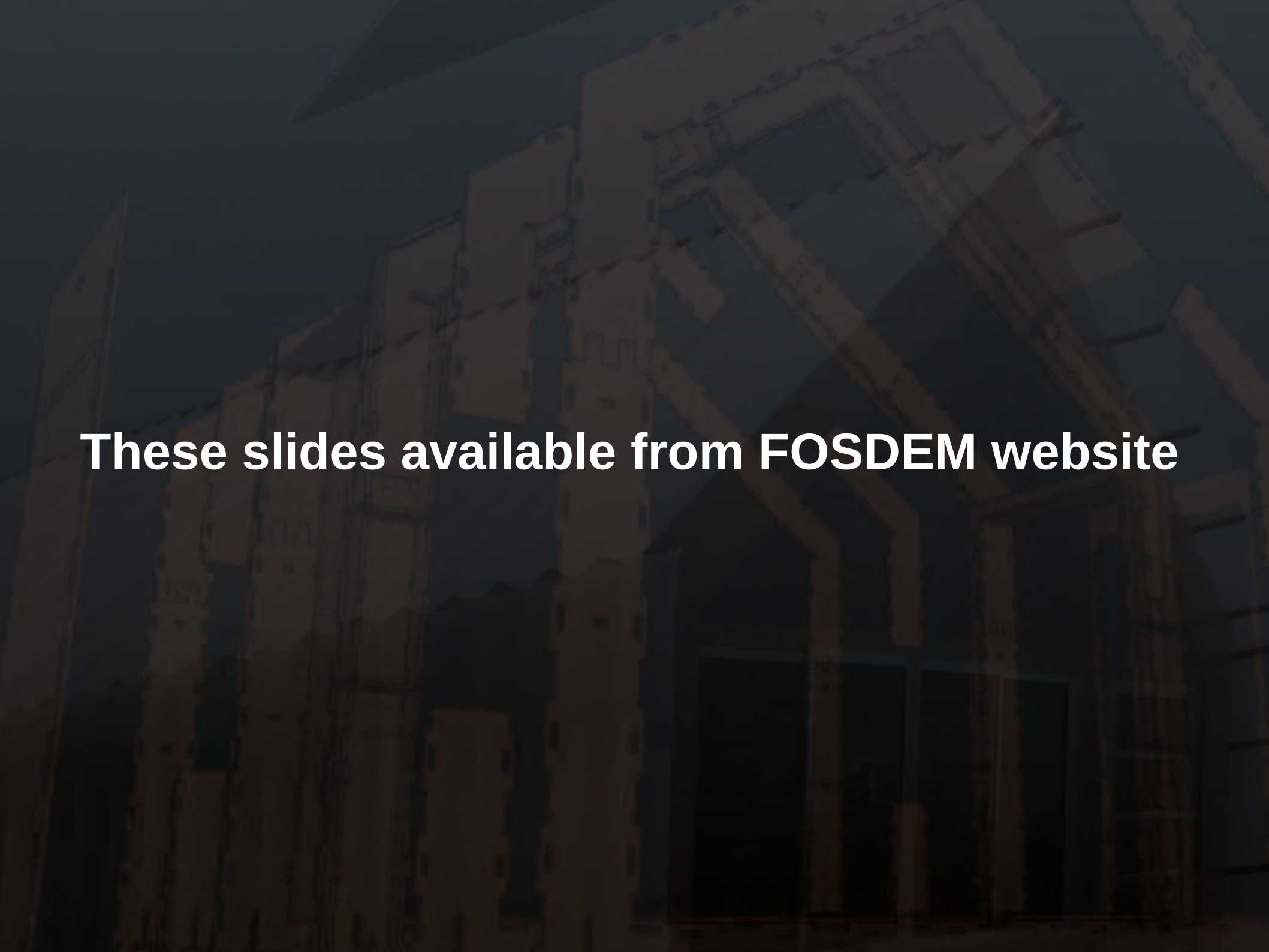
Wikilab, architecture & CNC

Collaborative architecture and construction with FreeCAD

Yorik van Havre

FOSDEM 2018

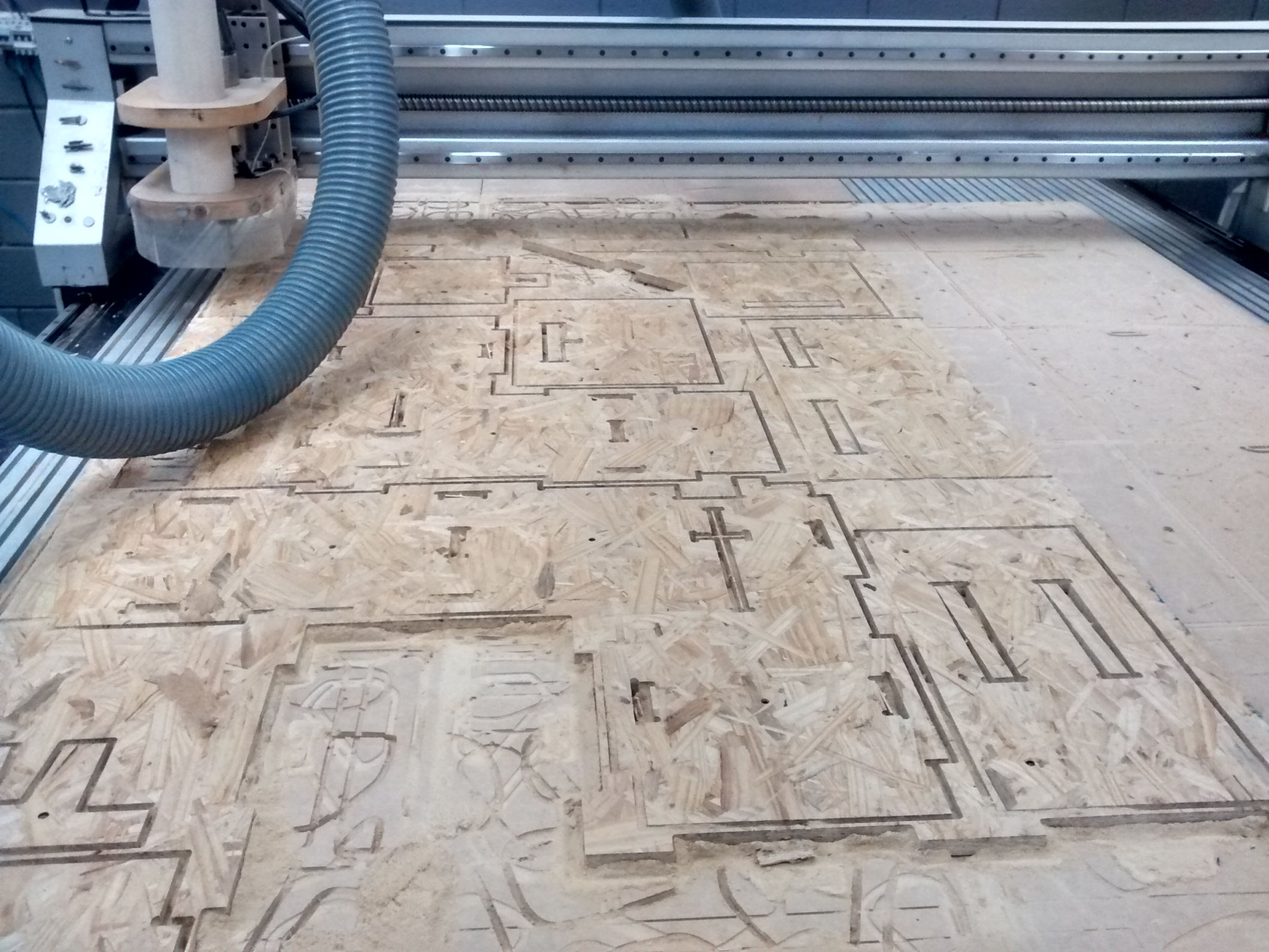

These slides available from FOSDEM website

The WikiLab

São Paulo, Brazil
Built in 2017

Based on WikiHouse
Built by volunteers
Fully open-source


CBS

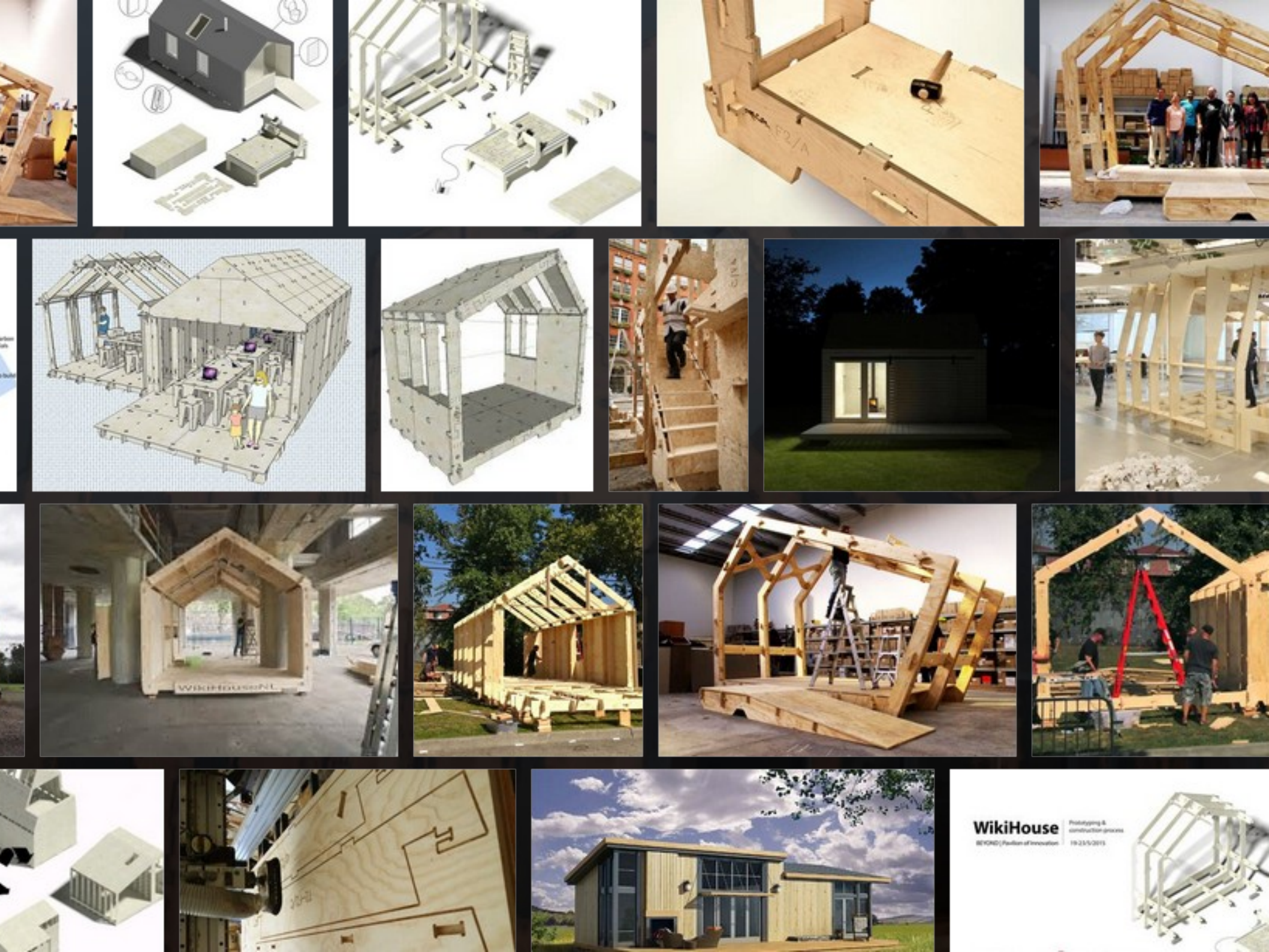



SPACER/R

The WikiHouse project

Do-it-yourself construction system made of CNC-cut wooden pieces

- Started in the UK in 2011
- Already several built units around the world
- Open-source
- Well-tested and matured system already
- http://wikihouse.cc


WikiHouse
Prototyping &
construction process

Wren Hardware

Wren components are CNC manufuctured using structural-grade timber panel materials (typically, plywood) and can be rapidly assembled to produce a structural chassis, onto which other components such as cladding, windows, doors can be fitted.

