

SE „Computational Design and Fabrication“

Welcome & Seminar Introduction

8.5.2023, Munich

Collaborators

TUM

Chair of Structural Analysis (Prof. Dr.-Ing. K.-U. Bletzinger, Dr.-Ing. Majid Hojjat)

Professorship of Structural Design (Prof. Dr. Pierluigi D'Acunto, Frederic Chovghi)

Professorship of Digital Fabrication (Prof. Dr. Kathrin Dörfler, Lidia Atanasova)

ETHZ

Gramazio Kohler Research (Dr. Daniela Mitterberger)



Agenda

- Welcome & introduction round
- Seminar topic introduction
- First introduction to the computational design workflow + example files
- Trouble shooting installation
- Safety introduction (Andreas Bittner)

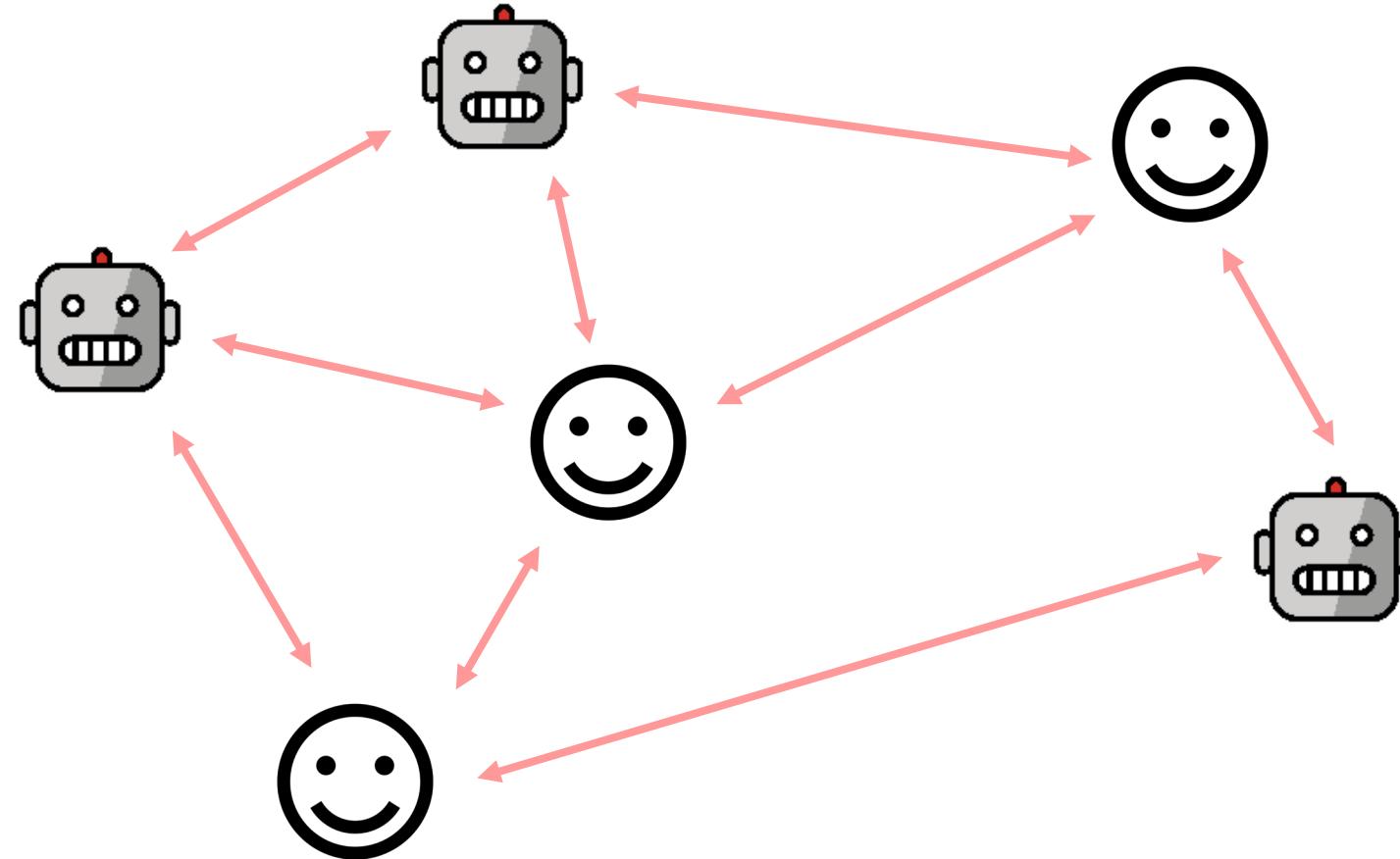
Course Schedule

[Github pages](#)

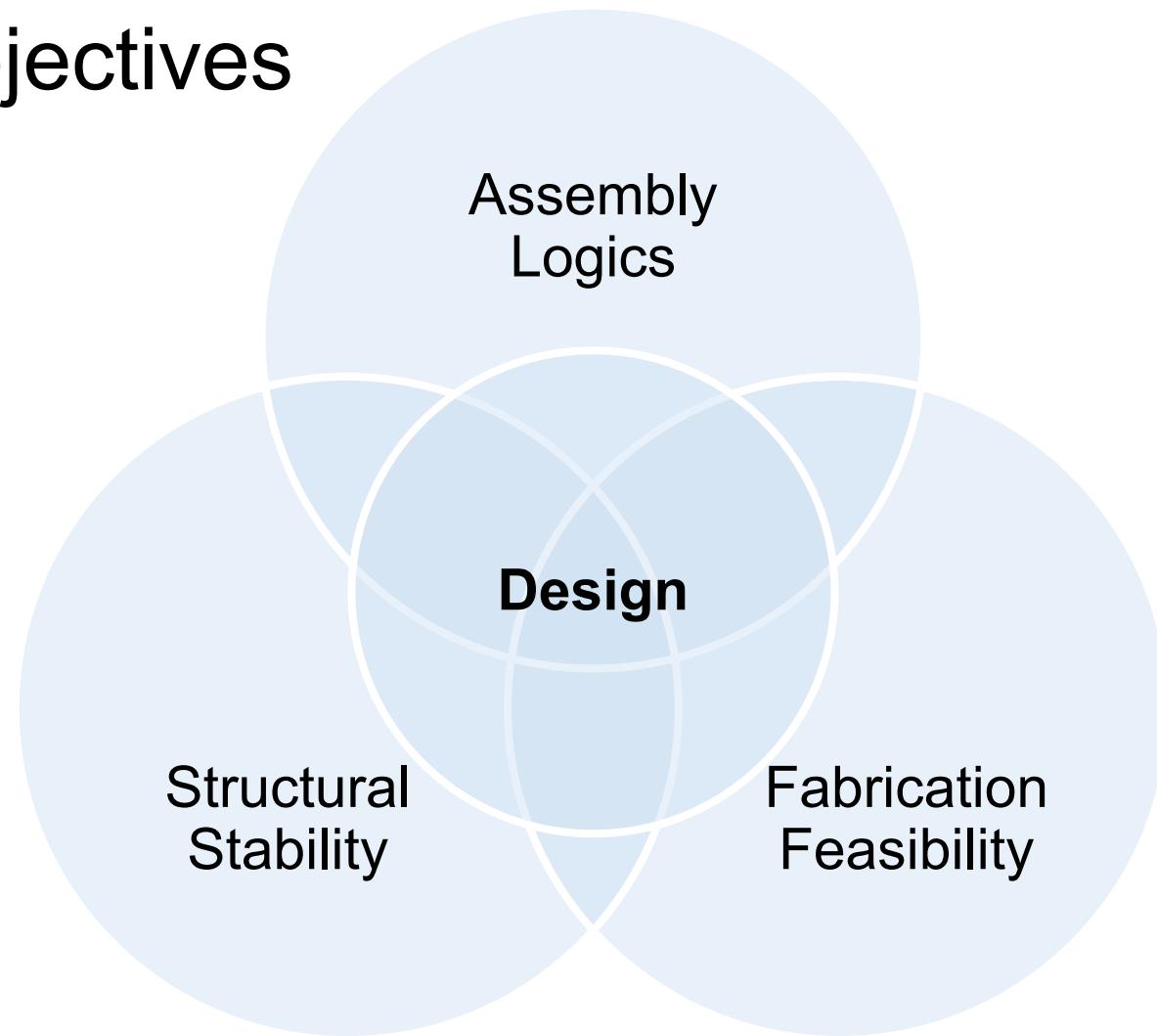
Introduction round

Human-Robot Cooperative Assembly for Reciprocal Frame Structures





Research Objectives



Course Structure

Part 1 - Computational Design

Part 2 - Computational Fabrication

Course Structure

Part 1 - Computational Design

- digital form-finding techniques
- digital fabrication methods of multi-robot assembly
- designing a reciprocal frame structures
- methods of robotic path planning and control

