Assignment

2D Project – Parachute Design and Prototyping

Context

Freshmore Term 1

Course

Computational Design Thinking

Date

2020

Student

Student Names Student IDs

Instructor

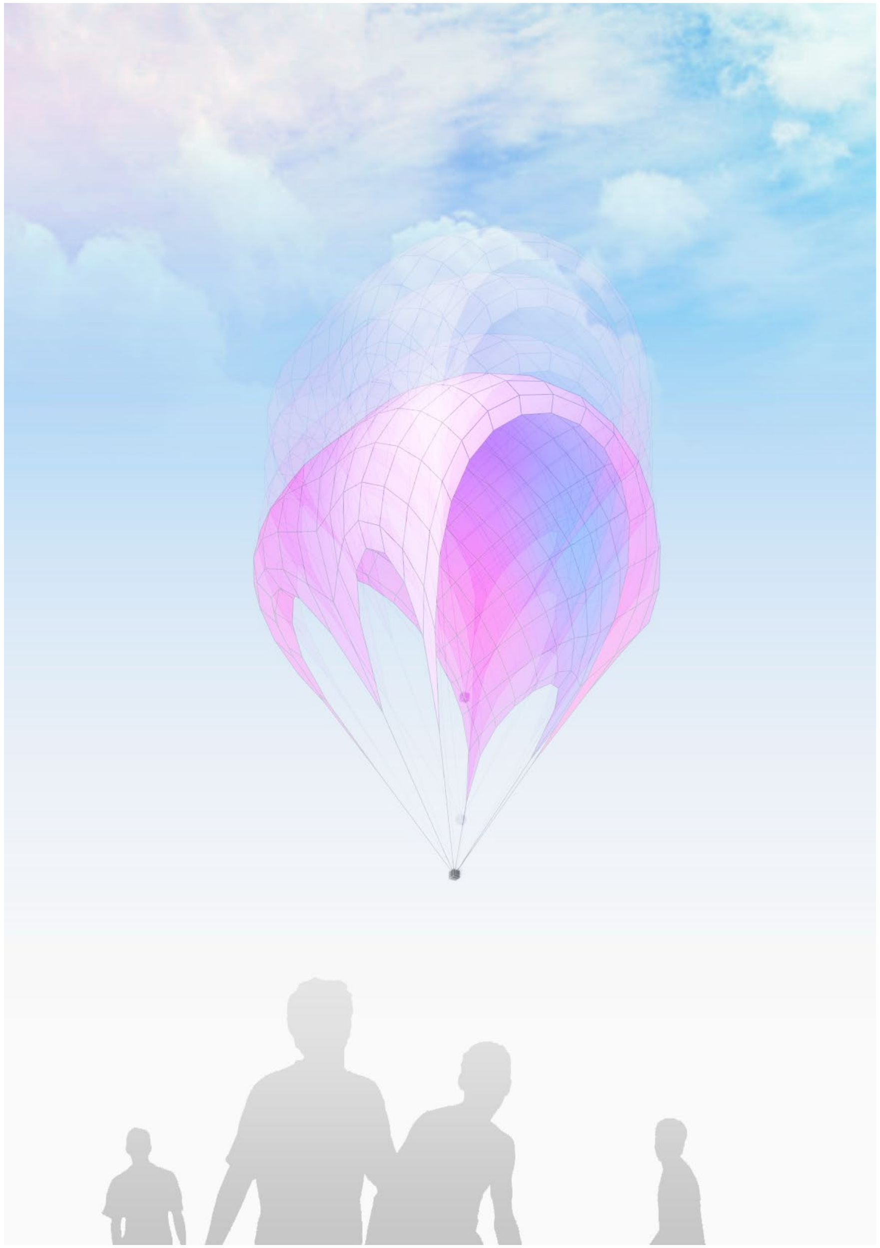
ASD Instructor ISTD Instructor

<Problem Statement>

Apply geometric modelling and simulation techniques to design the parachute of your emergency supply delivery system responsible for delivering the cargo within the following two constraints:

First, the parachute should have enough surface area (as determined from an optimization model developed in Modelling and Analysis) to slow down the descent of the airdropped supplies.