Wren is in development. For full documentation on how Wren works and how you can contribute to its development, visit the Wren wiki

Wren Parametrics

This version of the Wren structural language has been developed in Grasshopper, the parametric scripting plugin for Rhino 3D. This computational design platform is widely used in the design and construction industries, and is ideally suited to digital manufacturing.

Other formats of the Wren system are currently being developed, but currently this version in Grasshopper format represents the latest thinking and workflow for the structural technology.

Assembly Test
24 Oct 14:47

Community Build Photos
08 Aug 16:56

Images
16 Dec 19:38

My Project Engine.xlsx
Excel Spreadsheet
20 Dec 09:42

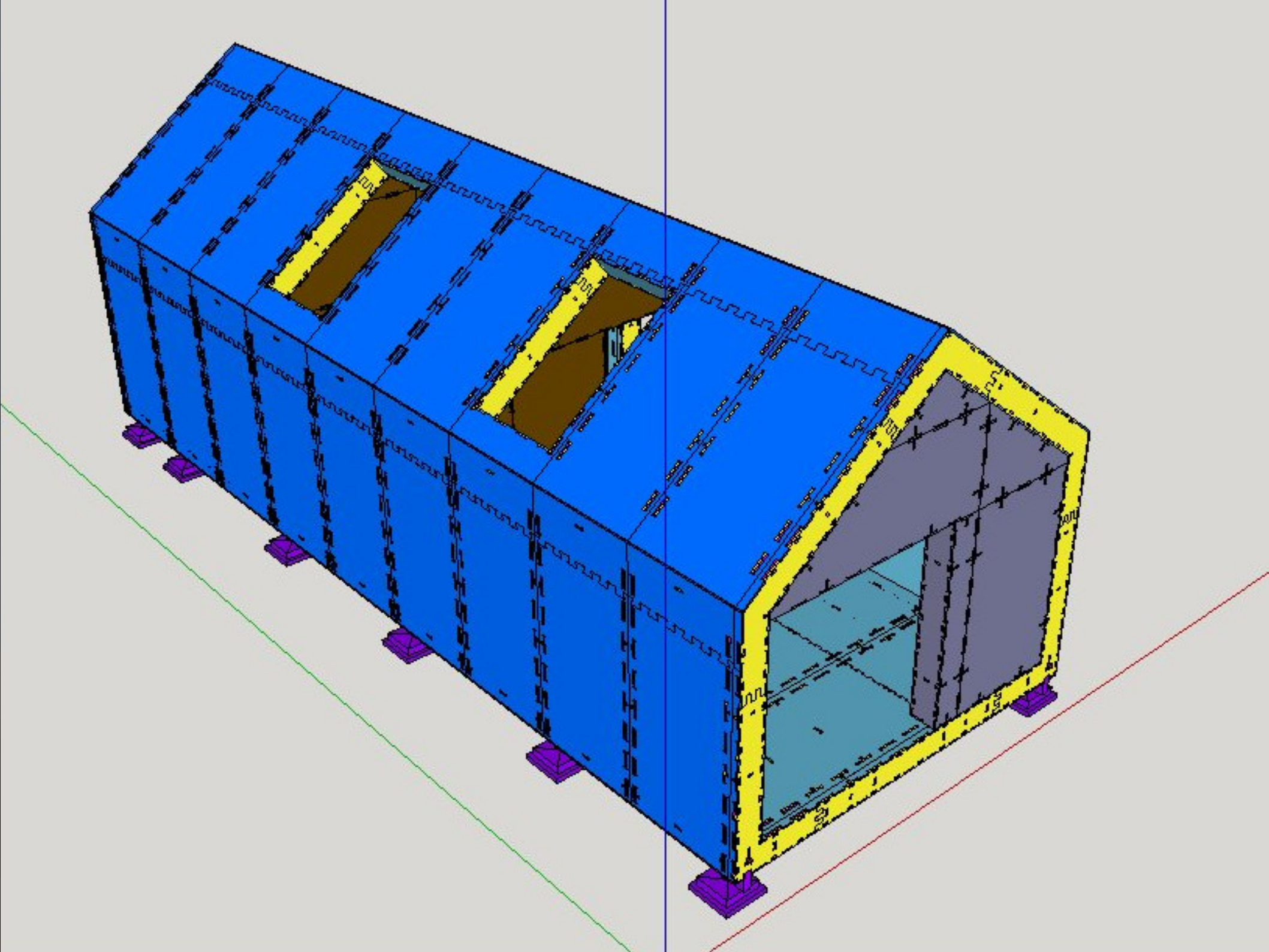
README.md
Markdown Document
08 Aug 15:19

