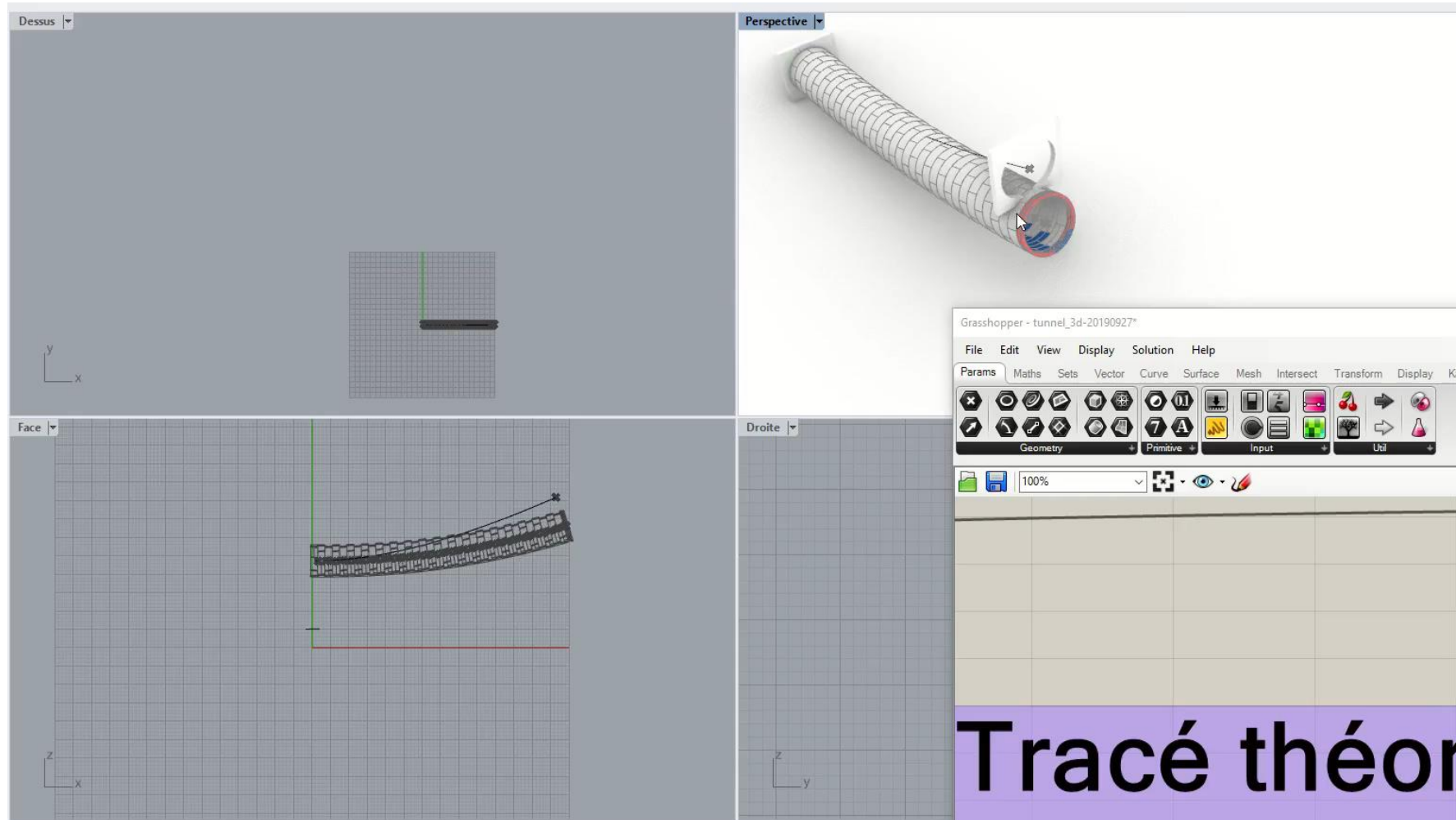


2. Optimisation de la conception des mannequins dans OPTIMAN

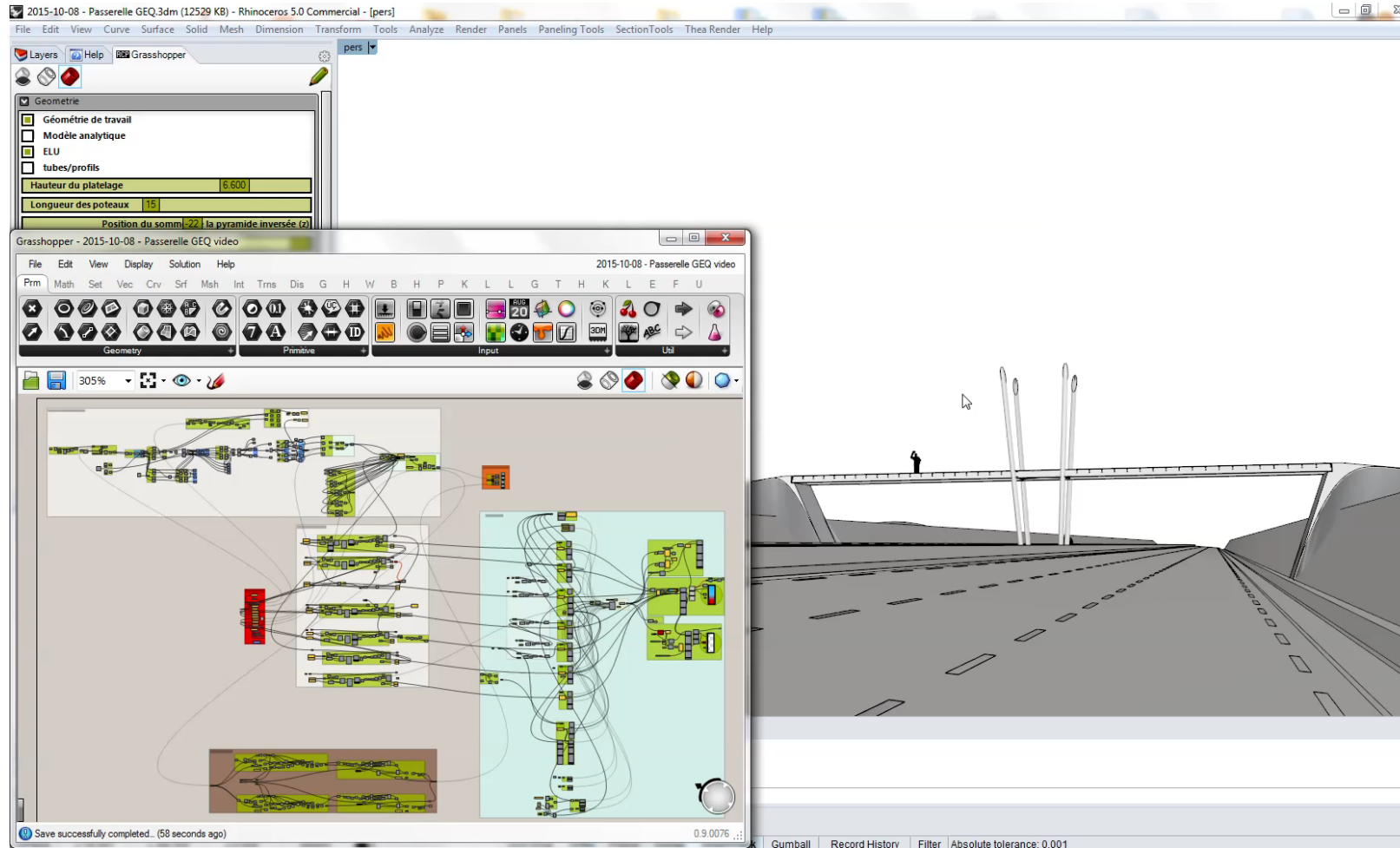


3. Automatisation des plans de fabrication des mannequins

## 2018 – Tunnel ring sequence



## 2018 – Walkway design



## 2019 – Space Planning

The image shows a screenshot of the Grasshopper software interface. The main workspace is a large grid with a mouse cursor. The top menu bar includes options like Standard, Plans, Définir la vue, Affichage, Selection, Disposition des fenêtres, Visibilité, and Transformer. The right-hand side of the interface features a toolbar with various tools categorized into Geometry, Primitive, and Input. Below the toolbar, there is a panel titled "Etape1" with the following text:

**Etape1**

Pour commencer, veuillez tracer la forme du couloir (polyline fermée ou ouverte)  
Pour créer une jonction en T, il suffit de connecter plusieurs polylines.

Below this text is a section titled "Exemples" showing three workflow diagrams:

- Diagram 1: Two 'Int' inputs connected to a 'Pt' component, which is connected to a 'PLine' component. The 'PLine' component is connected to a 'BATIMENT\_LINEAIRE' component.
- Diagram 2: Two 'Int' inputs connected to a 'Pt' component, which is connected to a 'PLine' component. The 'PLine' component is connected to a 'BATIMENT\_EN\_L' component.
- Diagram 3: Two 'Int' inputs connected to a 'Pt' component, which is connected to a 'PLine' component. The 'PLine' component is connected to a 'BATIMENT\_EN\_U, OU, EN, DONUT' component. A 'Toggle' component is also connected to the 'PLine' component.

On the right side of the "Exemples" section, there is a small diagram showing a yellow 'Crv' component connected to a 'COULEUR' component.