Second, the parachute should capture visual attention because it signals to people that vital and perishable supplies are being delivered to that location.



<Learning Objectives>

1. Apply physics-based computational methods implemented in a visual program to simulate forces acting on a loaded parachute system.

2. Set up and run simulation models to determine the form of the parachute system when deployed.

3. Generate design variations and select a solution that meets performative requirements.

4. Build a model describing the geometric cutting pattern of the parachute in a Computer Aided Design (CAD) environment.

<Measurable Outcomes>

1. To implement a computational simulation model based on real world physics.

2. To run the simulation model to generate geometric results.

3. To describe the inputs, algorithmic logic and outputs of the model through diagrams and animations.

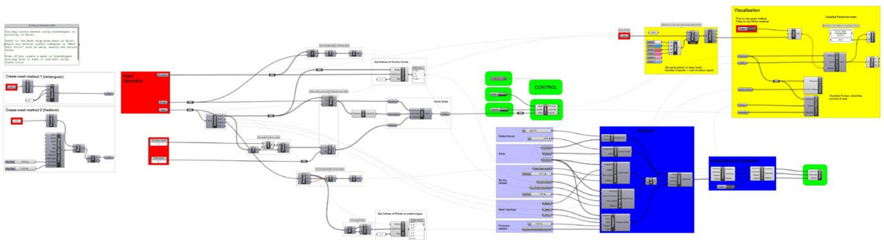
<Project files>

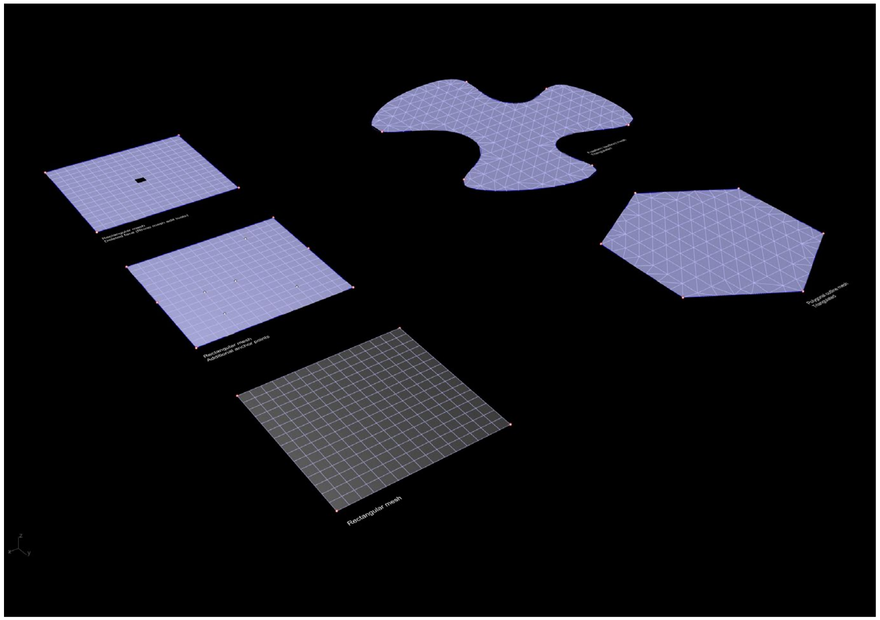
You are provided with a Grasshopper program and a Rhino file. Please download them from eDimensions.

<Deliverables>

Student groups are required to submit a 5-page PowerPoint report documenting their project using the given template by 30th November 2020.

The report will contribute 10% to the final mark for Computational Thinking Design course.