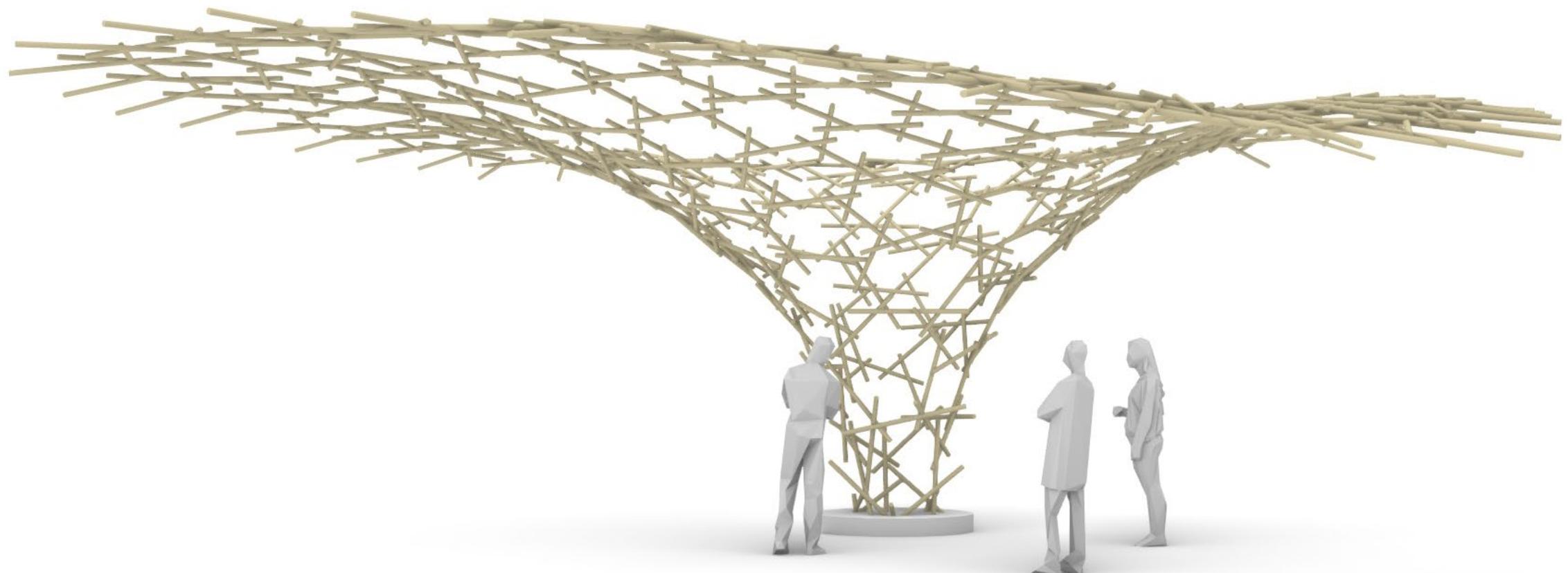
Part 2 - Computational Fabrication

Course Structure

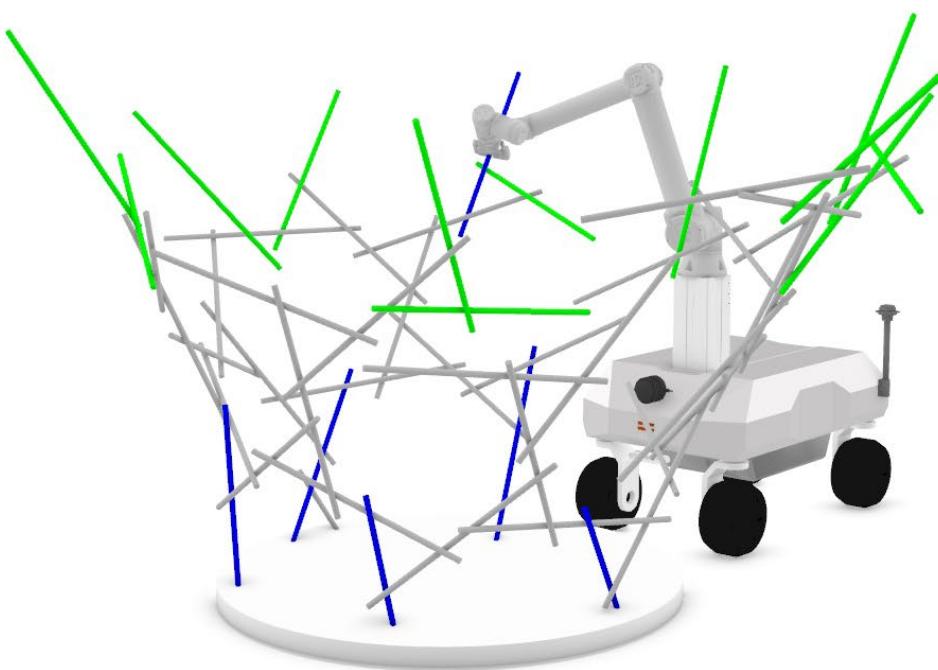
Part 1 - Computational Design

Part 2 - Computational Fabrication

- 1:1 scale demonstrator
- cooperative assembly workflow with two collaborative robots and multiple people
- custom mass-produced connectors
- custom mobile AR interface
- negotiate the levels of task distribution and coordination



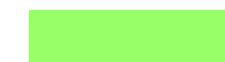
Color Coding: Design Generation



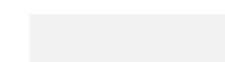
States colour scheme



'is_support'

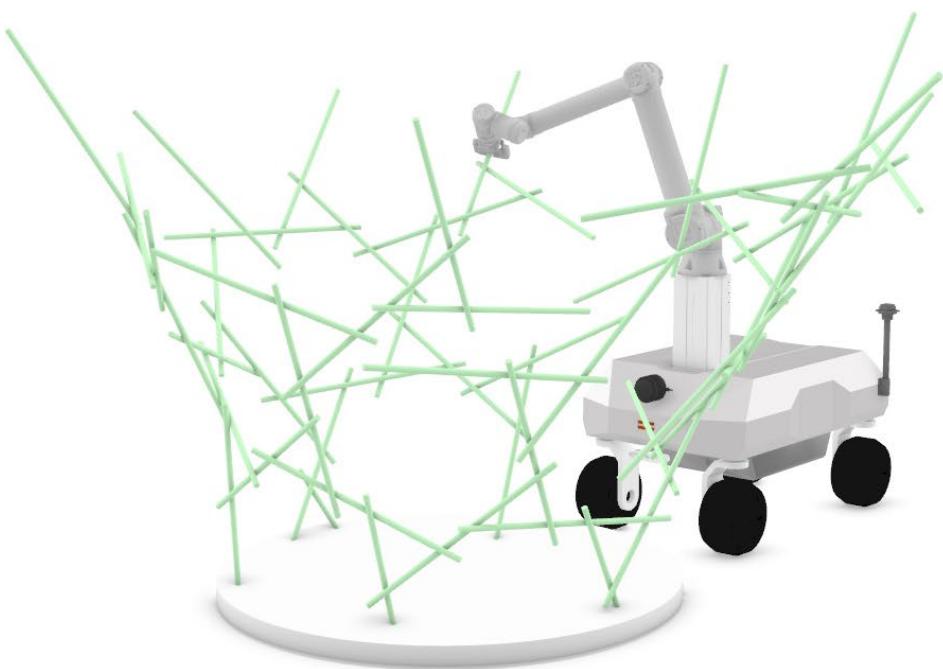


'has_open_connector'



has no open connectors

Color Coding: Assembly Workflow



States colour scheme

	'is_planned'
	'is_built'
	'built_by_robot'
	'built_by_human'

