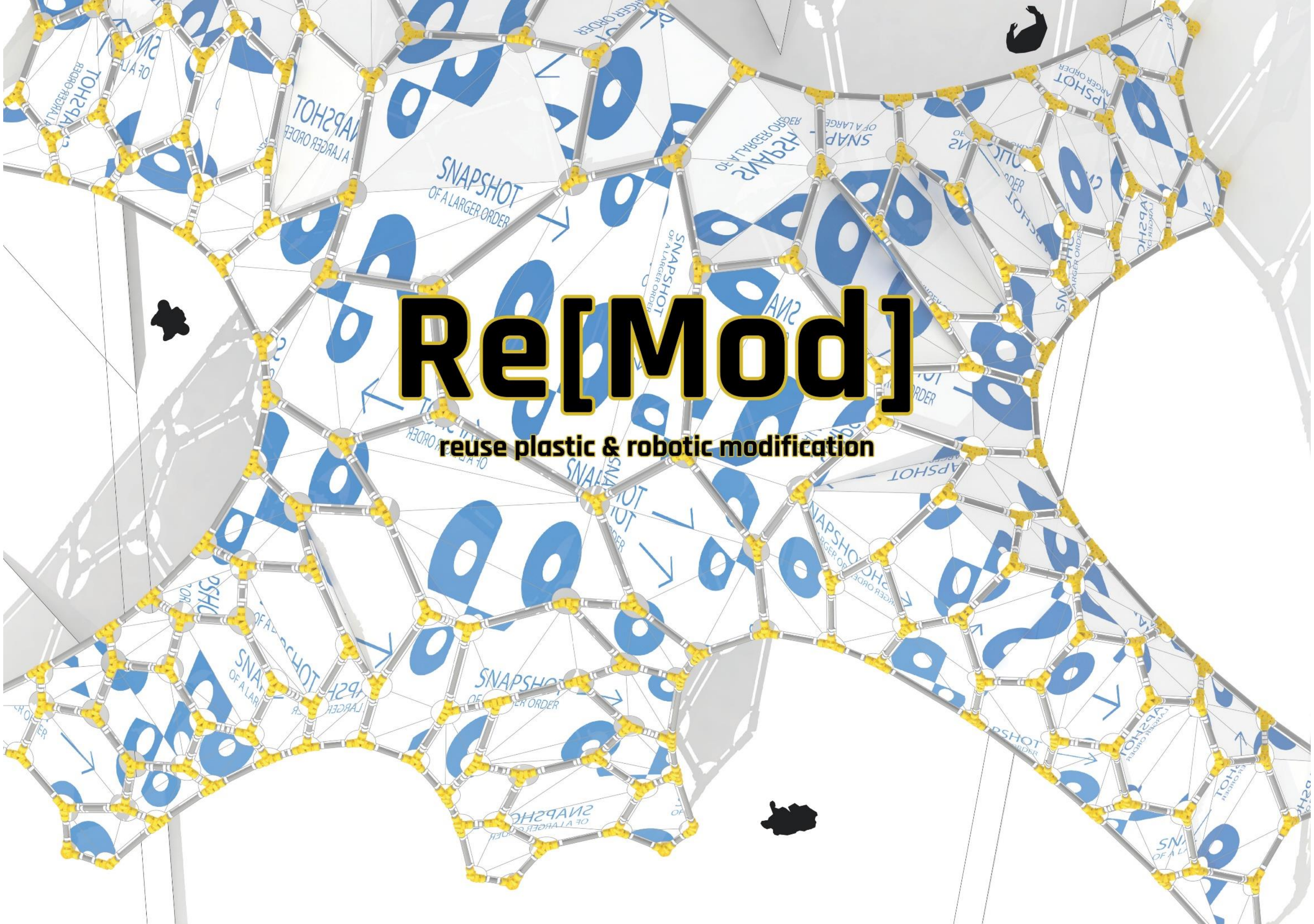
Re[Mod]

reuse plastic & robotic modification



1.0 BACKGROUND

1.1 Context

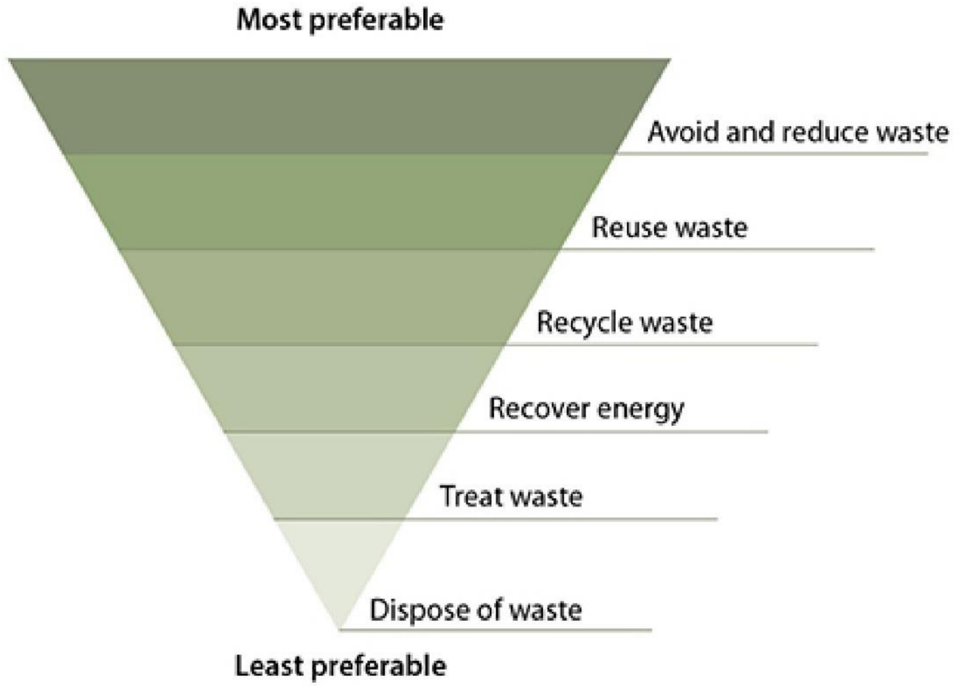
- IT IS KNOWN THAT THE GLOBAL IMPACT OF SOLID WASTE IS BECOMING MORE WORRYING DAY BY DAY

SOURCE: https://www.theguardian.com/environment/2019/may/10/nearly-all-the-worlds-countries-sign-plastic-waste-deal-except-us

1.0 BACKGROUND

1.1 Context

- THE WASTE MANAGEMENT INDUSTRY, TO DEAL WITH THE PROBLEM, FOLLOWS A **GENERALLY ACCEPTABLE HIERARCHY** THAT IS MEANT TO TAKE INTO ACCOUNT FINANCIAL, SOCIAL, AND ENVIRONMENTAL ISSUES.



SOURCE: Waste Avoidance and Resource Recovery Act, 2001

1.0 BACKGROUND

1.1 Context

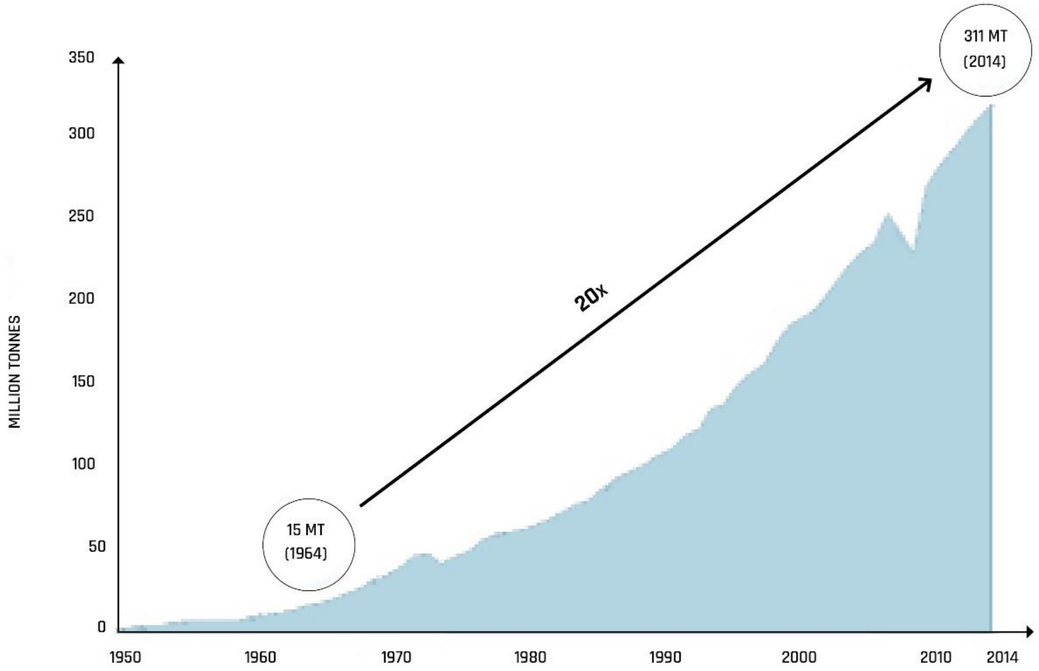
- PLASTIC COMPOSITES BECAUSE OF THEIR MANY AND DIFFERENT APPLICATIONS ARE NOW **FUNDAMENTAL FOR THE GLOBAL WORLD ECONOMY** AND THEY ALSO REPRESENT ONE OF THE BIGGEST ENVIRONMENTAL ISSUES NOWADAYS

- **PLASTICS PRODUCTION** HAS INCREASED TWENTYFOLD SINCE 1964, REACHING 311 MILLION TONNES IN 2014 AND IT IS EXPECTED TO ALMOST **QUADRUPLE BY 2050.**

- CURRENTLY, THE RESEARCH ABOUT PLASTIC IS ON TWO LEVELS:

1. REPLACEMENT OF OIL BY RENEWABLE BIO-SOURCED MATERIALS.

2. RECYCLING OR **REUSING THE PRODUCTS.**

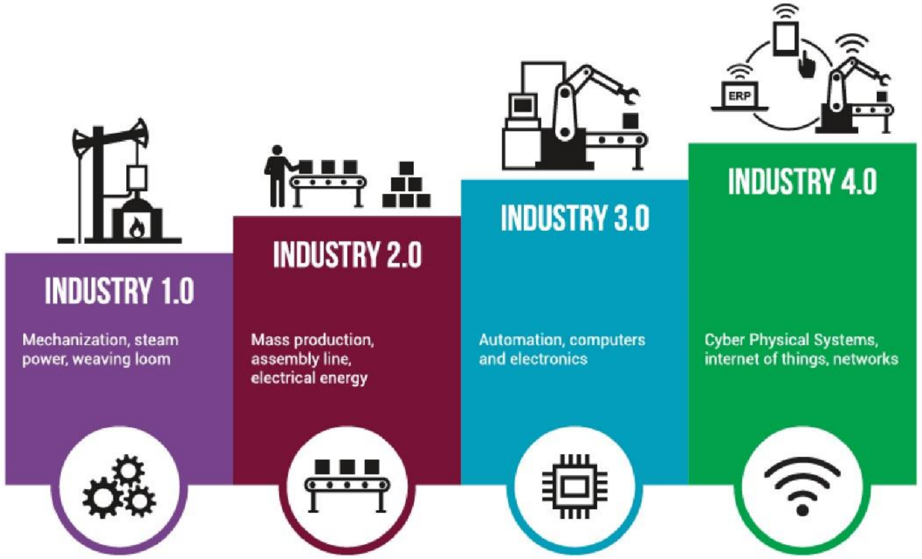


SOURCE: WORLD ECONOMIC FORUM, ELLEN MACARTHUR FOUNDATION (2016)

1.0 BACKGROUND

- PRESENTLY, WE ARE IN THE MIDDLE OF THE FOURTH TECHNOLOGICAL ADVANCEMENT WITH THE RISE OF A NEW DIGITAL INDUSTRIAL TECHNOLOGY CALLED **INDUSTRY 4.0.**

- THE QUESTION FOR THE FUTURE IS NOT ANYMORE IF ROBOTIC SYSTEMS WILL BE INCORPORATED INTO BUILDING PROCESSES AND PHYSICALLY BUILT ENVIRONMENT; BUT HOW IS THIS GOING TO HAPPEN.



SOURCE: https://erichfelbabel.com/2018/03/07/industry-4-0-are-you-ready/

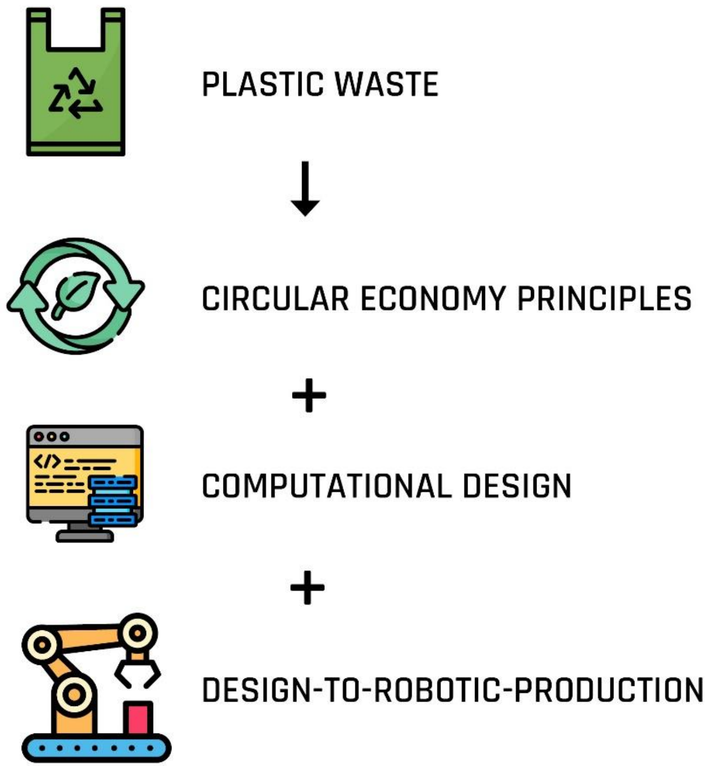
2.0 PROBLEM STATEMENT

HOW CAN COMPUTATIONAL DESIGN AND ROBOTIC PRODUCTION HELP TO REUSE PLASTIC IN ARCHITECTURE?

3.0 OBJECTIVE

3.1 General objective

CONTRIBUTE TO THE EFFORTS IN SUSTAINABLE DESIGN RESEARCH PROVIDING AN ALTERNATIVE OPTION TO THE TRADITIONAL TECHNIQUES APPLIED IN THE BUILDING CONSTRUCTION



3.0 OBJECTIVE

- **FINAL PRODUCT**: TEMPORARY STRUCTURE - PAVILION, FOR OUTDOOR USE DURING THE SUMMER SEASON; COULD BE EMPLOYED IN FESTIVALS, EVENTS OR EVEN ON OUR CAMPUS.

- BUILDING A PAVILION WOULD ALLOW THE DESIGNER TO FOCUS MORE ON THE MATERIALS AND BUILDING ITSELF, RATHER THAN ON THE PROGRAMME CONSTRAINS.

- **CONSTRAINS:**

1. APPLICATION OF REUSED PLASTIC OBJECTS
2. NEARLY ZERO EXTRA MATERIAL
3. DEMOUNTABLE
4. AFFORDABLE

SOURCE: https://indebuurt.nl/delft/doen/kraantje-pappie-en-dewolff-treden-op-tijdens-gratis-tu-festival/

4.0 RESEARCH QUESTIONS

4.1 Main Research question

*HOW CAN WE **REUSE PLASTIC OBJECTS IN THE BUILDING INDUSTRY** IN ORDER TO CONTRIBUTE REDUCING THE PROBLEM OF PLASTIC WASTE AND ITS SHARE OF GLOBAL OIL CONSUMPTION?*

RESEARCH PROCESS


RESEARCH DESIGN
DESIGN EXPLORATION & FABRICATION
PAVILION DESIGN

5.0 APPROACH AND METHODOLOGY

MESO - Component scale

- **MAIN REQUIREMENTS**: DIFFICULTY IN REUSING THE OBJECT IN DAILY LIFE, STRENGTH AND A WALL THICKNESS OF AT LEAST 1 MM.

RESEARCH OF POSSIBLE COMPONENTS:

DISPOSABLE KEG

PLASTIC CONE

DISPOSABLE KEG

DRILL CONTAINER

STRUCTURAL TESTS:

5.0 APPROACH AND METHODOLOGY

MESO - Component scale

- **FIRST SELECTED COMPONENT**: FROM SANDVIK COROMANT, A METALWORKING INDUSTRY SPECIALIZED IN MANUFACTURING TOOLS. THE COMPONENT IS A HOLLOW AND OPENABLE PLASTIC OBJECT USED TO TRANSPORT AND STORE DIFFERENT TYPOLOGIES OF DRILLING HEADS.

SOURCE: https://www.sandvik.coromant.com/en-gb/products/start-up-tool-kits/pages/default.aspx

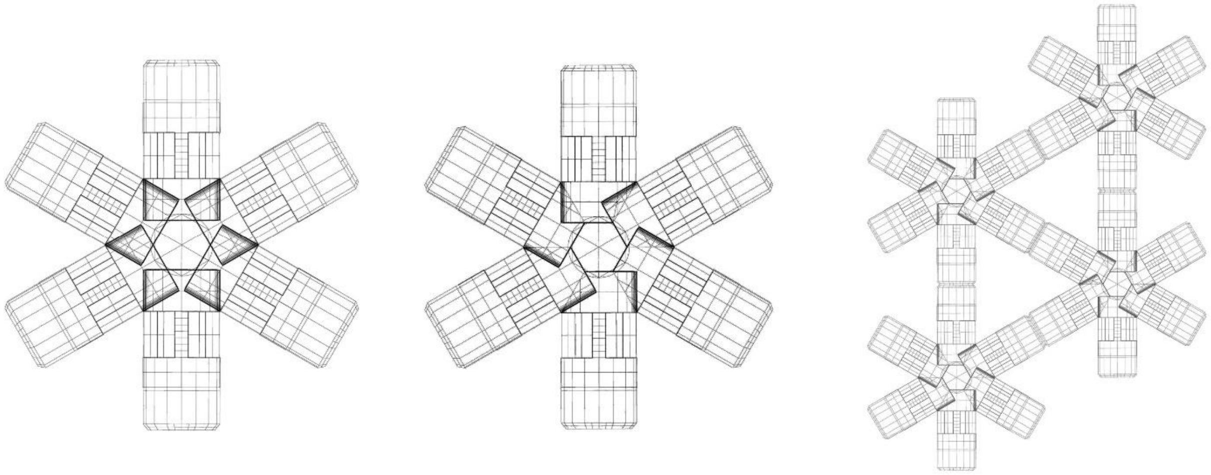
5.0 APPROACH AND METHODOLOGY

MACRO - Building scale

- **CONCEPT:** TAKE ADVANTAGE OF THE FLAT BASE OF THE DRILL CONTAINER OBJECT TO CREATE JUNCTION ELEMENTS OUT OF PATTERNS OF TRIANGLES, QUADRILATERAL, PENTAGONS, AND HEXAGONS TO CREATE STABLE STRUCTURES

- **DESIGN SYSTEM** (IN PLAN): DIVISION OF A RANDOM CIRCLE IN DIFFERENT PARTS, WHERE THE CENTER OF THE CIRCLE WILL BE THE CENTER OF THE JUNCTION.

SIX COMPONENTS JUNCTION



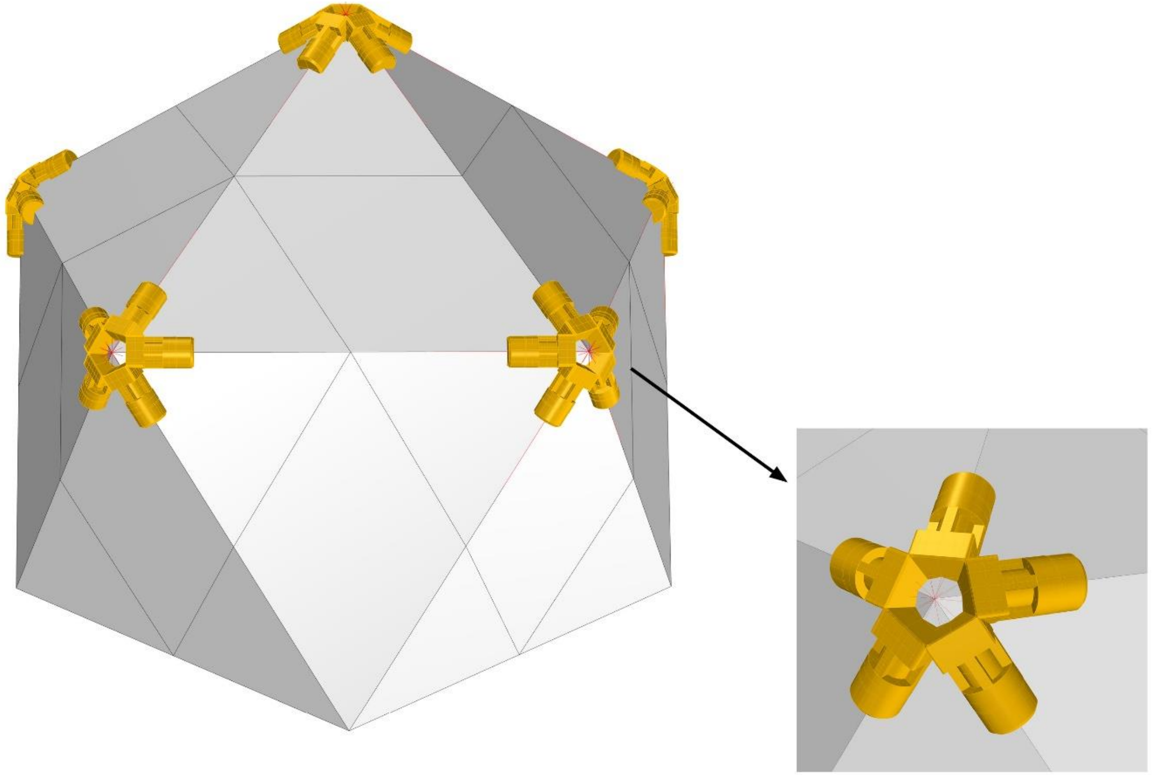
1 - POSITION **2 - CONNECTION** **3 - ASSEMBLY**

5.0 APPROACH AND METHODOLOGY

MACRO - Building scale

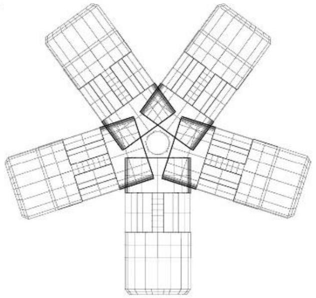
- THE JOINT SYSTEM BASED ON PENTAGONS IS TESTED IN THE 3D ENVIRONMENT, THROUGH THE **REGULAR ICOSAHEDRON** SHAPE.