Captions

01 Overview of Grasshopper program
02 Overview of Rhino file

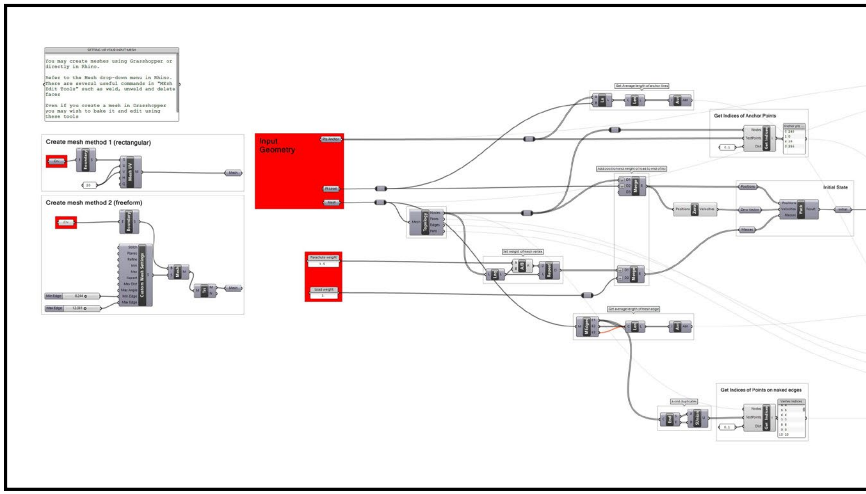
01

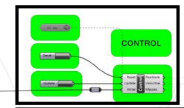
02

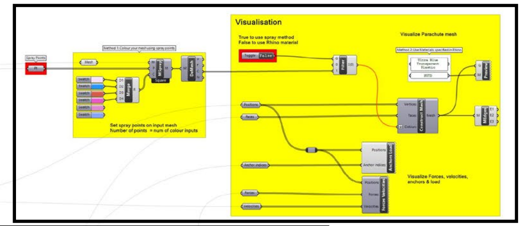
<Grasshopper Program Overview>
The Grasshopper definition provided is based on the Soap-film example introduced in week 5. There are four main parts: 1)Setup Model, 2)Simulation Controller, 3)Physics Logic and 4)Visualisation

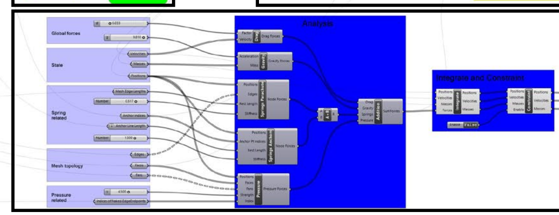
2) Sim Controller
Provides interactive controls to run and reset simulation and responsible for serialization/de-serialization

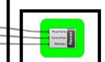
4) Visualisation
Provides custom vsiualisation of forces, velocities and parachute mesh











1)Setup Model
Responsible for either referencing or generating initial mesh describing flat parachute and all subsequent data required–initial state, spring lengths, topological information etc.–for downstream parts of program.

3)Physics Logic
Responsible for setting up drag, gravity, spring and pressure forces and their relative magnitudes.
Integrates forces to determine next state of each particle in system.
Includes an optional constraint system.