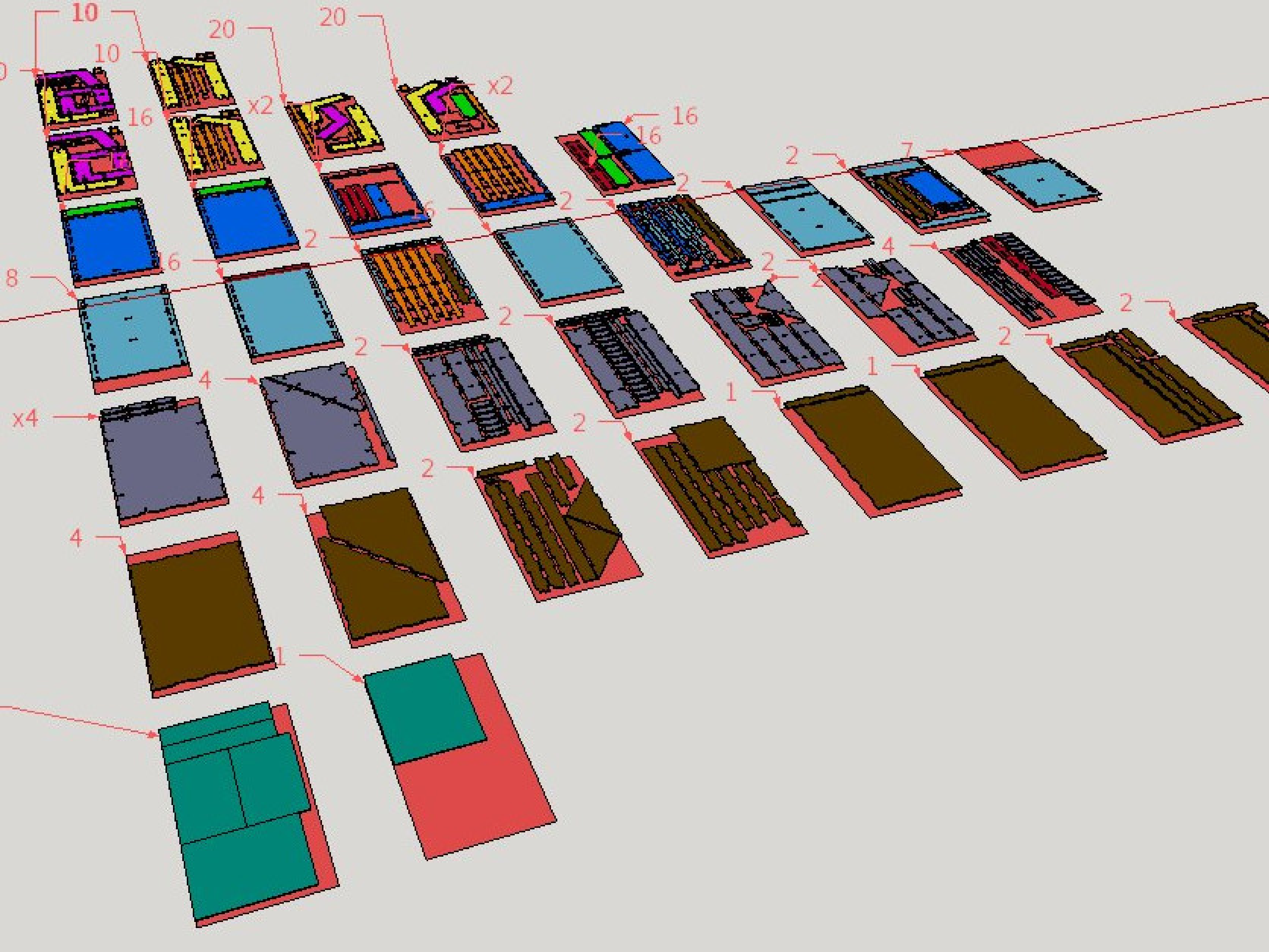
PDF
WikiHouseIntroProcess_v1.0.pdf
Document
08 Aug 15:03

GH
WikiHouse_WREN_(v4.3).gh
20 Dec 09:38

Report an Issue

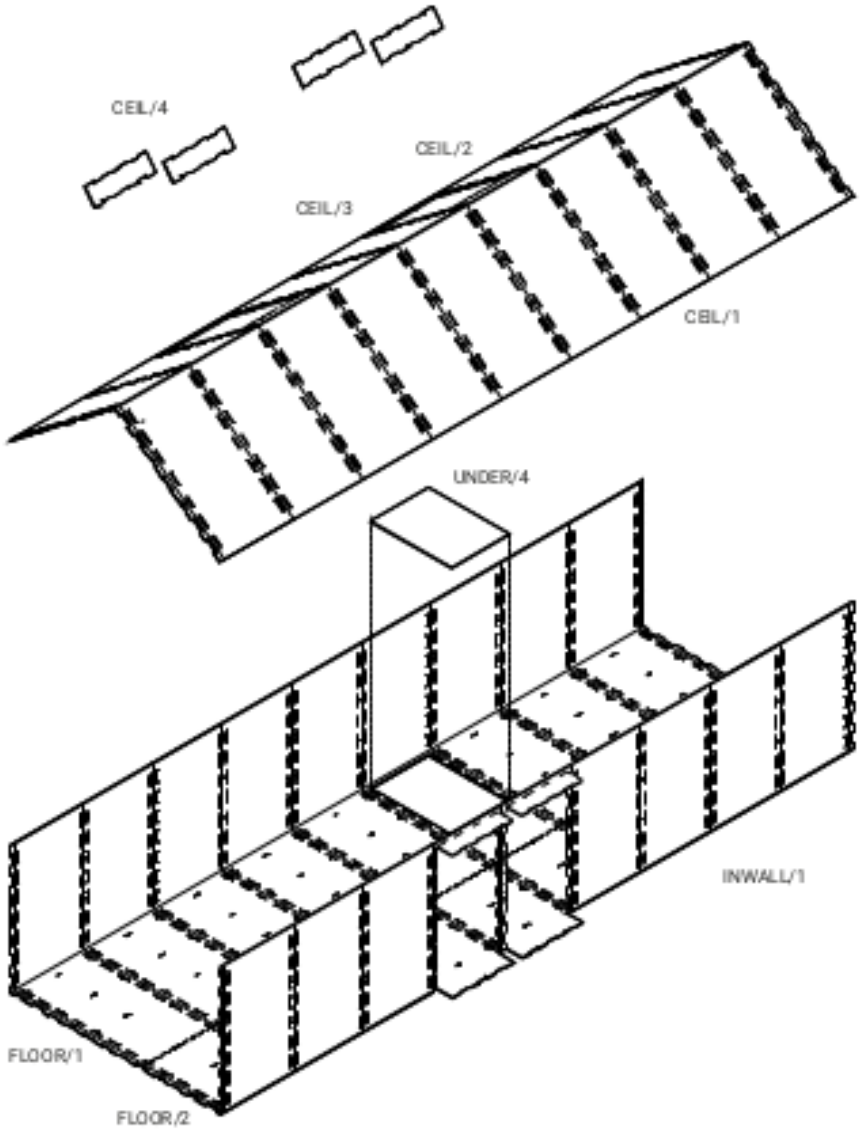
License



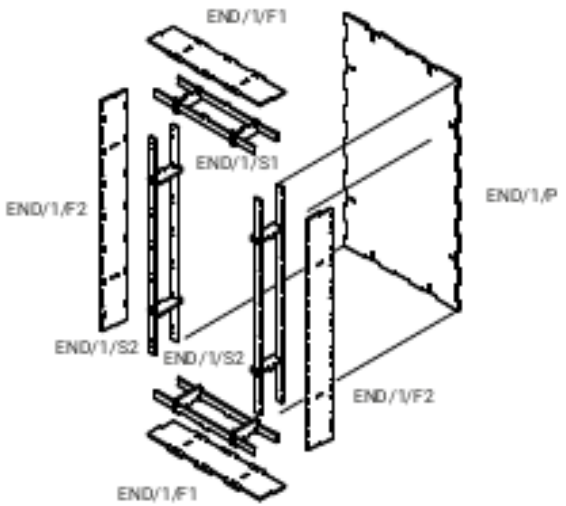


10
10
20
20
16
x2
x2
16
16
16
2
7
2
2
2
4
8
16
2
2
2
4
2
2
2
2
x4
4
1
2
1
2
2
4
4
1

