



Week 11

GRASSHOPPER PLUG-INS

This we will be gaining knowledge of available Grasshopper plug-ins. It is more of a surface approach on what are available out there, to inform your decisions in your future use of this parametric design software.



Outline

01

The use of plug-ins

What do we gain from the use of plug-ins of the plug-in (Grasshopper)?

02

Available plug-ins

A list of commonly used Grasshopper's plug-ins.

03

Discussion of 4 specific plug-ins with their unique functions

Ladybug, Kangaroo, Galapagos and Ivy.

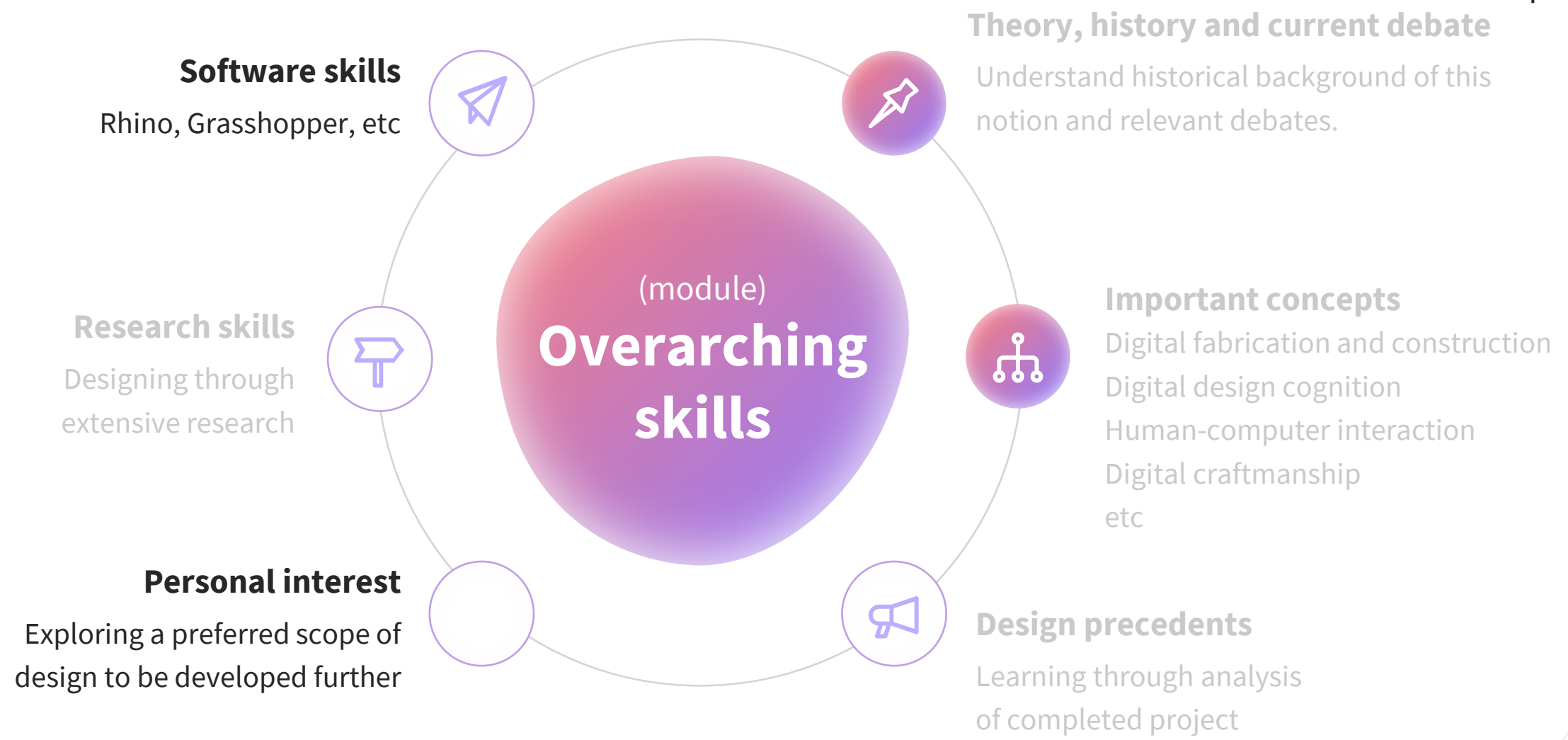
Aims and objectives

- To elicit **purposes** of additional plug-ins
- To contextualise **the use** of plug-ins in parametric design thinking
- To enumerate **available plug-ins** and their common use
- To illustrate kinds of **analysis** and **data** obtained from selected plug-ins
- To inform how can plug-ins be **useful** for future use in design

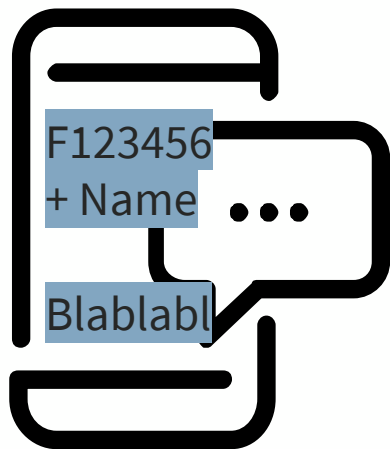
Learning outcomes

Students will be able to..

- 01** Gain understanding on how to **incorporate** GH plug-ins for future use.
—
- 02** Gain understanding how the GH plug-ins can bring **positive impacts** on design decisions and processes.
—
- 03** Choose which GH plug-ins they will decide to learn first.



Discussion



How do GH plug-ins contribute to design phases, in ways that we could not achieve without parametric software system?

In other words, what do they offer in comparison to non-computational design?

<https://miatedjosaputro.com/2020/05/05/week-11-discussion/>

Previously in Week 9..

Other parametric plug-ins: Bridging architecture with other disciplines

ENVIRONMENTAL ANALYSIS:

Ladybug

Honeybee

Geco

Heliotrope-Solar

STRUCTURAL ANALYSIS:

Kangaroo Physics

Karamba

BullAnt

Hummingbird

Mantis

<https://www.arch2o.com/10-parametric-plugins-every-architect-should-know/>

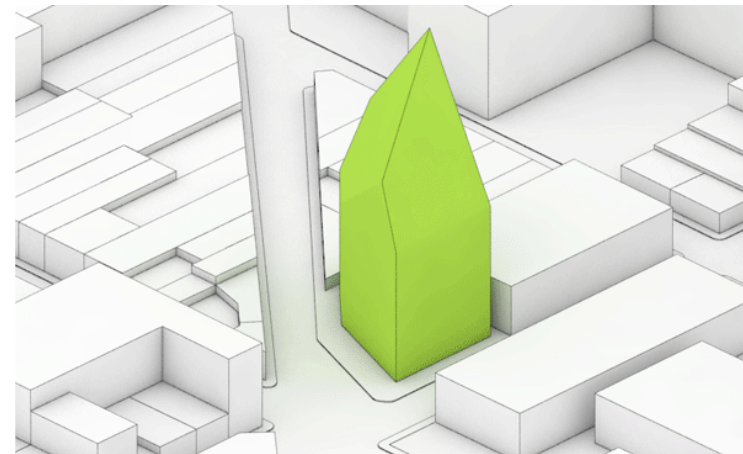
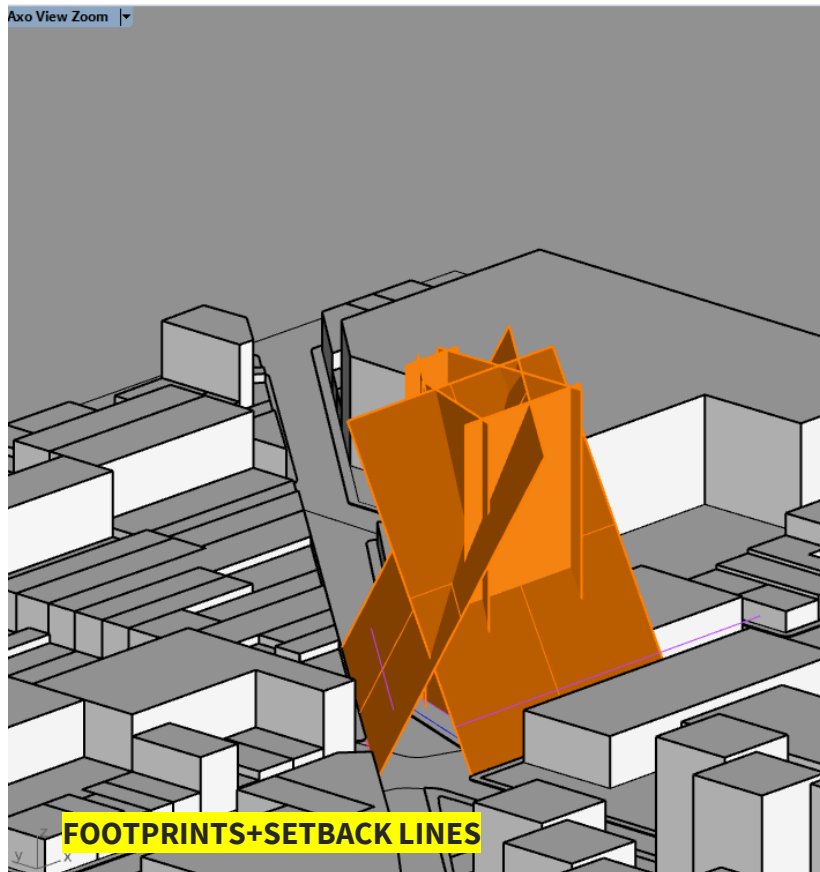
GH Plug-ins

<https://www.grasshopper3d.com/forum/topics/gh-s-origin>

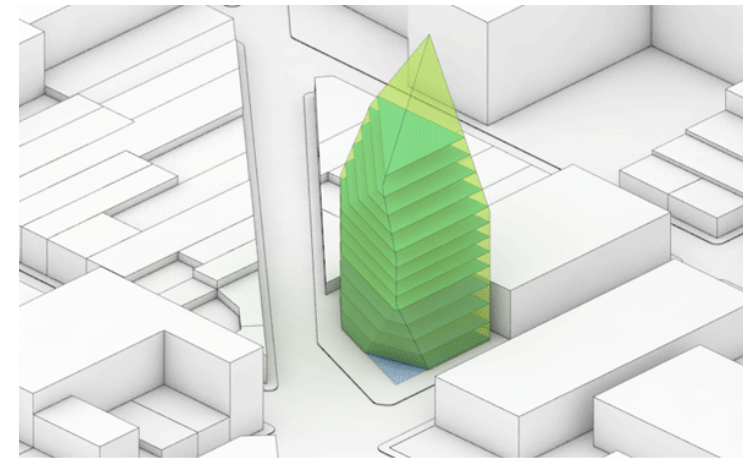
This week I do not expect you to learn individual plug-ins, as it is somewhat unlikely considering the current online learning situation. But I would like you to stay informed on what available out there and reflect on how can these **tools be useful for your future design projects.**