Captions

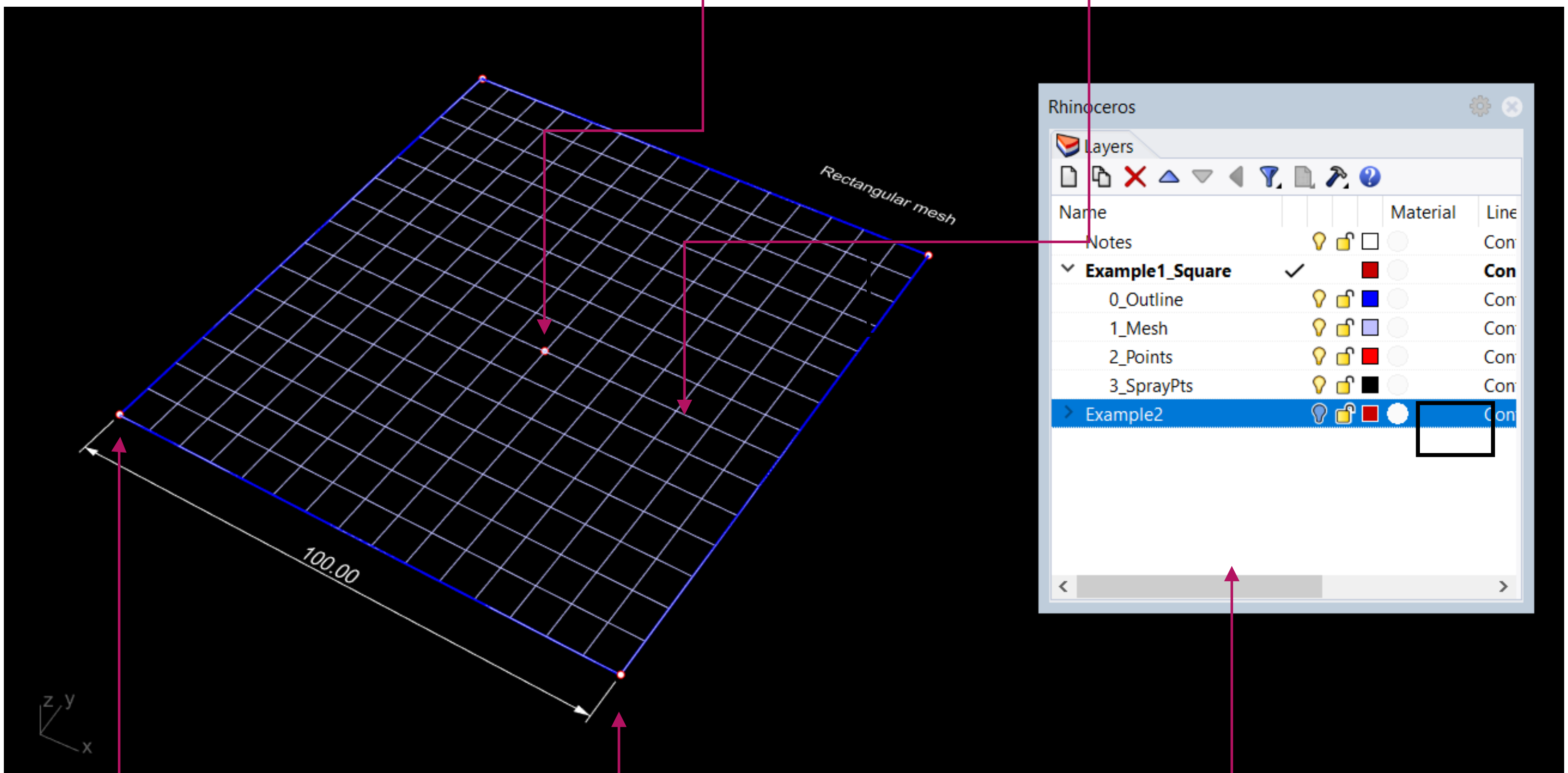
01 Grasshopper definition explanation

01

<Rhino Program Overview>
The model provides you with various setups (different initial meshes, anchor points condition) to begin with. The modelling units is in cm. Use Object Snaps (check ‘Vertices) to aid your modelling.

2) Loading Point
Position can be varied. Need not coincide with a mesh vertex

4) Mesh
Input mesh can be generated in Grasshopper then baked to set up anchor points or modelled directly in Rhino. It can mix quad and triangular faces



Anchor Points
You can vary position and number. Ensure that they coincide with mesh vertices. If so, Grasshopper program ensures a spring is created between the anchor and load.

Layers
Organise model geometry semantically in layers.