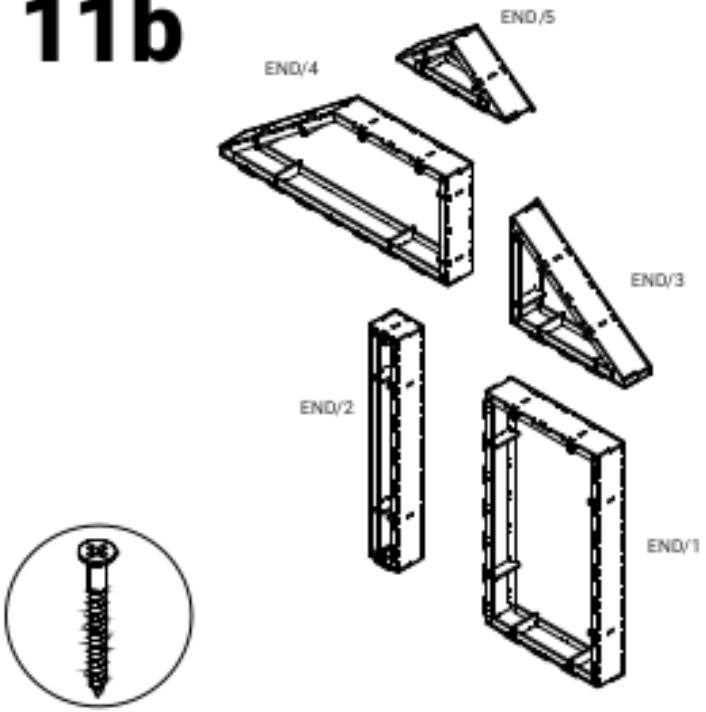
10


CEIL/4
CEIL/2
CEIL/3
CEIL/1
UNDER/4
INWALL/1
FLOOR/1
FLOOR/2

11a


END/1/F1
END/1/S1
END/1/P
END/1/F2
END/1/S2
END/1/S2
END/1/F2
END/1/F1

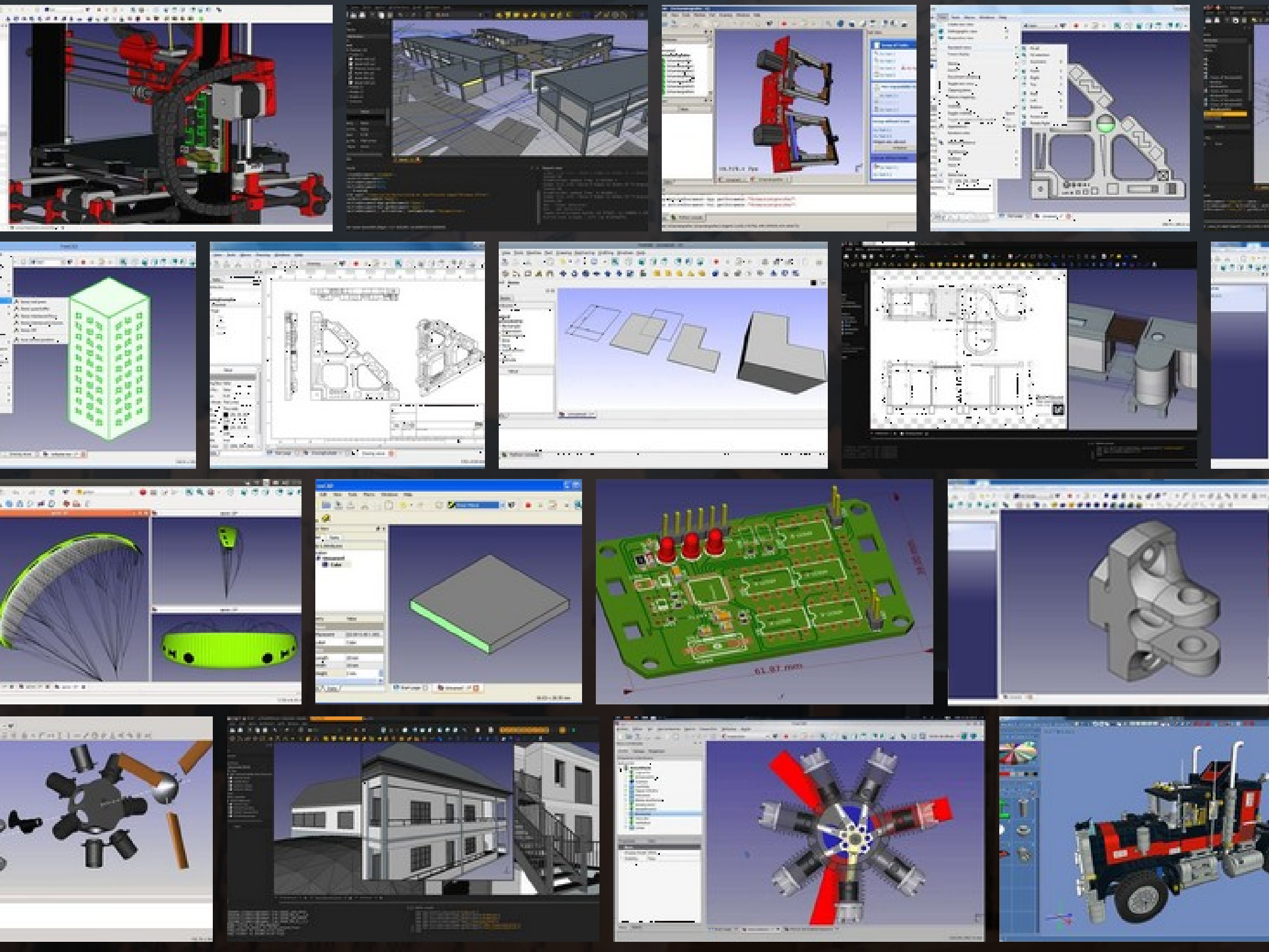
11b

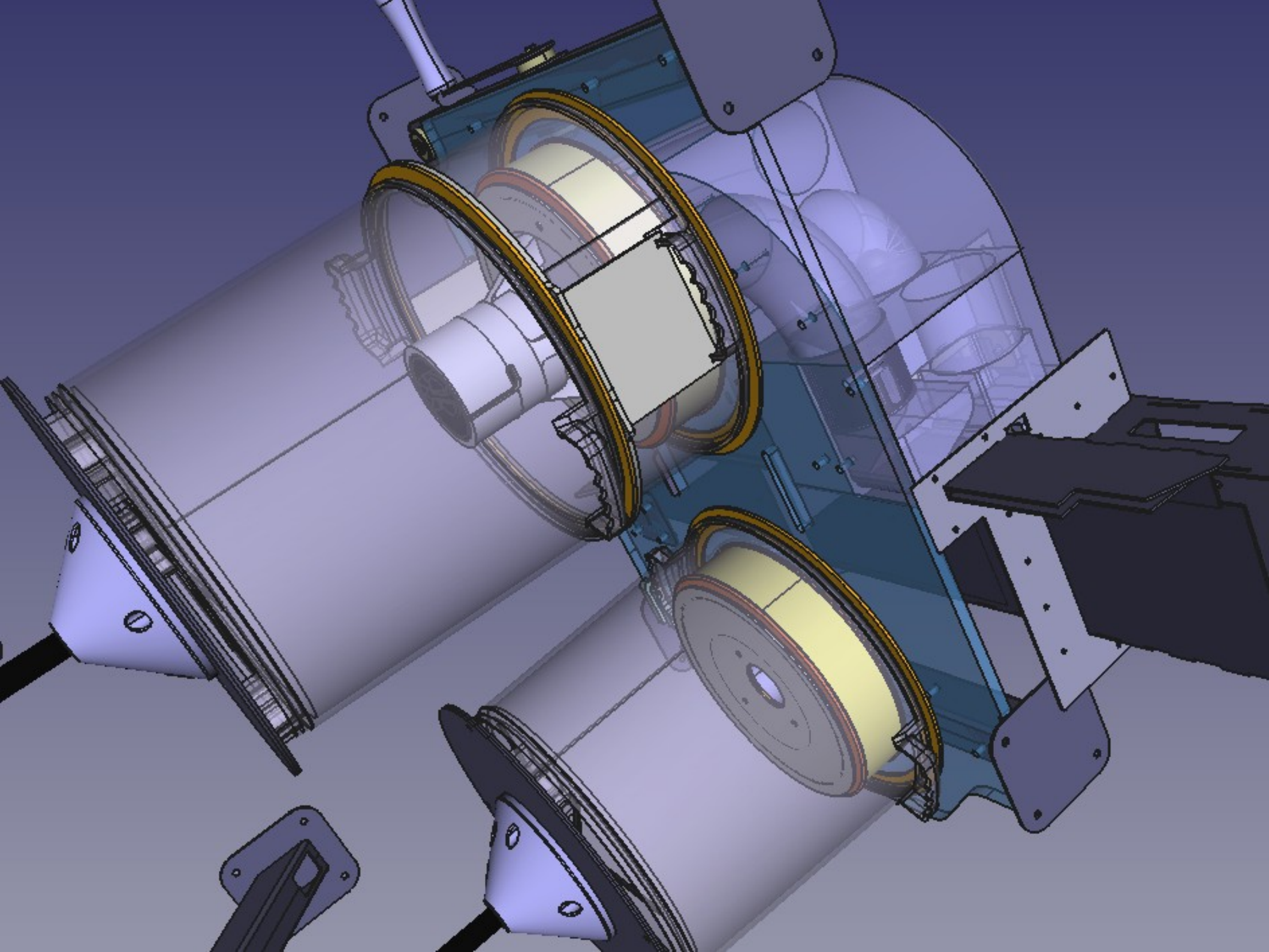

END/5
END/4
END/3
END/2
END/1

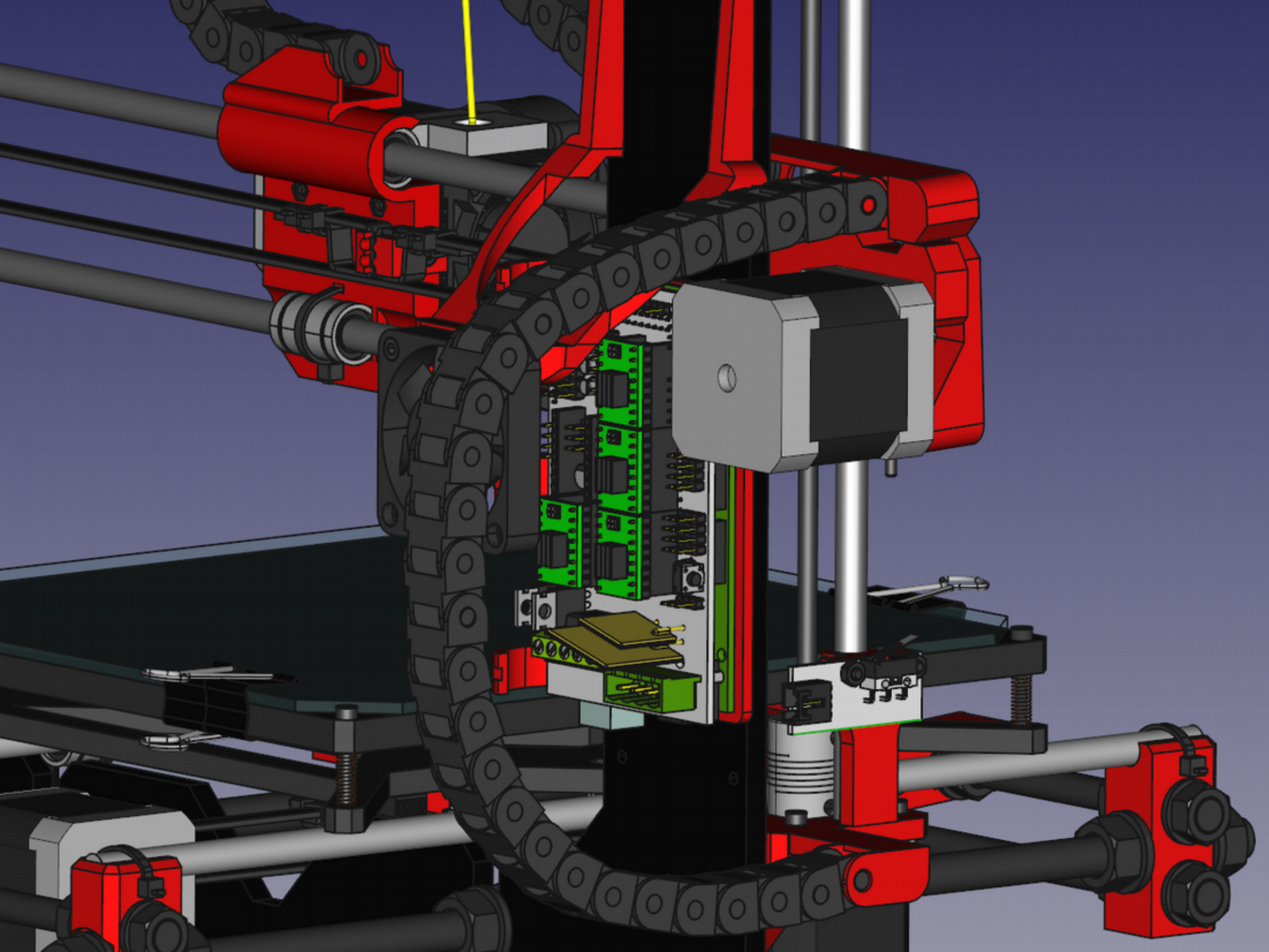