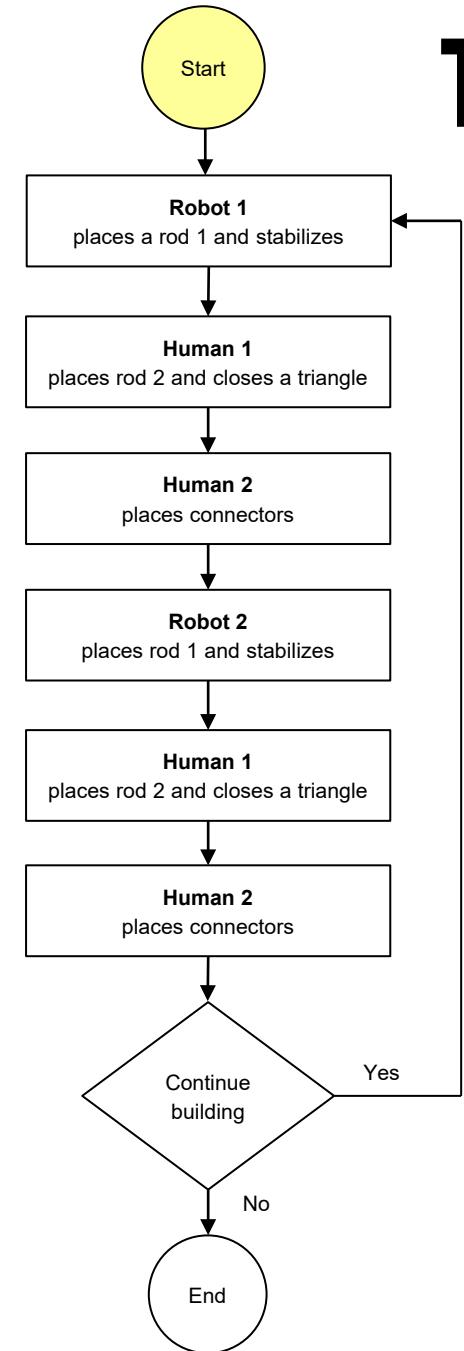
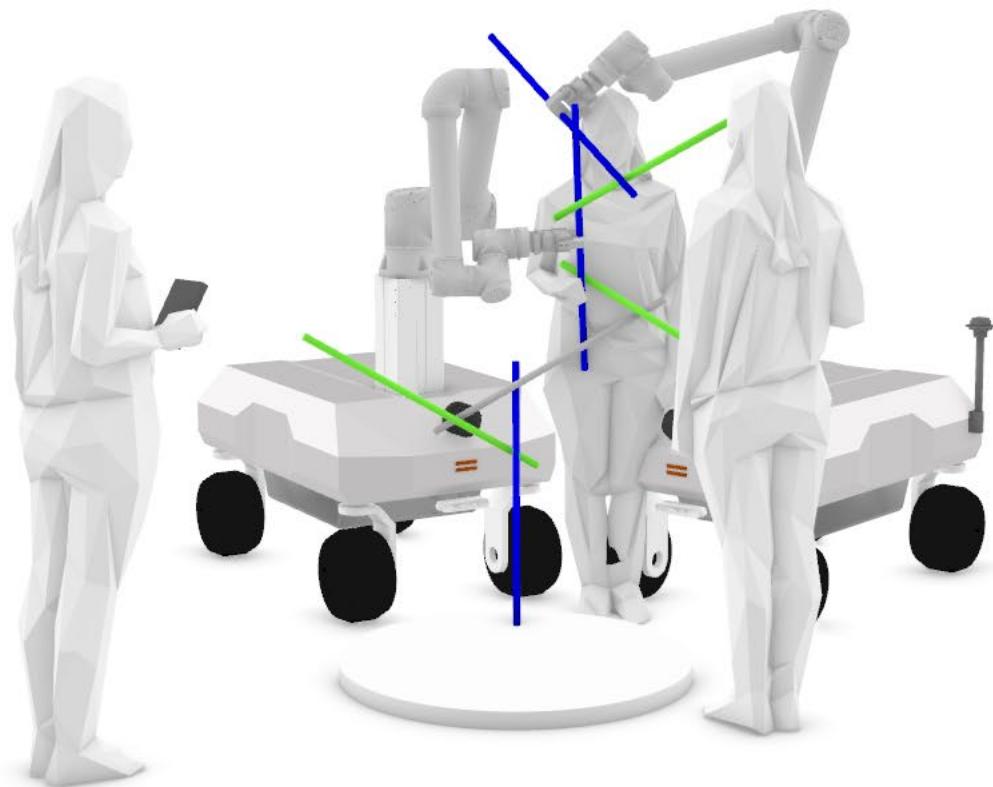
Color Coding: Assembly Workflow

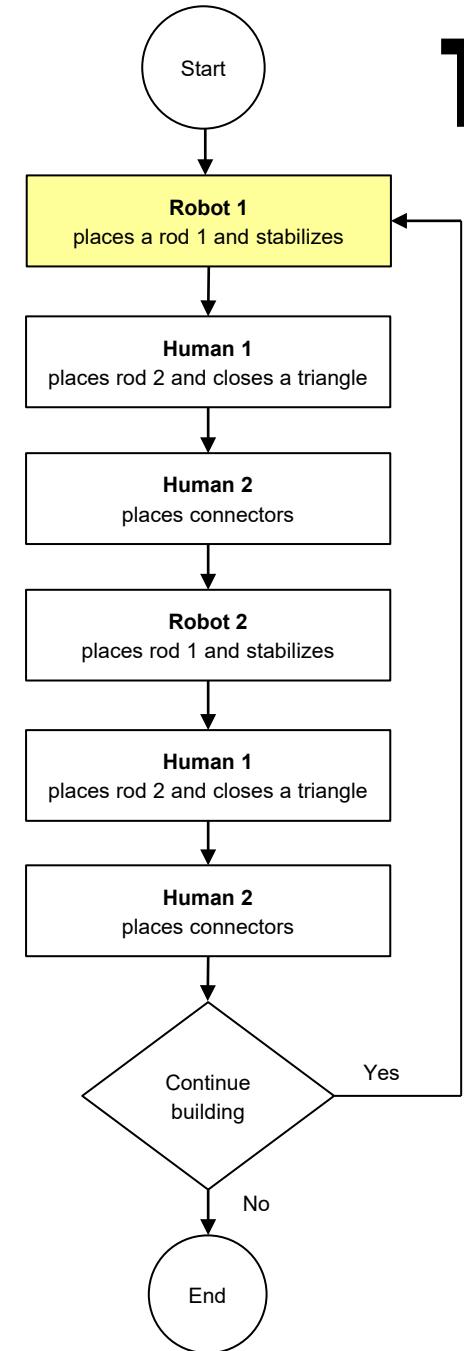
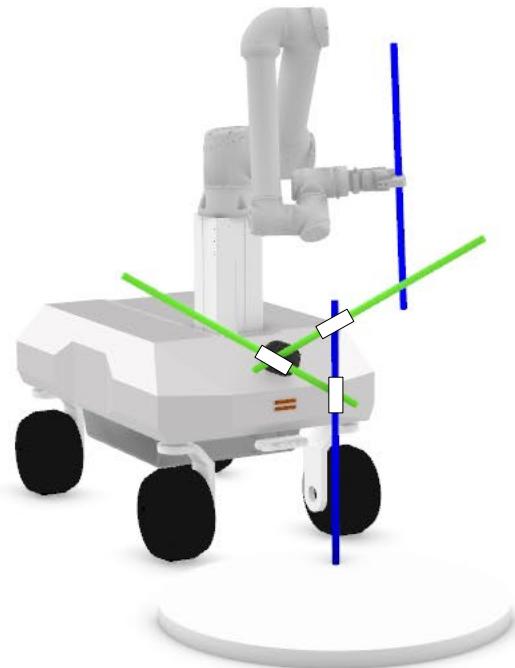