## 2019 – Energetic renovation panel

The screenshot displays a CAD software interface for a 3D model of an energetic renovation panel. The model is a red rectangular structure with a grid of 6.1cm x 6.1cm cells. A dimension line indicates a length of 5.99. The software interface includes a top toolbar, a left sidebar with various tools, and a right sidebar with analysis and display settings. A central panel displays a flowchart for "Calcul des déformations et optimisation de la section".

The flowchart shows the following steps:

- Model** (Inputs: ElemIds, GroupIds, CroSecs, MaxInfil, MaxDisp, Settings) feeds into **OptCroSec**.
- OptCroSec** feeds into **Model** (Inputs: Infil, Mass, Disp, Energy).
- Model** feeds into **Analyze** (Inputs: Model, Disp, G, Energy).
- Analyze** outputs **Déplacement maximal** (Values: 0.378462, 1.3439267).
- Analyze** feeds into **ModelView** (Inputs: R-Factor, ResCase, Color, Ids@repr).
- ModelView** feeds into **Model** (Inputs: Mesh, Curves, Legend C, Legend T).
- Model** feeds into **BeamView** (Inputs: Section Forces).

The right sidebar contains the following settings:

- Display Scales:** Deformation (0.13.91), Reactions (0.77), Loads (0.17), Supports (0.14), Local axes (0.67), Joints (1).
- Render Settings:** Length/Segment [m] (0.73), Upper Result Threshold (100).
- Section Forces:** Filled, Numbers, Scale (0.17), Mx, My, Mz, Nx, Vy, Vz.
- Render Settings:** Cross section, Axial Stress, Utilization, Displacement, Faces/Cross section (2).

The status bar at the bottom shows "Autosave complete (140 seconds ago)" and "1.0.0007".

## 2019 – Steel frame robotization