Example use of GH in early design stage:

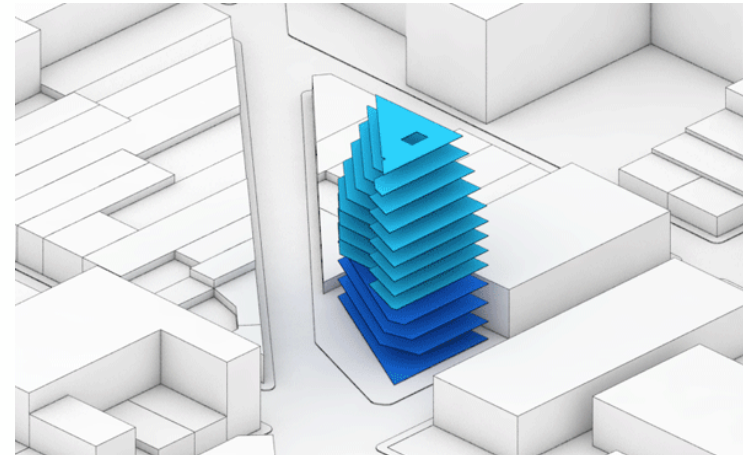
<http://designplaygrounds.com/blog/creating-models-for-development-analysis-with-grasshopper/>



BOUNDING VOLUME BASED ON RESTRICTIONS



FEASIBILITY STUDY OF GFA



LIVE CHANGES ARE MADE IF ONE OF THE CRITERIA CHANGED (FOR INSTANCE, NARROWER SETBACKS)

What do we gain from using plug-ins? How to choose from hundreds of them?

- **Open source** library
- Incorporating **design strategies** such as optimisation, structural, environmental in early design stage.
- Ability to **simulate** strategies in real time
- Align **decisions** with what your design strategy is, look for design precedents using the same plug-in, choose with plenty of tutorials
- Learn how to **interpret data**

Popular GH plug-ins

<https://www.food4rhino.com/>



Search

Sort by **Downloads**

TYPE

- App (390)
- Resource (0)

LICENSE

- Free (365)
- Trial (25)

PLATFORM

- Grasshopper (390)
 - Windows (390)
 - Version 4&5 (281)
 - Version 6 (209)
 - Version 7 WIP (8)
 - Mac (47)
 - Version 5 (37)
 - Version 6 (19)
- Rhino (30)
 - Windows (29)
 - Version 6 (25)
 - Version 5 (17)
 - Version 7 WIP (4)
 - Version 4 (0)
 - Mac (7)
 - Version 5 (5)
 - Version 6 (4)
- Rhino.Inside (2)

BROWSE

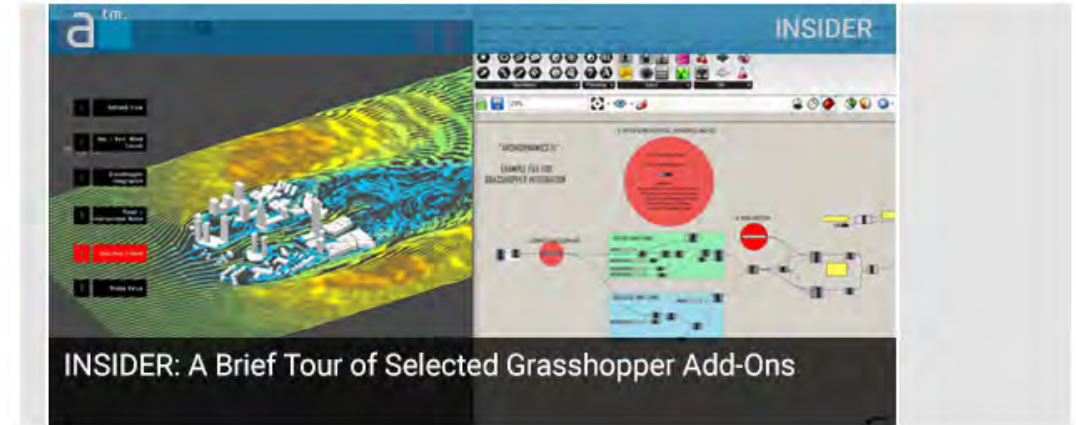
- Kangaroo Physics**
Kangaroo is a Live Physics engine for interactive simulation, form-finding, optimisation and constraint solving. 4 (346 votes)
- LunchBox**
LunchBox is a plug-in for Grasshopper for exploring machine learning, mathematical shapes, paneling, structures, and workflow. 3.6 (386 votes)
- Ladybug Tools**
Ladybug and Honeybee are open source environmental plugins for Grasshopper to help designers create an environmentally-conscious architecture. 4 (333 votes)
- GhPython**
Use the same flexible language everywhere: GhPython is the Python interpreter component for GH that allows to execute dynamic scripts. 3.6 (194 votes)
- Elk**
Elk is a set of tools to generate map and topographical surfaces using open source data from OpenStreetMap.org and USGS. 3.5 (229 votes)
- PanelingTools for Rhino and Grasshopper**
Paneling solutions from concept to fabrication. Generate 2D and 3D cellular patterns over rectangular grids. 3.8 (87 votes)

Review of 35 GH plug-ins

<https://architosh.com/2020/03/insider-a-brief-tour-of-select-grasshopper-add-ons/>

INSIDER: A Brief Tour of Select Grasshopper Add-Ons

by Anthony Frausto-Robledo, AIA, NCARB, LEED AP



We look at 35 Grasshopper plugins that add additional capabilities and superpowers to the number one AAD tool in the market used in AEC. Importantly, there are quite a few GH plugins working for the Mac version of Rhino + Grasshopper—a growing reality that is good for the market.

Grasshopper Plugins

In this brief article, we briefly discuss 35 Grasshopper plugins and what they essentially provide to the Rhino + Grasshopper user community. They are organized by category and we provide information on which plugins say, or we could confirm, work on both the Windows and Mac versions of Rhino + Grasshopper. Importantly, many entries in the Food4Rhino page can be incorrect in which plugins do or do not work on the Mac versions of

Review of GH plug-ins based on category

<http://james-ramsden.com/resources/list-of-grasshopper-components/>

A mix of favourite and interesting plugins for Grasshopper.

ENERGY AND BUILDING SIMULATION

| | |
|--------------------------------------|---|
| Ladybug and Honeybee | Import EPW files, solar radiation analysis, daylight calculations, thermal calculations |
| Diva for Rhino | Daylight calculations |
| mr comfy | Thermal and daylight calculations |

GEOMETRY

| | |
|---------------------------|-----------------------------------|
| Jackalope | Rhino morph operations |
| Lunchbox | Convert surfaces to panels |
| MeshEdit | Essential mesh manipulation tools |

WORKFLOW

| | |
|-----------------------------|---|
| Octopus | Multi-objective optimisation |
| Lunchbox | Read and write to Excel |
| GeometryGym | Move geometry between different BIM/analysis file formats |
| Firefly | Arduino control and internet data control |
| Mosquito | Facebook, Twitter and Google Maps queries |

VISUALISATION

| | |
|--|-------------------------------|
| Giulo | Generate frames for animation |
| Piacentino's renderAnimation | |
| Horster | Control Rhino camera |

MAPPING

| | |
|---------------------|---|
| Elk | Process OpenStreetMap OSM data and USGS HGT height data |
|---------------------|---|

...and of course there is the [Food4Rhino directory](#) for the full list of the most popular component

Plug-in 1: Ladybug

For environmentally
conscious design
decisions using local
weather data

By: Mostapha
Sadeghipour Roudsari



Ladybug

Ladybug performs detailed analysis of climate data to produce customized, interactive visualizations for environmentally-informed design.



Plug-in 1: Ladybug

Download the plug-in here

<https://www.food4rhino.com/app/ladybug-tools>

Interview with both co-founders (**Mostapha** and **Chris Mackey**) about how it came into existence:

<https://architosh.com/2020/03/insider-ladybug-tools-aim-to-take-environmental-analysis-to-wider-audience/>

Getting started with Ladybug with **Chris Mackey**, the co-founder

https://www.youtube.com/playlist?list=PLruLh1AdY-Sj_XGz3kzHUoWmpWDXNep1O

Resources:

FORUM: <https://discourse.ladybug.tools/>

SHARING PLATFORM: <http://hydrashare.github.io/hydra/>

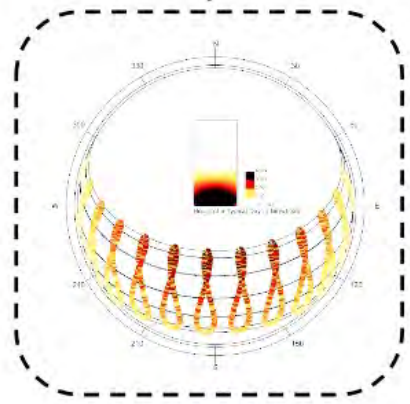
Plug-in 1: Ladybug

Ladybug Analysis Tools



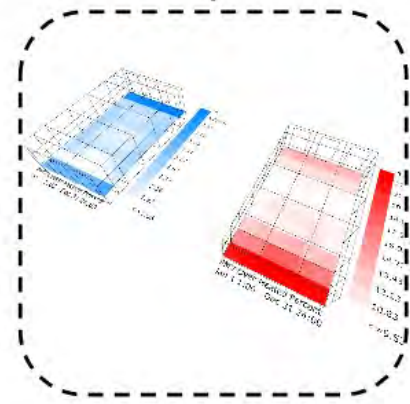
Ladybug

Climate Visualization
+ Analysis



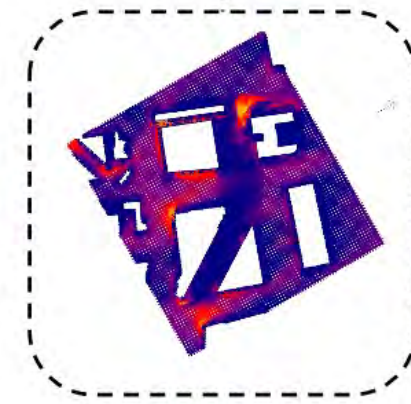
Honeybee

Building Energy, Daylight
+ Comfort Modelling



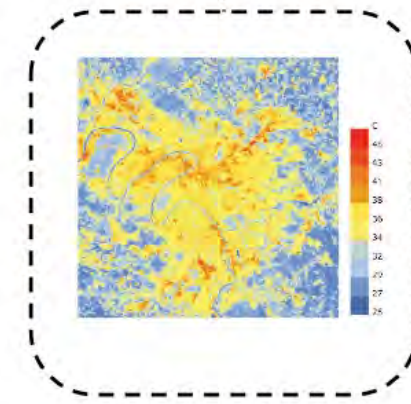
Butterfly

Airflow Modelling
(CFD)