- THE STRUCTURE IS BASED ON **CONNECTIONS MADE OF FIVE COMPONENTS AROUND EACH VERTEX** AND BECAUSE OF ITS REGULARITY, ALLOWS ALL THE CONNECTIONS TO BE THE SAME.



FIVE COMPONENTS JUNCTION

1



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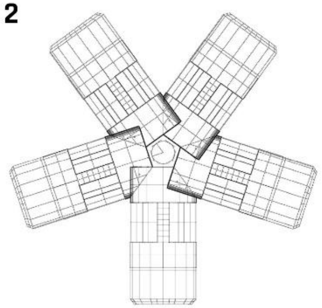

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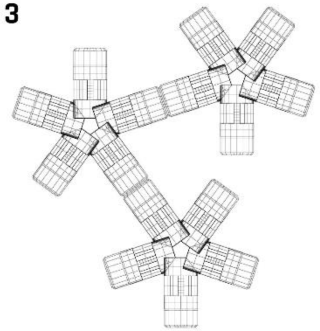


5.0 APPROACH AND METHODOLOGY

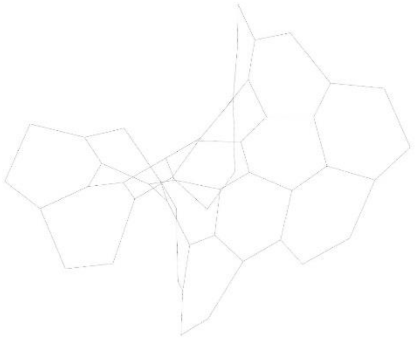
5.3 Computational System

- POSSIBILITY TO MOVE A STEP FORWARD FROM TRADITIONAL GEOMETRY AND TO ACHIEVE **GEOMETRY COMPLEXITY** THROUGH ALL THE SCALES OF THE DESIGN (MICRO-MESO-MACRO)

- SCRIPT BASED ON THE IDEA OF BUILDING A SYSTEM THAT COULD TESSELLATE EVERY POSSIBLE SHAPE, PLACING THE JOINTS BASED ON THE NAIL CONTAINER COMPONENTS, AT THE VERTEX OF THE TESSELLATION.

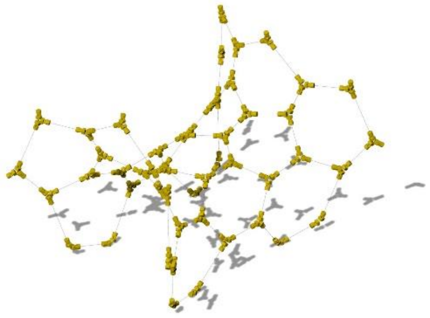
STEP 0

INITIAL SURFACE



STEP 1

TESSELLATION OF THE SHAPE



STEP 3

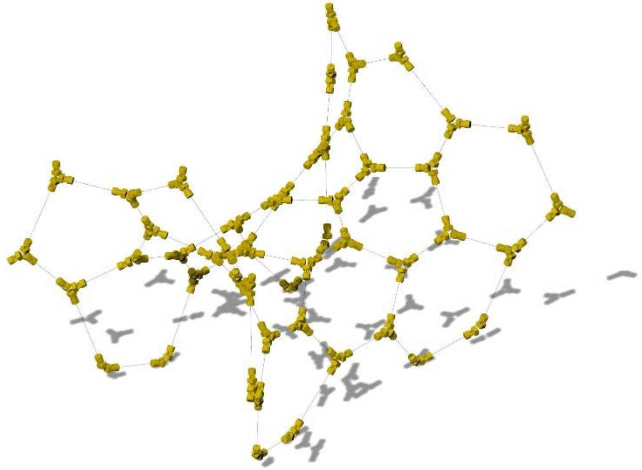
POSITION OF THE COMPONENTS
AT THE VERTEX
OF THE TESSELLATION


RESEARCH DESIGN
DESIGN EXPLORATION
&
FABRICATION
PAVILION DESIGN

5.0 APPROACH AND METHODOLOGY

5.5 Design-to-Robotic-Production

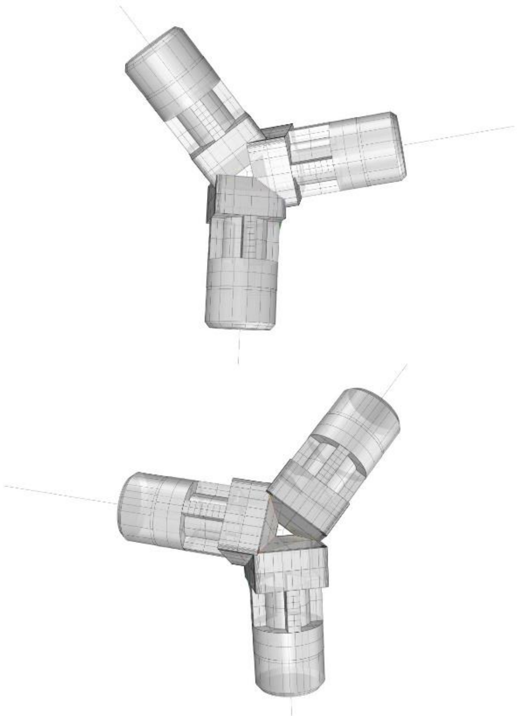
- D2RP FACILITATE THE CREATION OF A **FEEDBACK LOOP** BETWEEN THE DIGITAL DESIGN AND THE 1:1 SCALE PROTOTYPE; STARTING FROM THE ALREADY OPTIMIZED DIGITAL MODEL, IT IS POSSIBLE TO CONVERT THE **DESIGN INTO ROBOTIC TOOL PATH** TO ADD, CUT OUT OR TRANSFORM A MATERIAL SO AS THE RESEARCHED DESIGN CAN BE PHYSICALLY VISUALIZED.