FreeCAD

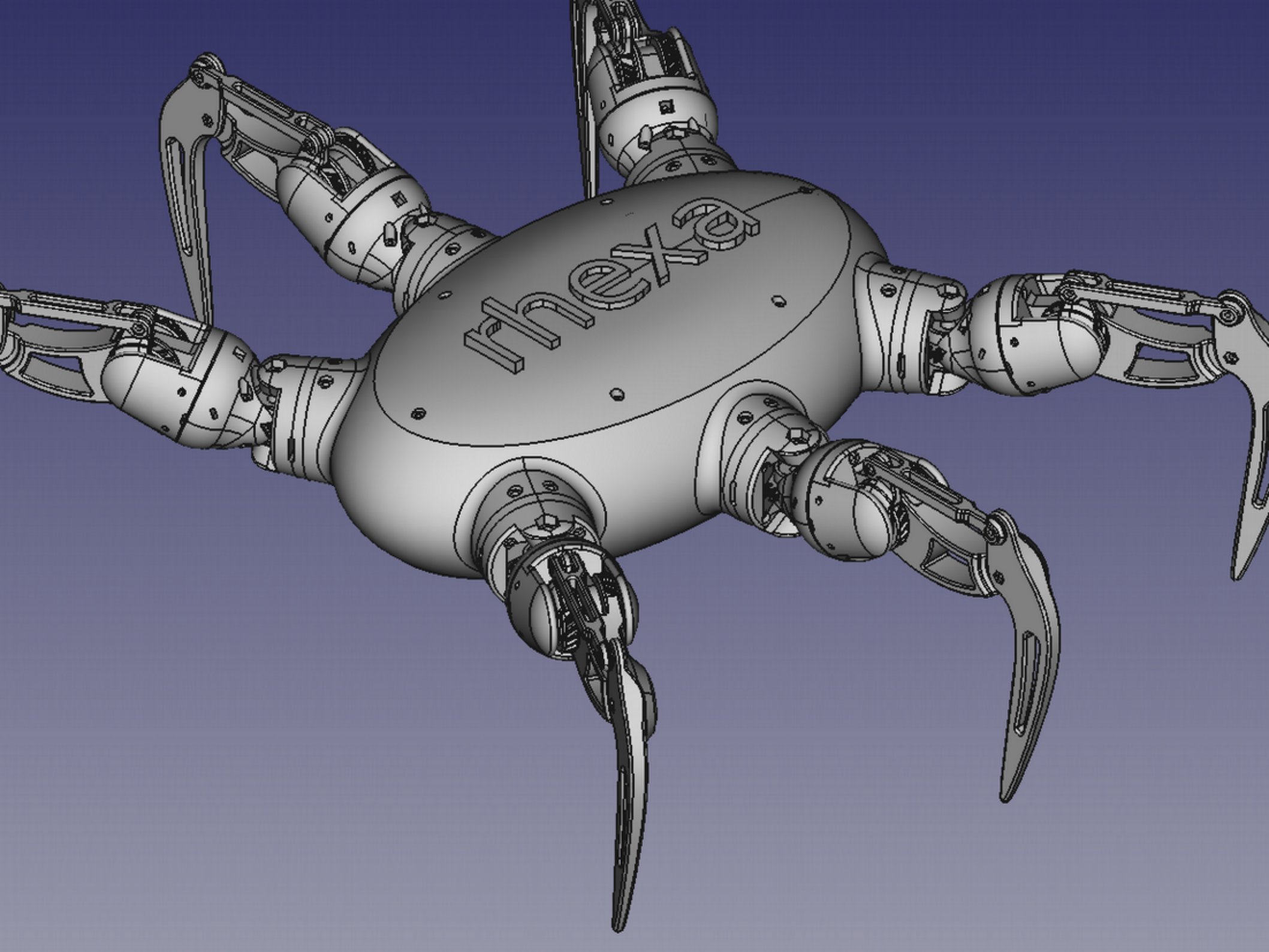
Open-source parametric 3D modeller

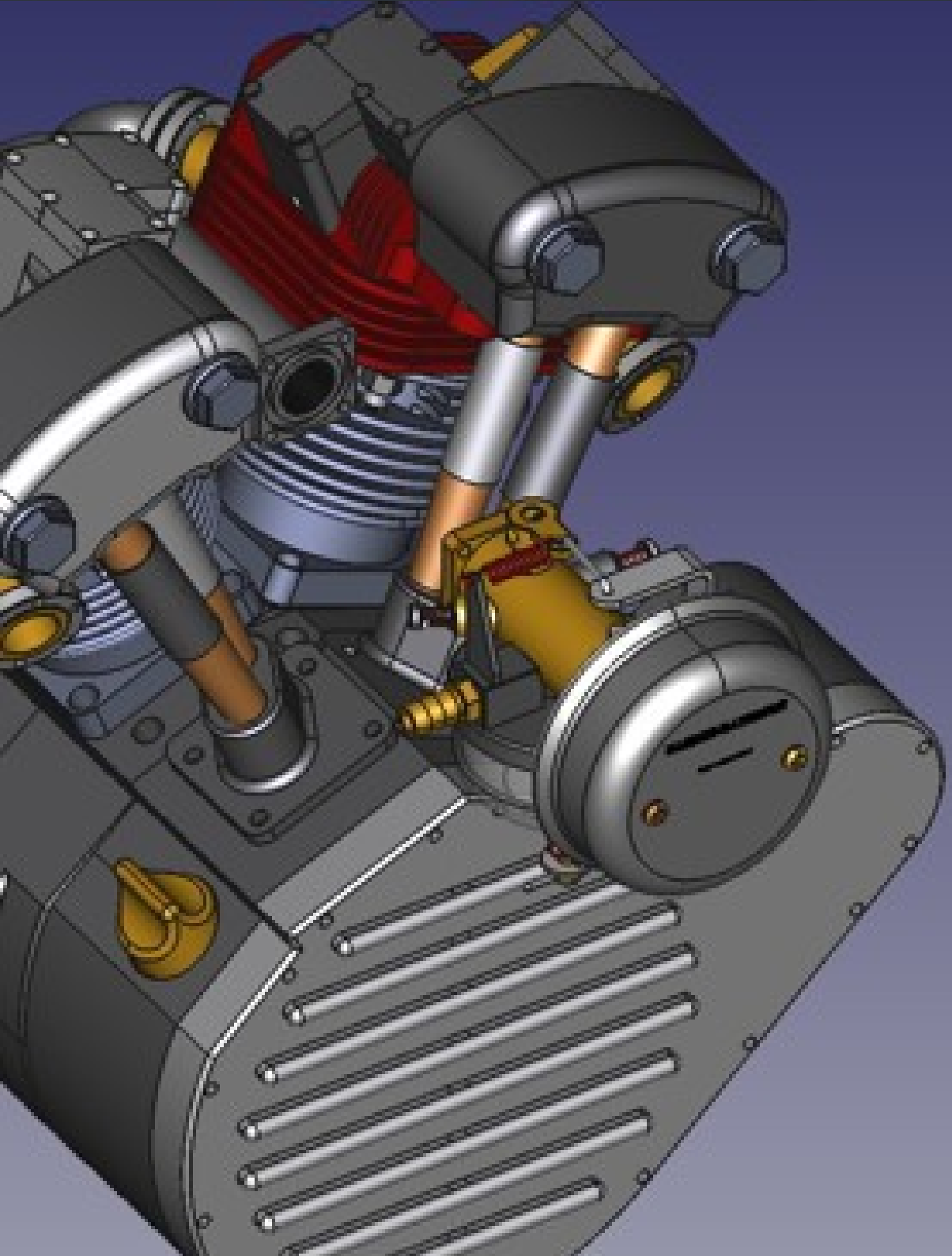
- Started in Germany in 2002
- Today probably the most well-known “technical” open-source 3D app
- Generic, many uses and specialties
- Parametric, objects are defined by their parameters
- http://freecadweb.org