Dragonfly

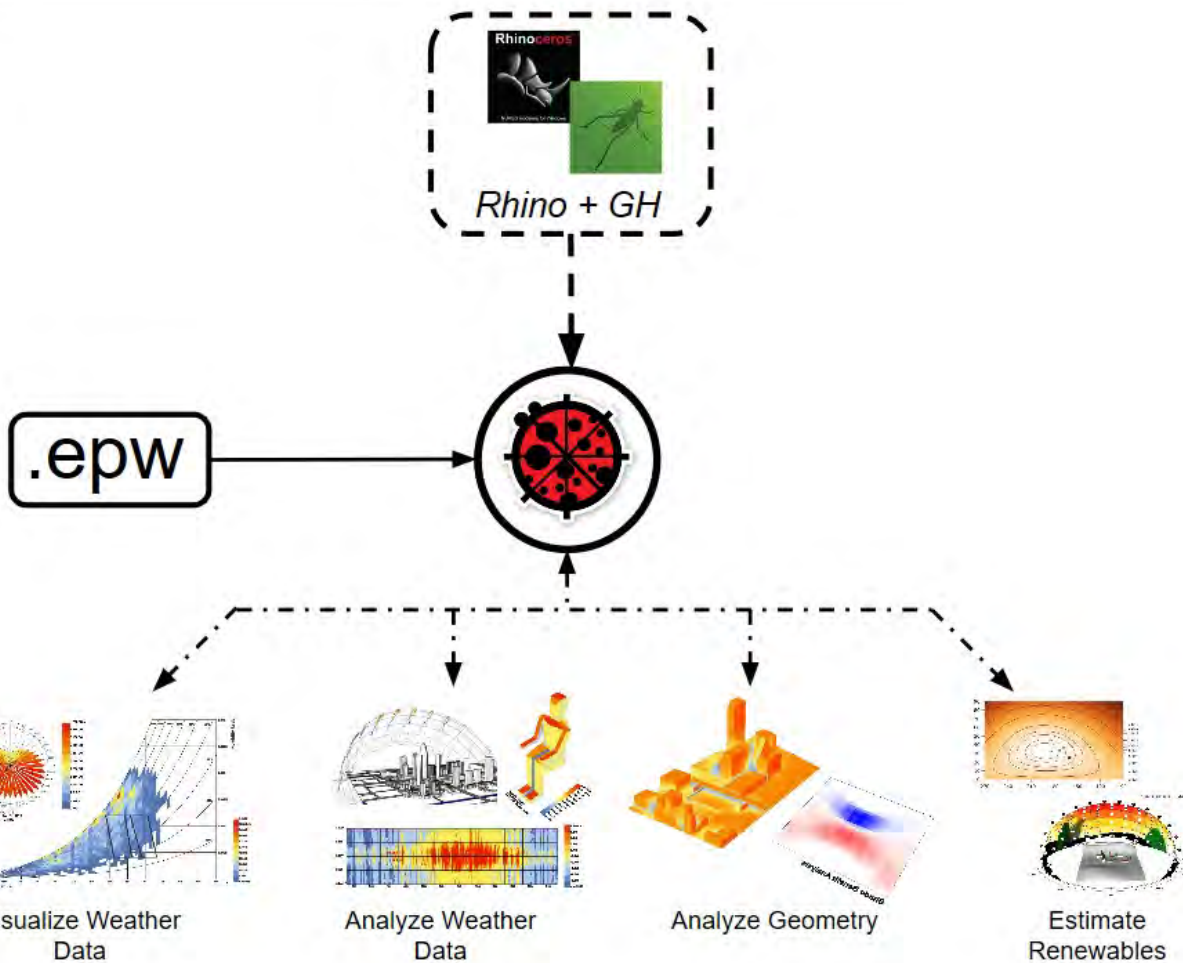
Climate Modelling
(heat island, climate change)



- 1. Introduction to Ladybug Project
- 2. Introduction to Ladybug
- 3. Ladybug Analysis Tools
- 4. Ladybug Analysis Tools
- 5. Ladybug Analysis Tools
- 6. Ladybug Analysis Tools
- 7. Ladybug
- 8. Ladybug
- 9. What Attracted Me to the Ladybug Project
- 10. Environmental design never compromises on energy efficiency, increases comfort, improves long-term performance.

Plug-in 1: Ladybug

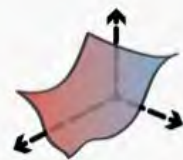
.epw files



- 1. Performance Newtwork Presentation1
- 2. Performance Newtwork Presentation1
- 3. Ladybug Analysis Tools
- 4. Ladybug Analysis Tools
- 5. Ladybug Analysis Tools
- 6. Ladybug Analysis Tools
- 7. Ladybug
- 8. What Attracted Me to the Ladybug Project
- 9. What Attracted Me to the Ladybug Project
- 10. Environmental Design saves energy/money, increases comfort, improves long term economic

Plug-in 1: Ladybug

Instantaneous
feedback and
evaluation



CLIMATE DATA
PLOTS



SUNPATH
GRAPHICS



SHADOW
STUDIES



VIEW FROM
SUN



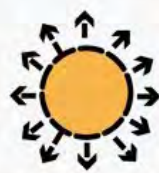
SOLAR ACCESS
STUDIES



SOLAR
ENVELOPE



SOLAR FAN



RADIATION
STUDIES



VIEW STUDIES



PSYCHROMETRIC
CHARTS



ADAPTIVE
COMFORT
CHARTS



OUTDOOR
COMFORT
STUDIES



LOCAL
THERMAL
COMFORT
STUDIES



SHADE
BENEFIT
ANALYSIS



GENERATIVE
SHADE DESIGN



RAYTRACING



SHADOW
MASKS



RENEWABLES

Plug-in 1: Ladybug

Potential use:

Weather data Visualisation

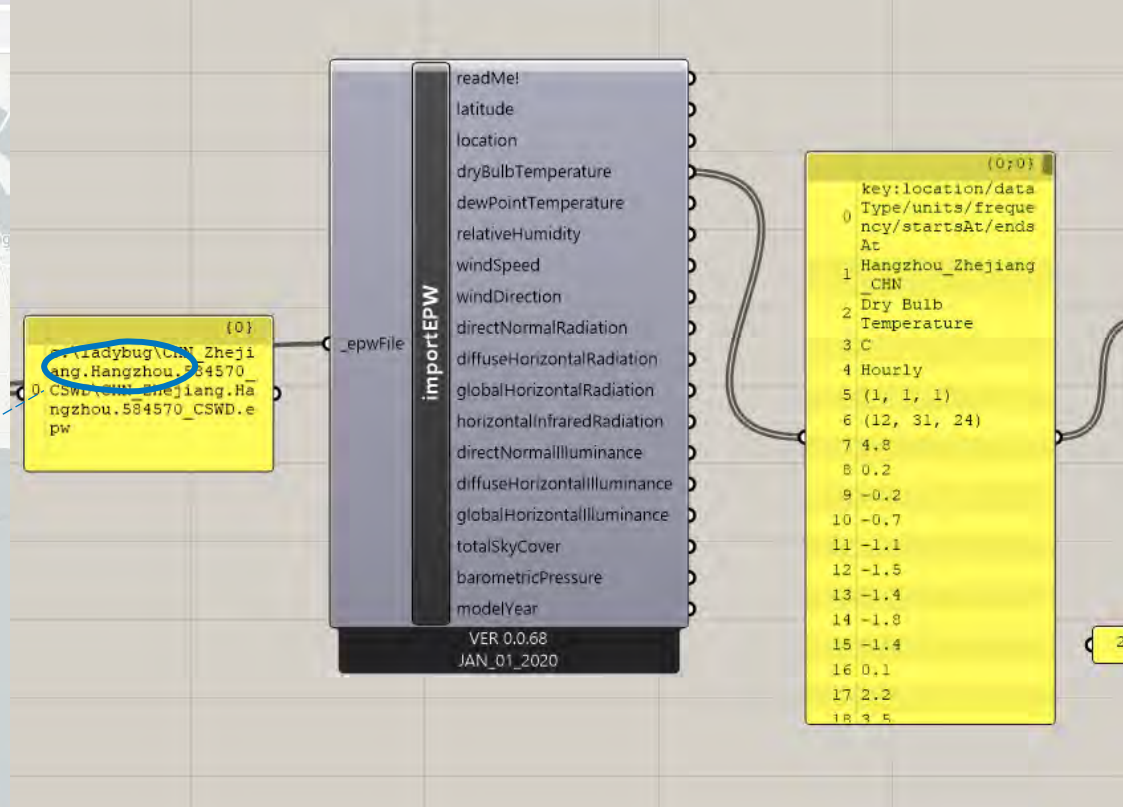
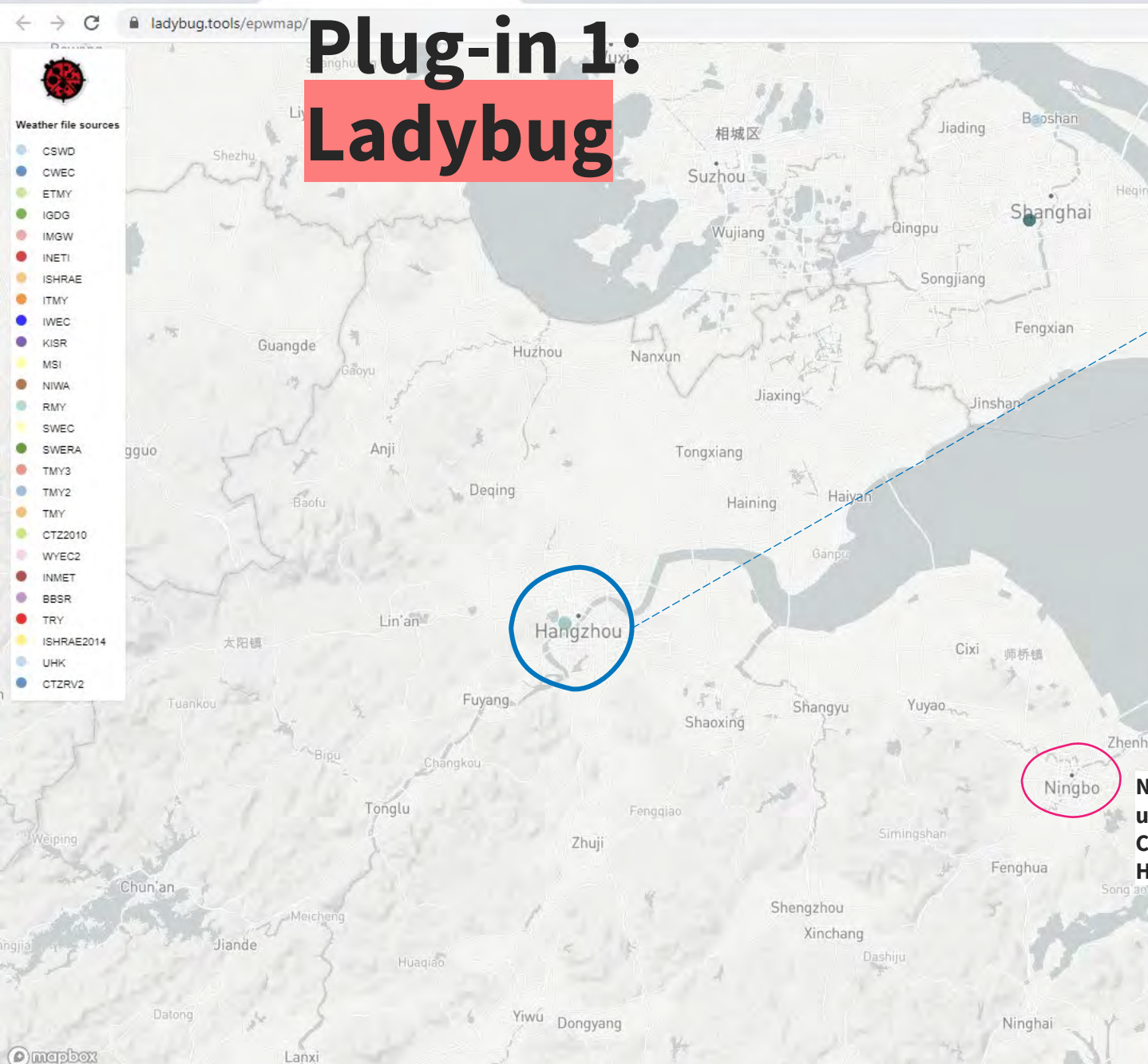
Basic and advanced sun path study