STEP 3

POSITION OF THE COMPONENTS
AT THE VERTEX
OF THE TESSELLATION

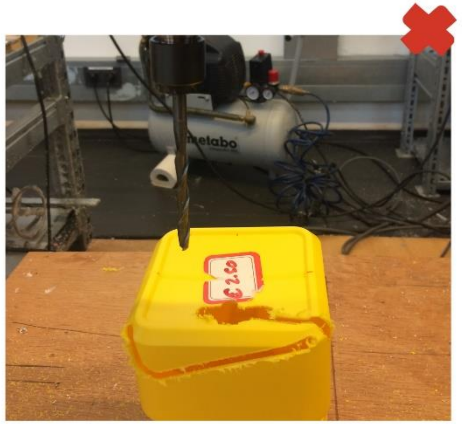
→



JOINT ORIGINATED FROM THE SCRIPT

5.0 APPROACH AND METHODOLOGY

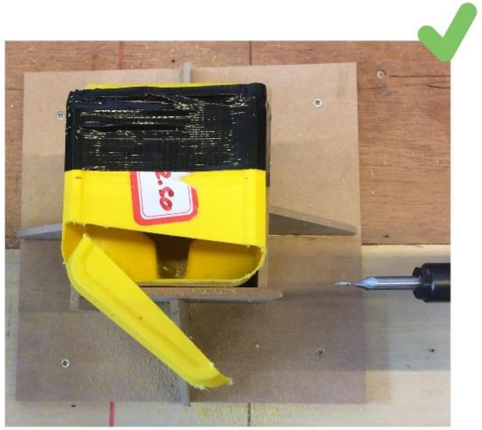
5.5 D2RP - Starting Points



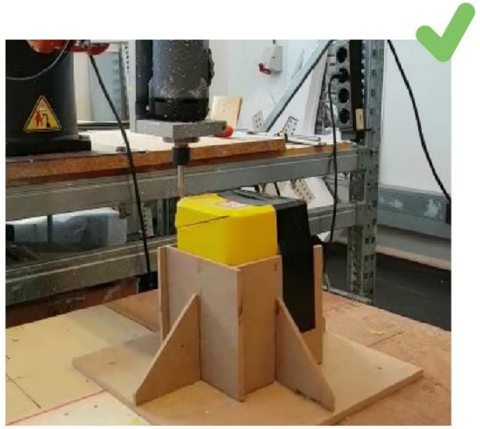
6 MM DRILL BIT

NO BOUNDARIES

REAL OBJECT



3 MM DRILL BIT



CONSTRUCTION TO KEEP THE COMPONENT IN PLACE

3D MODEL

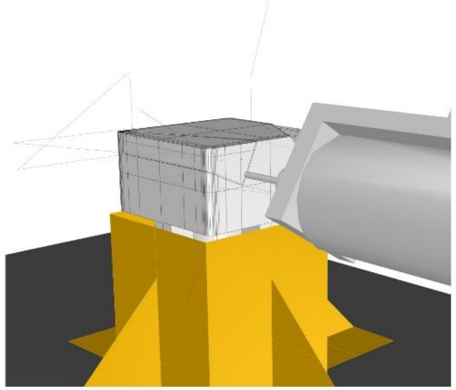
5.0 APPROACH AND METHODOLOGY

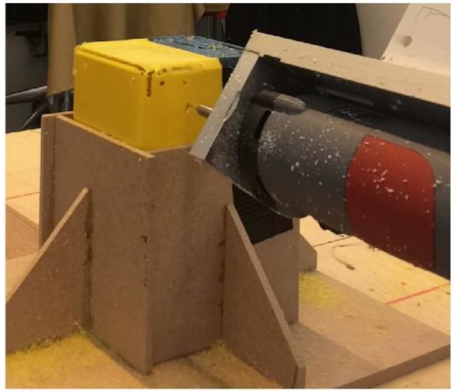
5.5 D2RP - First Prototype

SIMULATION

REAL ENVIRONMENT

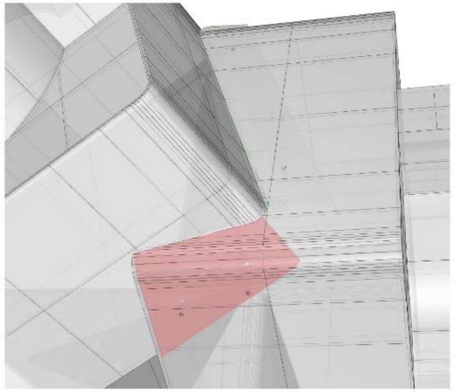
STEP 1 : CUTTING





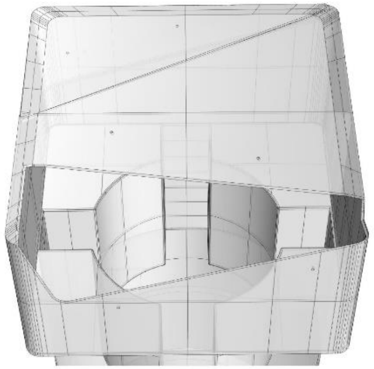
DRILLING HOLES & MATERIAL REMOVAL

STEP 2 : FOLDING

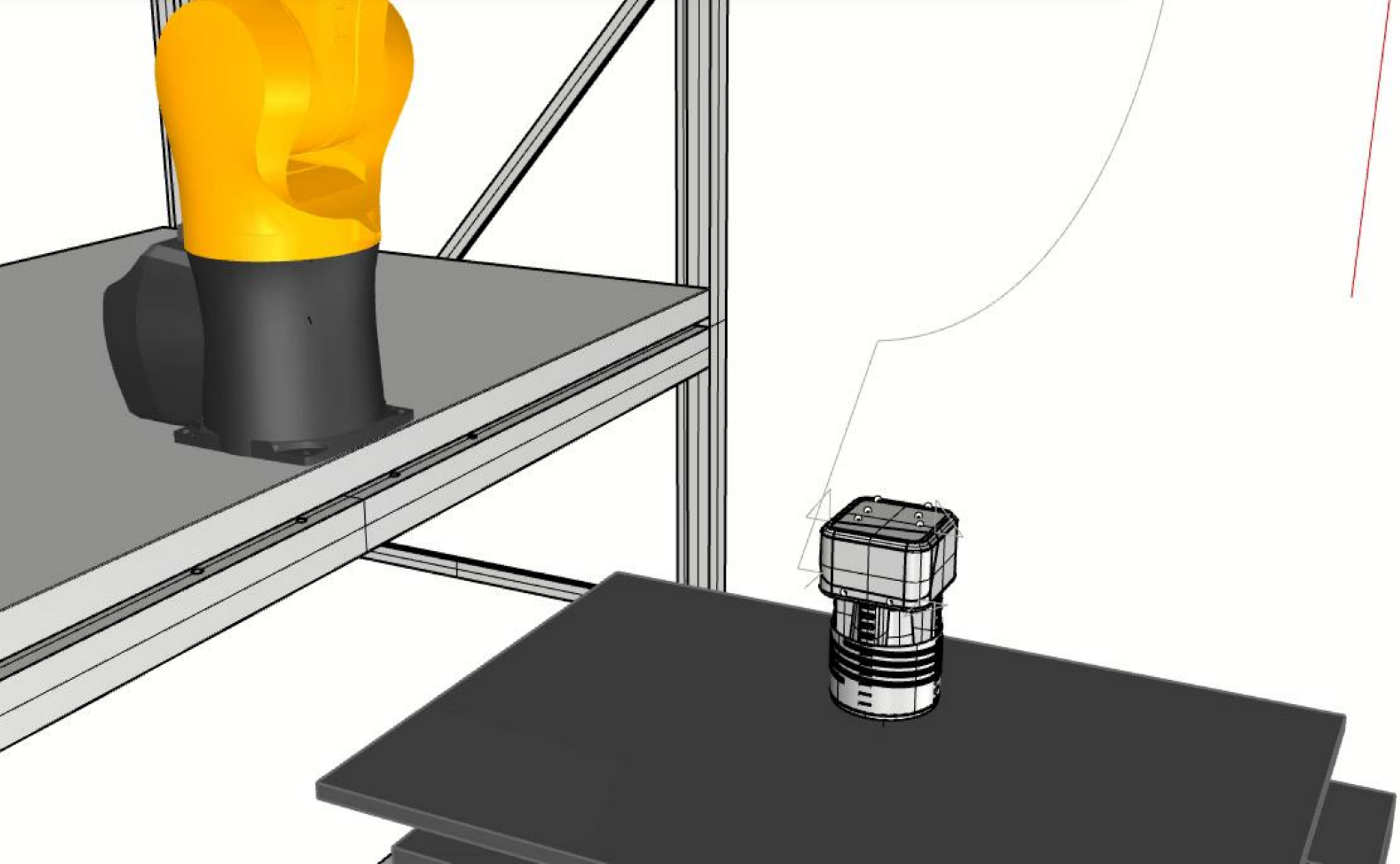


FOLDING PARTS WITH AN UTILITY KNIFE

STEP 3 : CONNECTING



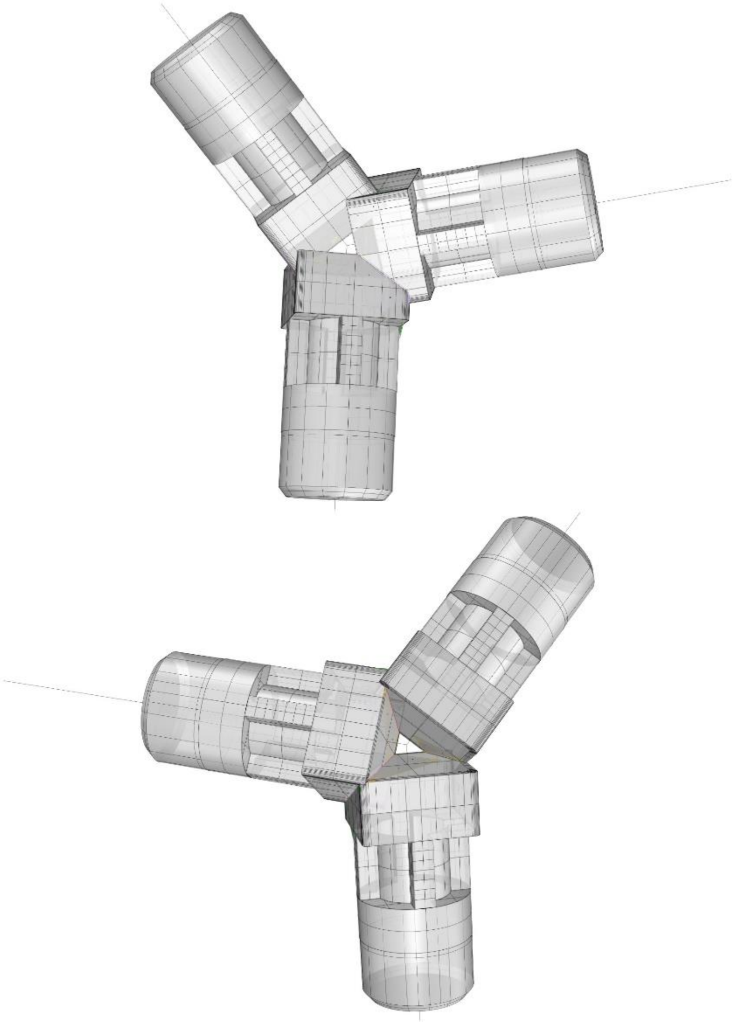
CONNECTING PARTS WITH 4MM NUT&BOLT



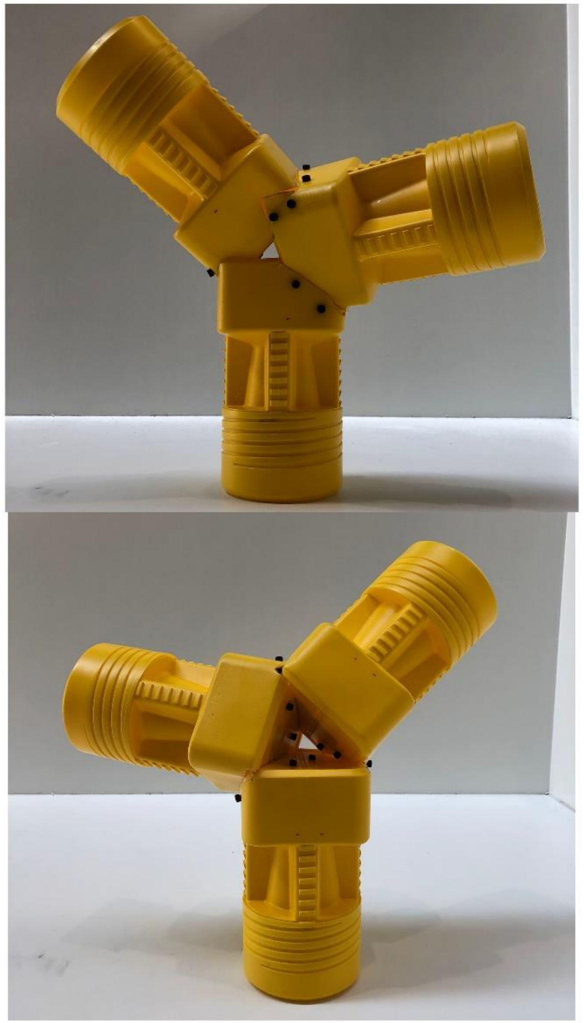
5.0 APPROACH AND METHODOLOGY

5.5 D2RP - First Prototype

3D MODEL

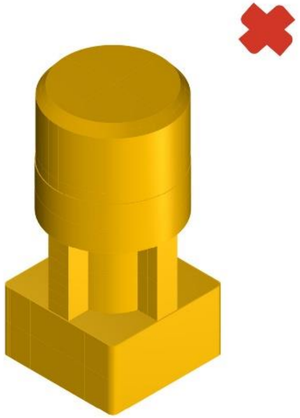


FIRST PROTOTYPE | 15.03.2019

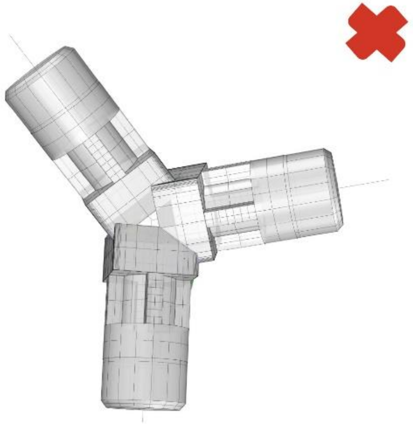


5.0 APPROACH AND METHODOLOGY

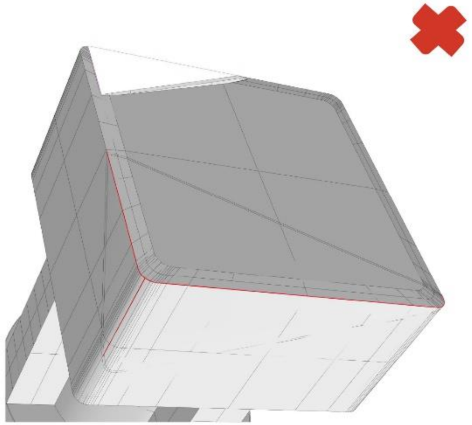
5.5 D2RP - Second Prototype



3D MODEL



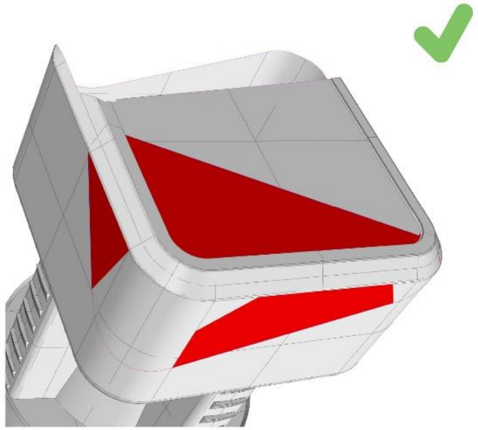
2 CM FROM THE VERTEX



FOLDING ALL THE MATERIAL

3D SCAN

1.5 CM FROM THE VERTEX

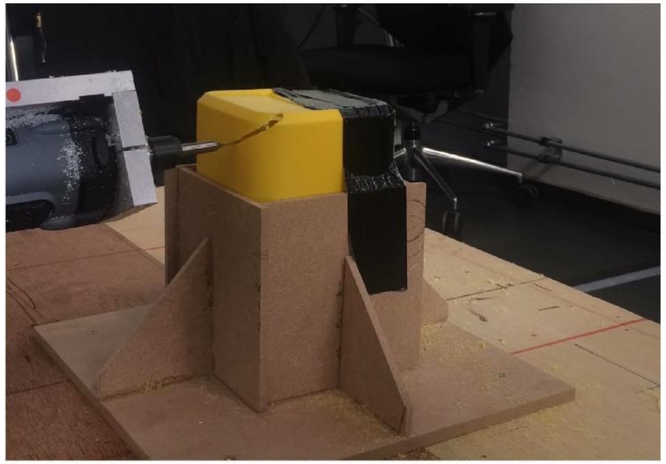


FOLDING ONLY PARTS

5.0 APPROACH AND METHODOLOGY

5.5 D2RP - Second Prototype

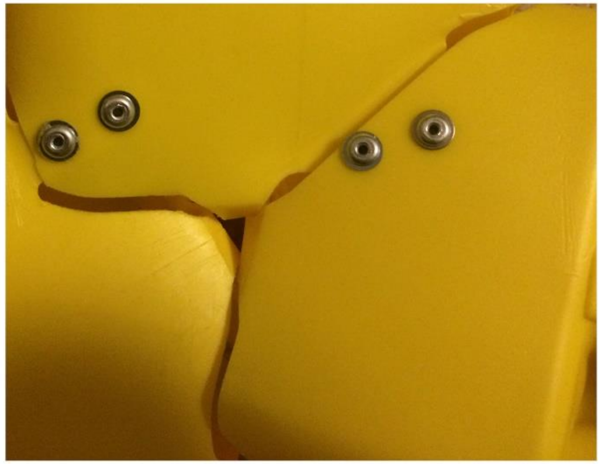
STEP 1 : CUTTING



STEP 2 : FOLDING

STEP 3 : GLUING THE WASHERS

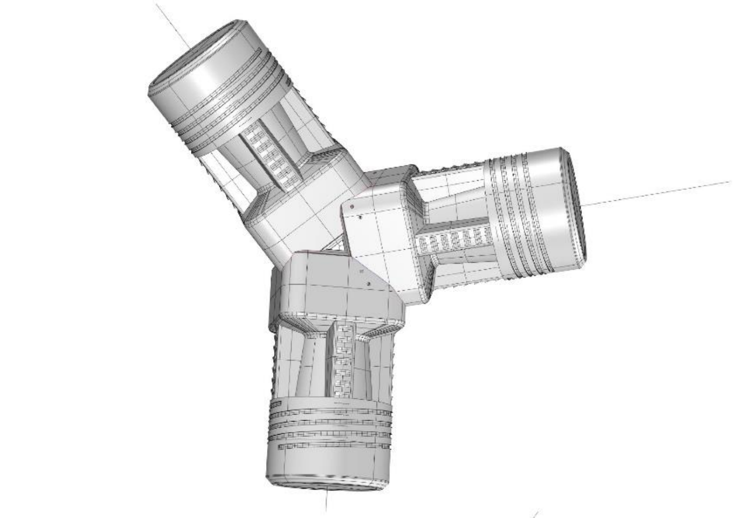
STEP 4 : CONNECTING WITH RIVETS

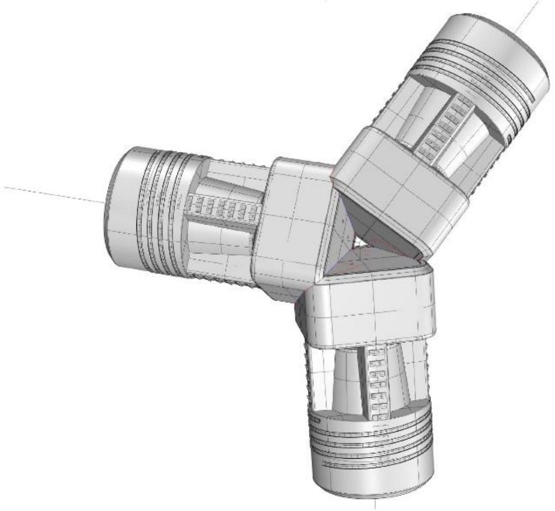


5.0 APPROACH AND METHODOLOGY

5.5 D2RP - Second Prototype

3D MODEL





SECOND PROTOTYPE | 08.04.2019

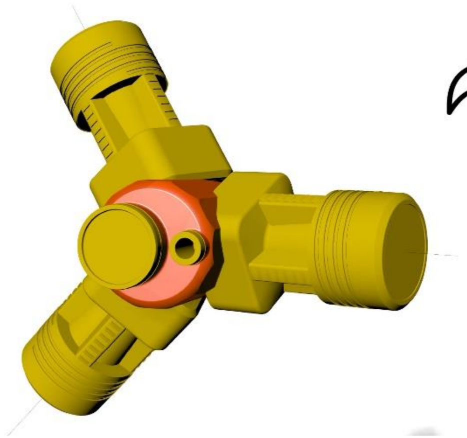
5.0 APPROACH AND METHODOLOGY

5.5 D2RP - Third Prototype

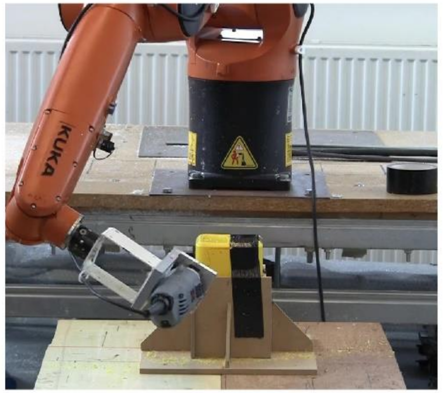
- **SECOND SELECTED COMPONENT**: FROM KIMA, SPECIALIZED IN THE PRODUCTION OF DISPOSABLE LABORATORY WARE. THE COMPONENT IS A CONTAINER BOTTLE SHAPED USE TO COLLECT SAMPLE OF LIQUID,

SOURCE: http://www.kima.it/en/prodotti-monouso-da-laboratorio/

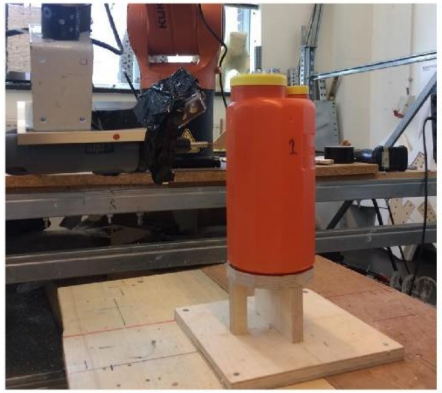
5.5 D2RP - Third Prototype



FINAL JOINT CONFIGURATION



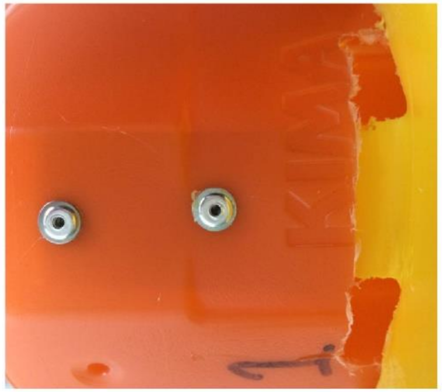
STEP 1 : CUTTING LATERAL COMPONENTS



STEP 2 : CUTTING CENTRAL COMPONENT

STEP 3 : FOLDING LATERAL COMPONENTS

STEP 4 : GLUING THE WASHERS

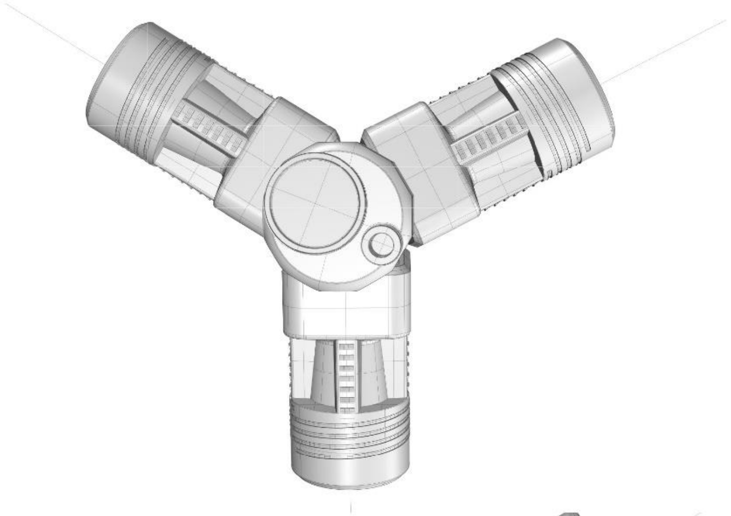


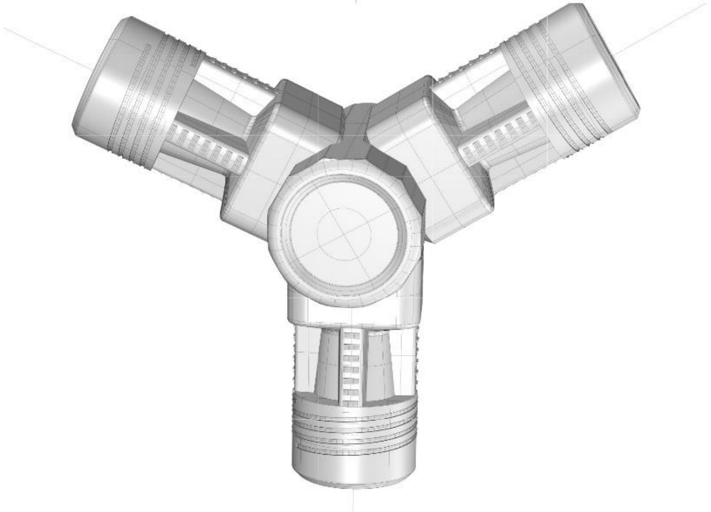
STEP 5 : CONNECTING WITH RIVETS

5.0 APPROACH AND METHODOLOGY

5.5 D2RP - Third Prototype

3D MODEL





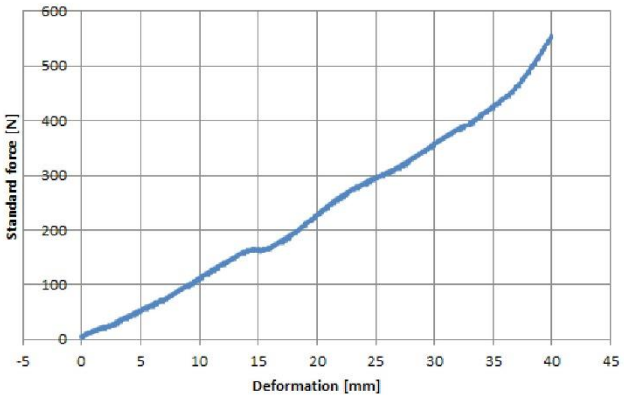
THIRD PROTOTYPE | 28.05.2019

5.0 APPROACH AND METHODOLOGY

5.5 D2RP - Structural Tests

SECOND PROTOTYPE

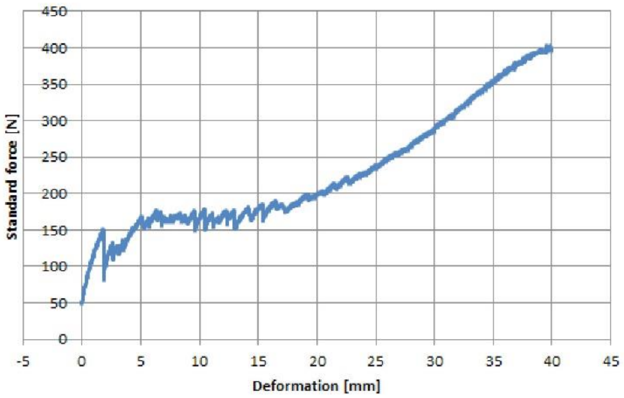
Specimen 2



graph Force [N] / Deformation [mm]

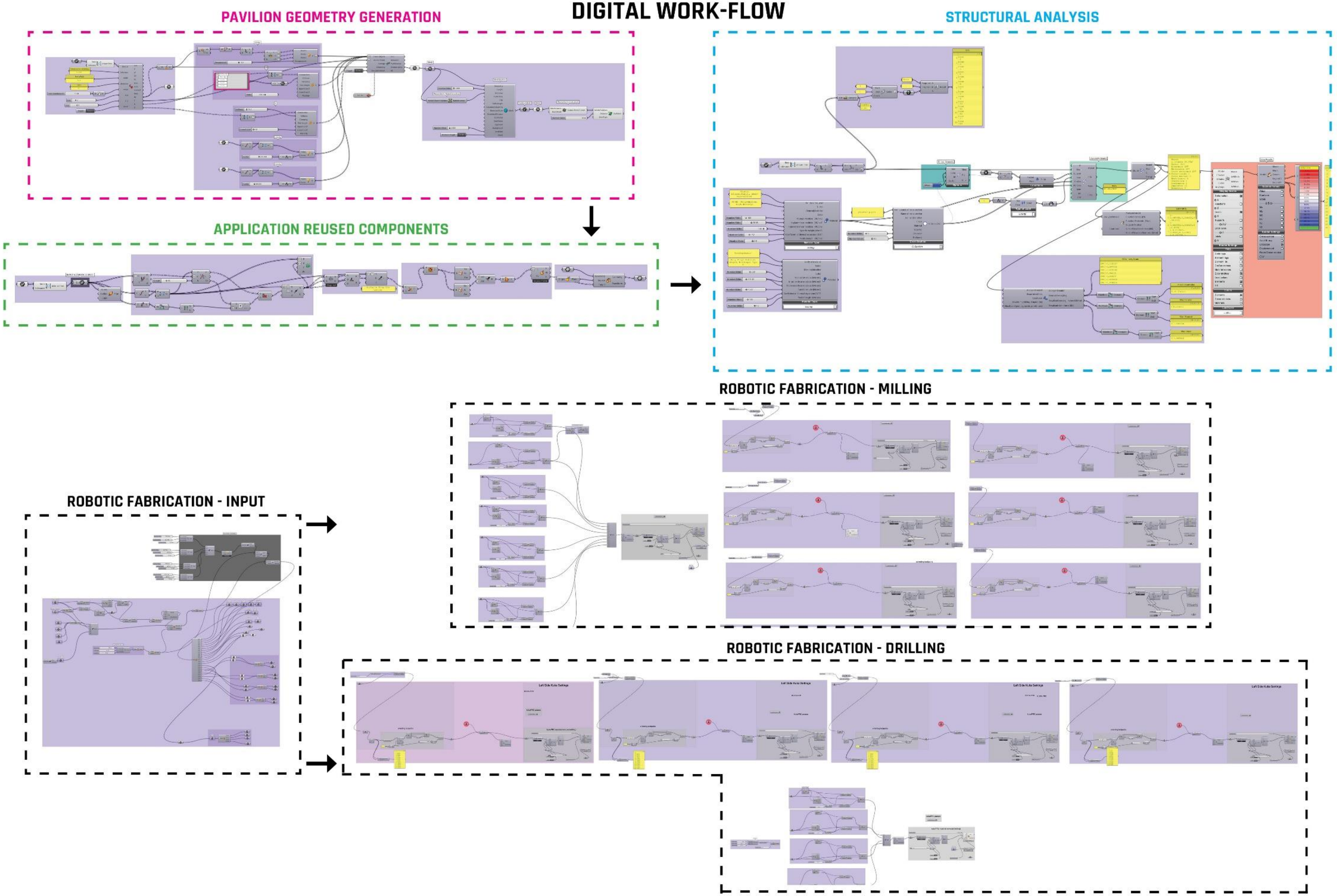
THIRD PROTOTYPE

Specimen 1



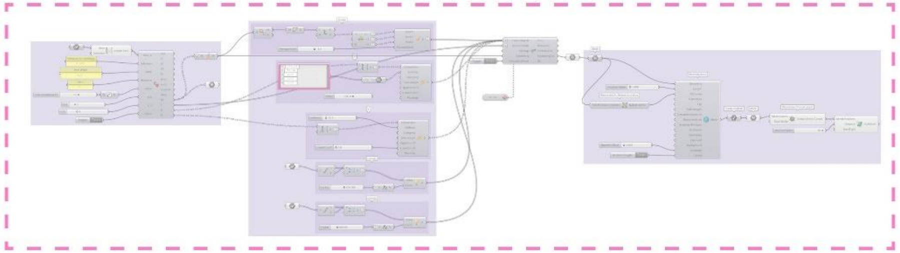
graph Force [N] / Deformation [mm]

DIGITAL WORK-FLOW

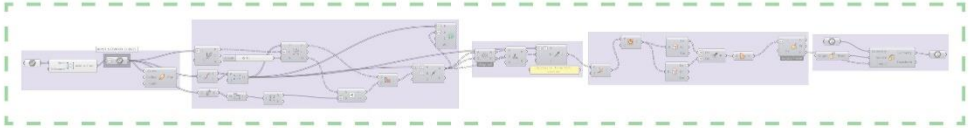


DIGITAL WORK-FLOW

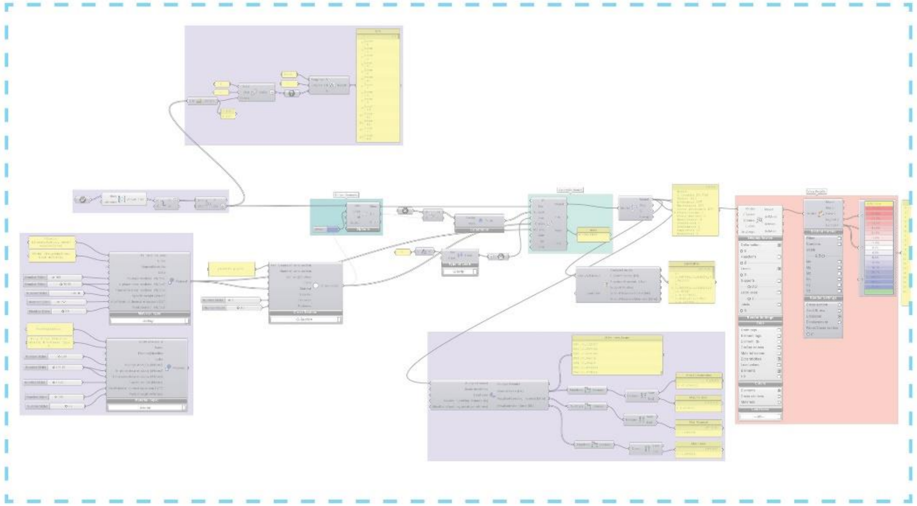
PAVILION GEOMETRY GENERATION



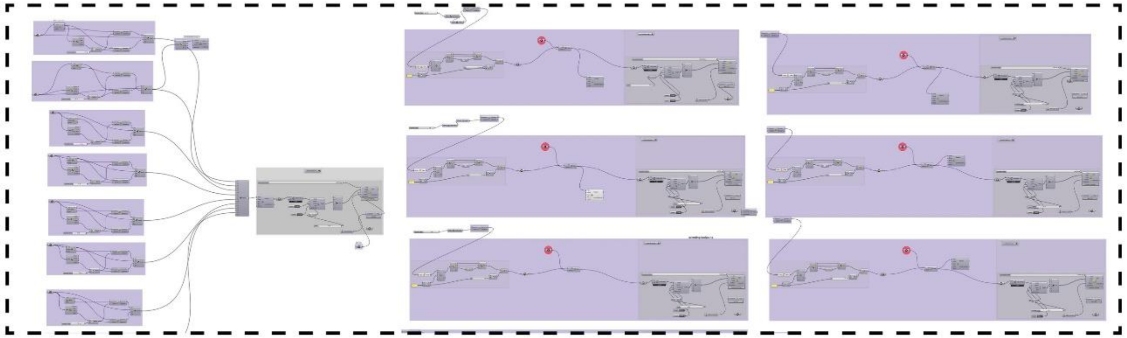
APPLICATION REUSED COMPONENTS



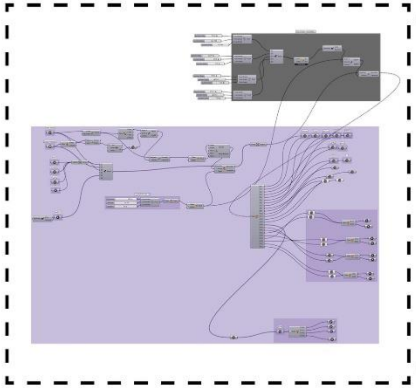
STRUCTURAL ANALYSIS



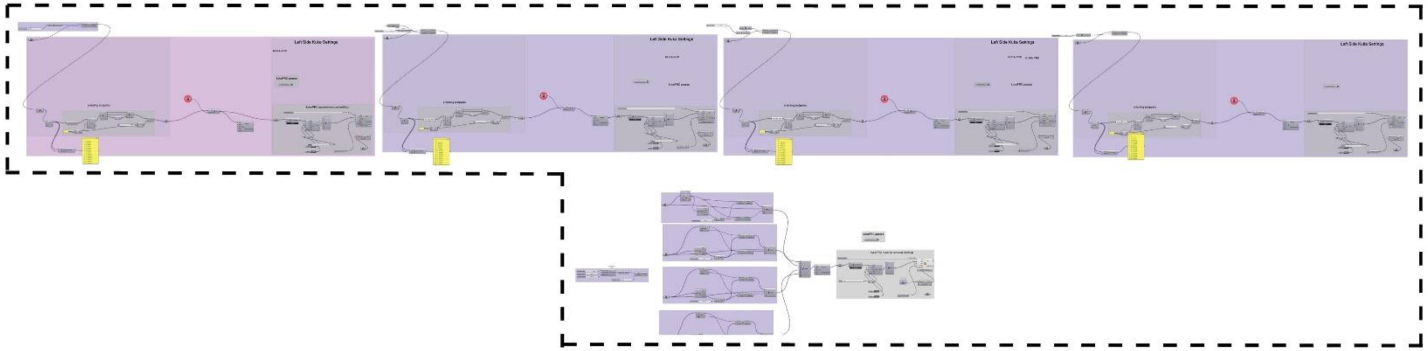
ROBOTIC FABRICATION - MILLING



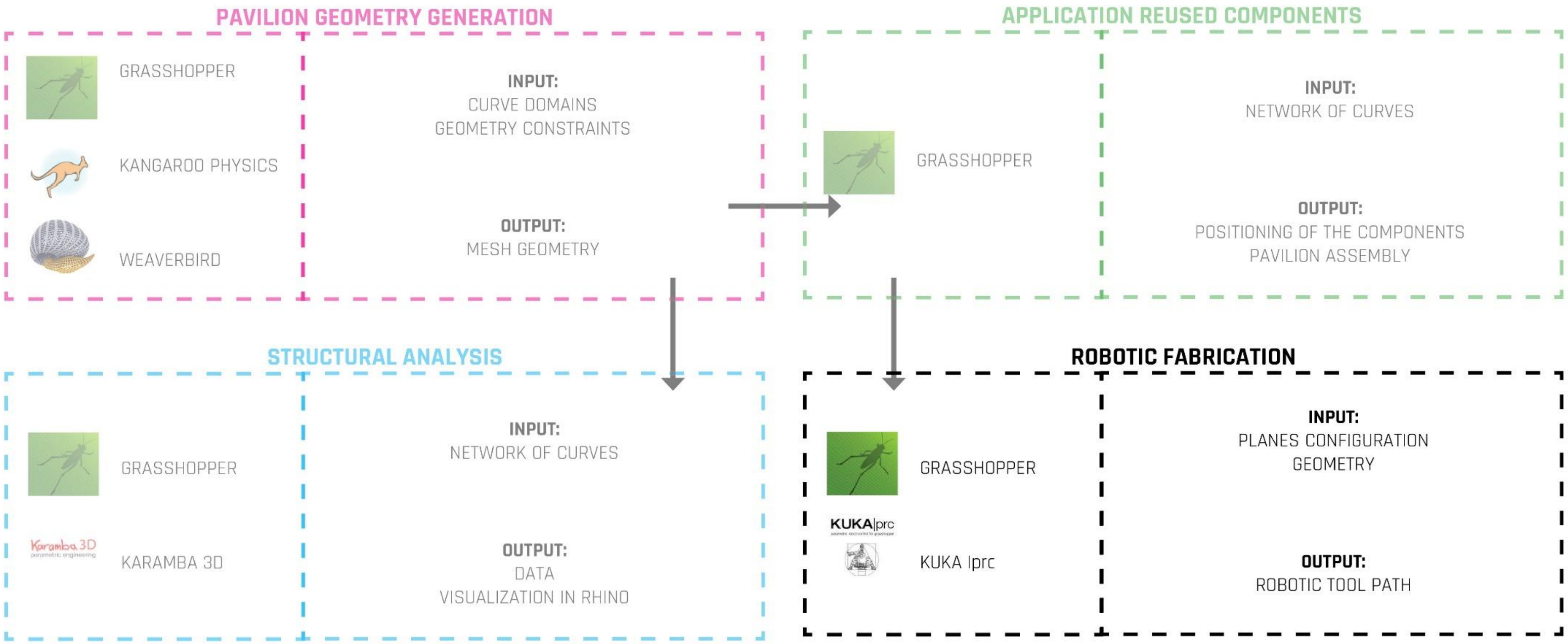
ROBOTIC FABRICATION - INPUT



ROBOTIC FABRICATION - DRILLING



DIGITAL WORK-FLOW



5.0 APPROACH AND METHODOLOGY

5.5 Design-to-Robotic-Production

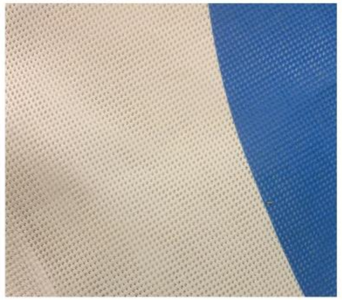
- **RIBBON STRUCTURE:** IT WAS NECESSARY TO FIND A COMPONENT THAT WAS LONG ENOUGH TO COVER THE ALL LENGTH OF THE RIBS - PVC PIPES FOR WATER SUPPLY