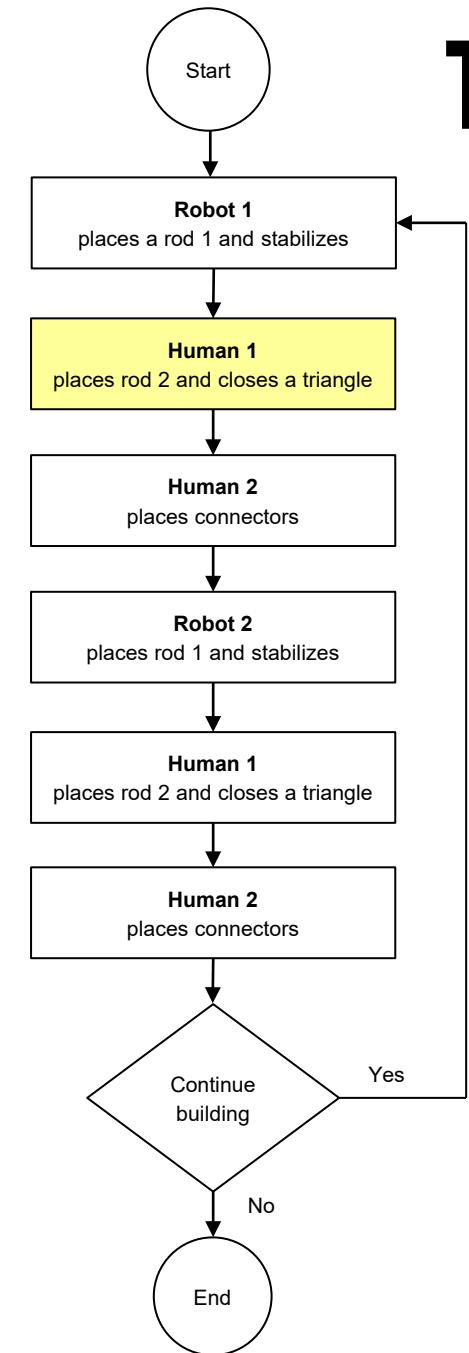
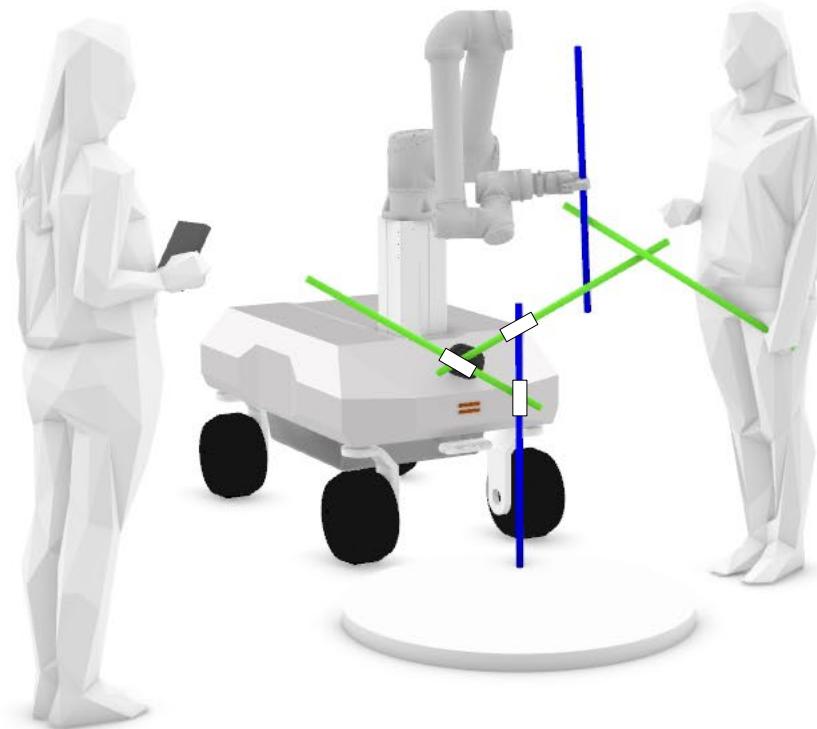
States colour scheme

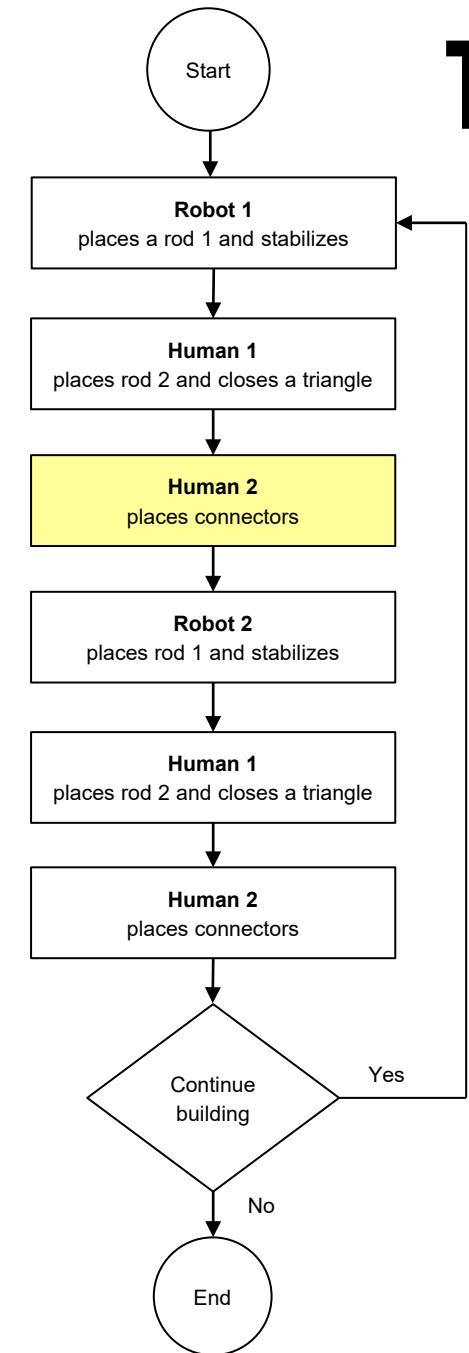
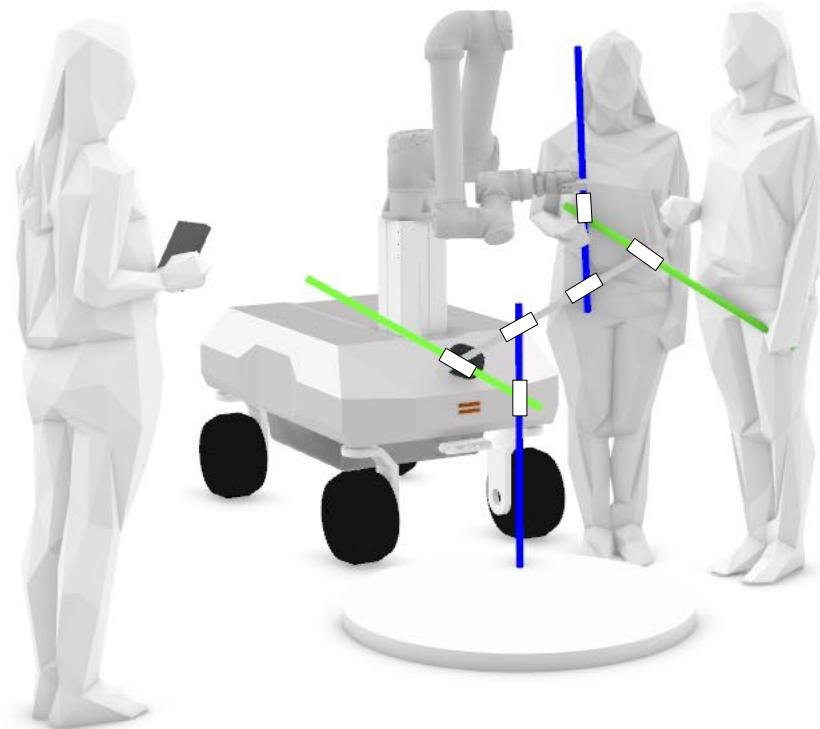
Light grey	'is_planned'
Medium grey	'is_built'
Cyan	'built_by_robot'
Yellow	'built_by_human'