Sunlight hours study

Outdoor comfort study

Solar radiation study

Plug-in 1: Ladybug



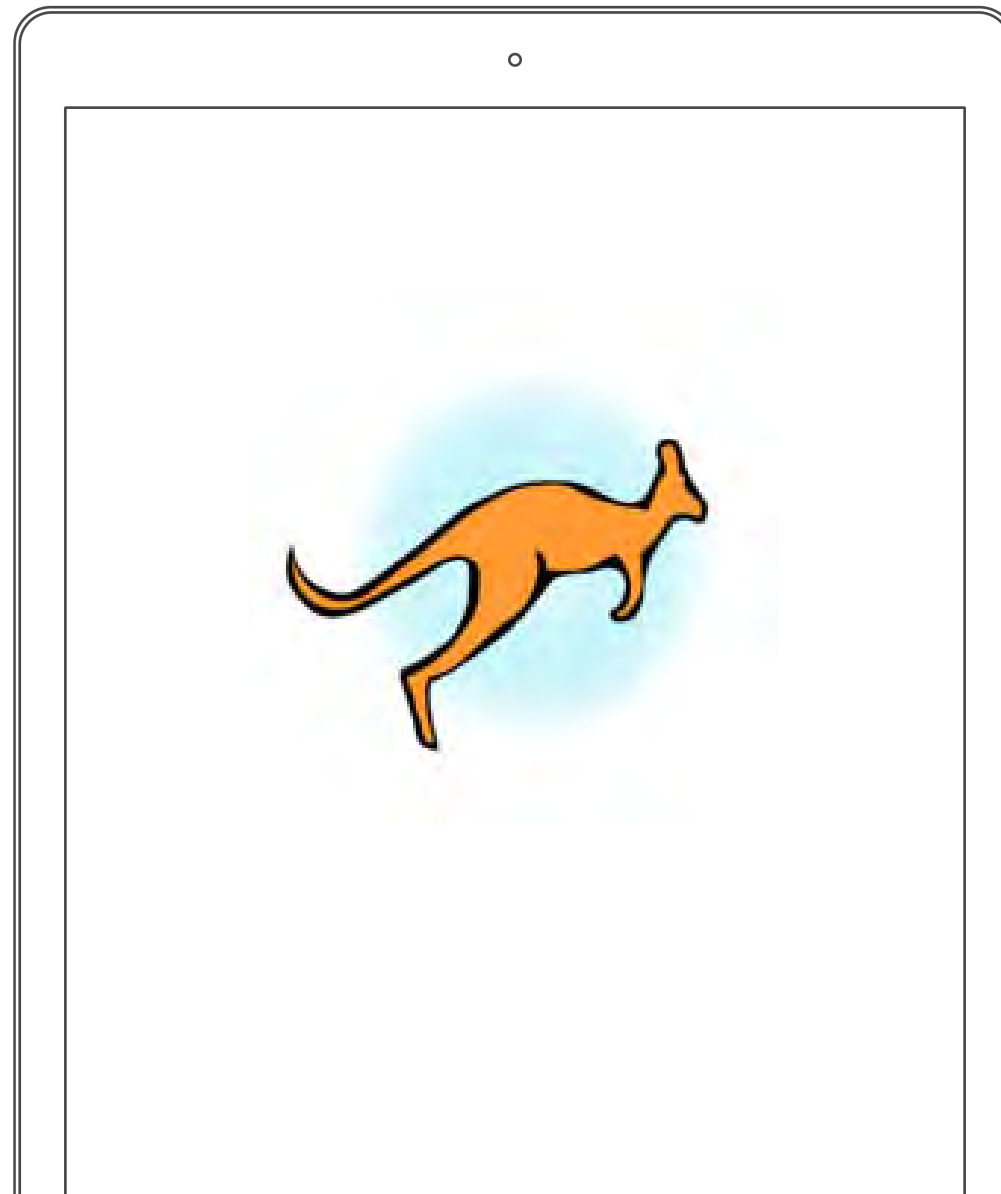
No Ningbo data unfortunately, Closest stations are Hangzhou or Zhoushan

[Download from ONEBUILDING](#)
[Copy link to clipboard](#)

Plug-in 2: Kangaroo

Physics engine
and form finding
platform for
Grasshopper

By: Daniel Piker



Plug-in 2:

Kangaroo

Kangaroo2 comes with Rhino 6 onwards, no need to download or install separately.

<http://kangaroo3d.com/>

Download link if you need it:

<https://www.food4rhino.com/app/kangaroo-physics>

RESOURCES:

<https://discourse.mcneel.com/c/grasshopper/kangaroo>

Plug-in 2: Kangaroo

Potential use:

Simulate physical interaction between object

Simulate objects' properties through time

Creating unique shapes (*catenary curves, catenary vault systems, tensile membrane systems, dome and tensile structure*) we could not do using hands by

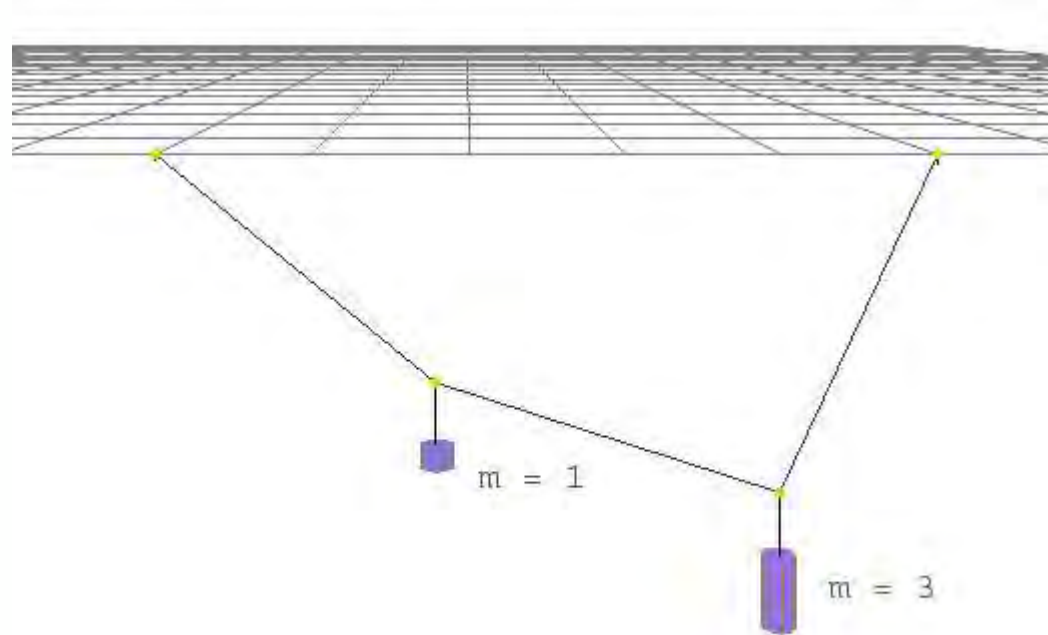
Modelling different forces

Plug-in 2: Kangaroo

Based on *particle-spring systems*

” Particle-spring systems are based on lumped masses, called particles, which are connected by linear elastic springs”

Kilian, A. & Ochsendorf, J. (2005). Particle-spring systems for structural form finding. *Journal of the international association for shell and spatial structures*, 46, 77-84.