- **MEMBRANE:** ADOPT A FABRIC THAT IS STIFF IN BOTH DIRECTIONS -CONNECTION BETWEEN THE FABRICS NOT WATERTIGHT- NOT COVERING THE STRUCTURE OF THE PAVILION - ENCLOSING THE MEMBRANE INSIDE EVERY HEXAGON

TRUCK PROTECTION
HEAVY FABRIC

AGRICOLTURE
LIGHTWEIGHT FABRIC

PACKAGING
DOUBLE-LAYERED



FASHION
SEMI-OPEN FABRIC

AGRICOLTURE
LIGHTWEIGHT FABRIC

5.0 APPROACH AND METHODOLOGY

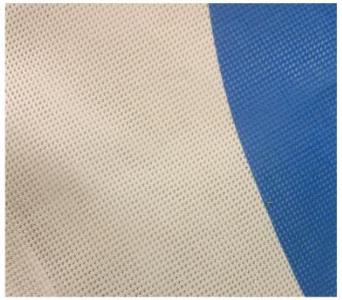
- **RIBBON STRUCTURE:** IT WAS NECESSARY TO FIND A COMPONENT THAT WAS LONG ENOUGH TO COVER THE ALL LENGTH OF THE RIBS - PVC PIPES FOR WATER SUPPLY

- **MEMBRANE:** ADOPT A FABRIC THAT IS STIFF IN BOTH DIRECTIONS -CONNECTION BETWEEN THE FABRICS NOT WATERTIGHT- NOT COVERING THE STRUCTURE OF THE PAVILION - ENCLOSING THE MEMBRANE INSIDE EVERY HEXAGON

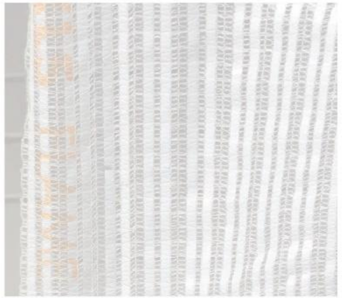
TRUCK PROTECTION
HEAVY FABRIC

AGRICOLTURE
LIGHTWEIGHT FABRIC

PACKAGING
DOUBLE-LAYERED



FASHION
SEMI-OPEN FABRIC



AGRICOLTURE
LIGHTWEIGHT FABRIC

5.0 APPROACH AND METHODOLOGY

5.5 Design-to-Robotic-Production

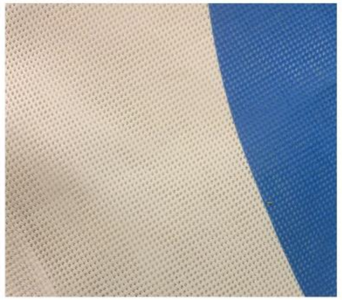
- **RIBBON STRUCTURE:** IT WAS NECESSARY TO FIND A COMPONENT THAT WAS LONG ENOUGH TO COVER THE ALL LENGTH OF THE RIBS - PVC PIPES FOR WATER SUPPLY

- **MEMBRANE:** ADOPT A FABRIC THAT IS STIFF IN BOTH DIRECTIONS -CONNECTION BETWEEN THE FABRICS NOT WATERTIGHT- NOT COVERING THE STRUCTURE OF THE PAVILION - ENCLOSING THE MEMBRANE INSIDE EVERY HEXAGON

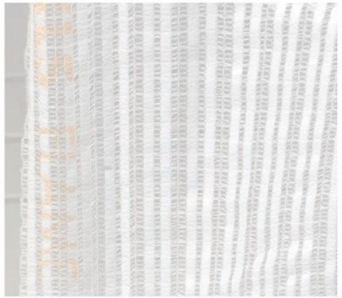
TRUCK PROTECTION
HEAVY FABRIC

AGRICOLTURE
LIGHTWEIGHT FABRIC

PACKAGING
DOUBLE-LAYERED



FASHION
SEMI-OPEN FABRIC

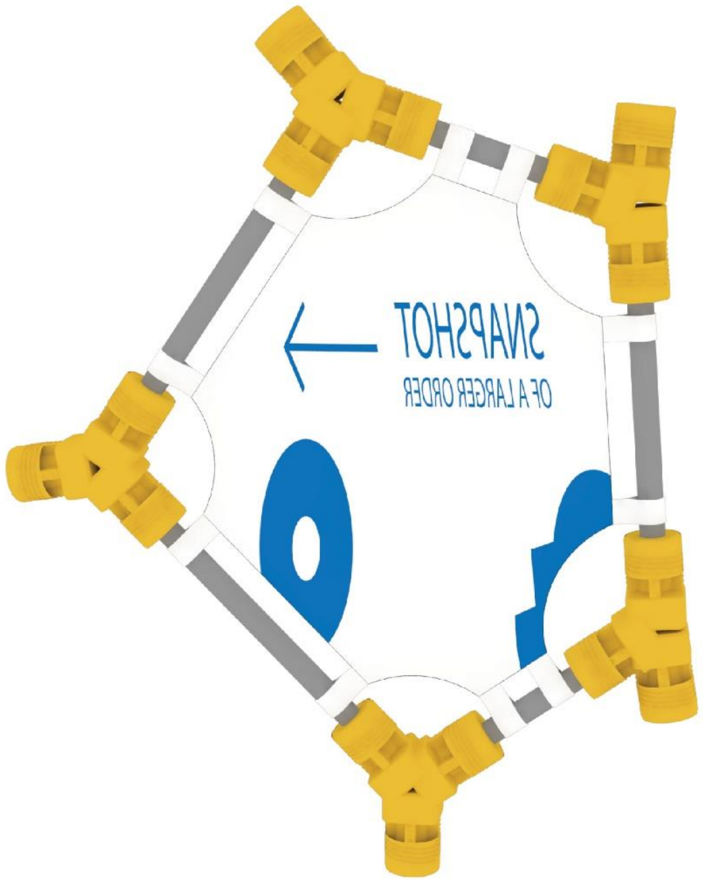


AGRICOLTURE
LIGHTWEIGHT FABRIC

5.0 APPROACH AND METHODOLOGY

5.5 Final Prototype

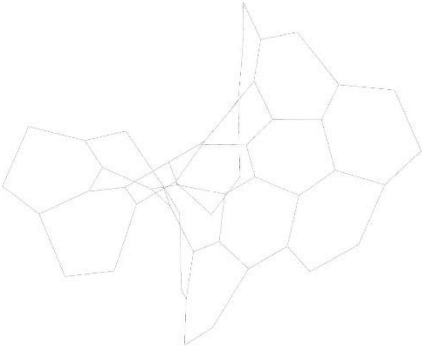
- THE CONNECTION OF THE FABRIC TO THE PIPES WILL HAVE A SIMILAR CONCEPT TO THE ONE USED PREVIOUSLY IN THE CONNECTION OF THE COMPONENTS OF THE JOINT, IN FACT THE MATERIAL OF THE FABRIC ITSELF WILL ACT AS CONNECTION ELEMENT TO THE RIBBON STRUCTURE