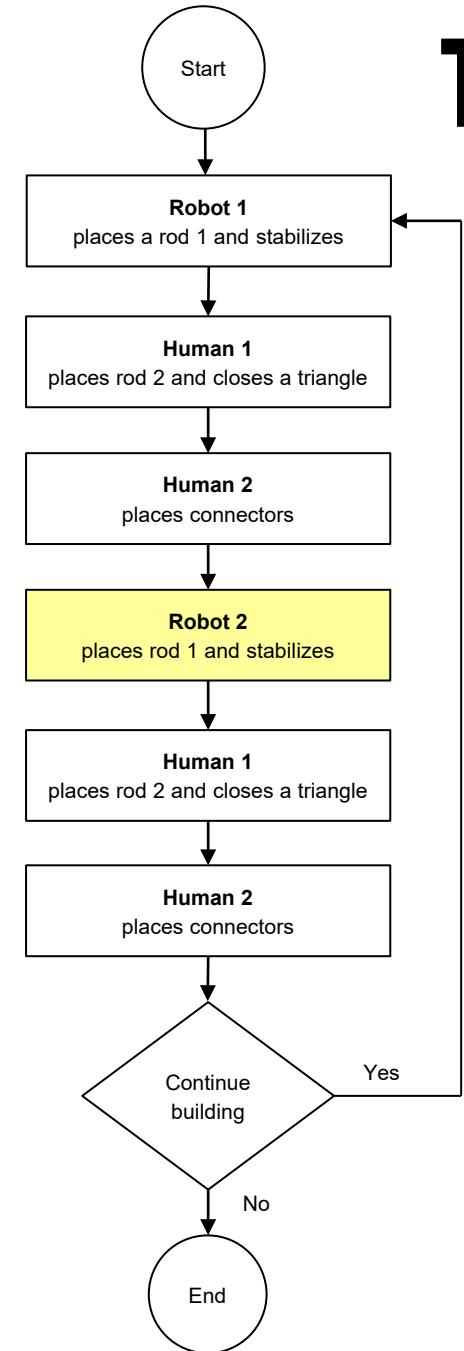
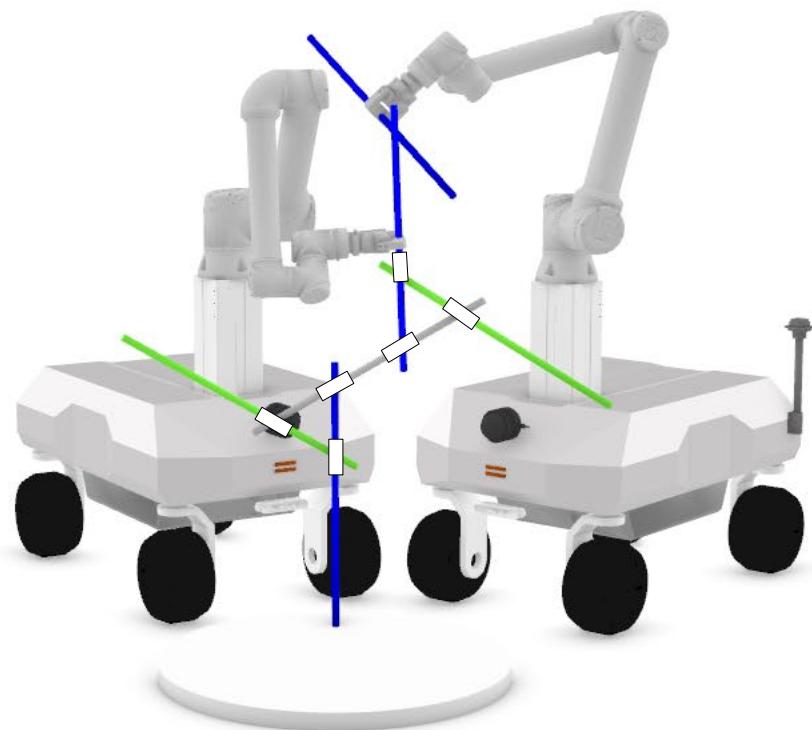
Assembly Workflow

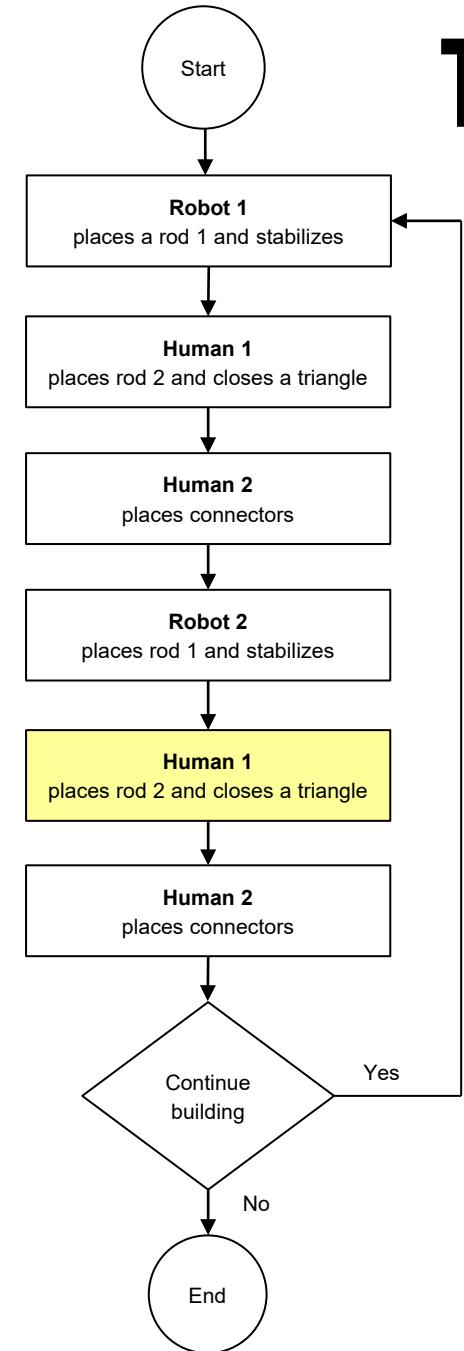
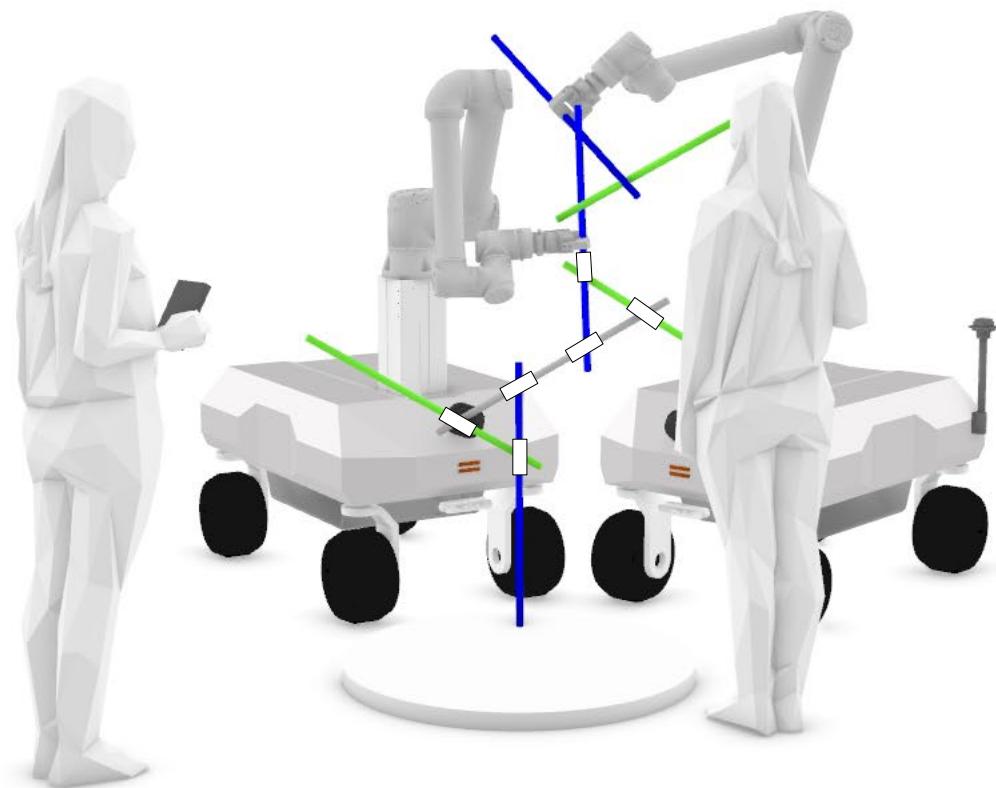