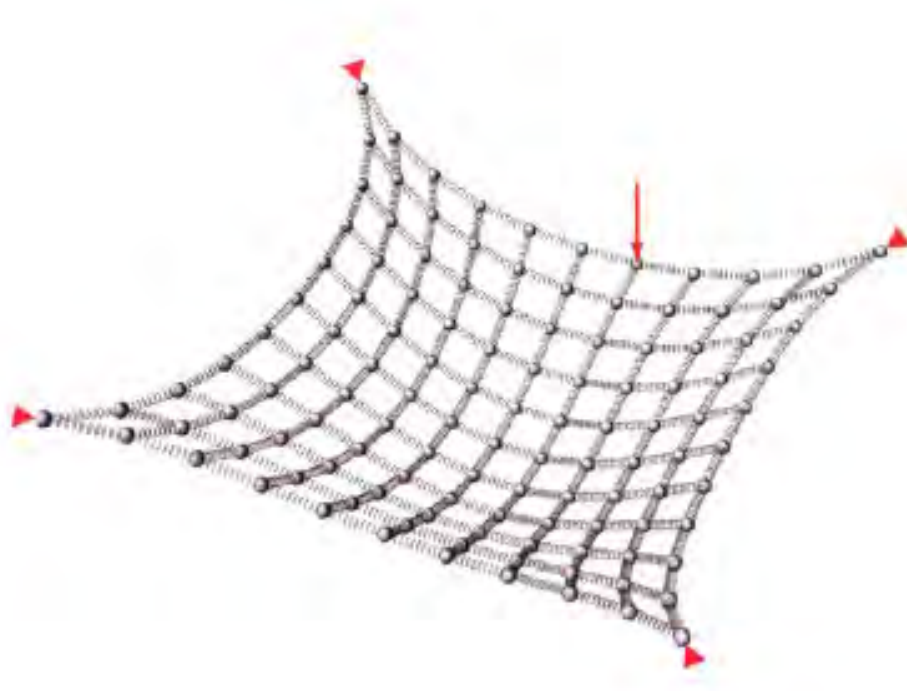
Equilibrium of simple particle spring system (Kilian and Ochsendorf, 2005)

Plug-in 2: Kangaroo

Based on *particle-spring systems*

Main components of a
particle-spring system
are:

1. Particles
2. Springs
3. Forces
4. Anchor point

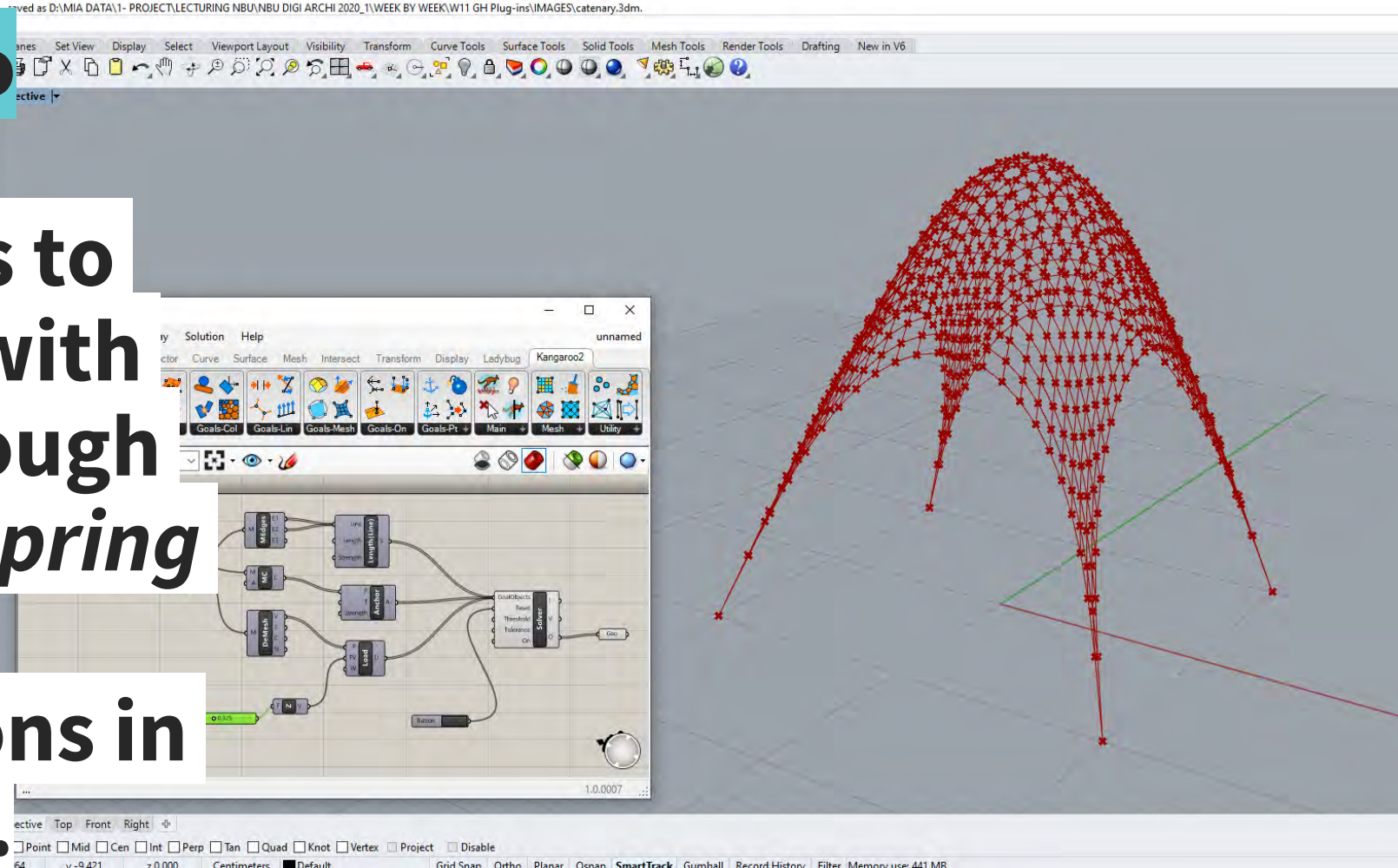


A particle-spring system that simulates a square membrane anchored at its corner. Force vectors are applied to the particles.

Plug-in 2:

Kangaroo

enables designers to interact with form through *particle-spring system* simulations in real time.



Plug-in 2: Kangaroo

Potential form: Catalan vault

<https://inspiration.detail.de/technology-the-catalan-vault-a-historical-structural-principle-with-a-bright-future-106565.html>

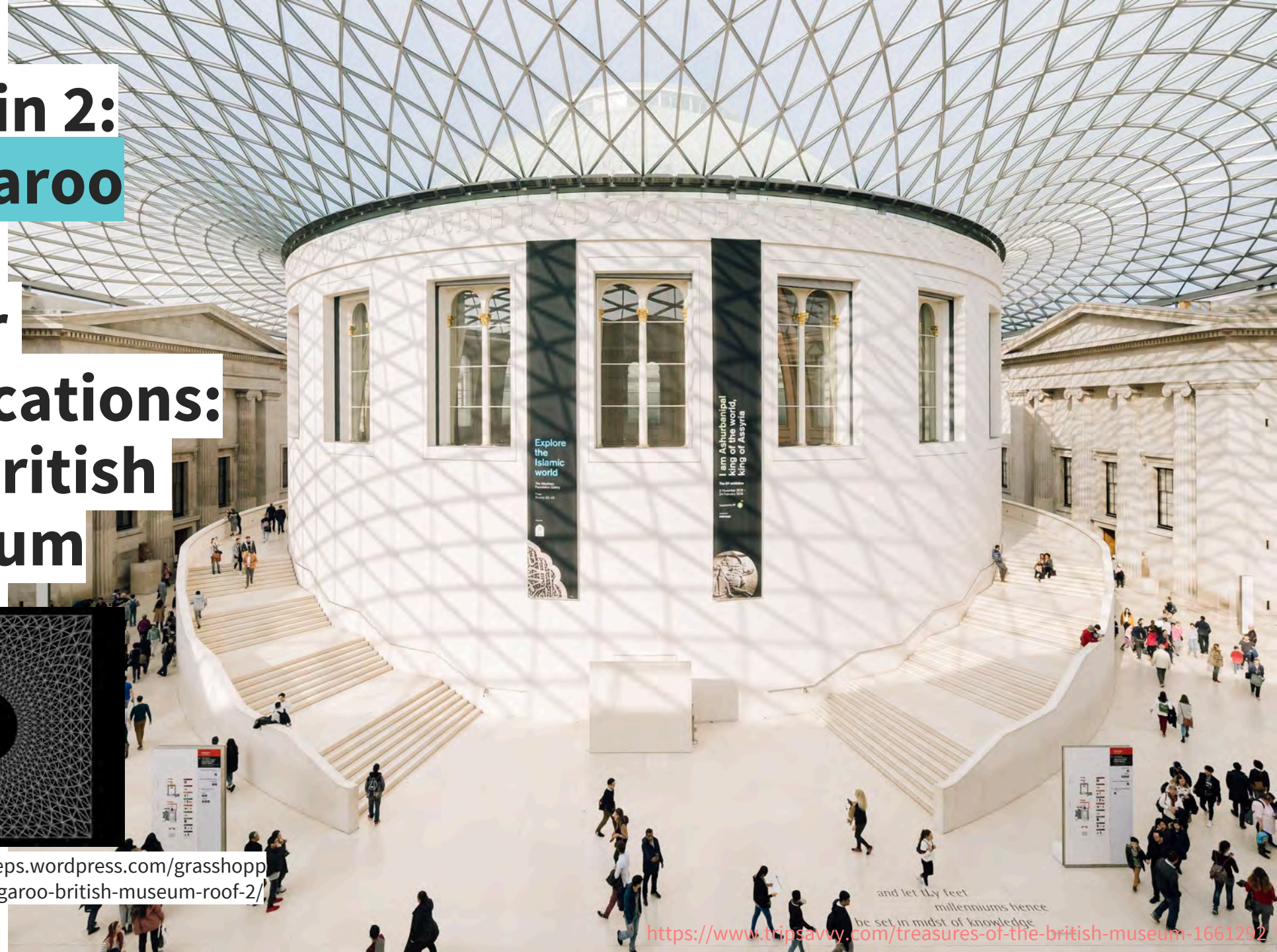


Plug-in 2: Kangaroo

Other applications: The British Museum



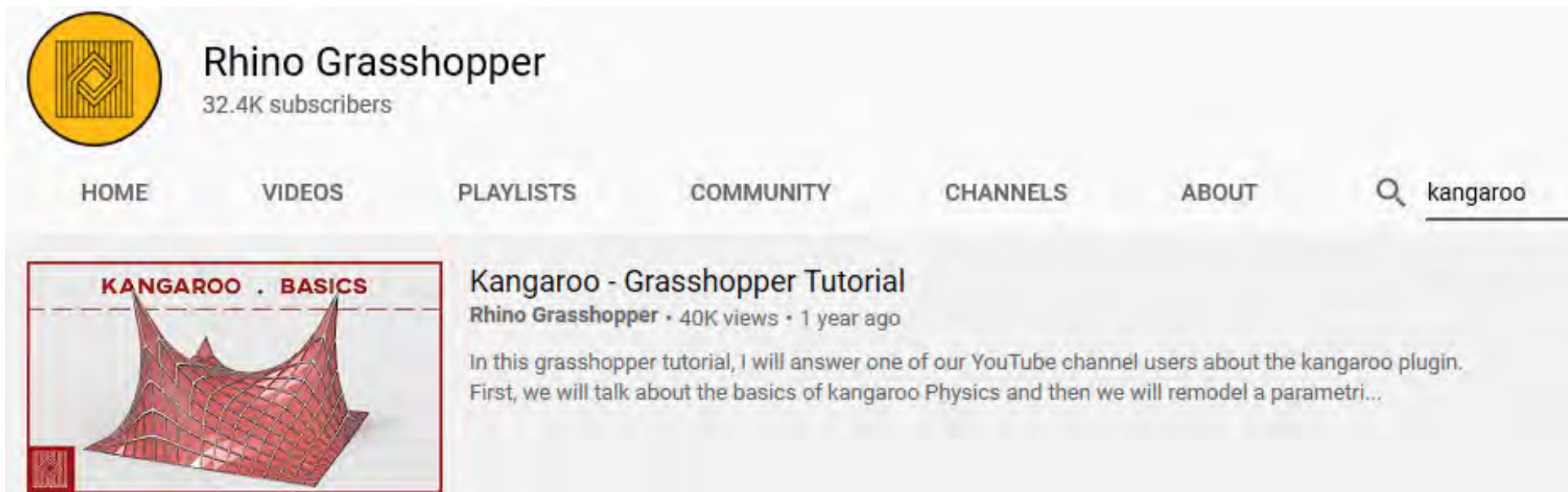
<https://explodebeps.wordpress.com/grasshopper-definitions/kangaroo-british-museum-roof-2/>