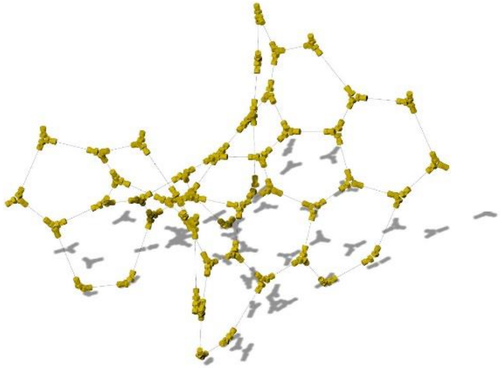
5.0 APPROACH AND METHODOLOGY

5.3 Computational System

STEP 0 - INITIAL SURFACE



STEP 1 - TESSELLATION OF THE SHAPE

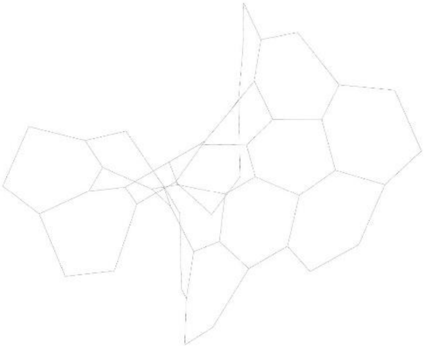


STEP 2 - JOINTS PART 1

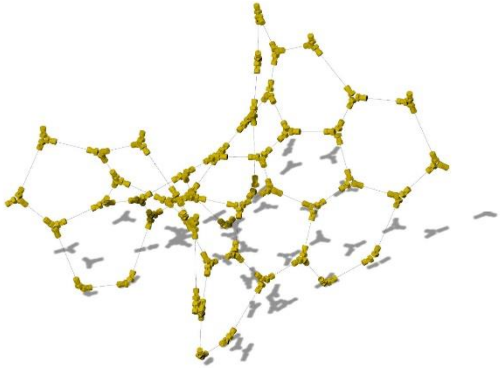
5.0 APPROACH AND METHODOLOGY

5.3 Computational System

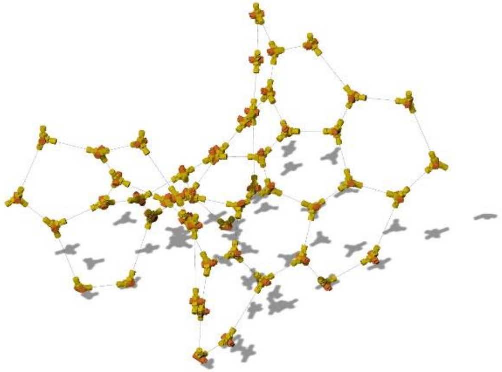
STEP 0 - INITIAL SURFACE



STEP 1 - TESSELLATION OF THE SHAPE



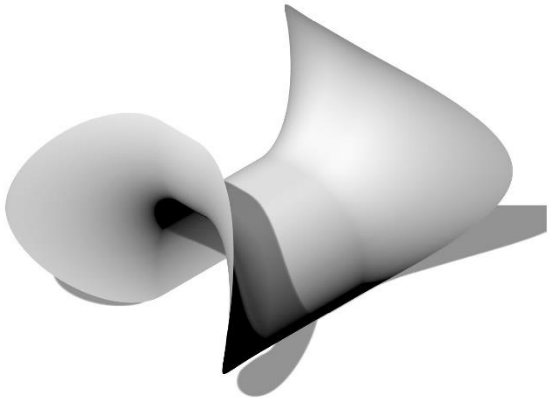
STEP 2 - JOINTS PART 1



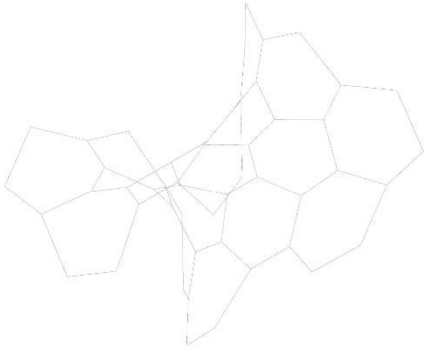
STEP 3 - JOINTS PART 2

5.0 APPROACH AND METHODOLOGY

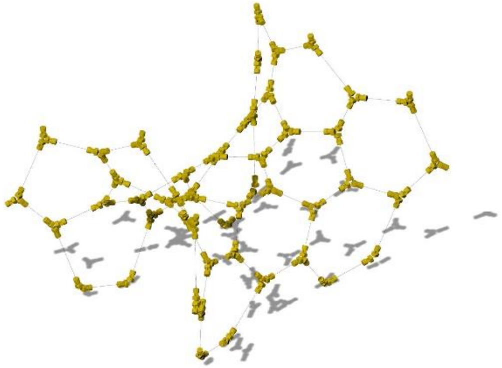
5.3 Computational System



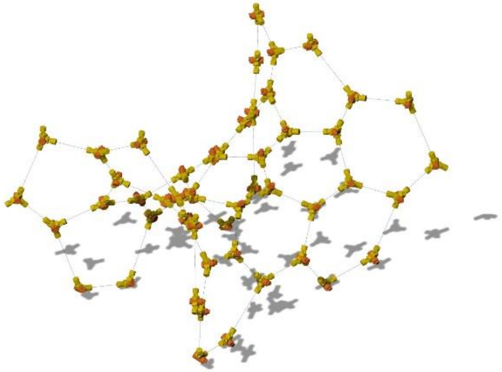
STEP 0 - INITIAL SURFACE



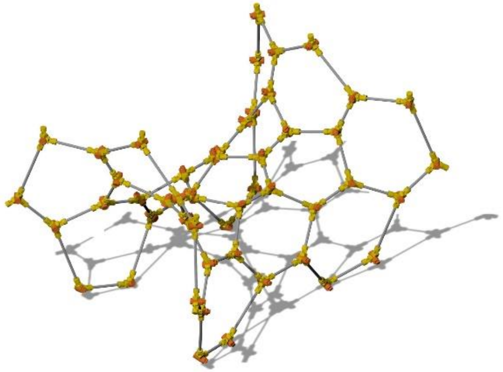
STEP 1 - TESSELLATION OF THE SHAPE



STEP 2 - JOINTS PART 1



STEP 3 - JOINTS PART 2

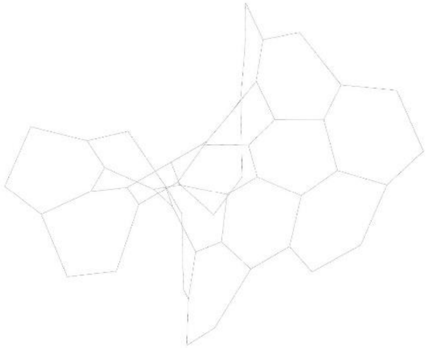


STEP 4 - RIBBON STRUCTURE

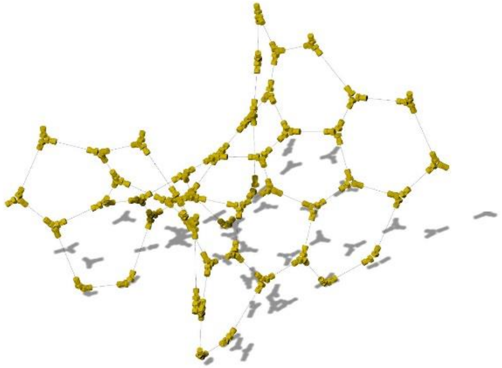
5.0 APPROACH AND METHODOLOGY

5.3 Computational System

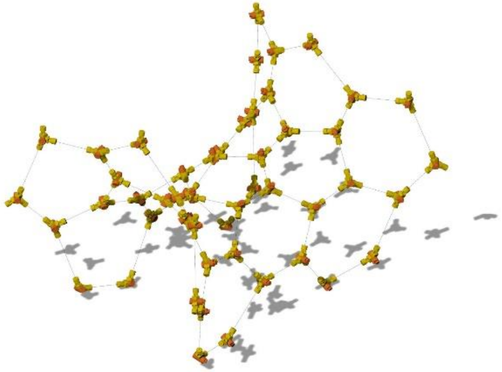
STEP 0 - INITIAL SURFACE



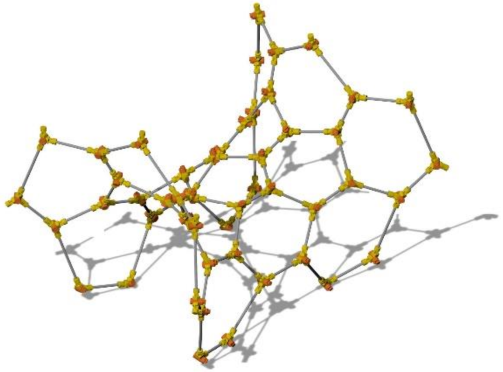
STEP 1 - TESSELLATION OF THE SHAPE



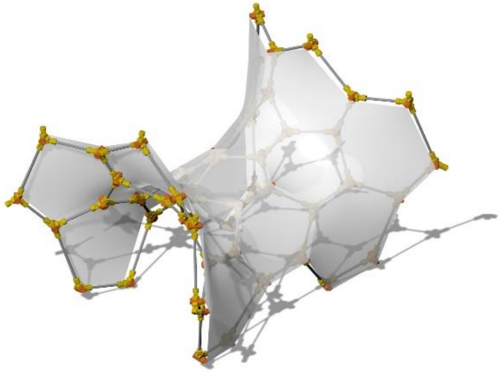
STEP 2 - JOINTS PART 1



STEP 3 - JOINTS PART 2

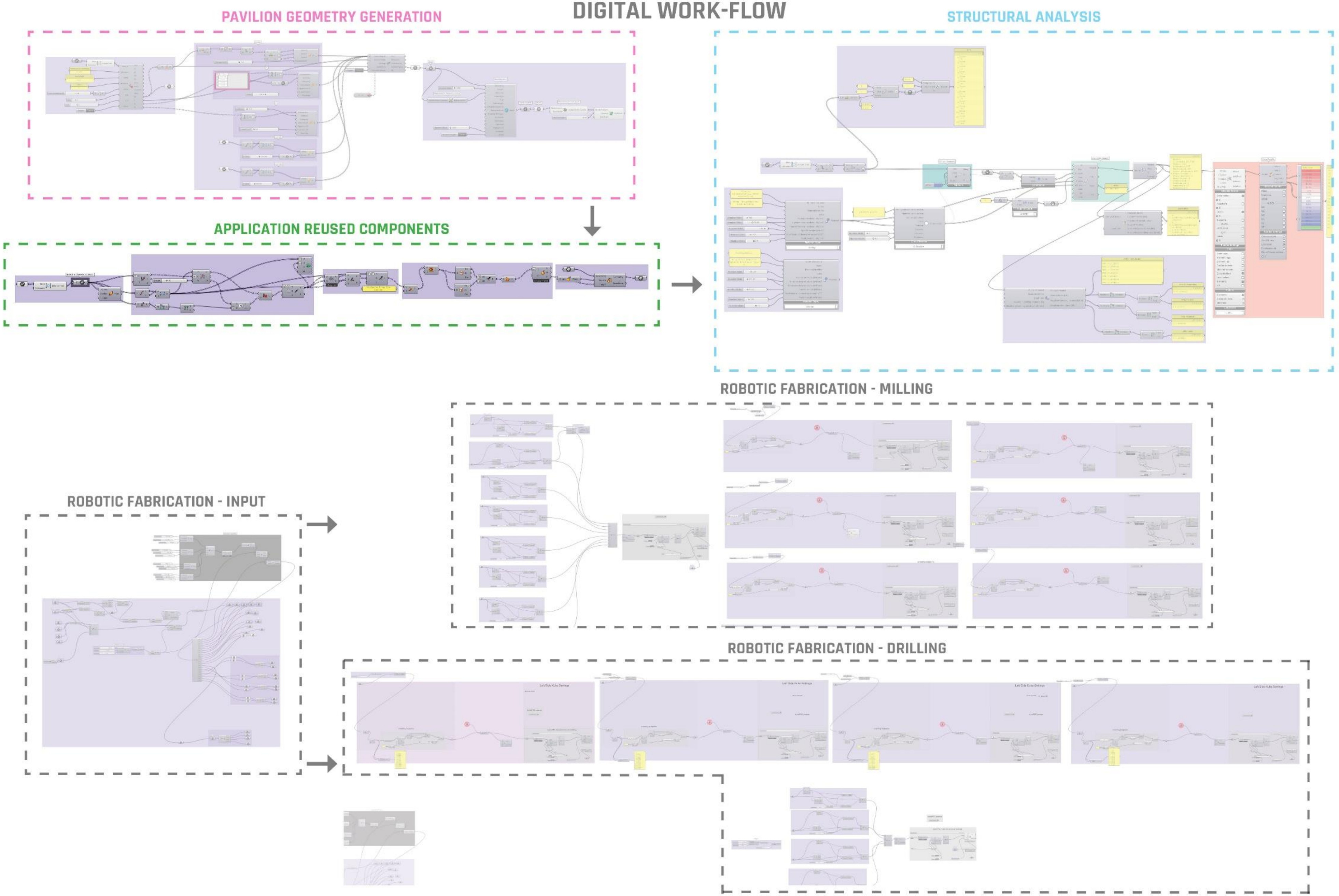


STEP 4 - RIBBON STRUCTURE



STEP 5 - SURFACES

DIGITAL WORK-FLOW



DIGITAL WORK-FLOW

PAVILION GEOMETRY GENERATION

GRASSHOPPER

KANGAROO PHYSICS

WEAVERBIRD

INPUT:
CURVE DOMAINS
GEOMETRY CONSTRAINTS

OUTPUT:
MESH GEOMETRY

APPLICATION REUSED COMPONENTS

GRASSHOPPER

INPUT:
NETWORK OF CURVES

OUTPUT:
POSITIONING OF THE COMPONENTS
PAVILION ASSEMBLY

STRUCTURAL ANALYSIS

GRASSHOPPER

KARAMBA 3D

INPUT:
NETWORK OF CURVES

OUTPUT:
DATA
VISUALIZATION IN RHINO

ROBOTIC FABRICATION

GRASSHOPPER

KUKA lprc

INPUT:
PLANES CONFIGURATION
GEOMETRY

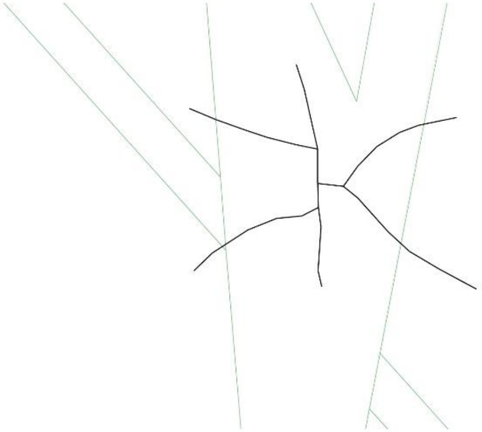
OUTPUT:
ROBOTIC TOOL PATH


RESEARCH DESIGN
DESIGN EXPLORATION
&
FABRICATION
PAVILION DESIGN

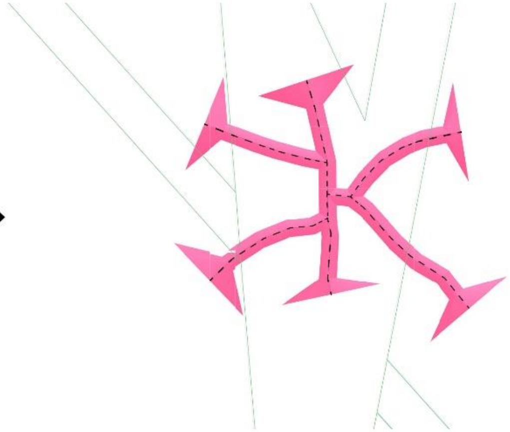
- **LOCATION:** FREE ZONE AREA, CLOSE TO THE TU DELFT AUDITORIUM AND IT IS A PUBLIC OUTDOOR SPACE OFTEN USED FOR EVENTS IN THE TU DELFT CAMPUS.

- INFORM THE DESIGN WITH THE SPECIFIC OF THE SITE, IN FACT A **2D NETWORK OF LINES** AS A FOOTPRINT WHERE DEVELOPED BASED ON THE INTERSECTING ROADS OF THE LOCATION

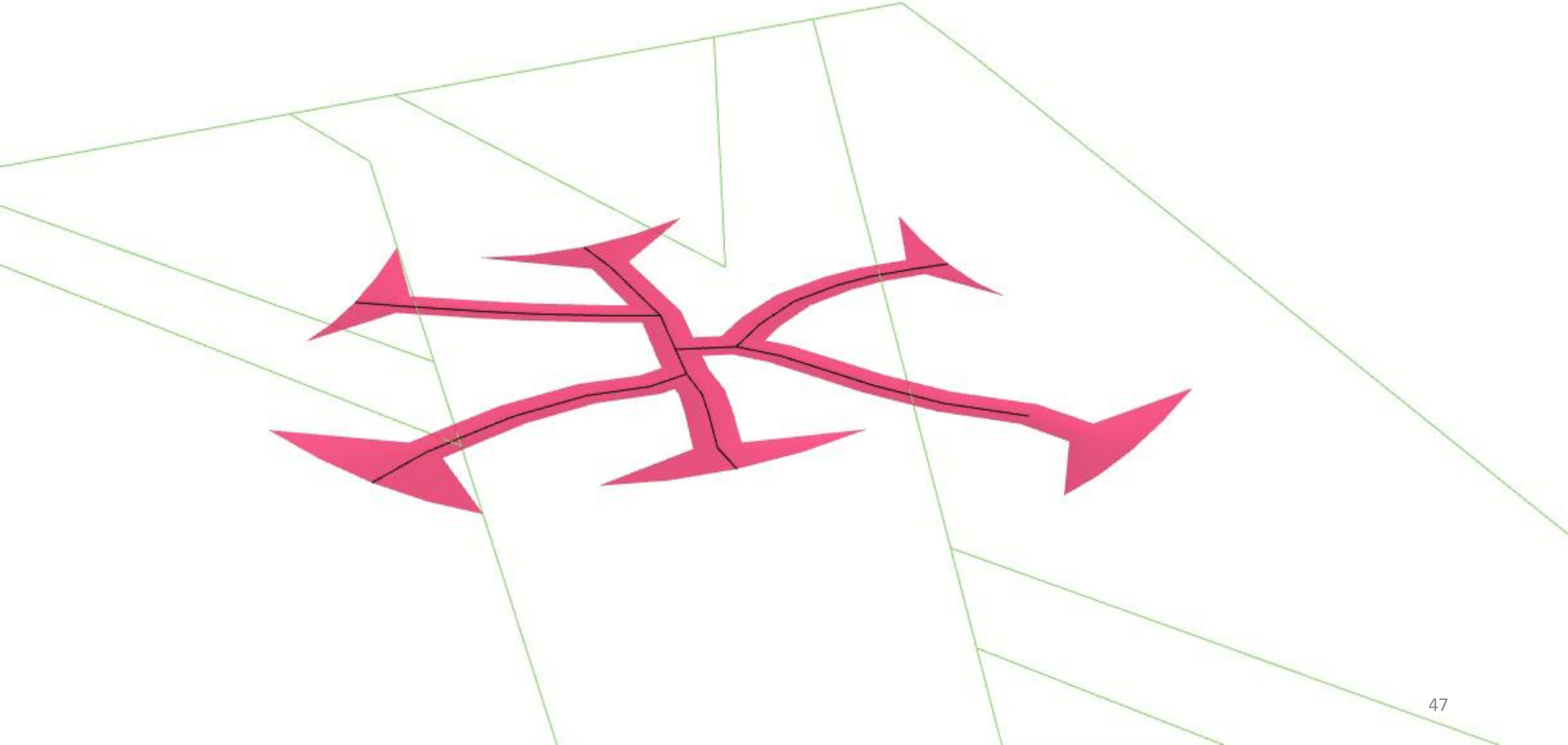
LOCATION



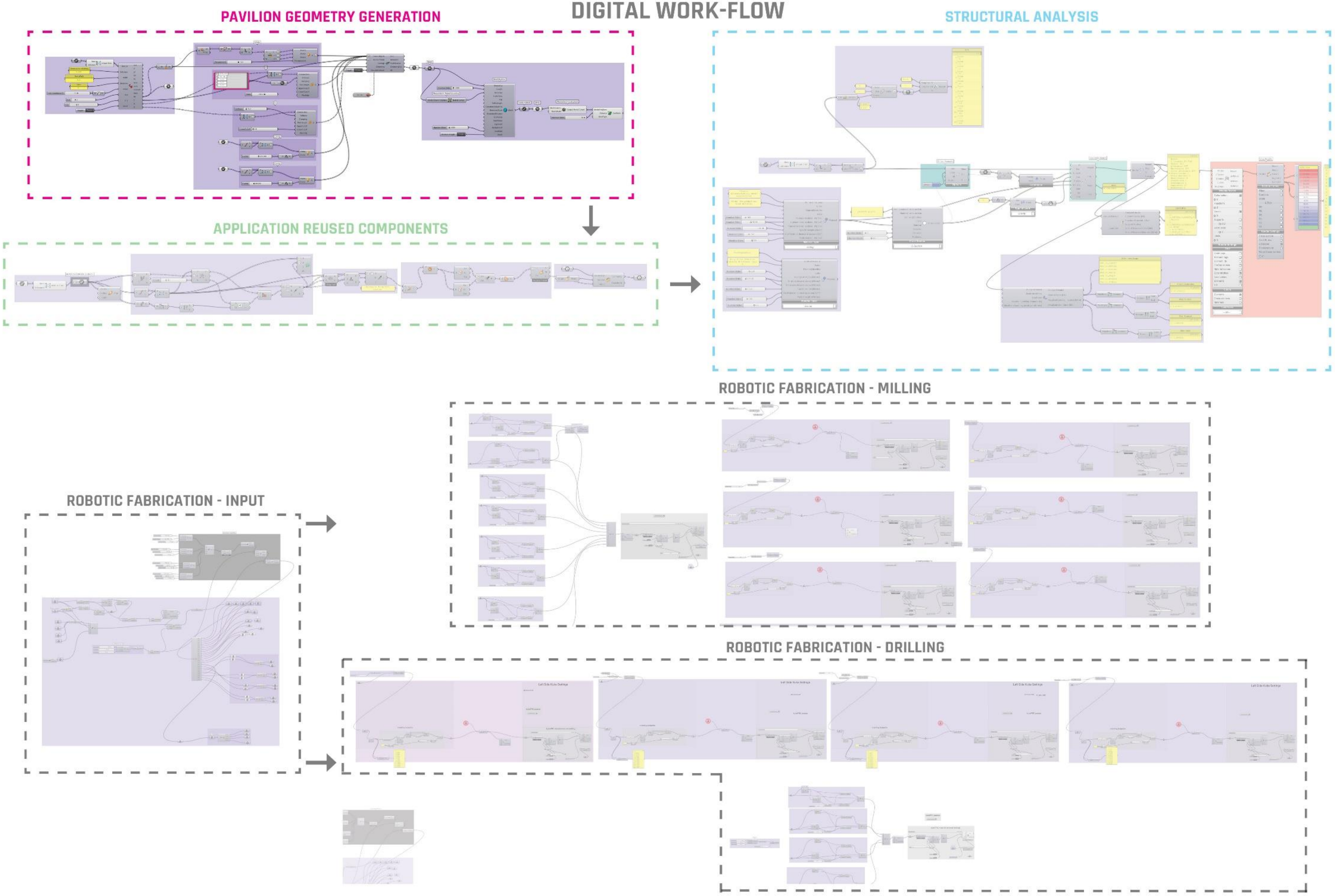
NETWORK OF LINES



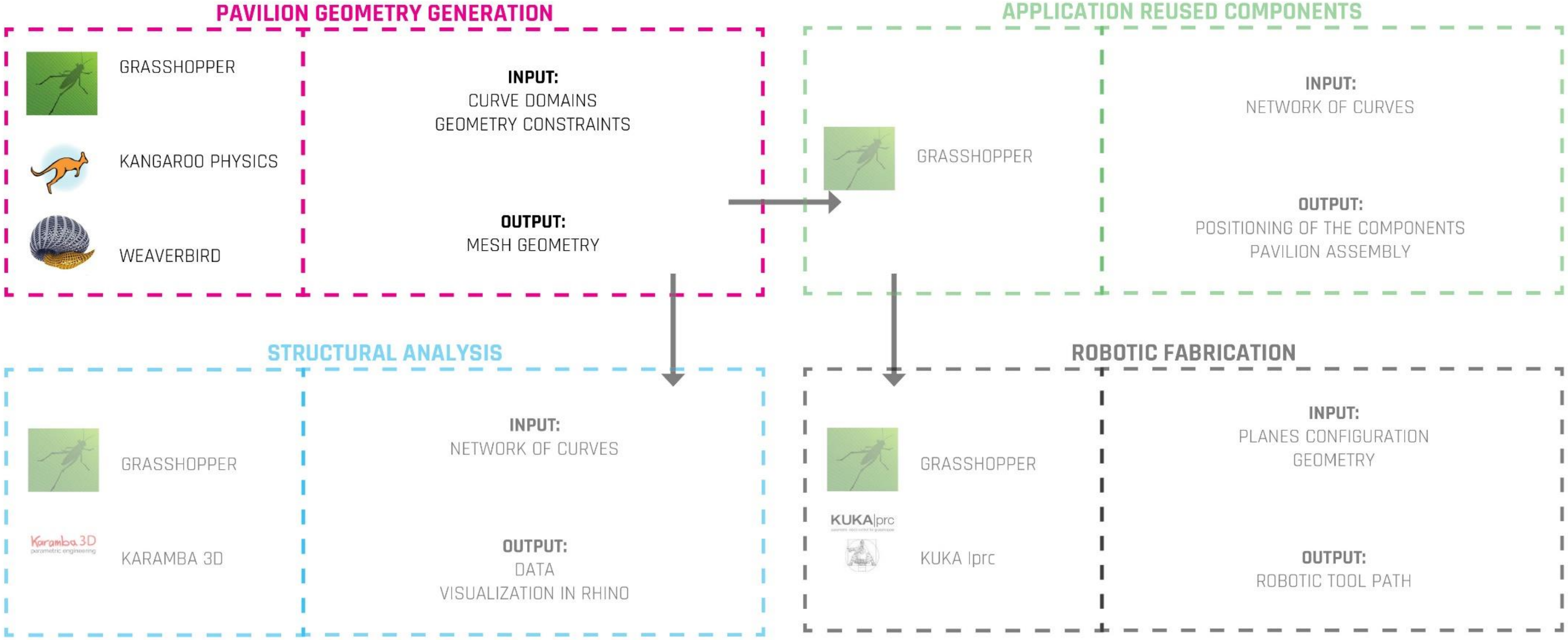
BASIC SHAPE



DIGITAL WORK-FLOW



DIGITAL WORK-FLOW



5.0 APPROACH AND METHODOLOGY

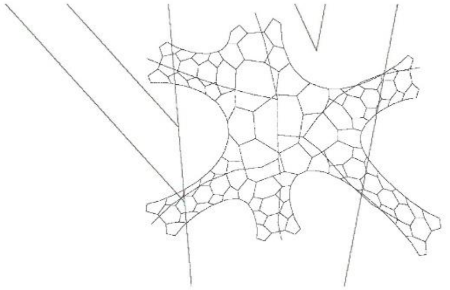
5.8 Final design

- THANKS TO A COMPUTATIONAL SYSTEM BASED ON SOME FORCE OBJECTS AND ANCHOR POINTS CONNECTED TO THE KANGAROO PHYSICS ENGINE, T**HE 2D NETWORK OF CURVES INFLATES AND EXPANDS IN THE AIR**

- THE RESULT IS A SHAPE THAT WORKS AT THE SAME TIME AS STRUCTURE, ENCLOSURE AND SPATIAL EXPERIENCE.

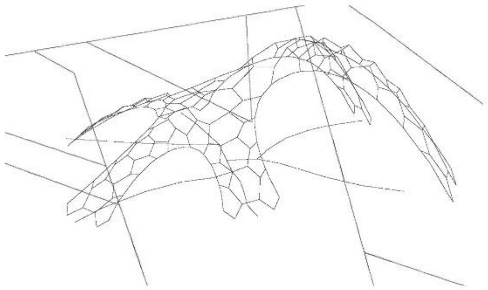
- THE DESIGNED MESH IS THEN **TESSELLATED** AND THE **COMPUTATIONAL SYSTEM** DEVELOPED DURING THE RESEARCH PROJECT IS APPLIED TO THE TESSELLATED SHAPE

INFLATED GEOMETRY - TOP VIEW



TESSELLATED GEOMETRY - TOP VIEW

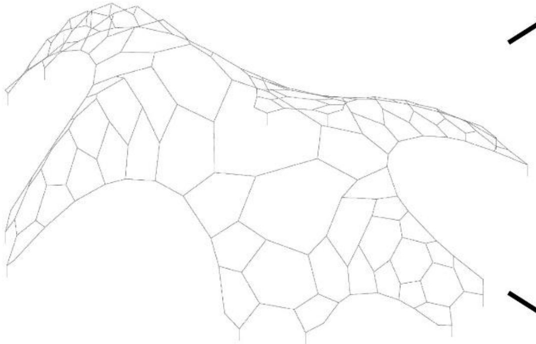
INFLATED GEOMETRY - PERSPECTIVE



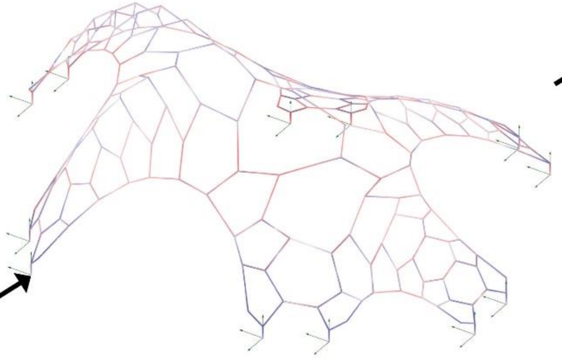
TESSELLATED GEOMETRY - PERSPECTIVE

5.0 APPROACH AND METHODOLOGY

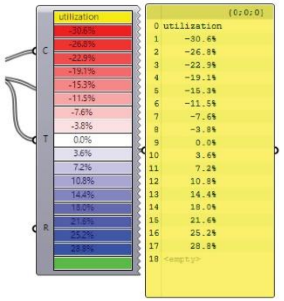
5.8 Final design



TESSELLATED GEOMETRY

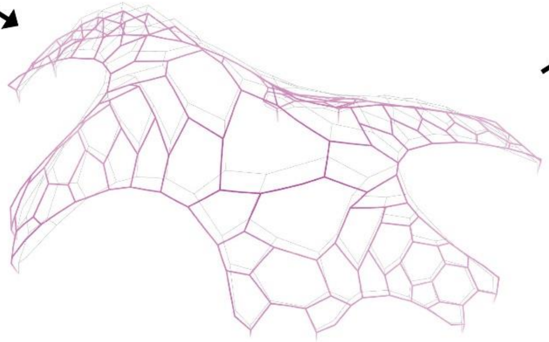


UTILIZATION OF THE STRUCTURE

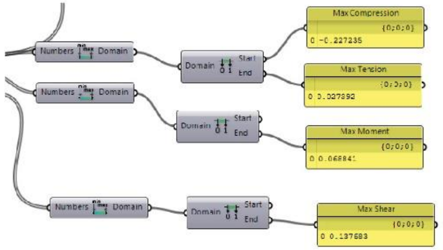


UTILIZATION:

COMPRESSION: 34% (DISPLAYED IN RED)
TENSION: 32% (DISPLAYED IN BLUE)



MAXIMUM DEFORMATION



COMPRESSION:

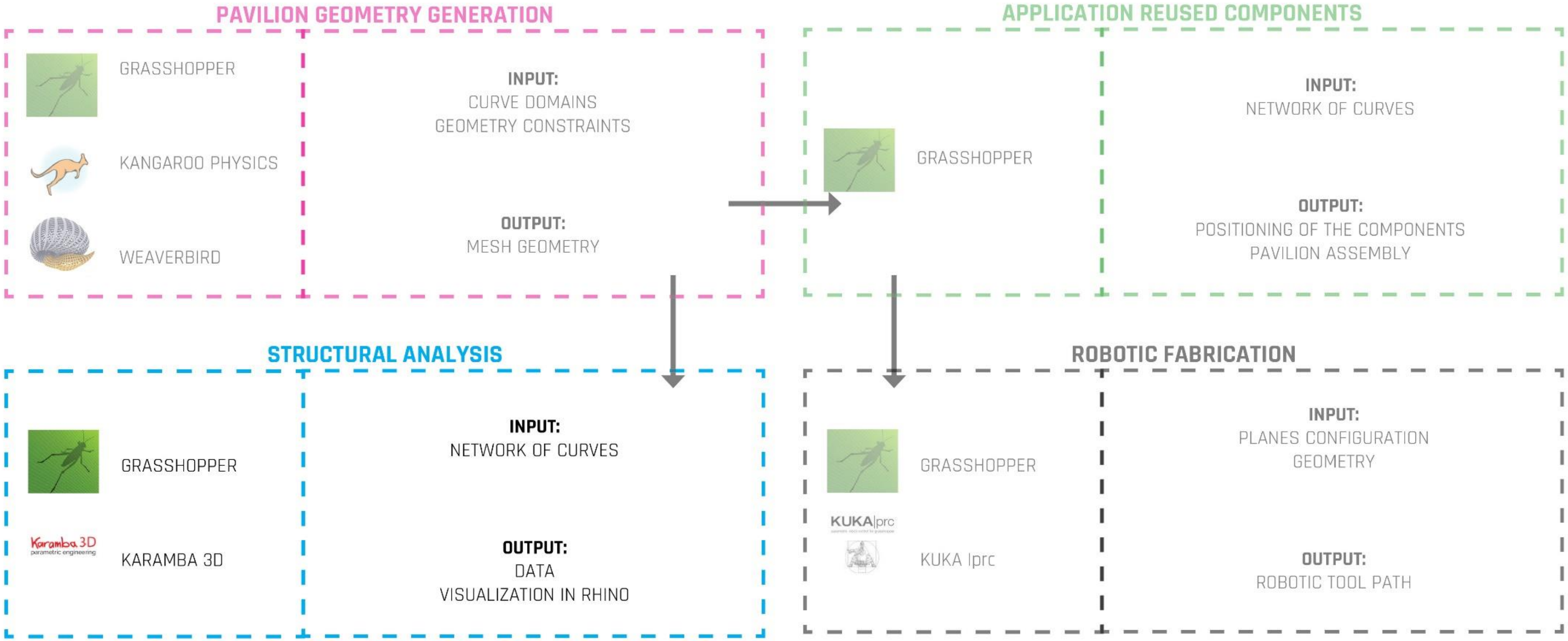
0.512 N/ MM^2 < 40.65 N/ MM^2

TENSION:

0.0618 N/ MM^2 < 47.05 N/ MM^2

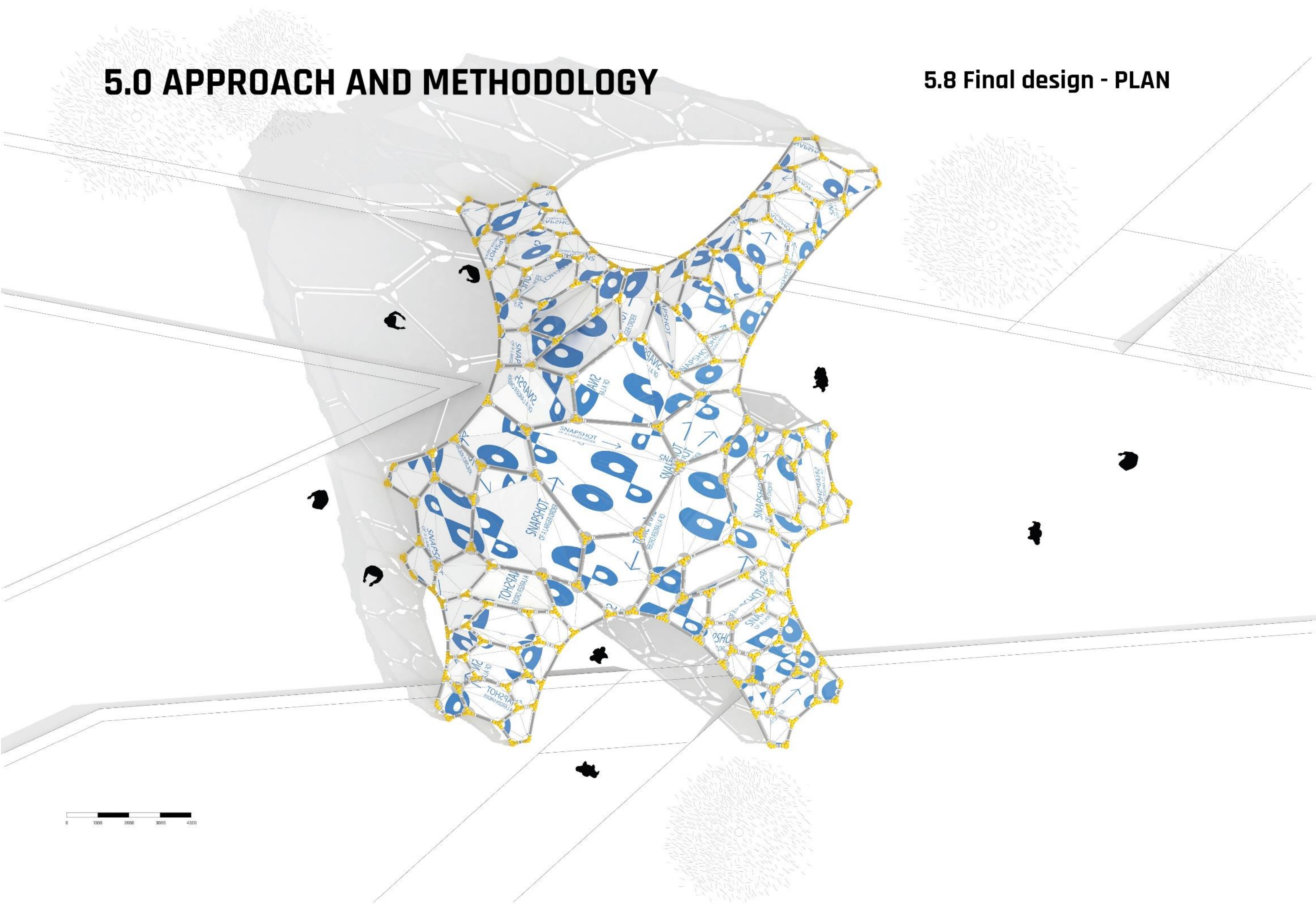
DIGITAL WORK-FLOW

DIGITAL WORK-FLOW



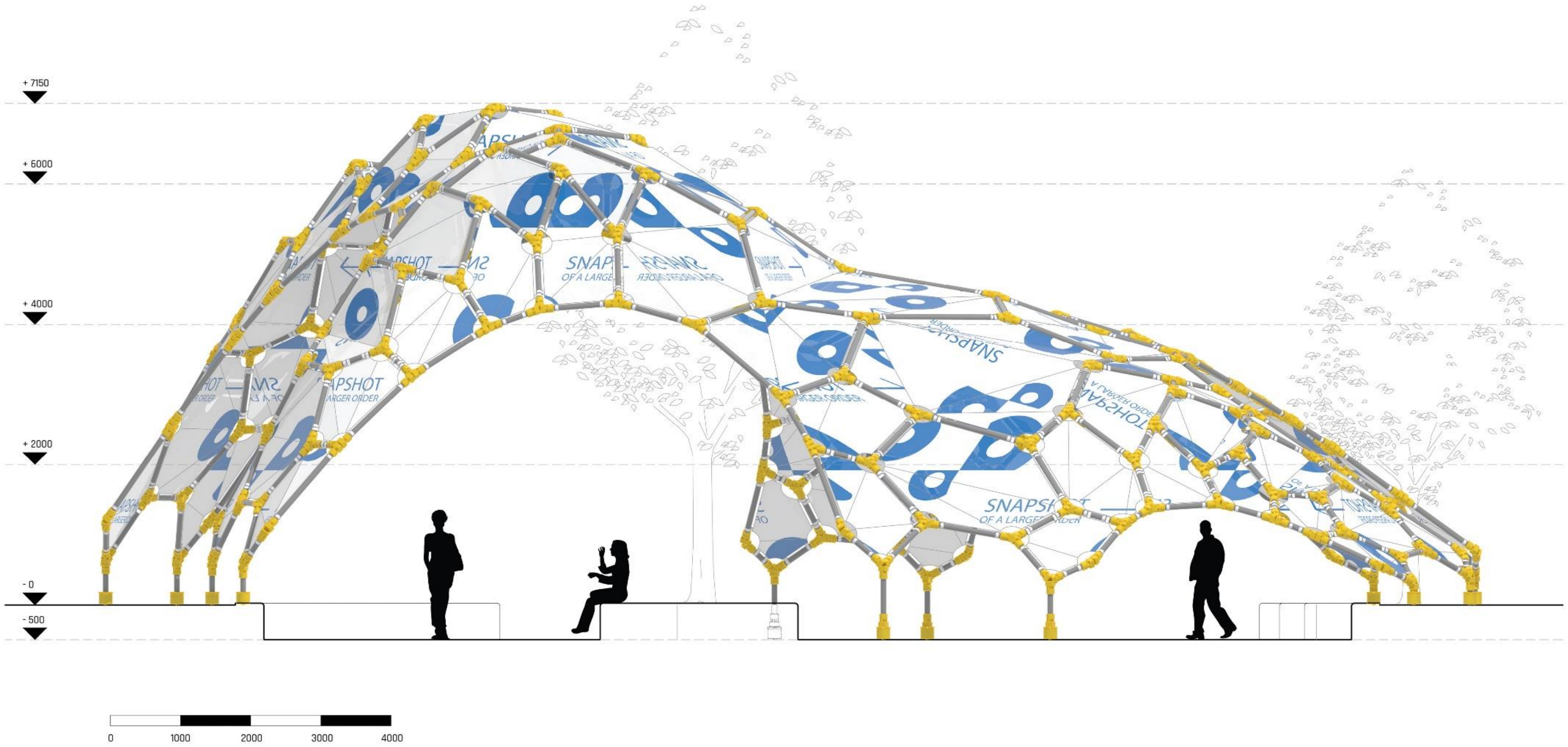
5.0 APPROACH AND METHODOLOGY

5.8 Final design - PLAN



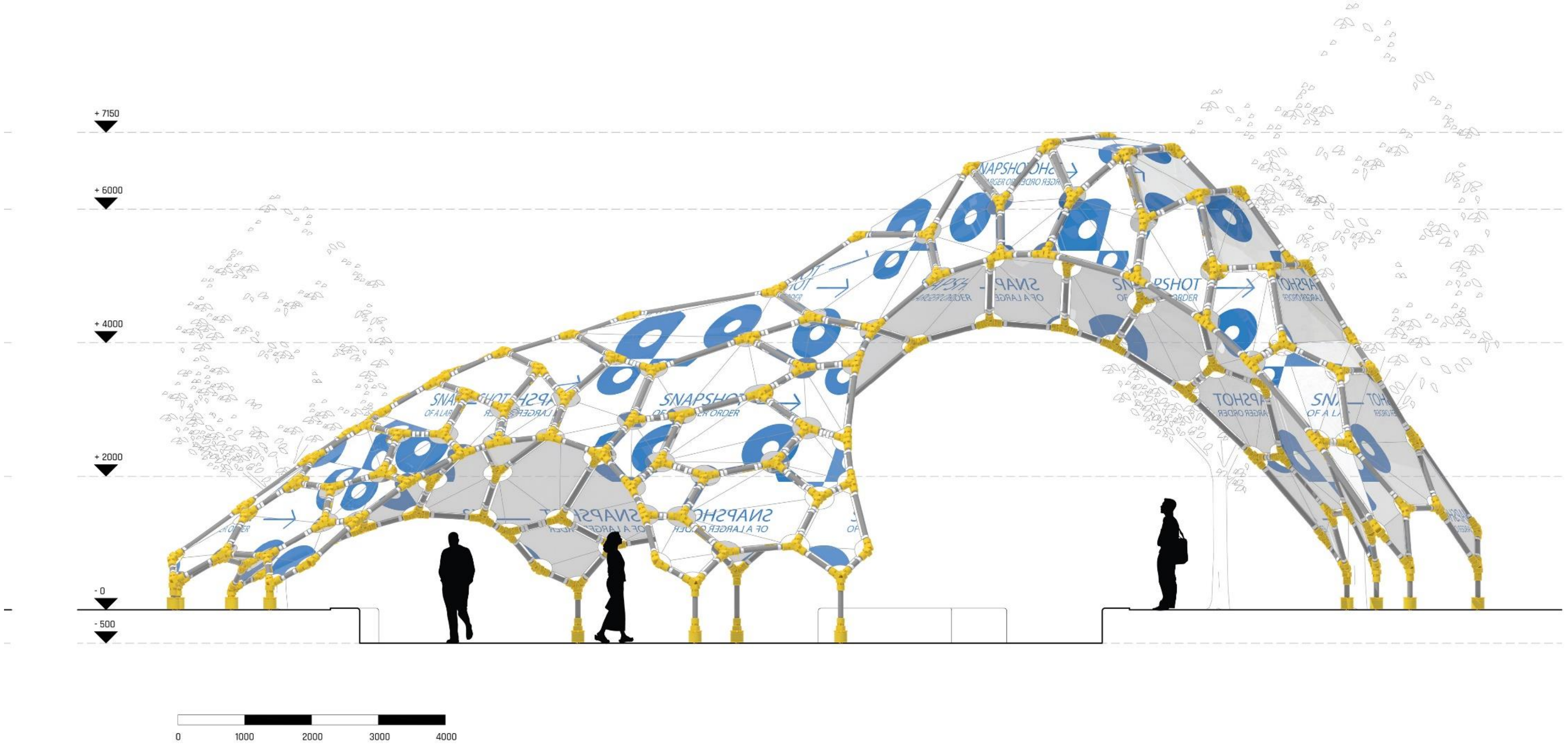
5.0 APPROACH AND METHODOLOGY

5.8 Final design - North Elevation

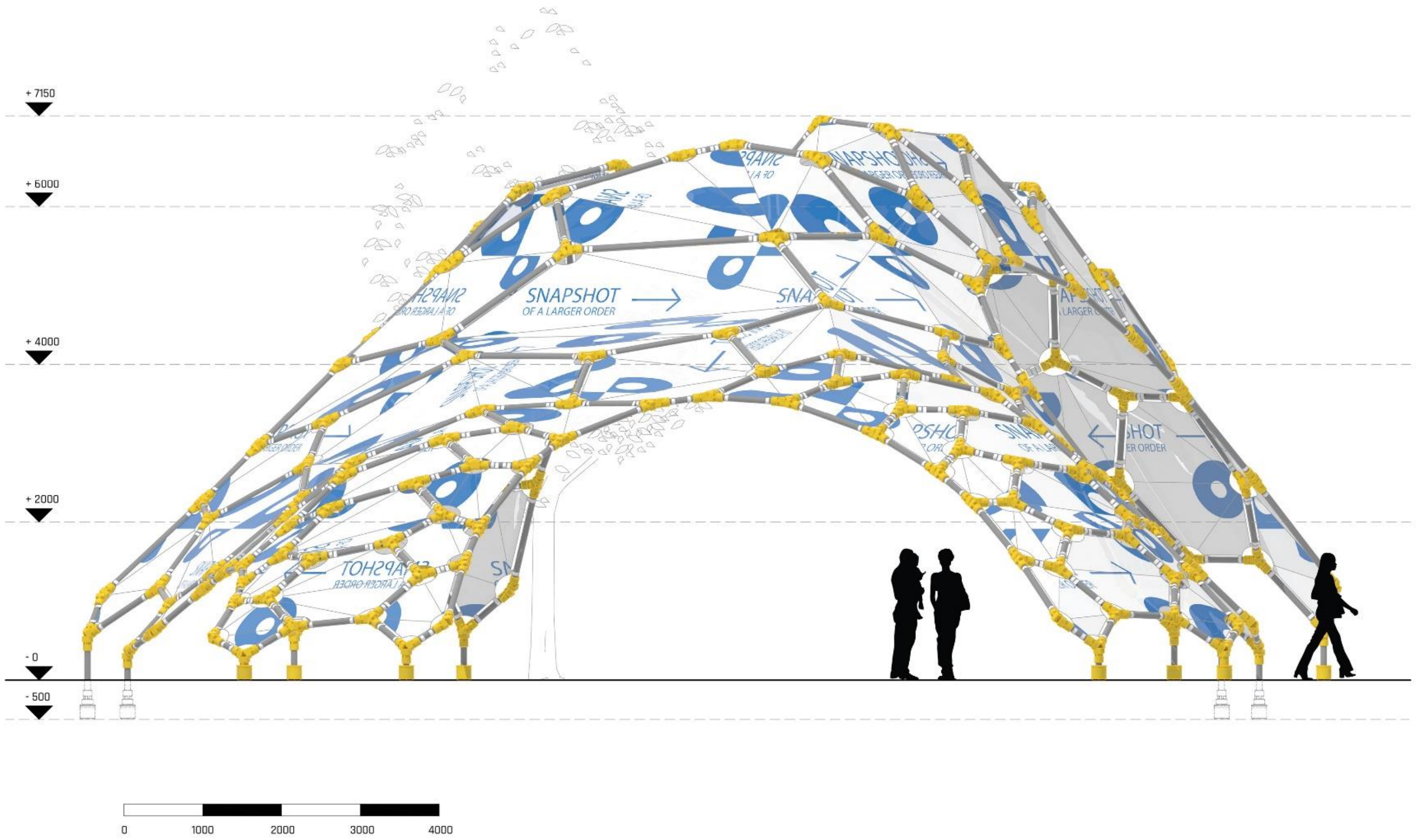


5.0 APPROACH AND METHODOLOGY

5.8 Final design - South Elevation

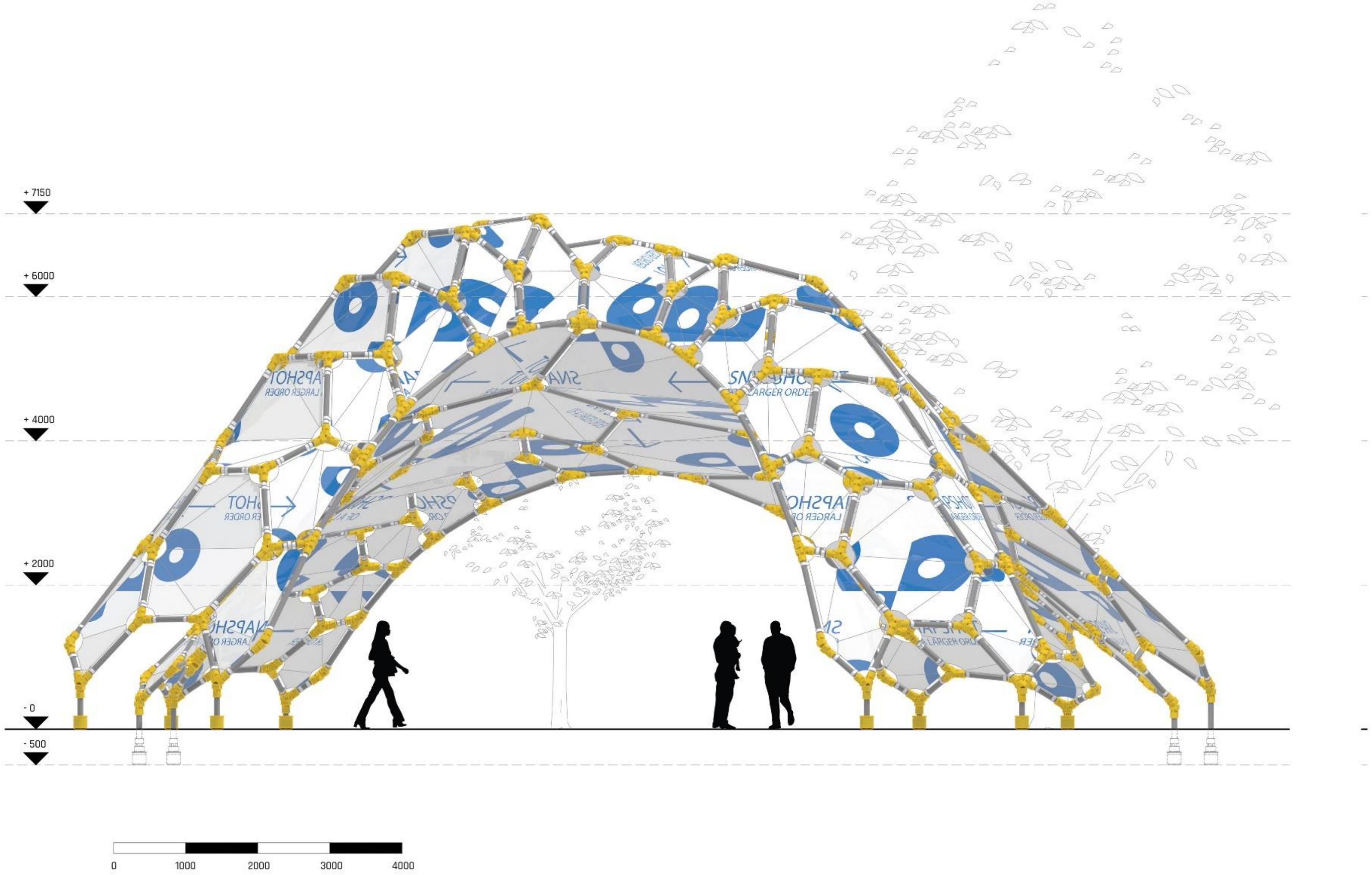


5.8 Final design - West Elevation



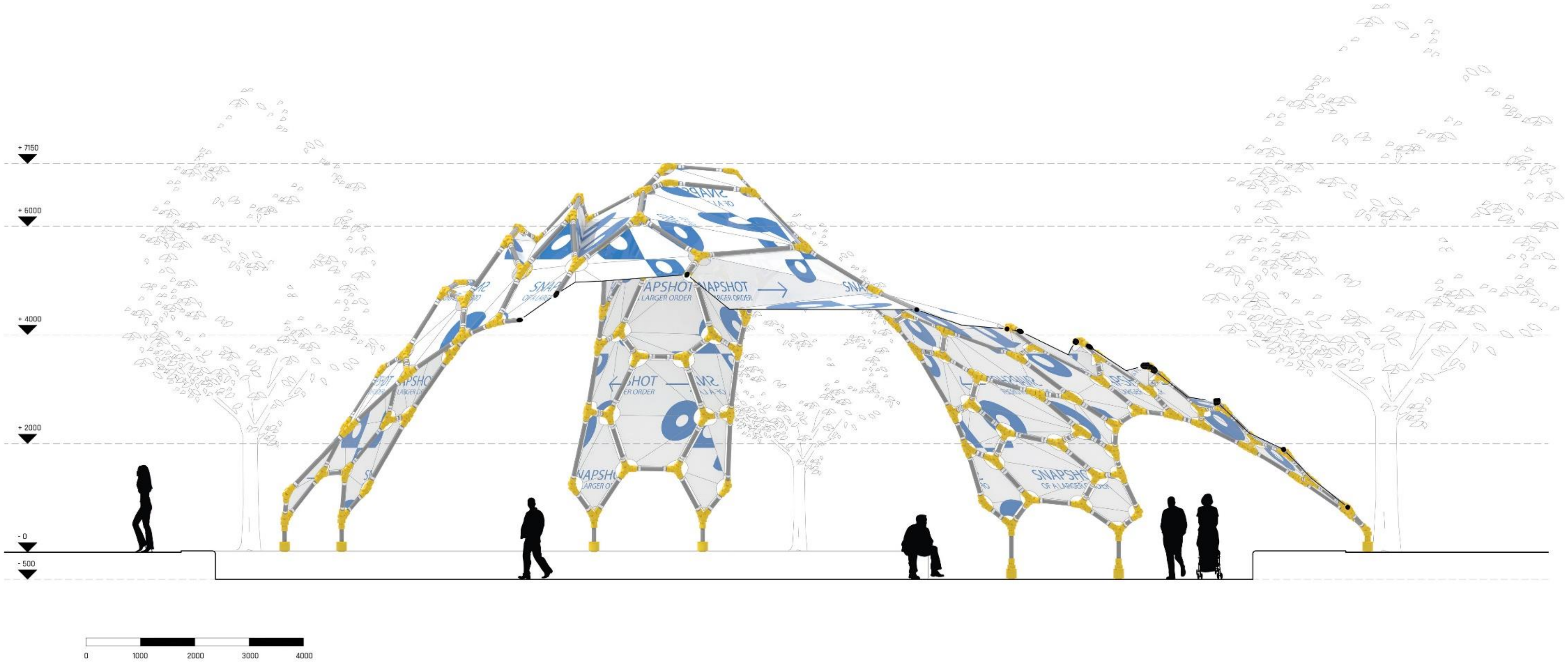
5.0 APPROACH AND METHODOLOGY

5.8 Final design - East Elevation



5.0 APPROACH AND METHODOLOGY

5.8 Final design - Section A-A1



5.8 Final design - Bird's-eye view

5.0 APPROACH AND METHODOLOGY

5.8 Final design - South view

5.0 APPROACH AND METHODOLOGY

5.8 Final design - West view

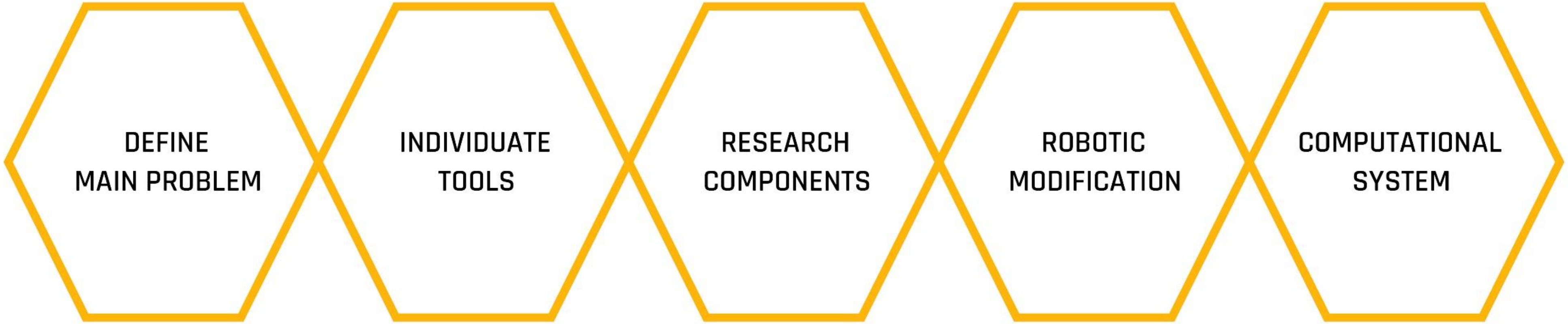
5.0 APPROACH AND METHODOLOGY

5.8 Final design - Interior view

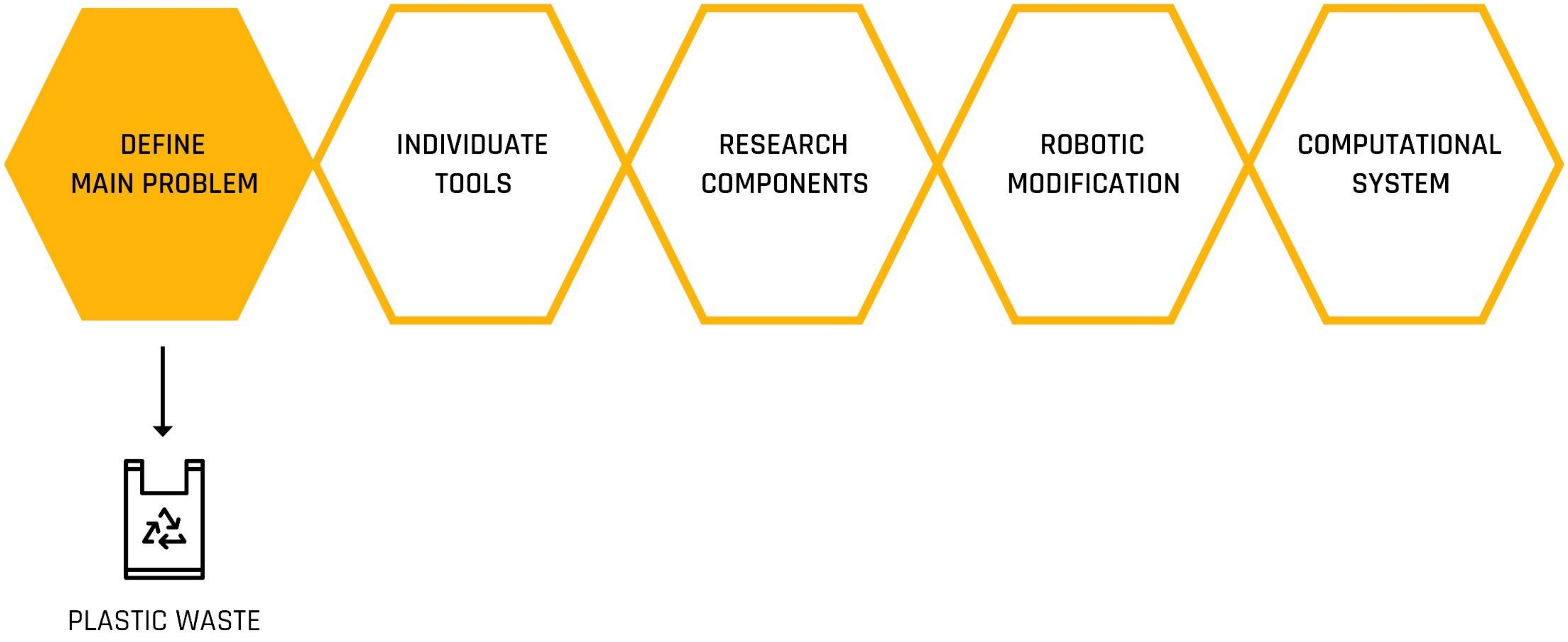
5.0 APPROACH AND METHODOLOGY

5.8 Final design - Event space

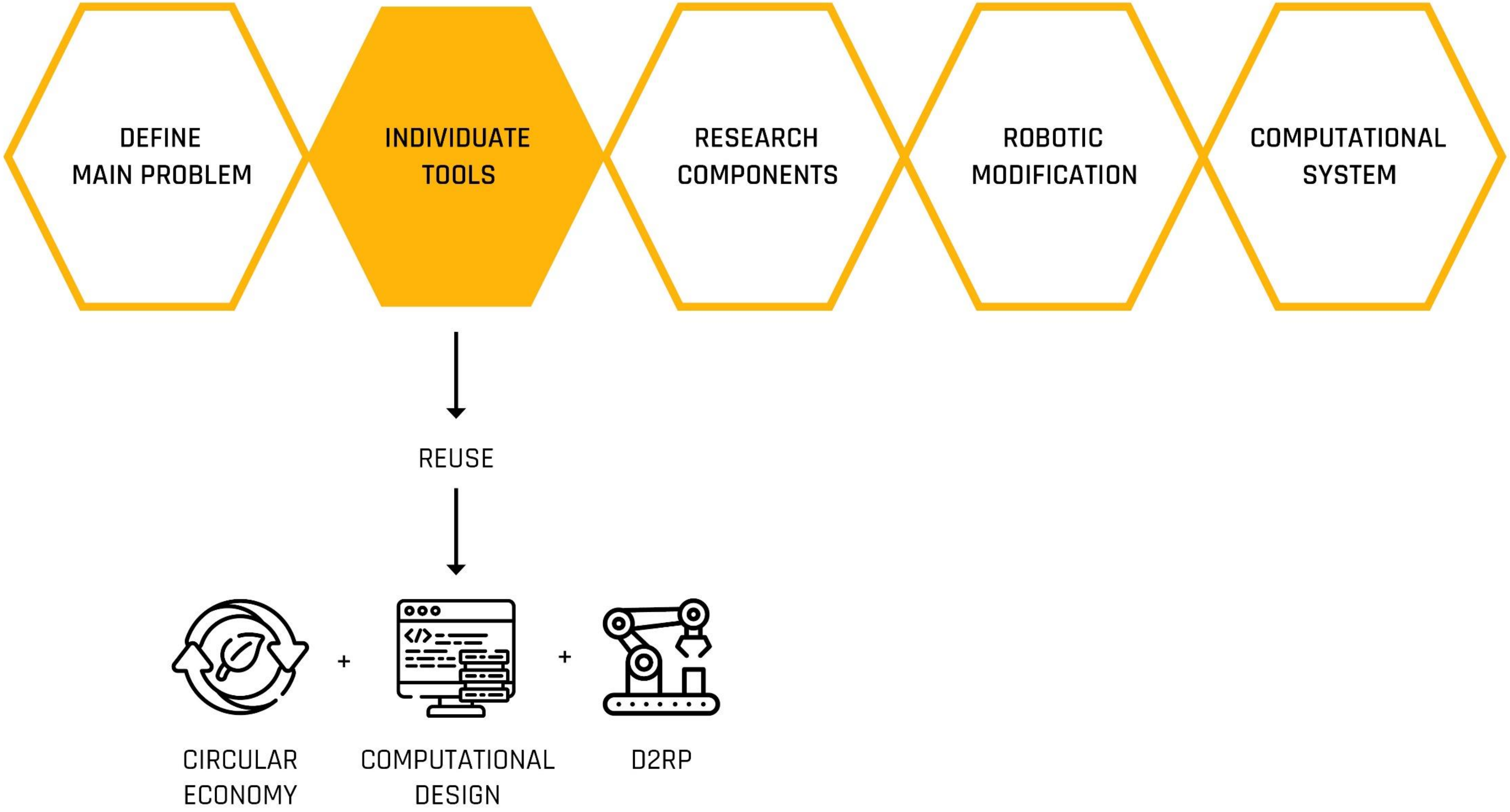