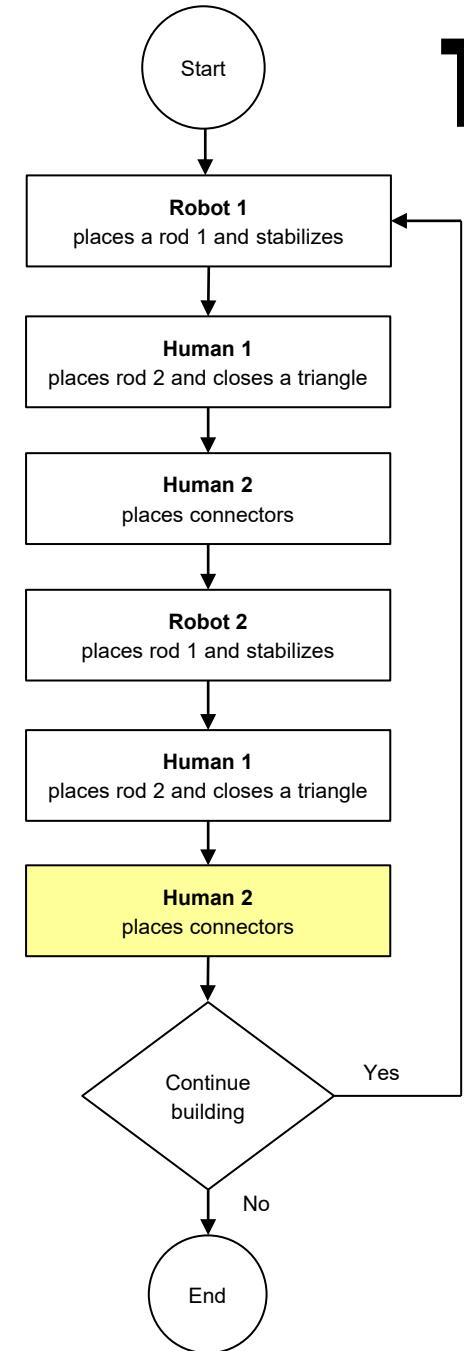
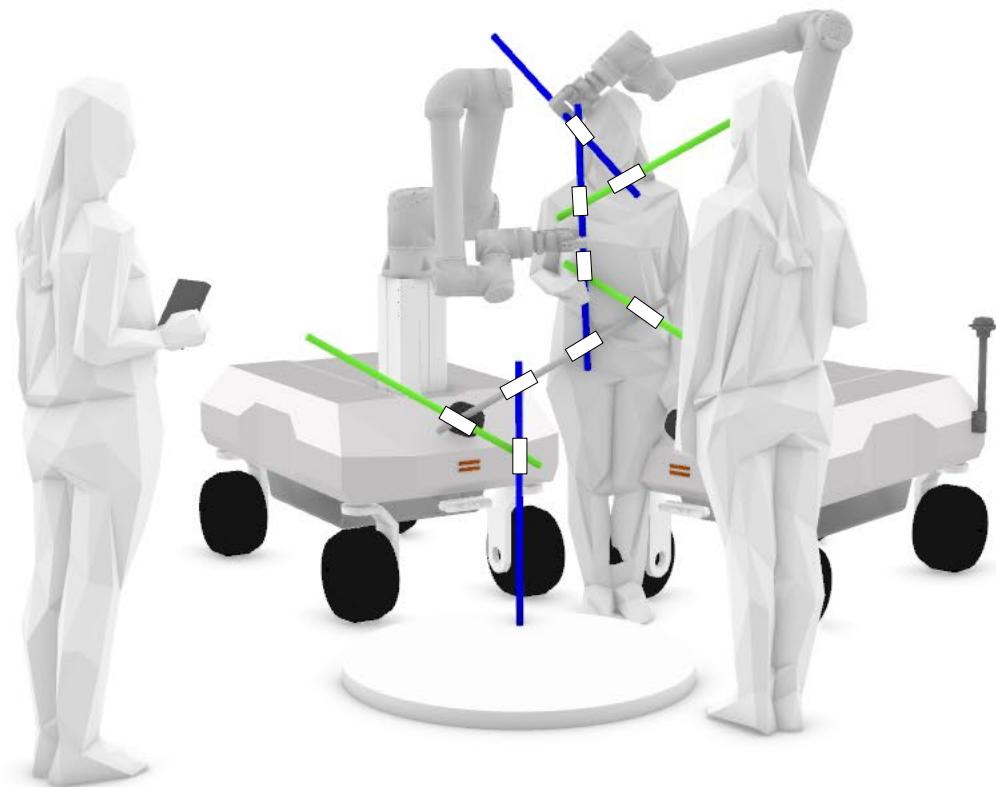