<https://www.tripsavvy.com/treasures-of-the-british-museum-1661292>

Plug-in 2: Kangaroo Physics and Kangaroo 2 introduction

<https://youtu.be/ToHLIEGvhqA>



The screenshot shows the YouTube channel page for 'Rhino Grasshopper', which has 32.4K subscribers. The navigation menu includes HOME, VIDEOS, PLAYLISTS, COMMUNITY, CHANNELS, and ABOUT. A search bar contains the text 'kangaroo'. The featured video is 'Kangaroo - Grasshopper Tutorial' by Rhino Grasshopper, with 40K views and posted 1 year ago. The video description states: 'In this grasshopper tutorial, I will answer one of our YouTube channel users about the kangaroo plugin. First, we will talk about the basics of kangaroo Physics and then we will remodel a parametri...'. The video thumbnail shows a red wireframe mesh structure with the text 'KANGAROO . BASICS' at the top.

Rhino Grasshopper
32.4K subscribers

HOME VIDEOS PLAYLISTS COMMUNITY CHANNELS ABOUT

🔍 kangaroo

KANGAROO . BASICS

Kangaroo - Grasshopper Tutorial
Rhino Grasshopper • 40K views • 1 year ago

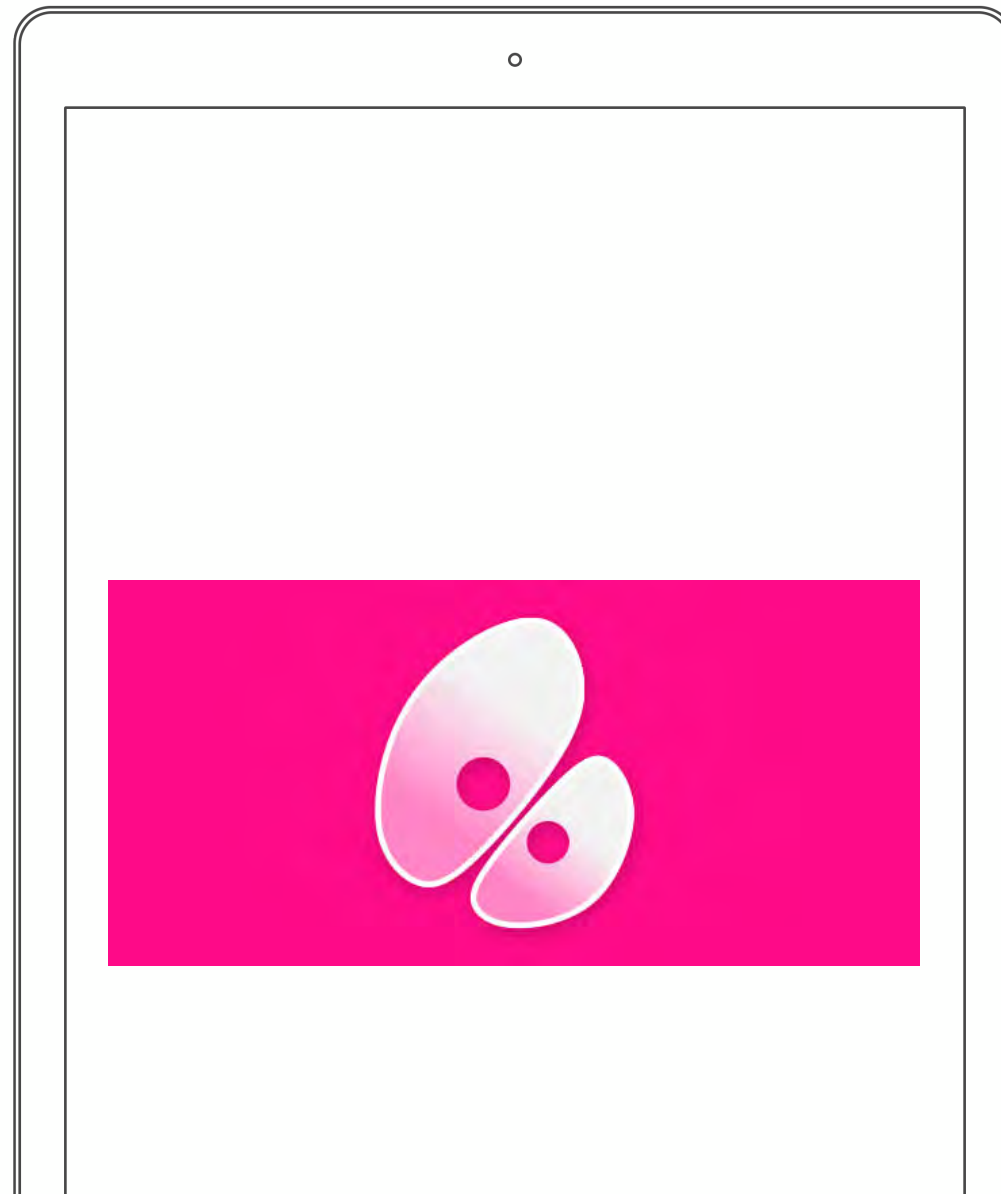
In this grasshopper tutorial, I will answer one of our YouTube channel users about the kangaroo plugin. First, we will talk about the basics of kangaroo Physics and then we will remodel a parametri...

Plug-in 3: Galapagos

Evolutionary
Solving,
Genetic Algorithm
(GA)

By: David Rutten

It is named after the
Galapagos Island



Plug-in 3: Galapagos

Galapagos comes with Grasshopper, under Params tab.



Blog post by David Rutten:

<https://www.grasshopper3d.com/profiles/blogs/evolutionary-principles>

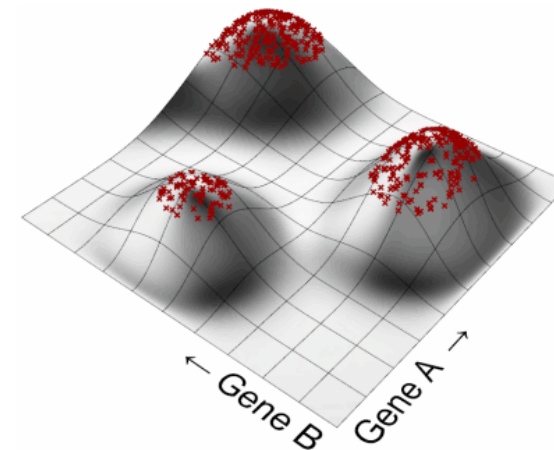
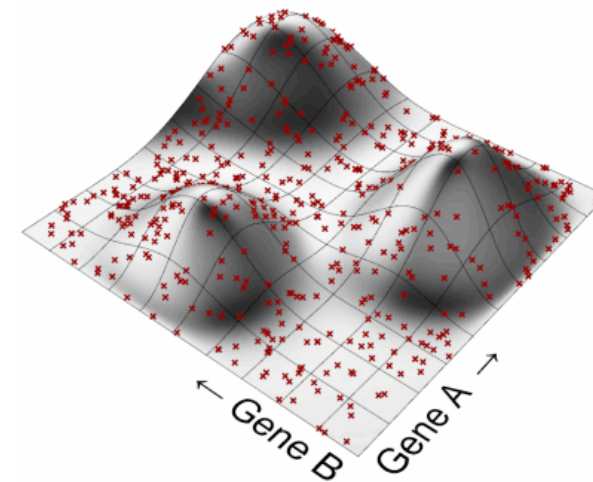
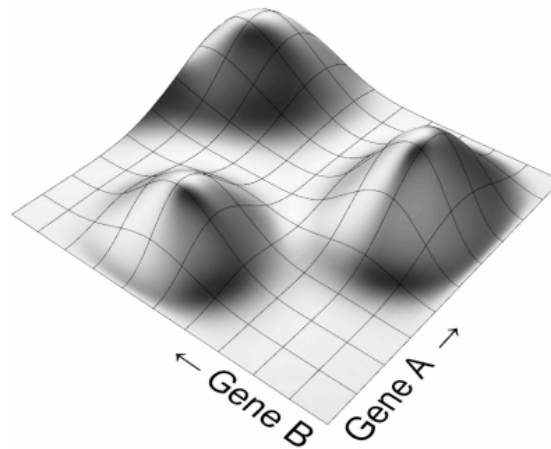
Plug-in 3: **Galapagos**

Evolutionary computing goes back as early as 1948. Alan Turing proposed the term, “genetical or evolutionary search”.

Plug-in 3: Galapagos

Evolutionary Solver in Galapagos.