SUMMARY


DEFINE
MAIN PROBLEM
INDIVIDUATE
TOOLS
RESEARCH
COMPONENTS
ROBOTIC
MODIFICATION
COMPUTATIONAL
SYSTEM

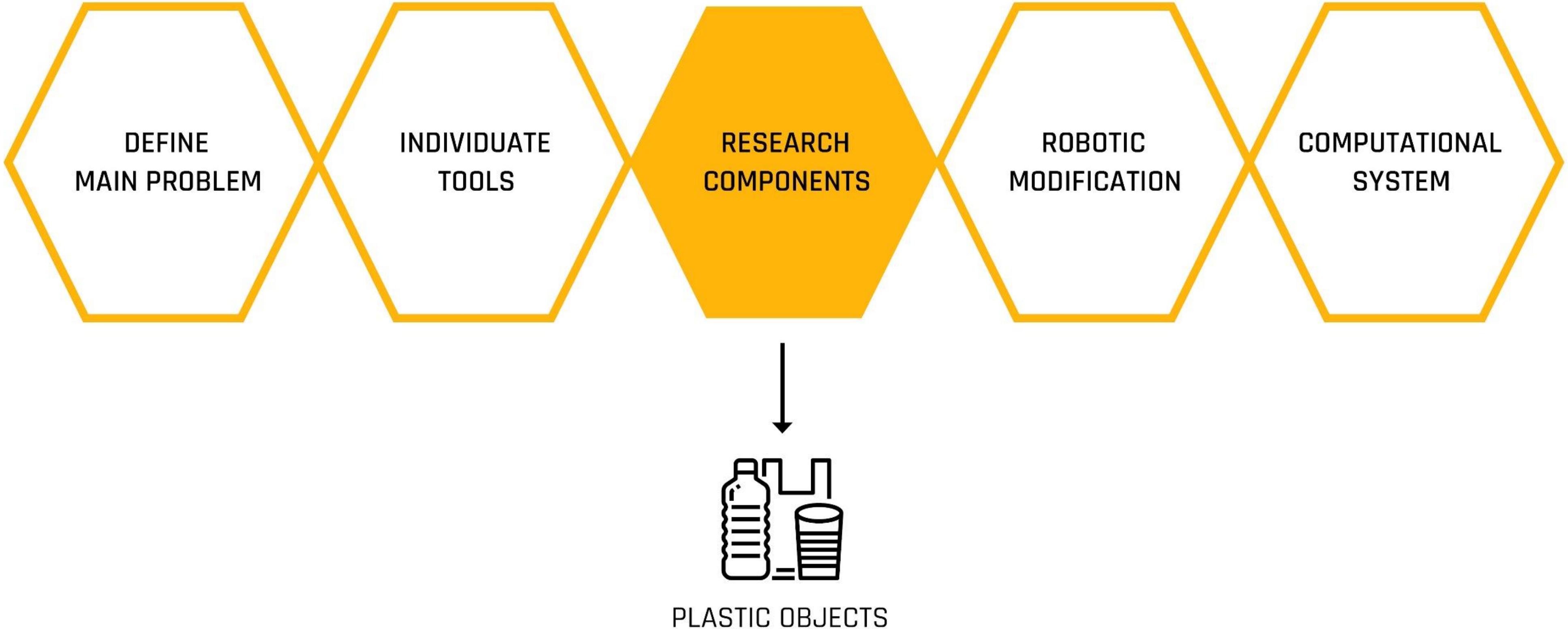
SUMMARY


DEFINE
MAIN PROBLEM
INDIVIDUATE
TOOLS
RESEARCH
COMPONENTS
ROBOTIC
MODIFICATION
COMPUTATIONAL
SYSTEM
PLASTIC WASTE

SUMMARY


DEFINE
MAIN PROBLEM
INDIVIDUATE
TOOLS
RESEARCH
COMPONENTS
ROBOTIC
MODIFICATION
COMPUTATIONAL
SYSTEM
REUSE
+
+
CIRCULAR
ECONOMY
COMPUTATIONAL
DESIGN
D2RP

SUMMARY


DEFINE
MAIN PROBLEM
INDIVIDUATE
TOOLS
RESEARCH
COMPONENTS
ROBOTIC
MODIFICATION
COMPUTATIONAL
SYSTEM
PLASTIC OBJECTS

SUMMARY

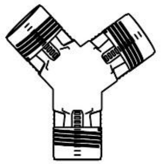
DEFINE
MAIN PROBLEM

INDIVIDUATE
TOOLS

RESEARCH
COMPONENTS

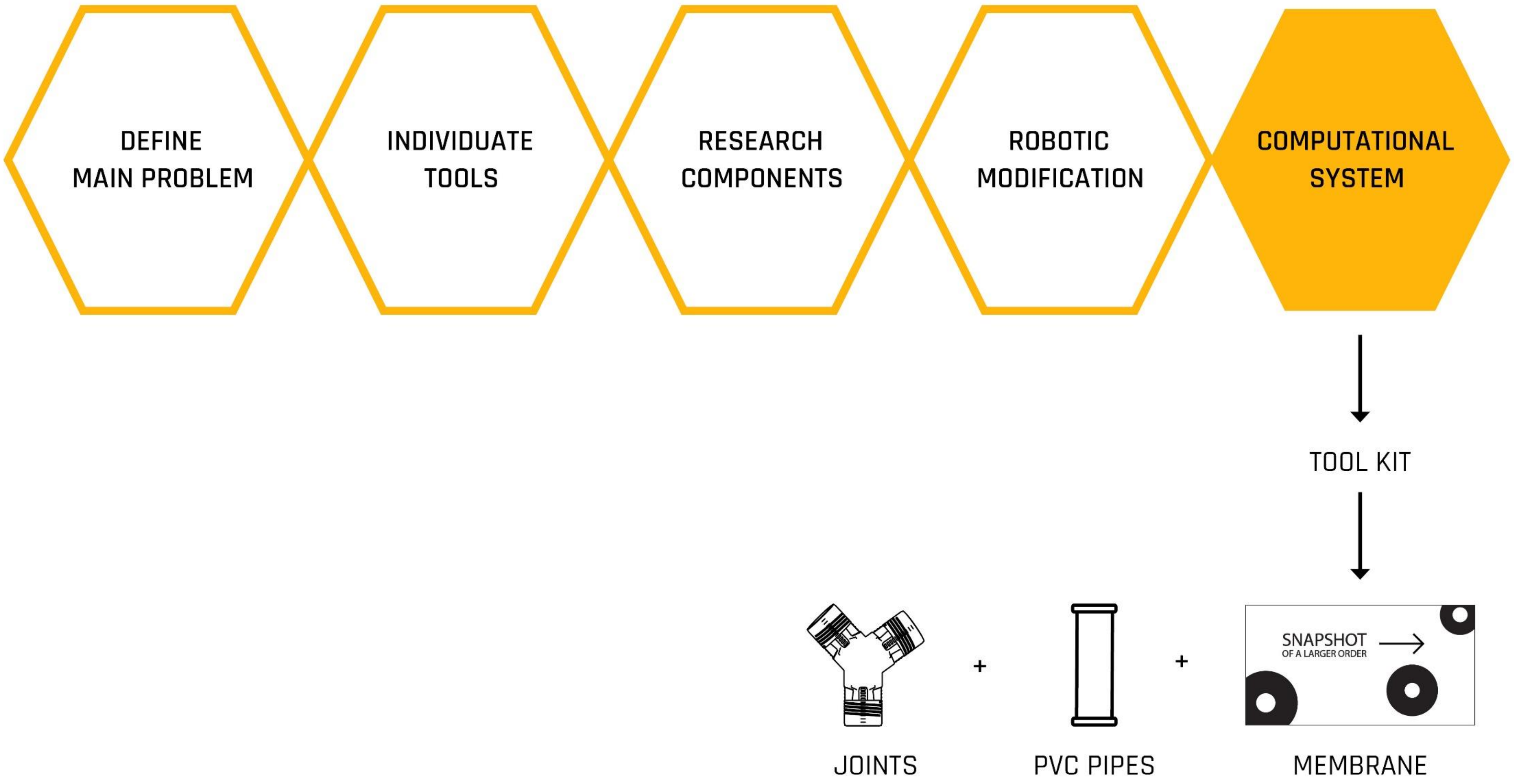
**ROBOTIC
MODIFICATION**

COMPUTATIONAL
SYSTEM

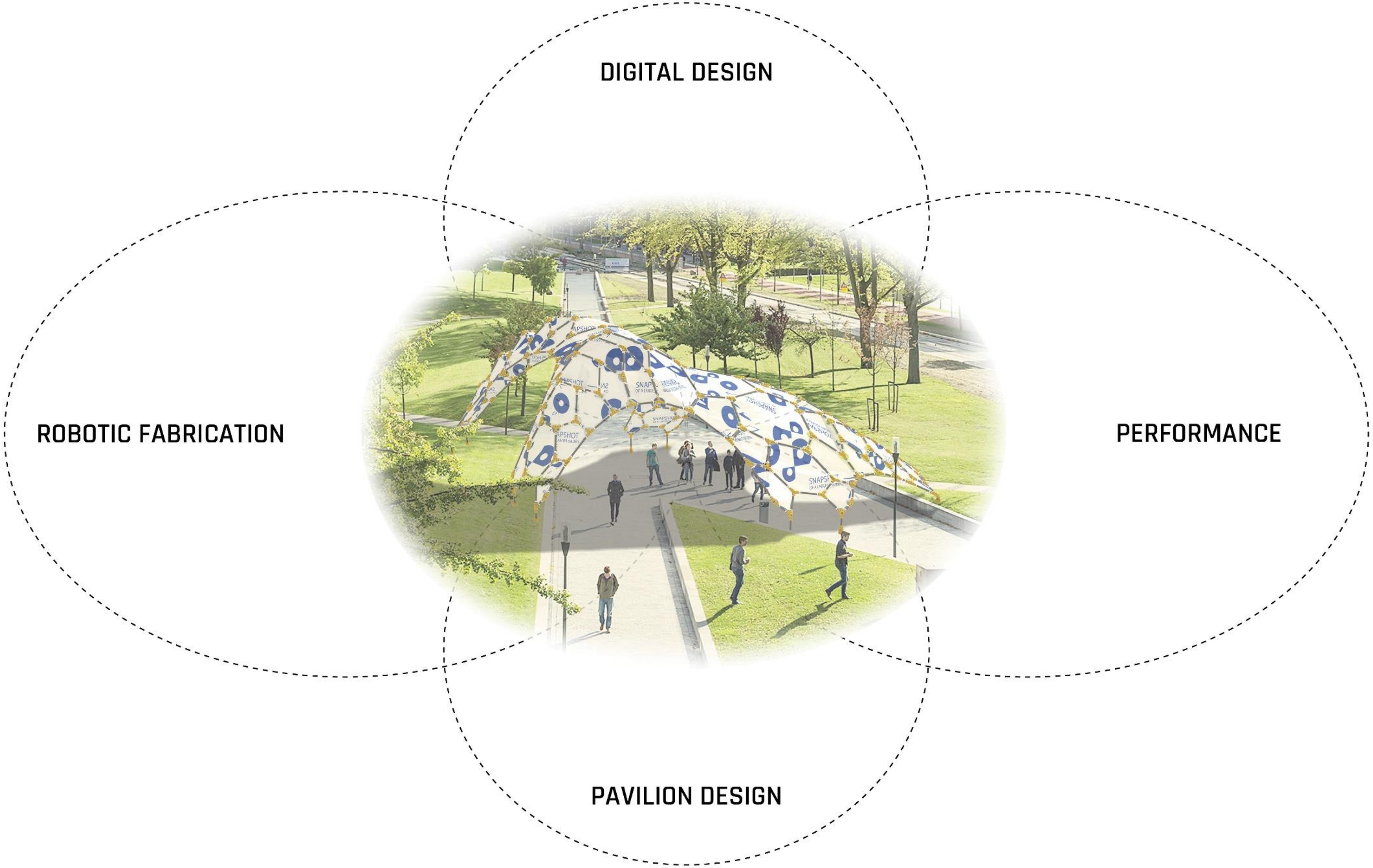


ORIGINATE
CONSTRUCTION
ELEMENTS

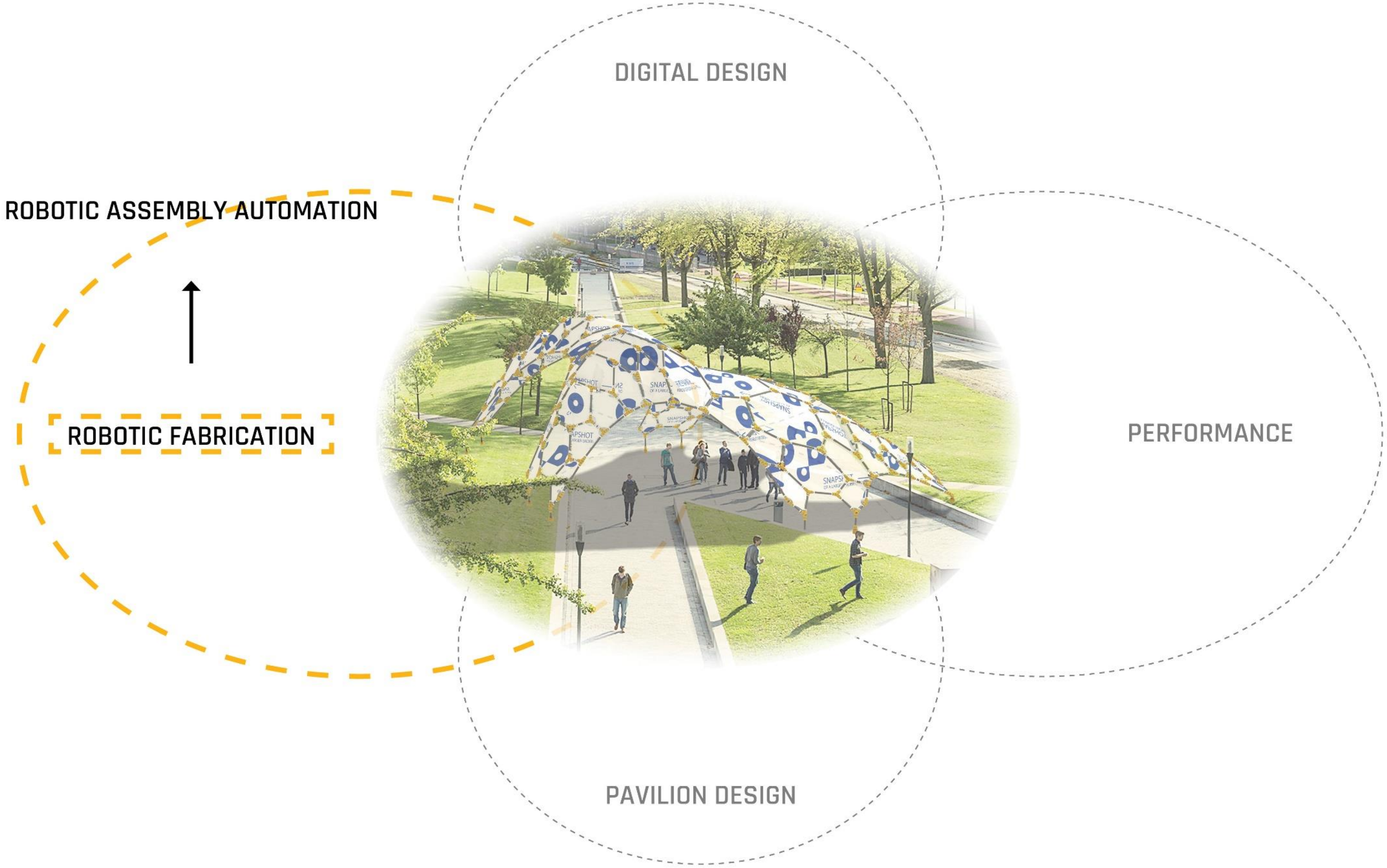
SUMMARY


DEFINE
MAIN PROBLEM
INDIVIDUATE
TOOLS
RESEARCH
COMPONENTS
ROBOTIC
MODIFICATION
COMPUTATIONAL
SYSTEM
TOOL KIT
+
+
SNAPSHOT
OF A LARGER ORDER
JOINTS
PVC PIPES
MEMBRANE