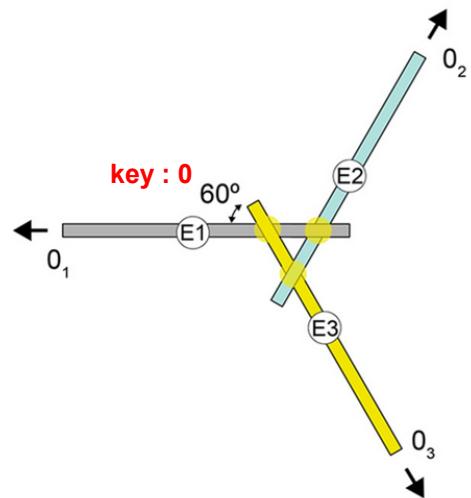






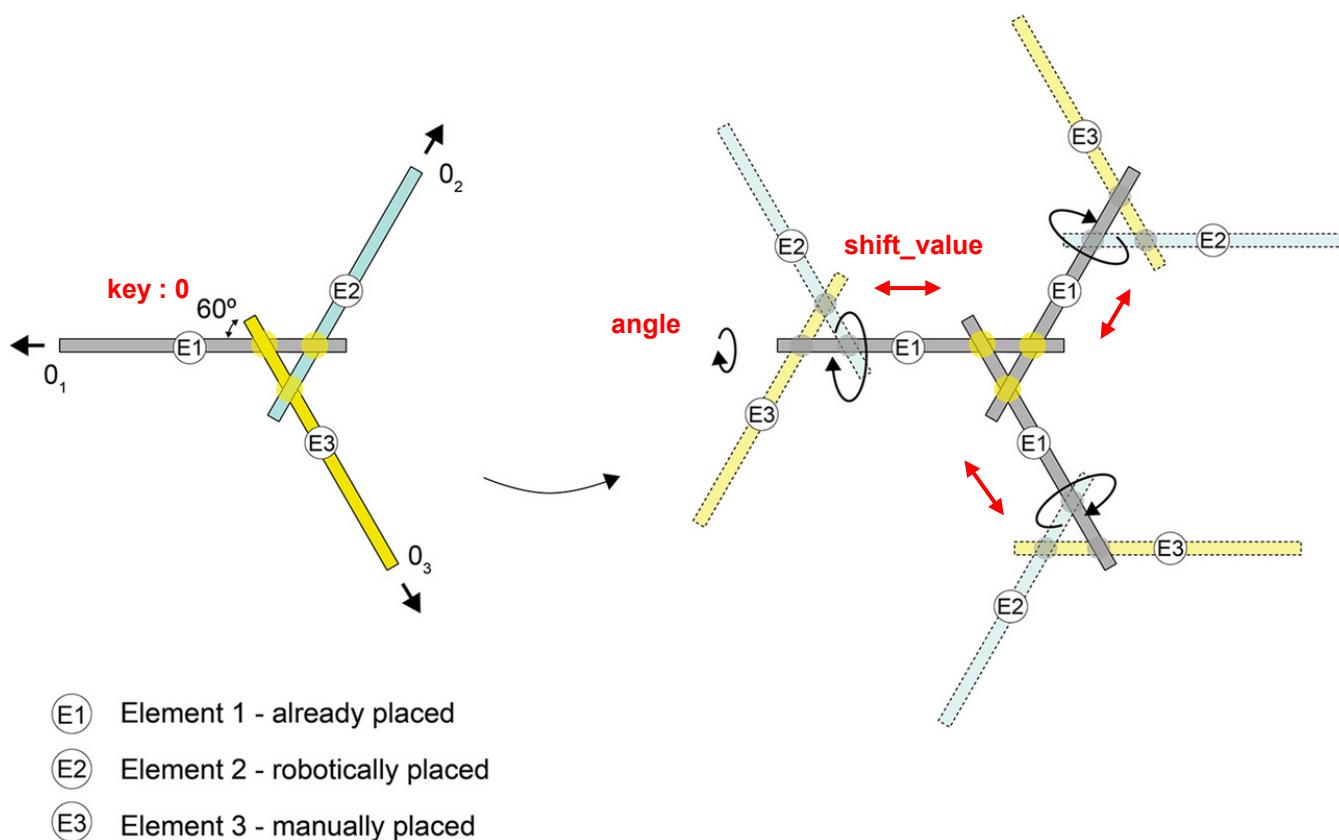


Reciprocal Frame



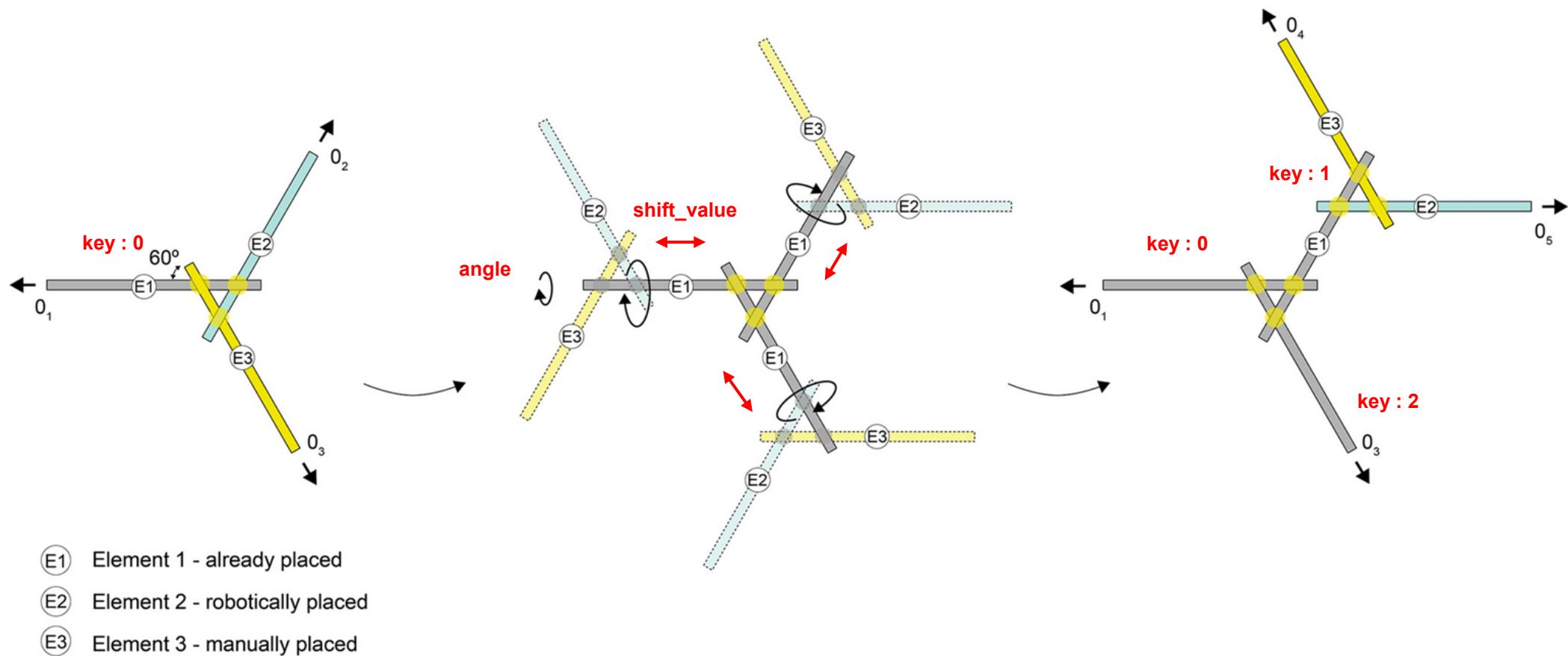
- (E1) Element 1 - already placed
- (E2) Element 2 - robotically placed
- (E3) Element 3 - manually placed

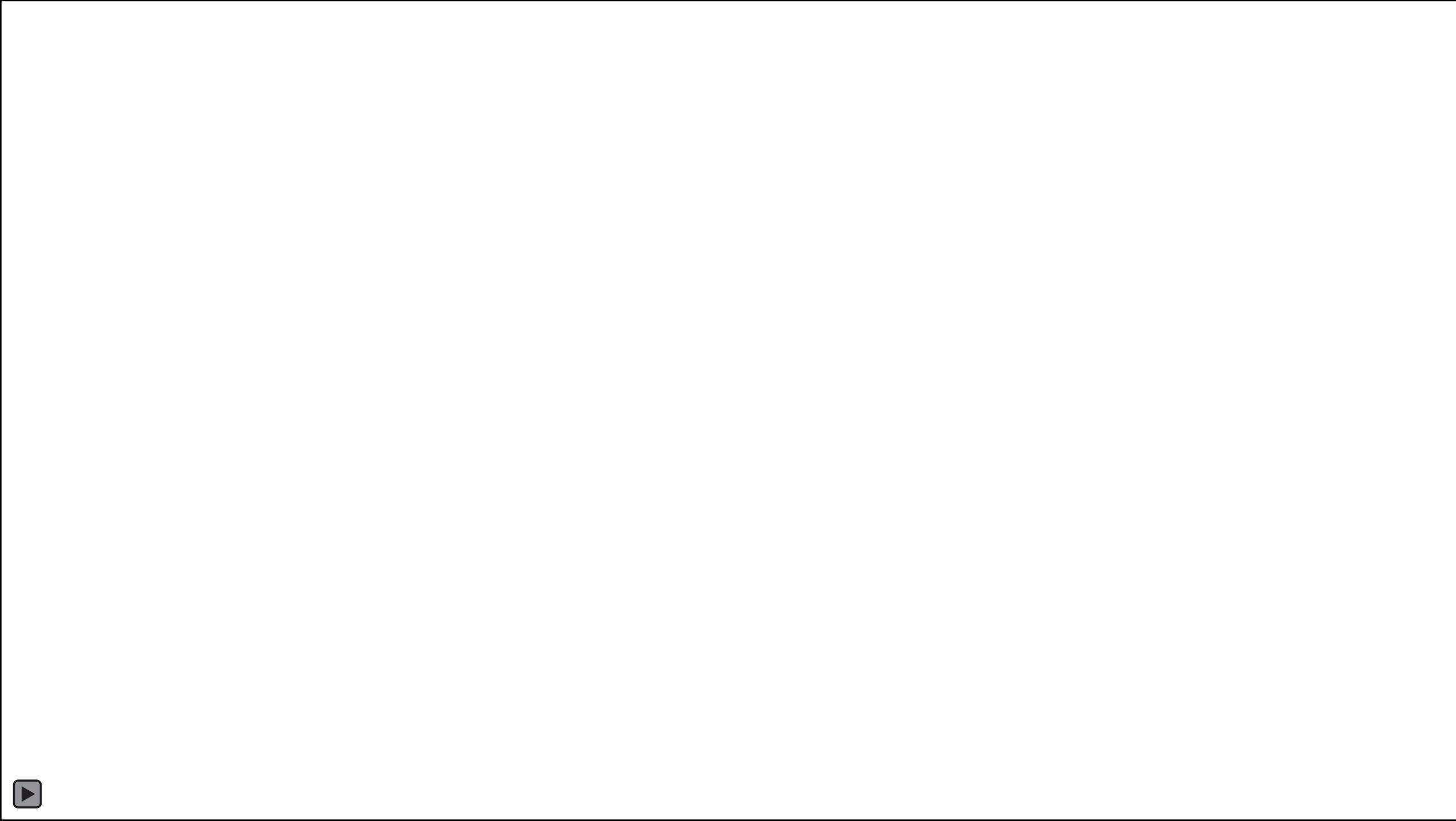
Reciprocal Frame: Parameters



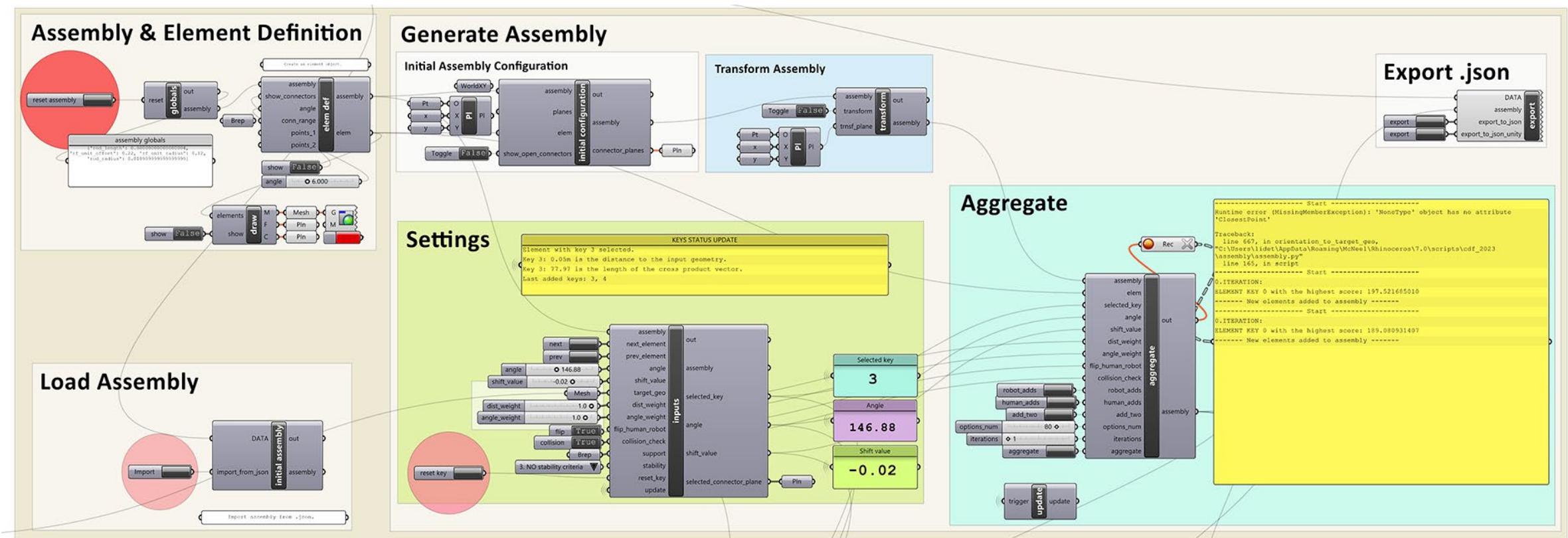
- Element key
- Rotation angle
- Shift value