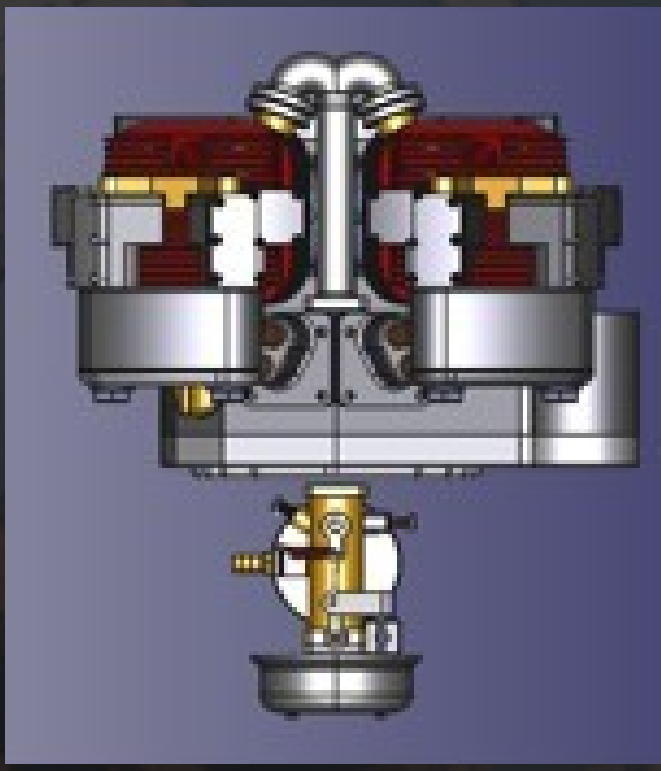


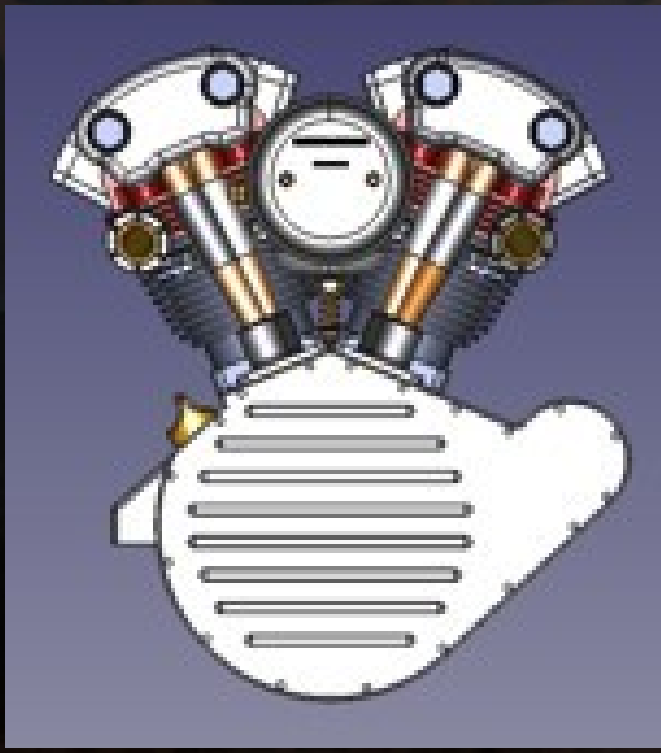





inexa

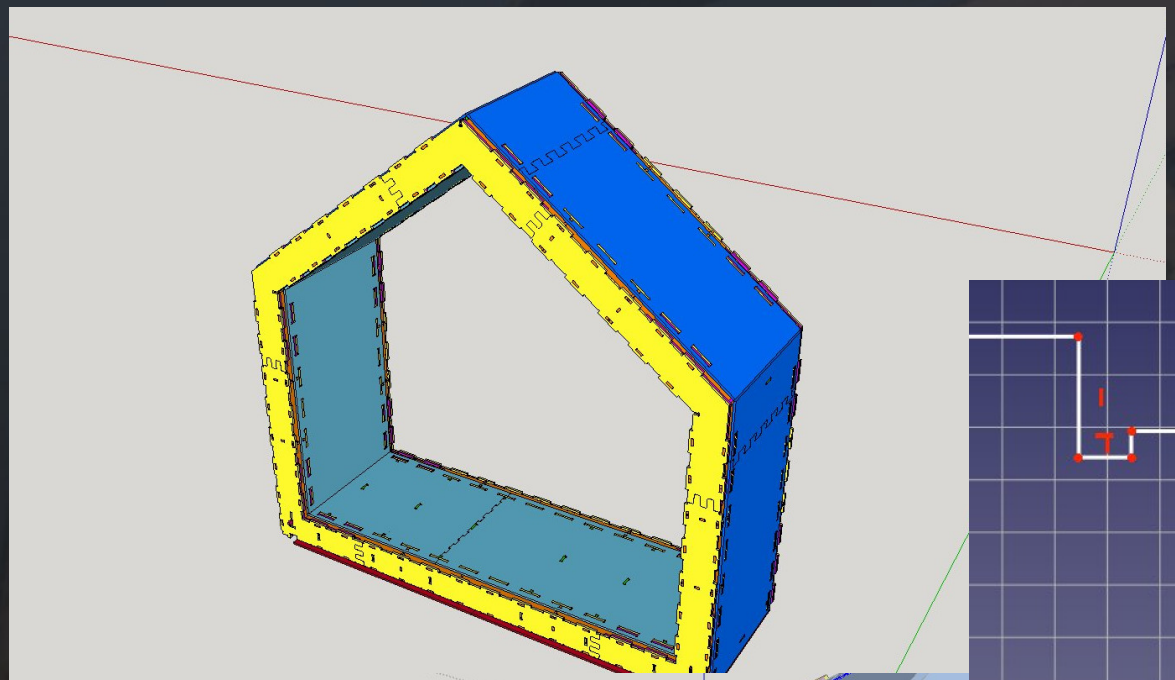


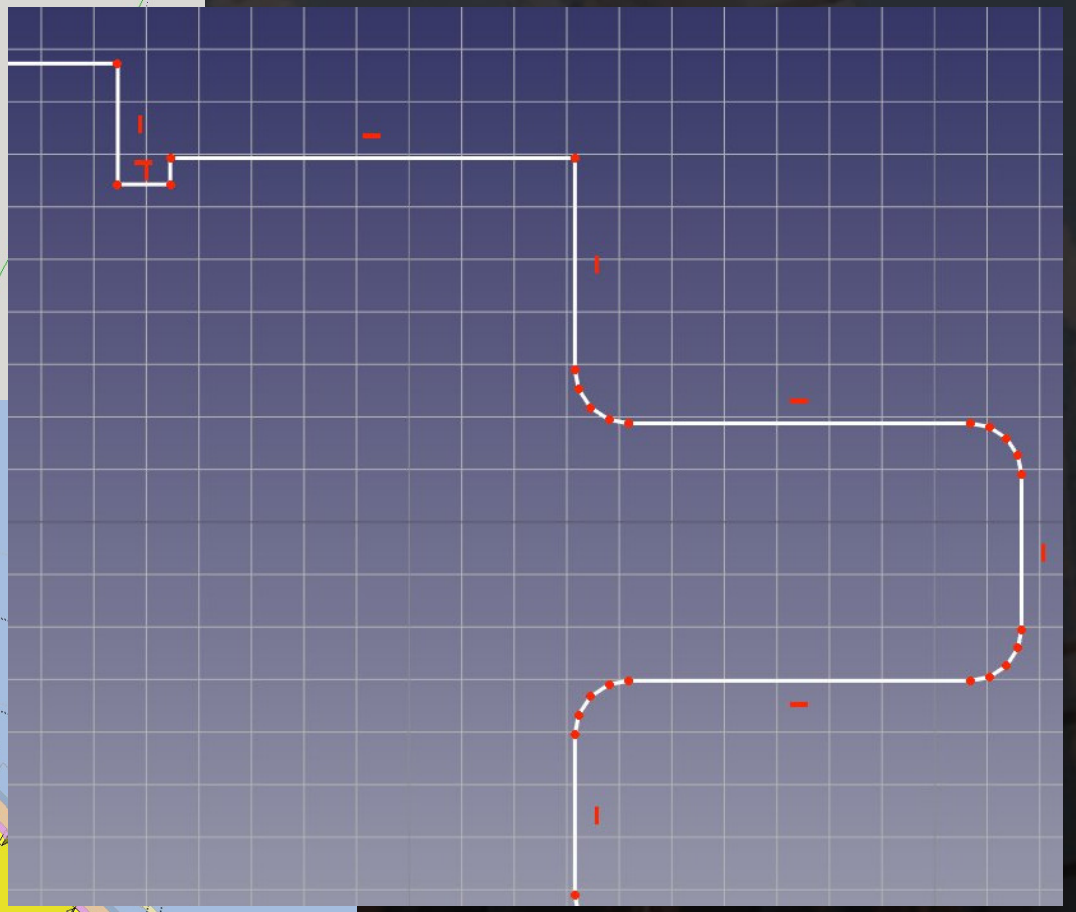


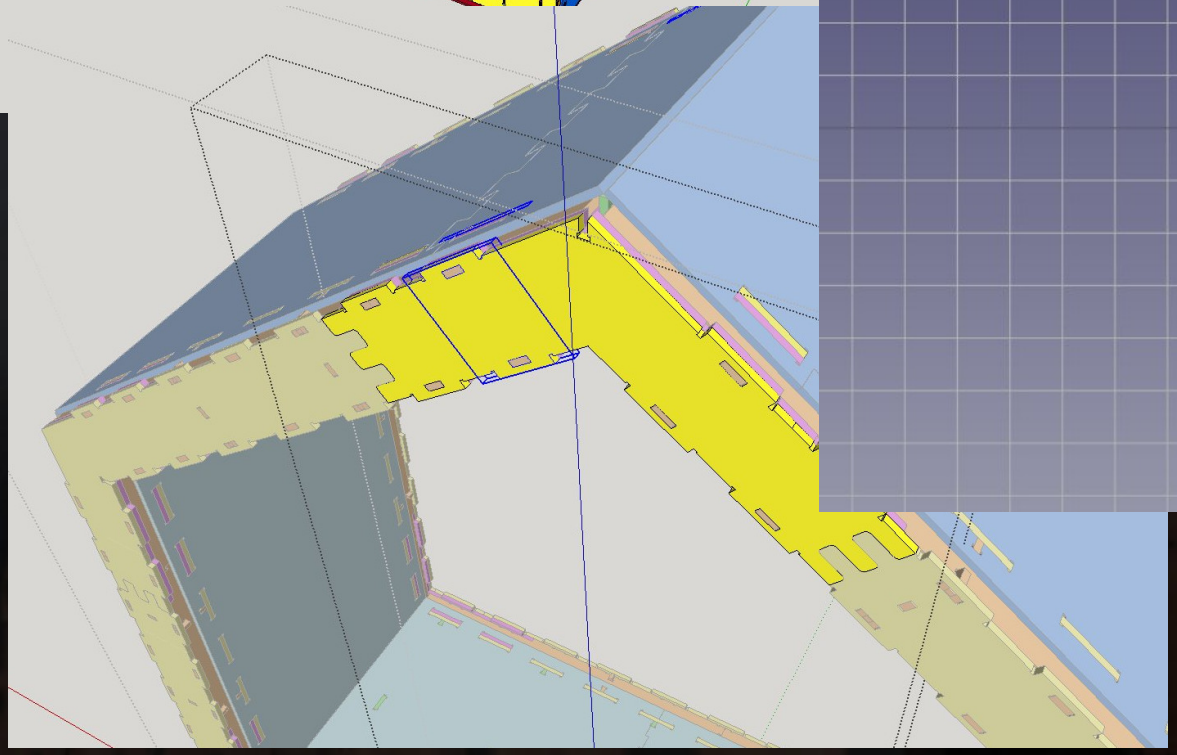


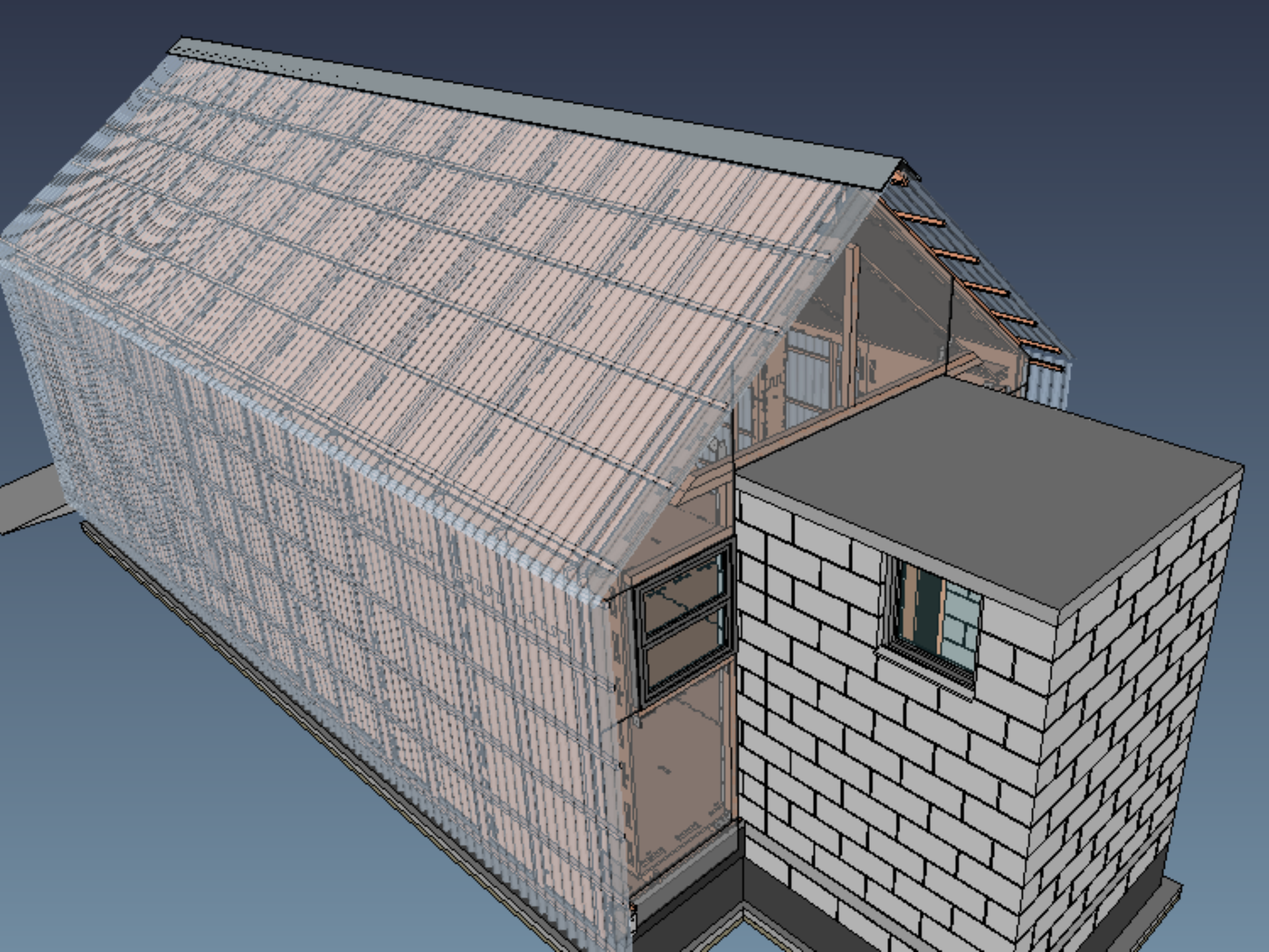
Sketchup → FreeCAD

- Mesh geometry → Brep geometry (NURBS-based)
- Step-by-step conversion to parametric model
- Integration with other elements (brickwork, piping, etc…)
- Precise quantities
- Production of all needed files (2D plans, spreadsheets, mesh models for rendering, CNC code, etc)