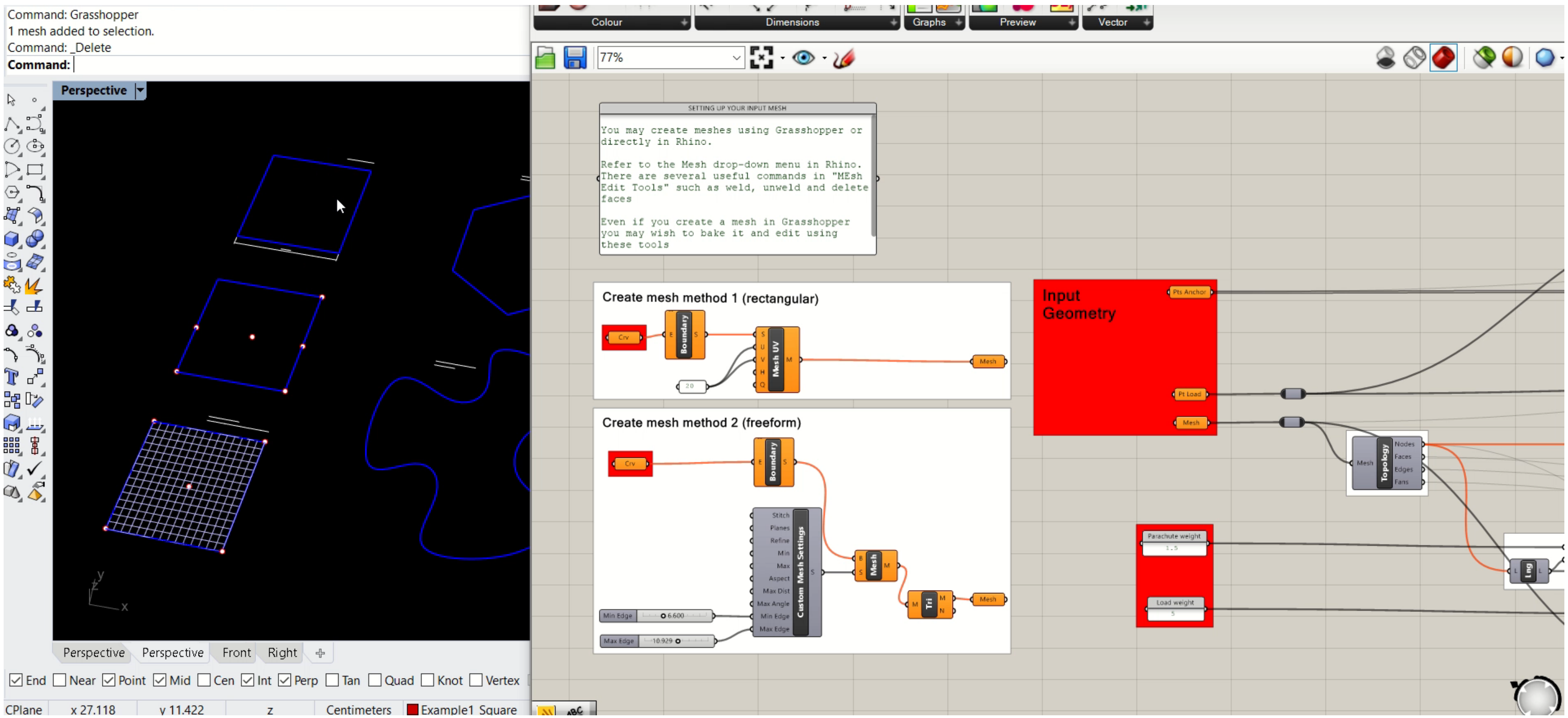
Captions

01 Rhino file explanation

01

<Model Setup>

1) Create surface from boundary curve
2) Generate mesh from surface. Specify U and V division (method 1) for rectangular surfaces. Or specify custom meshing settings for irregular surfaces (method 2)
3) Bake mesh
4) Alternatively you may create a mesh directly in Rhino
5) Set the anchor points (use OSNAP modeling aid)
6) Set single point load (you must extend program to include more loads)
7) Reference geometry in Rhino