FURTHER RESEARCH DIRECTIONS



FURTHER RESEARCH DIRECTIONS

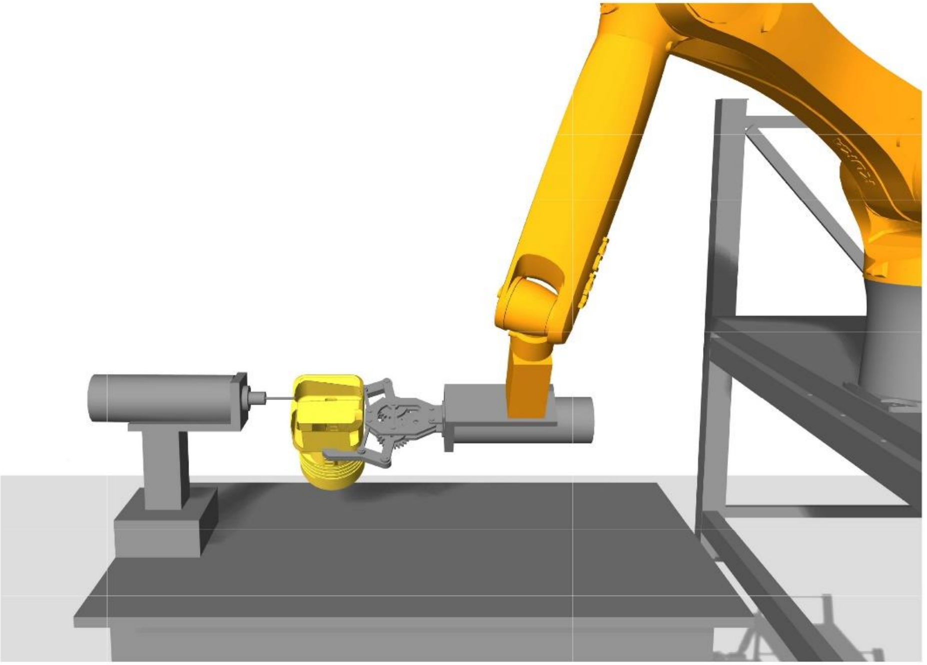


ROBOTIC ASSEMBLY AUTOMATION

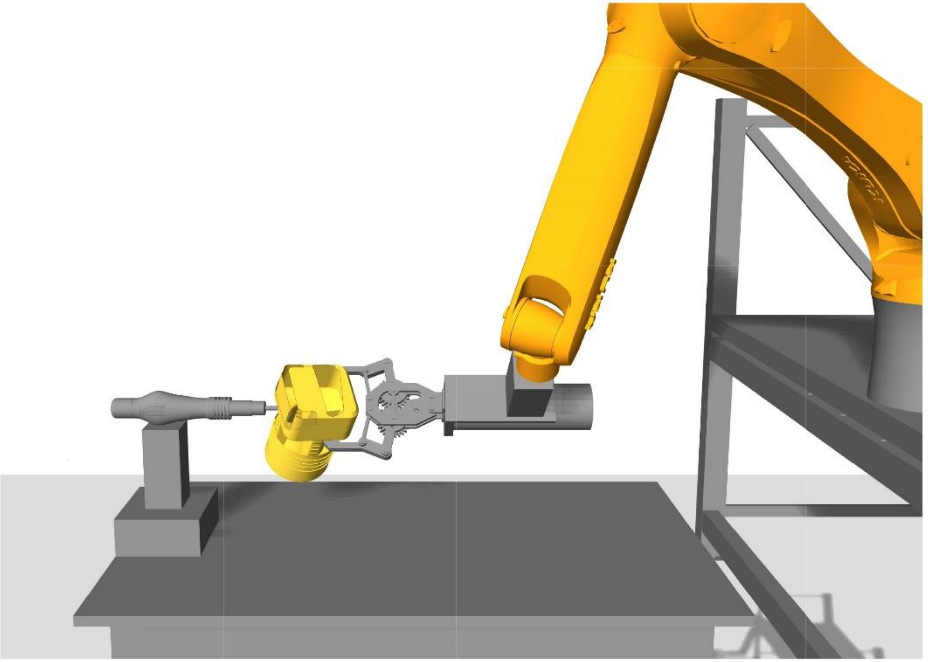
- SUGGEST SOME GUIDELINES IN ORDER TO FURTHER IMPLEMENT THE ASSEMBLY OF THE JOINTS DEVELOPED DURING THE RESEARCH PROJECT AND REDUCE THE REQUIRED MANUAL INPUT

- **INITIAL CONFIGURATION:** FIX ROBOT - MOVING TOOL (DRILL) - FIXED OBJECT | FOLDING & ASSEMBLY OUTSIDE THE ROBOTIC SETUP

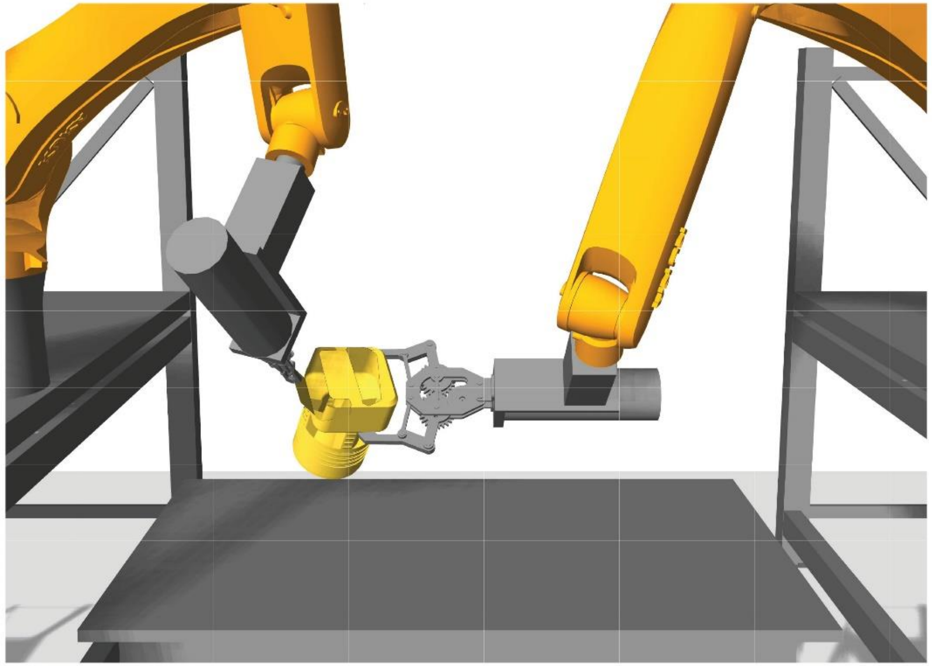
- **NEW CONFIGURATION:** FIX ROBOT - FIX TOOLS - MOVING OBJECT | FOLDING & ASSEMBLY WITH MULTI-ROBOT SETUP



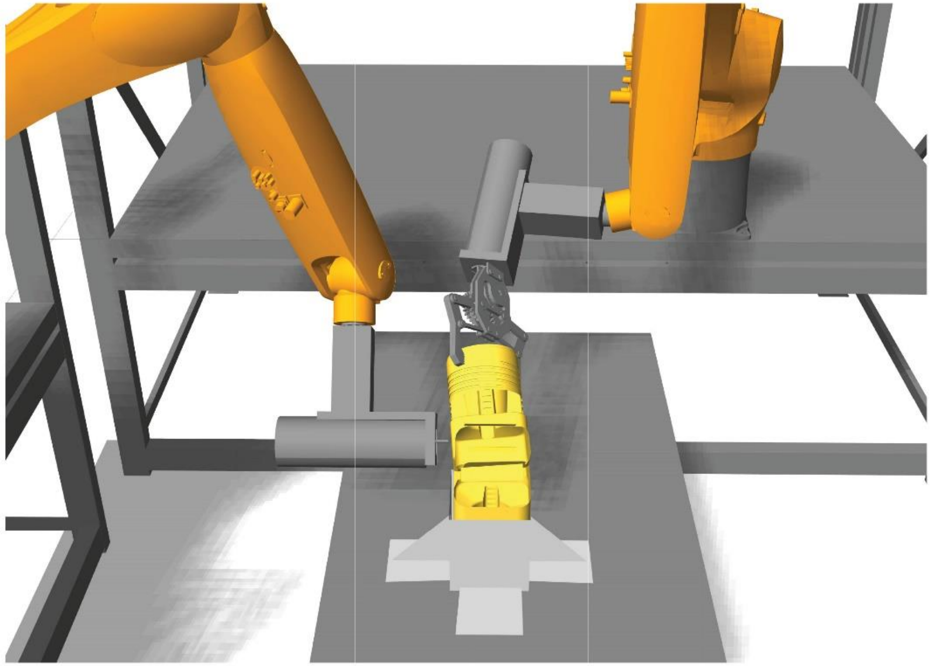
STEP 1 - MILLING



STEP 2 - HEAT GUN

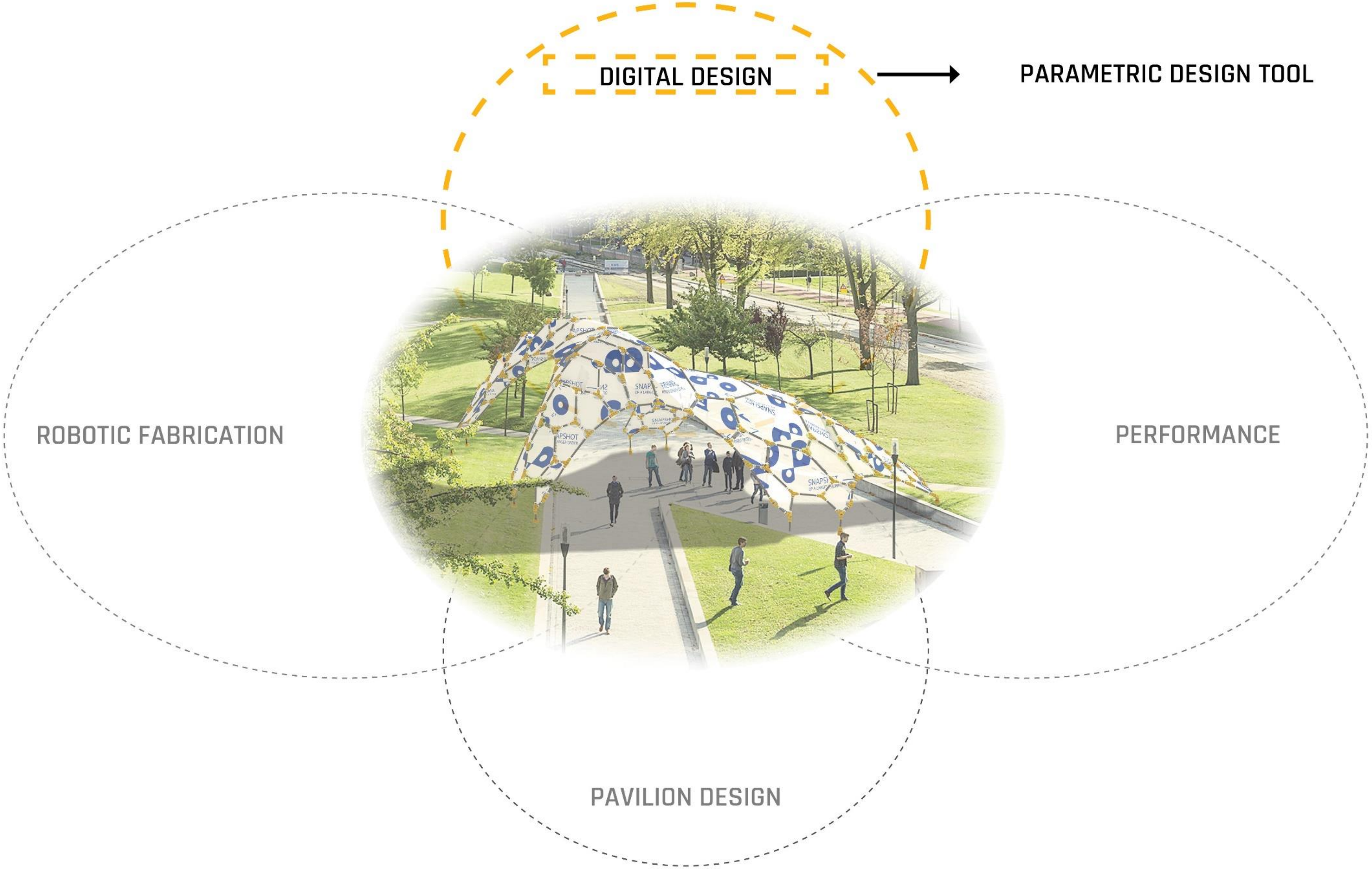


STEP 3 - FOLDING

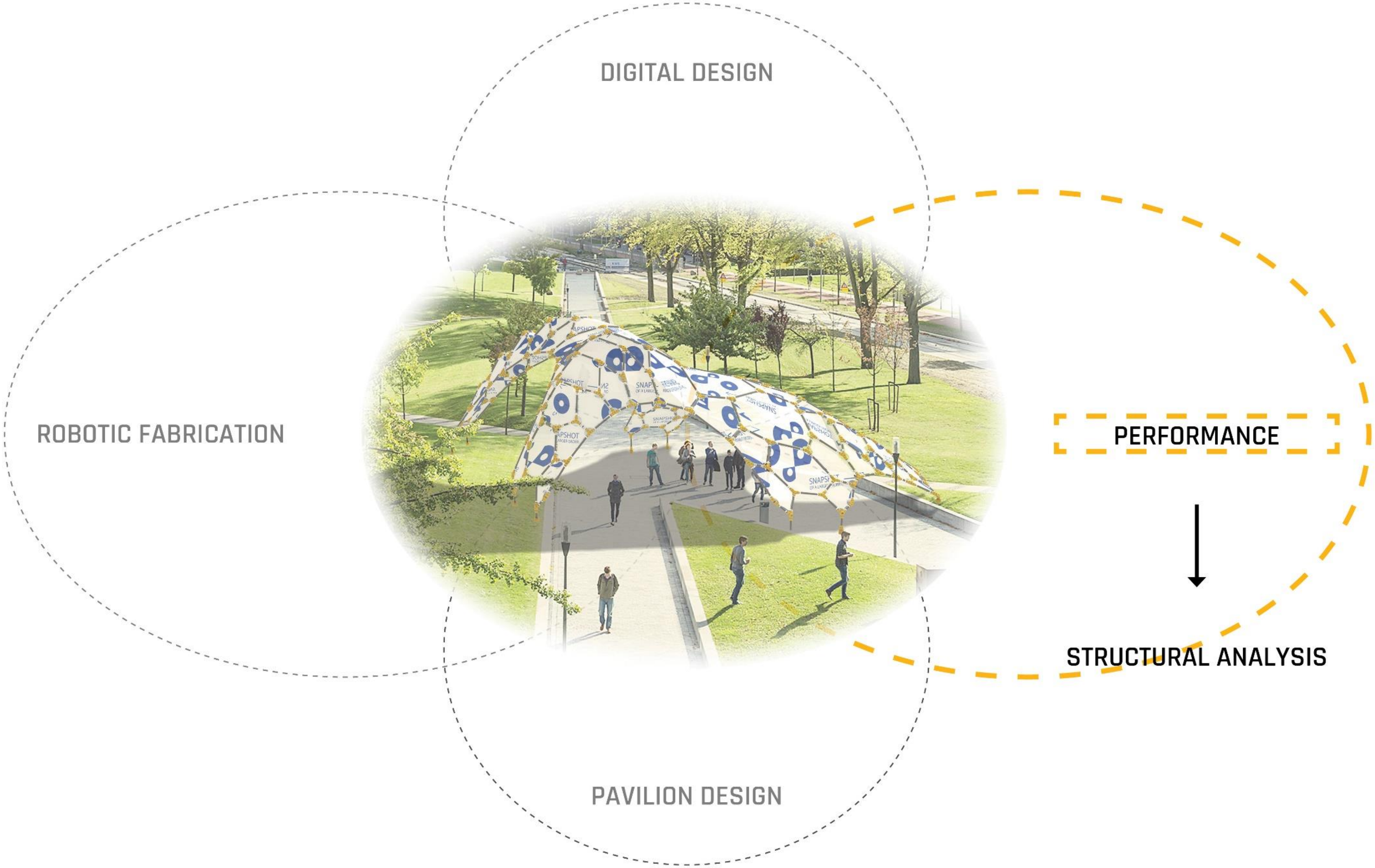


STEP 4 - ASSEMBLY

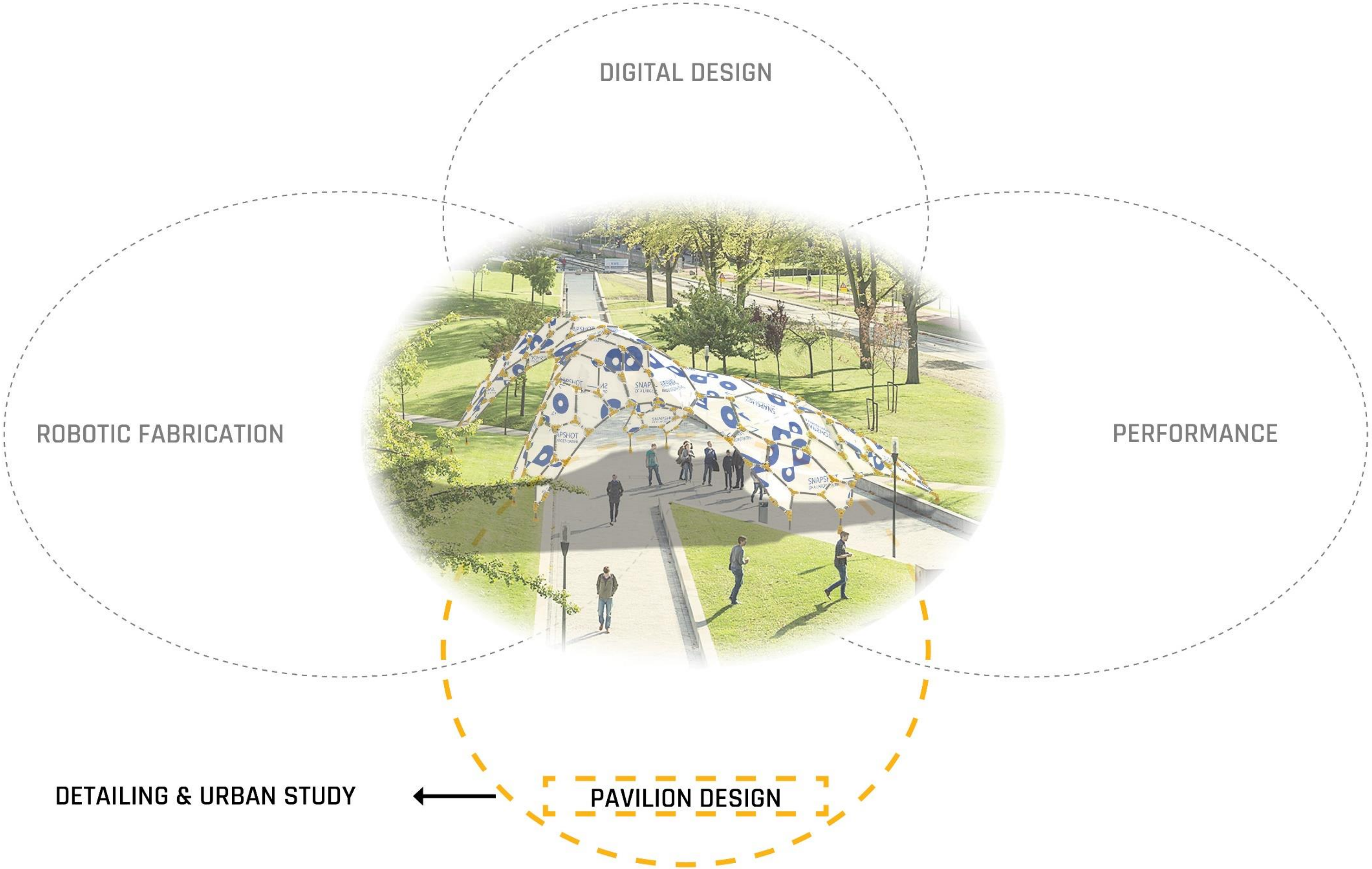
FURTHER RESEARCH DIRECTIONS



FURTHER RESEARCH DIRECTIONS



FURTHER RESEARCH DIRECTIONS



THANK YOU!