<https://www.grasshopper3d.com/profiles/blogs/evolutionary-principles>

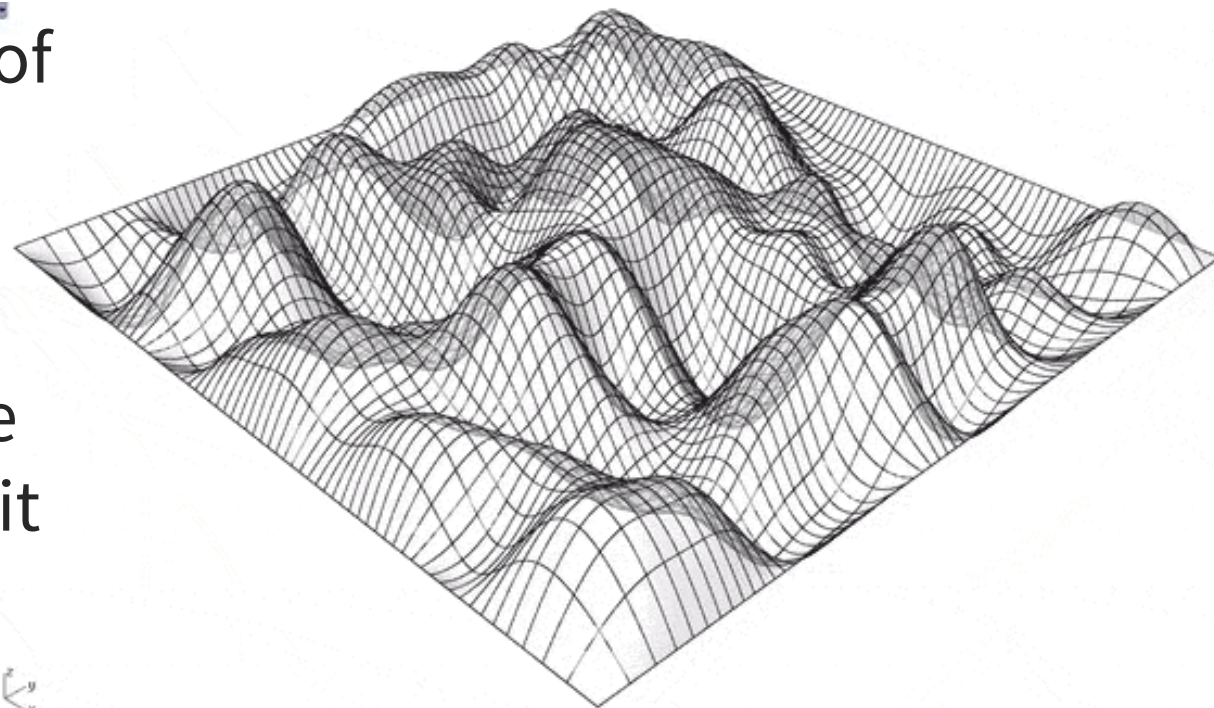


A *Fitness Landscape* of a particular model. The model has two variables (genes), Gene A and B. As Gene A changes, the fitness of entire model also changes. Every combination of A and B results in particular fitness, and it is represented as the **height of fitness landscape**. The solver's job is to **find highest peak in this landscape**. The third picture shows a cluster around three fitness peaks, and the process is repeated until we reach the highest peak.

Plug-in 3: Galapagos

designplaygrounds.com/blog/galapagos-101-fundamentals-course/

So a **peak** represents a range of 'successful' genomes and a **valley** belong to less fit combinations. With every iteration the genomes that are less fit get discarded and the fit enough one will generate offspring and carry on to the next iteration.



Plug-in 3: Galapagos

Evolutionary Solver in Galapagos.

[https://www.grasshopper3d.com/
profiles/blogs/evolutionary-
principles](https://www.grasshopper3d.com/profiles/blogs/evolutionary-principles)

The anatomy of solver requires these 5 interlocking parts:

- Fitness Function
- Selection Mechanism
- Coupling Algorithm
- Coalescence Algorithm
- Mutation Factory

Plug-in 3: Galapagos

Potential use:

Multiple-objective optimisation

Drawbacks according to David Ruten:

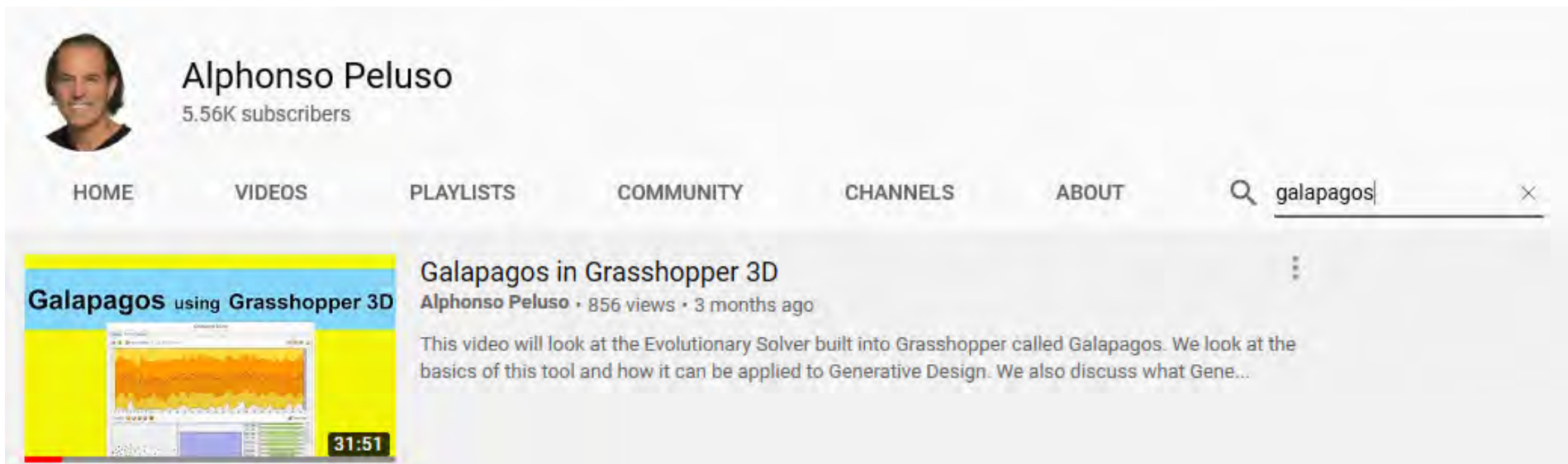
Slow and do not guarantee a solution (tend to run on

indefinitely unless good-enough value is specified)

Advantages: flexible (wide variety of problems), **forgiving** (happily work on problem that have been under or over constrained) **and high degree of interaction.**

Plug-in 3: Galapagos Introduction

<https://youtu.be/PjGcF7STf7c>



The image shows a screenshot of a YouTube channel page for Alphonso Peluso. The channel name is "Alphonso Peluso" with 5.56K subscribers. The navigation menu includes HOME, VIDEOS, PLAYLISTS, COMMUNITY, CHANNELS, and ABOUT. A search bar contains the text "galapagos". The search results show a video titled "Galapagos in Grasshopper 3D" by Alphonso Peluso, with 856 views and posted 3 months ago. The video description reads: "This video will look at the Evolutionary Solver built into Grasshopper called Galapagos. We look at the basics of this tool and how it can be applied to Generative Design. We also discuss what Gene...". The video thumbnail shows a 3D visualization of a landscape with a red and yellow color scheme and a duration of 31:51.

Alphonso Peluso
5.56K subscribers

HOME VIDEOS PLAYLISTS COMMUNITY CHANNELS ABOUT

galapagos

Galapagos in Grasshopper 3D
Alphonso Peluso • 856 views • 3 months ago

This video will look at the Evolutionary Solver built into Grasshopper called Galapagos. We look at the basics of this tool and how it can be applied to Generative Design. We also discuss what Gene...

31:51

Plug-in 3: Galapagos

Galapagos Editor

Options Solvers Record

Start Solver Stop Solver

| | |
|-----------|--------------------------|
| 12.563115 | <input type="checkbox"/> |
| 12.563115 | <input type="checkbox"/> |
| 12.563083 | <input type="checkbox"/> |
| 12.563073 | <input type="checkbox"/> |
| 12.563069 | <input type="checkbox"/> |
| 12.563066 | <input type="checkbox"/> |
| 12.563033 | <input type="checkbox"/> |
| 12.563007 | <input type="checkbox"/> |
| 12.562989 | <input type="checkbox"/> |

OK Cancel

Grasshopper - galapagos*

File Edit View Display Solution Help

Params Maths Sets Vector Curve Surface Mesh Intersect Transform Display Ladybug Kangaroo2

100%

X coordinate 0.89877

Y coordinate 0.73248

1.0.0007

End Near Point Mid Cen Int Perp Tan Quad Knot Vertex Project Disable

Solid Tools Mesh Tools Render Tools Drafting New in V6

Vi...
P
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K

Plug-in 4: Ivy

Mesh analysis,
Segmentation and
unrolling

By: Andrei Nejur



Plug-in 4:

Ivy

Download the plug-in:

<https://www.food4rhino.com/app/ivy>

Andrei Nejur on Ivy:

<https://vimeo.com/nejur>

Plug-in 4: Ivy

Papers on development

Ivy

Bringing a Weighted-Mesh Representation to Bear on Generative Architectural Design Applications

Andrei Nejur
Technical University of
Cluj-Napoca

Kyle Steinfeld
University of California, Berkeley



Ivy

Progress in Developing Practical Applications for a Weighted-Mesh Representation for Use in Generative Architectural Design

Andrei Nejur
Technical University of
Cluj-Napoca

Kyle Steinfeld
University of California, Berkeley

ABSTRACT

Mesh segmentation has become an important and well-researched topic in computational geometry in recent years (Agathos et al. 2008). As a result, a number of new approaches have been devel-

1 The Elephetus project by Anders Holden Deleuran (CITA/KADK) and

ABSTRACT

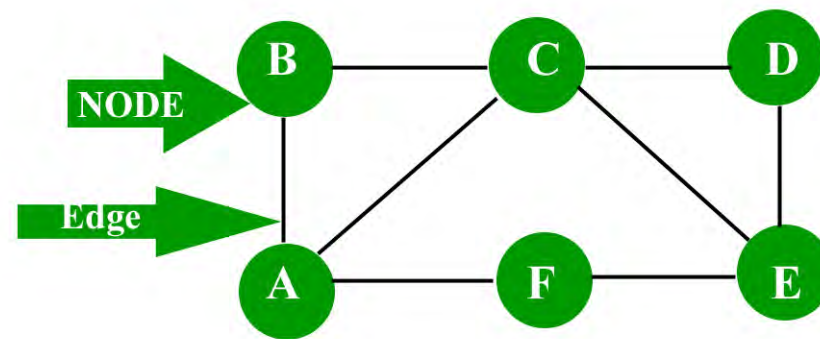
This paper presents progress in the development of practical applications for graph representations of meshes for a variety of problems relevant to generative architectural design (GAD). In previous