Captions

01 Setup video

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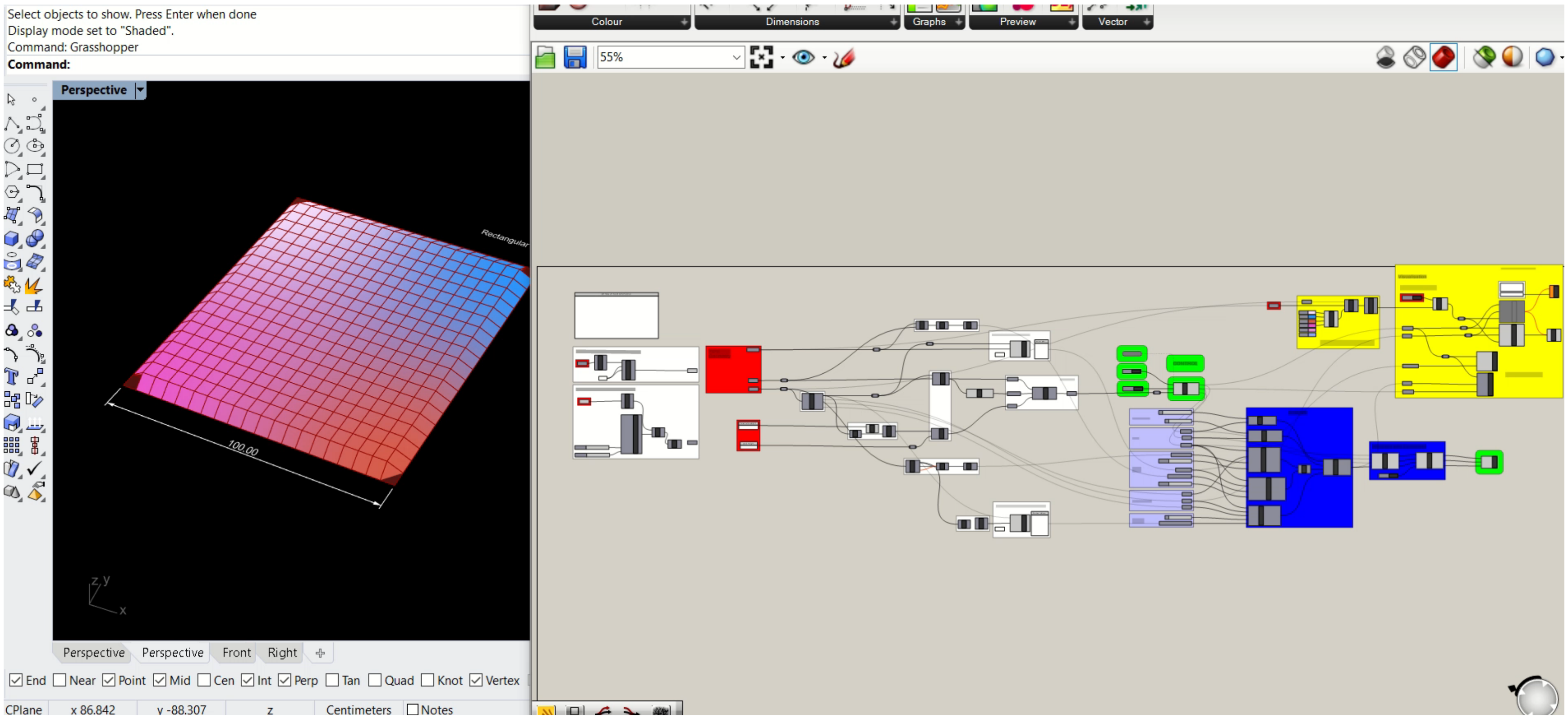
<Simulation Control>

1) Hit reset to return simulation to initial state
2) Fire timer to update simulation automatically or hit button to do so manually
3) Double click timer to pause simulation to for example, capture screenshots