Reciprocal Frame: Growth rules

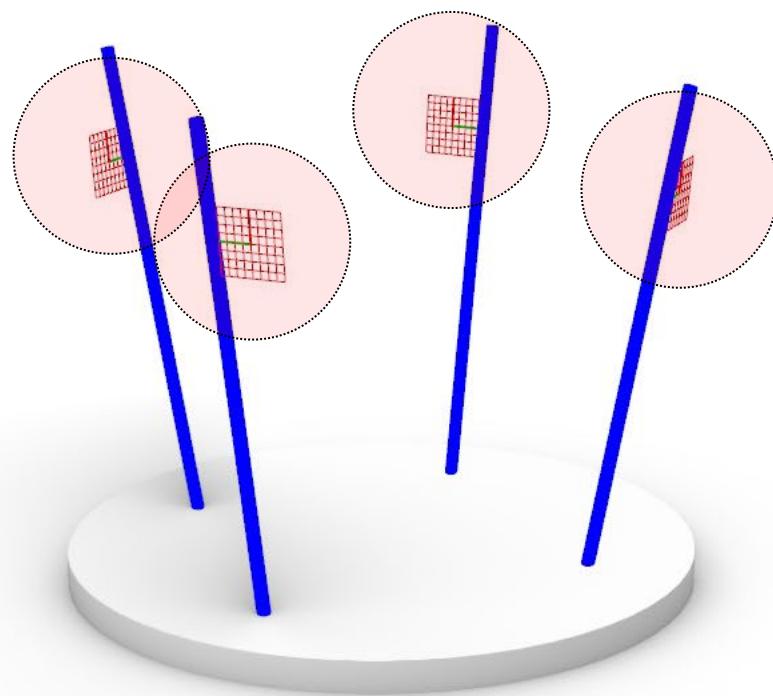




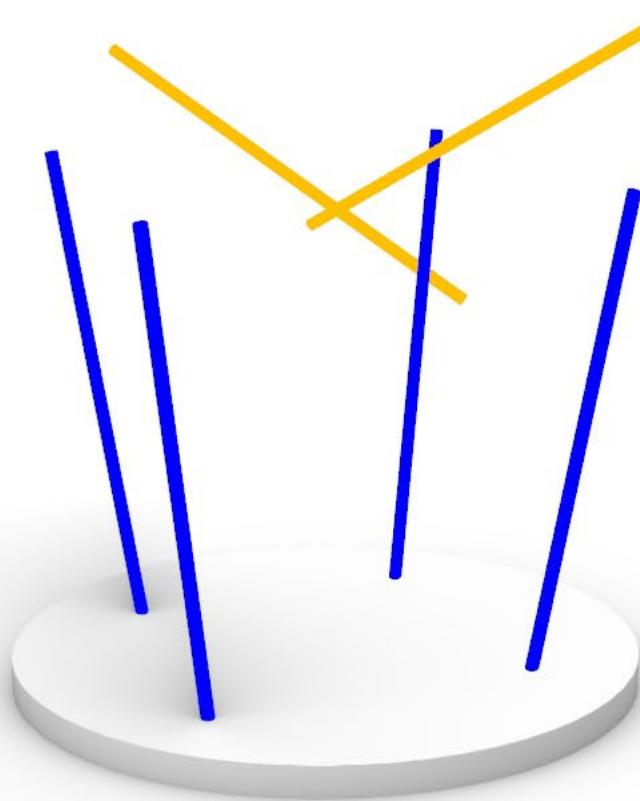
Design Tool



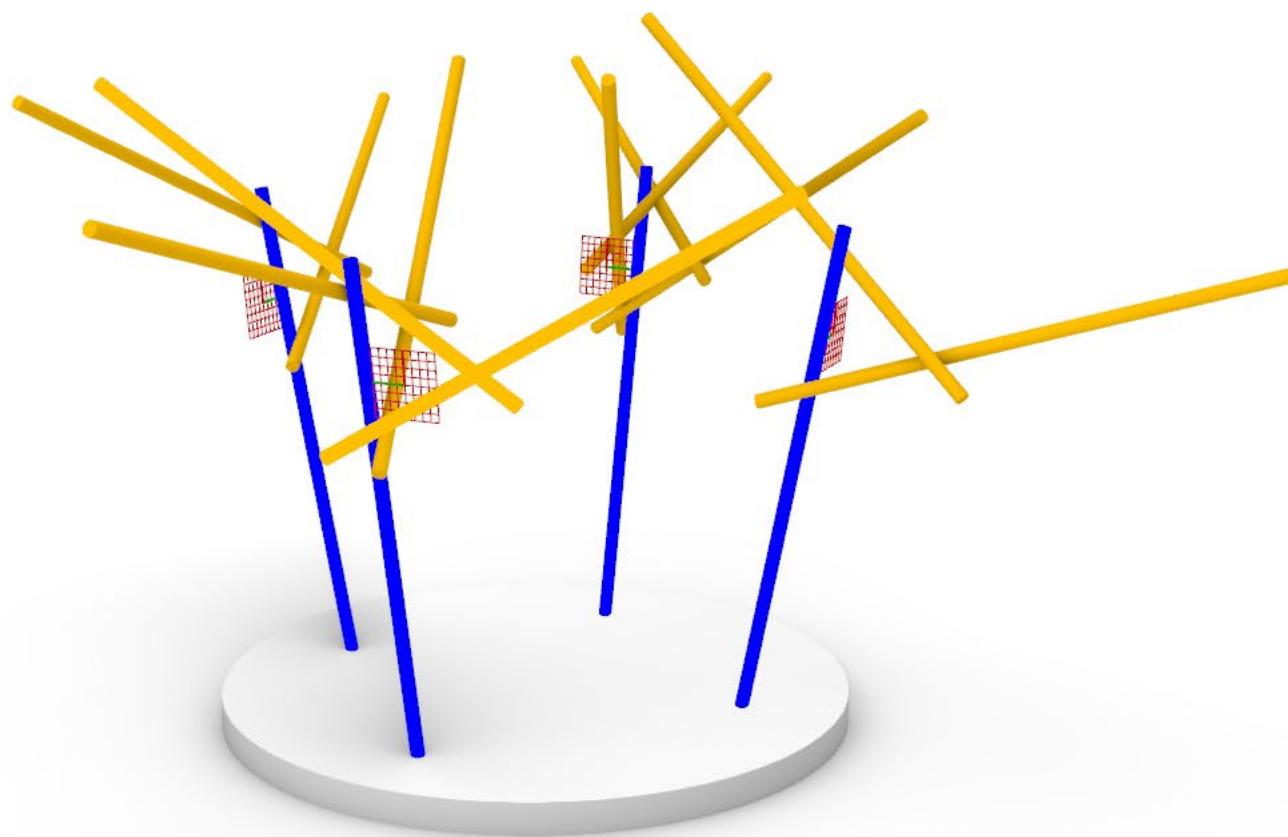
Open Connectors



Option elements



Multiple option elements



Growth criteria

1. Random growth without stability criteria
2. Random growth with stability criteria (global and local)
3. Growth following a target geometry