1 A papercraft model fabricated using Ivy.

Plug-in 4: Ivy

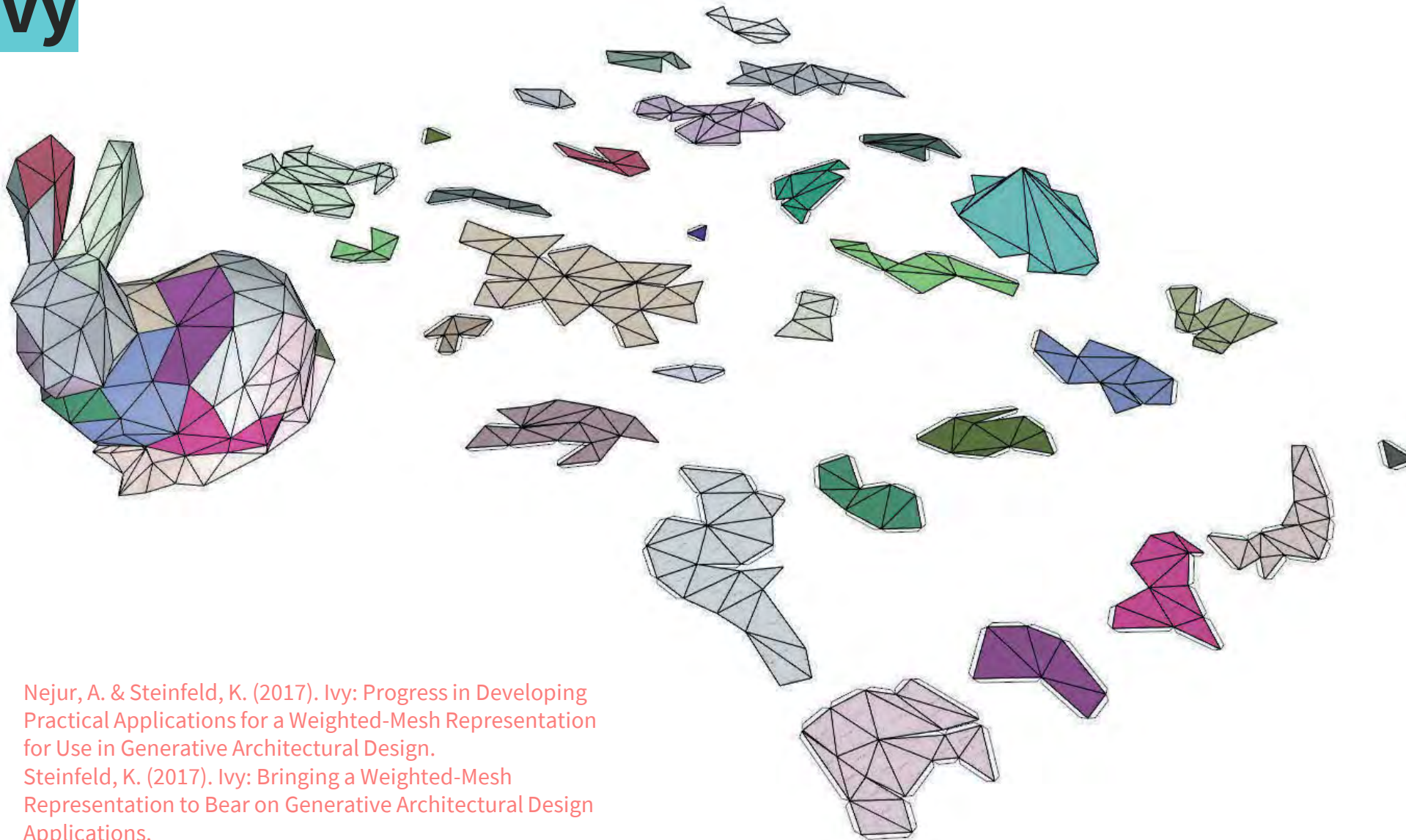
Based on
Graph Theory,

Creating
segmentations and
unroll them, then
send them to
digital fabrication
process



Plug-in 4:

Ivy

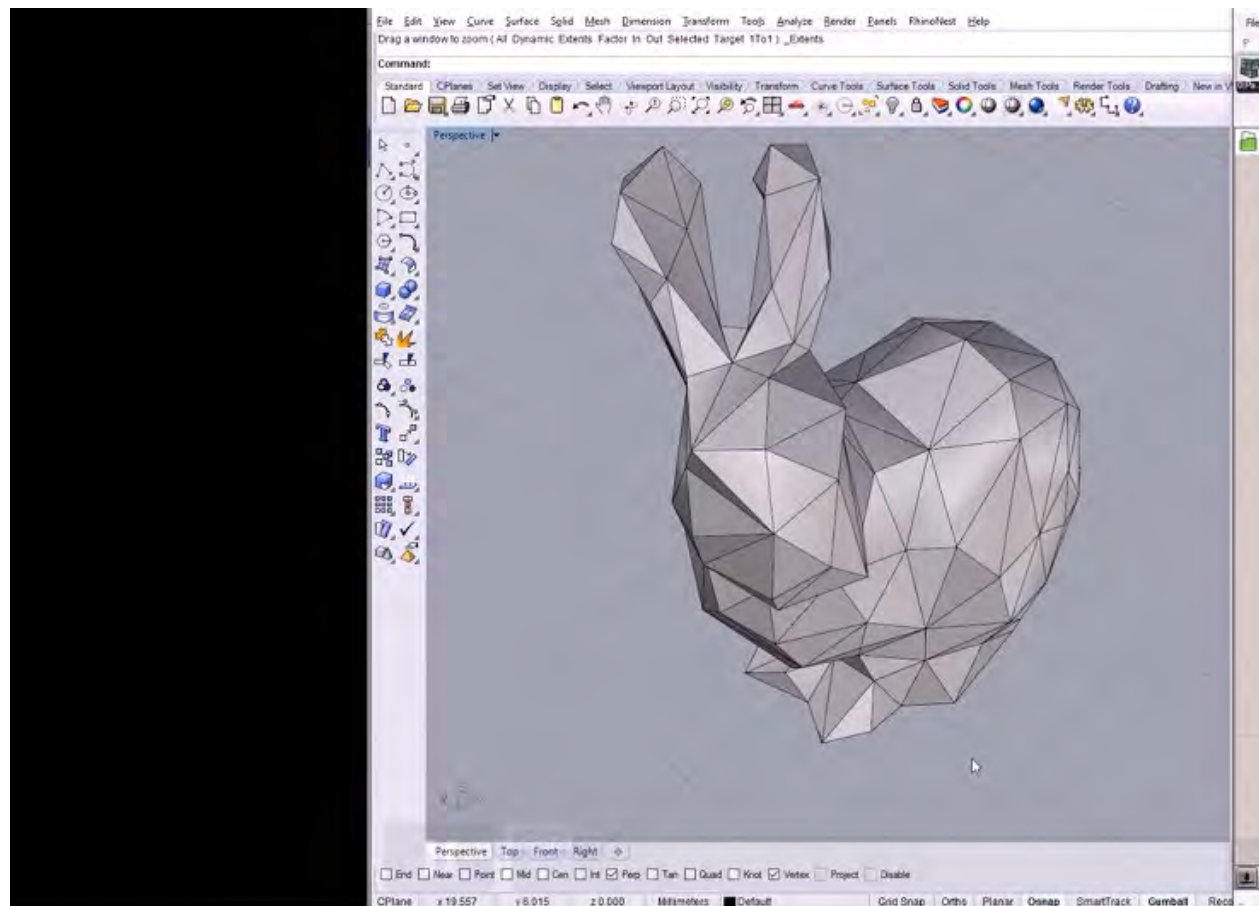


Nejur, A. & Steinfeld, K. (2017). Ivy: Progress in Developing Practical Applications for a Weighted-Mesh Representation for Use in Generative Architectural Design.

Steinfeld, K. (2017). Ivy: Bringing a Weighted-Mesh Representation to Bear on Generative Architectural Design Applications.

Plug-in 4: Ivy Introduction

<https://vimeo.com/nejur/ivy-01>



Ivy for Grasshoper basic mesh unroll

4 years ago | More



Andrei Nejur

+ Follow

Six common techniques:

3- Tiling/ Tessellating

It involves development of objects that when assembled together, forming **a coherent plane without gaps or overlaps.**

Advantages tiling/tessellating in digital fabrication approach:

- **Effective time investment**
- **Provide ways which patterns are generated and optimised (visually and materially sound)**
- **Optimised for reduction of waste.**

Six common techniques:

3- Tiling/ Tessellating

Translating digital information from **mesh to complex 3D form**, using sheet materials through tiling, has made digital fabrication technique become **more apparent** from early design stage.

Tiling/tessellating also affords **greater variation and modulation**, as they provide an inherent economy of means.

Previously in Week 6, how Ivy can contribute to the process..

Six common techniques:

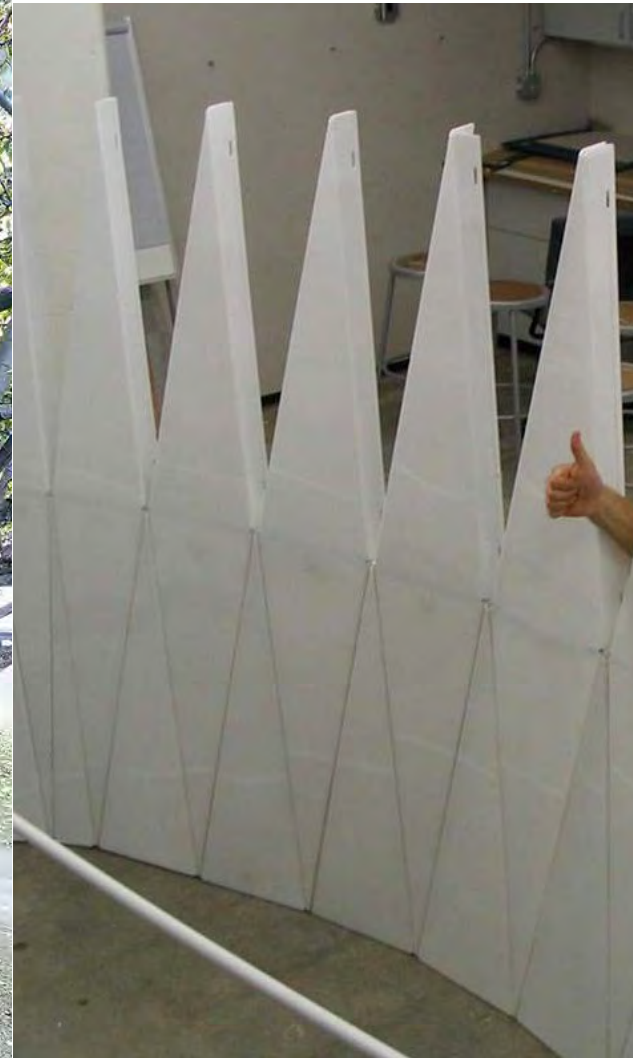
3- Tiling/ Tessellating

Huyghe + Le Corbusier

Puppet Theater,

MOS

2004



<https://www.mos.nyc/project/puppet-theater>

Re-iterated aims and objectives

- To elicit **purposes** of additional plug-ins
- To contextualise **the use** of plug-ins in parametric design thinking
- To enumerate **available plug-ins** and their common use
- To illustrate kinds of **analysis** and **data** obtained from selected plug-ins
- To inform how can plug-ins be **useful** for future use in design