Captions

01 Sim control video

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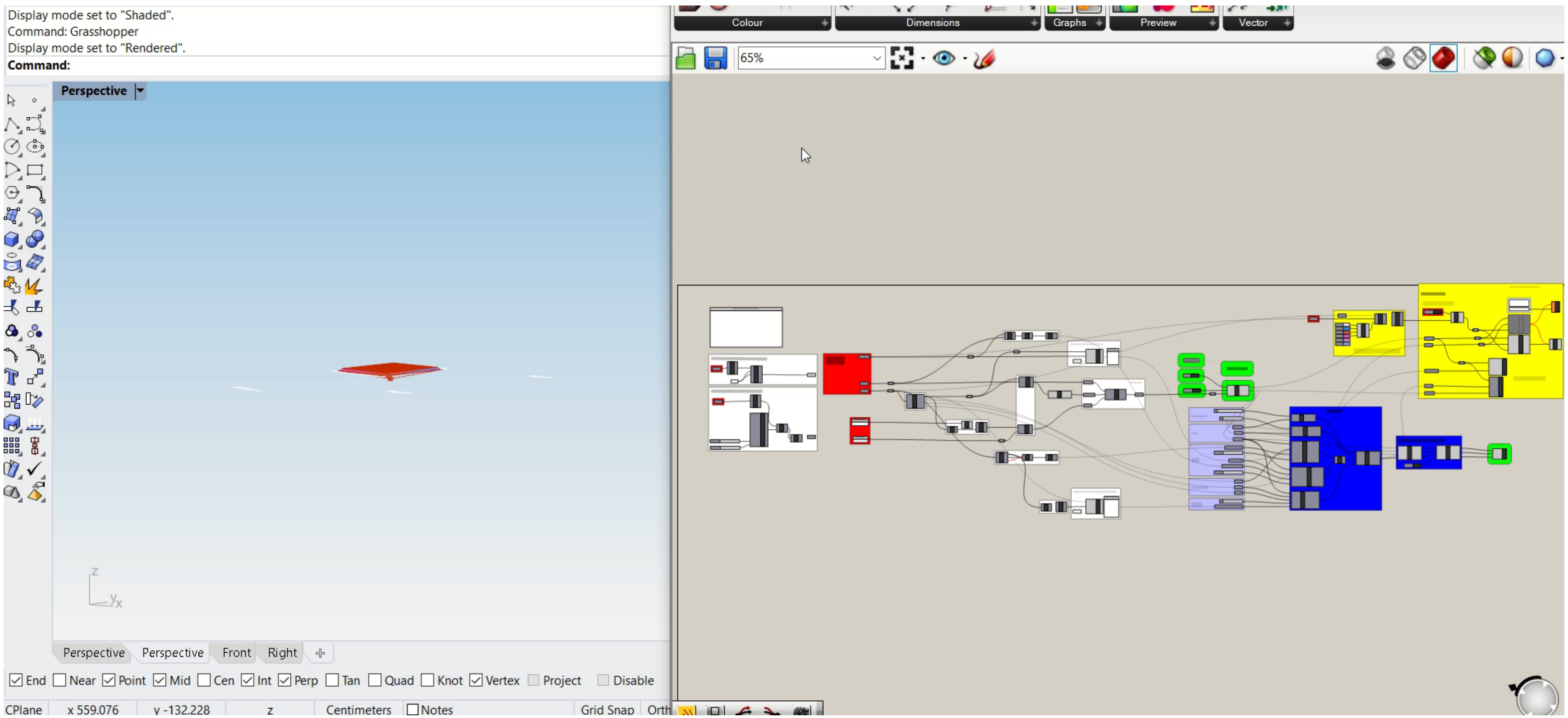
<Physics Logic>

Test the input parameter values to the Analysis part to get stable simulation results. Important factors include:

1) Resolution and topology of parachute mesh
2) Number and position of anchor/load points (both 1 and 2 affect spring forces in system)
2) Drag force (recommended to set value < 0.1)
3) Gravity (keep constant)
4) Spring stiffness (parachute mesh and anchor lines)
5) Pressure force (affects parachute mesh only)
6) Parachute and point load weight



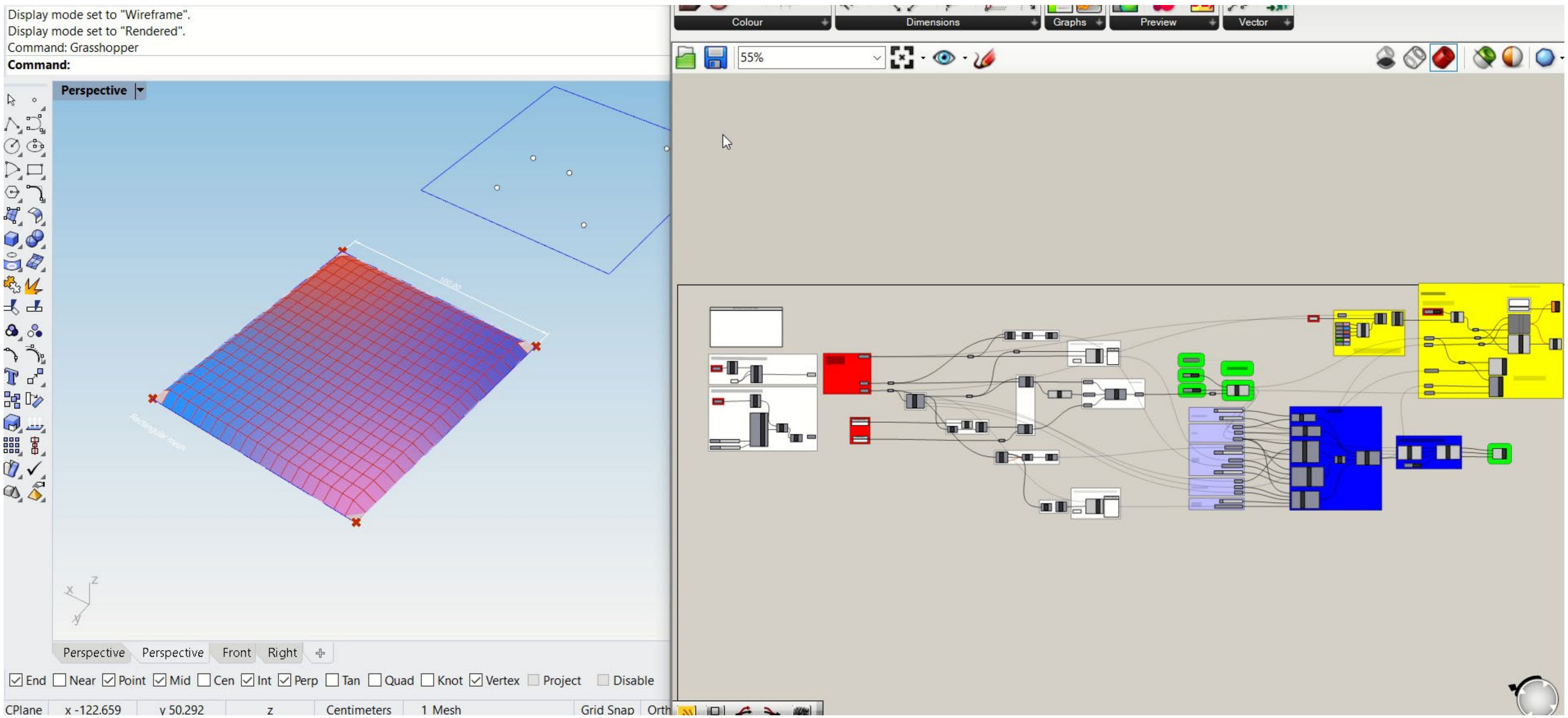
Captions

01 Physics setup video

01

<Visualisation>

1) You can set custom colours for the parachute using the spray points (set to 4 corner points by default)
2) You may also specify additional spray points. However, ensure the number of input colours match the number of spray points.
3) Alternatively, you may reference materials that are specified in Rhino (a few are set up in the base file for you to try out). Creating materials is a more advanced technique so this is optional.



Captions

01 Visualisation video

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