File Edit View Tools Macro Arch Draft Windows Help

Arch | Auto | 1px | 60.00 | None

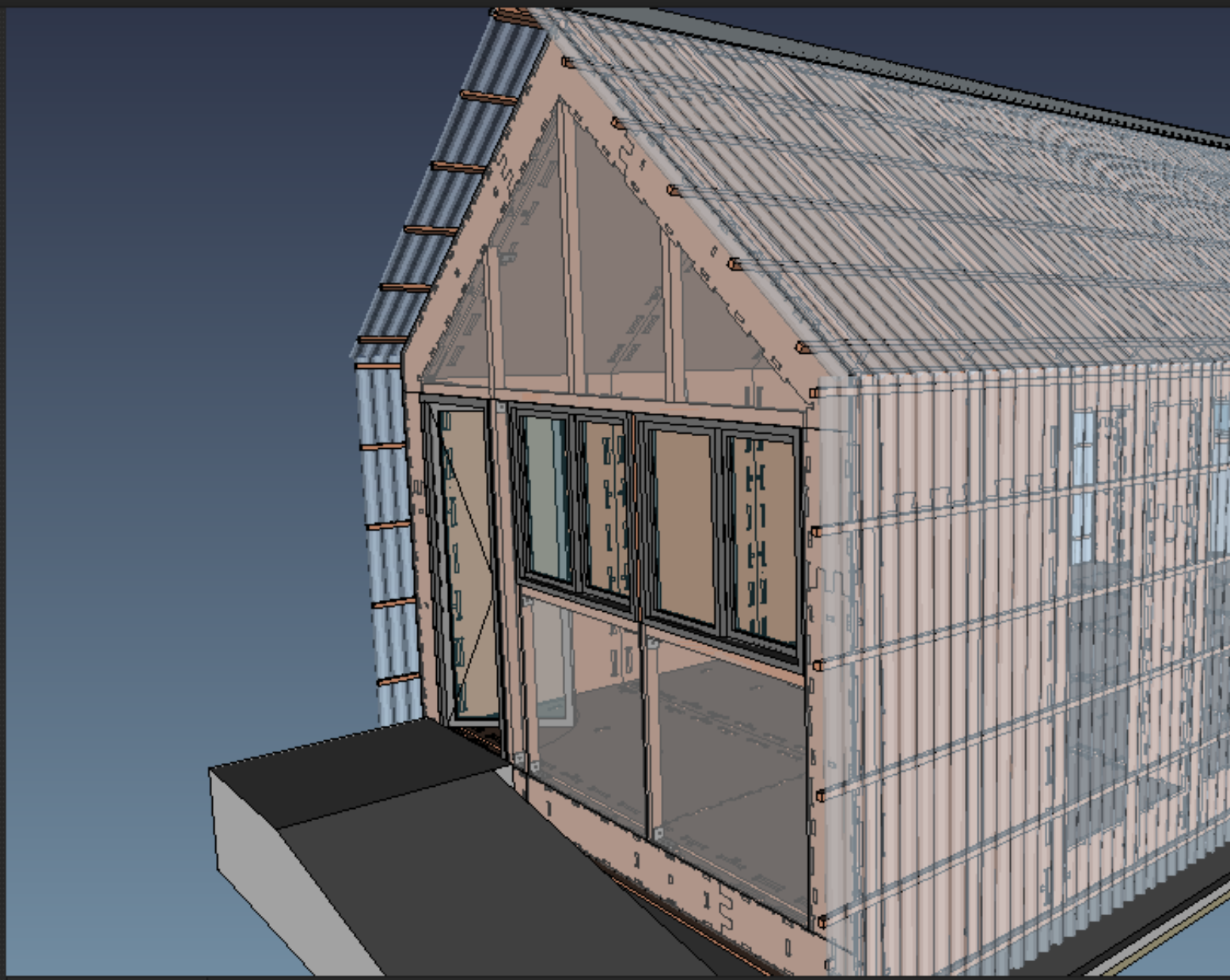
Combo View

Model Tasks

Labels & Attributes

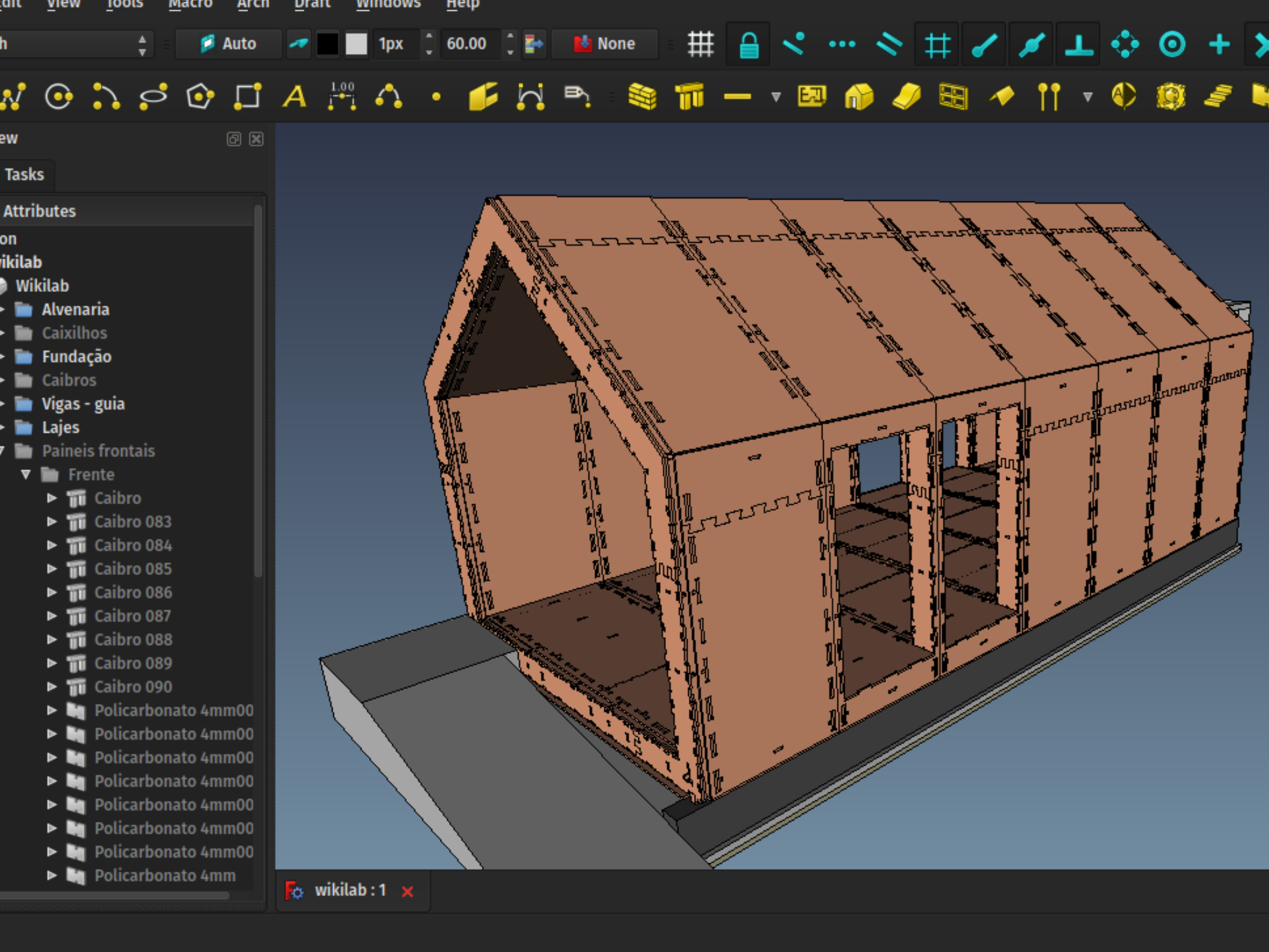
Application

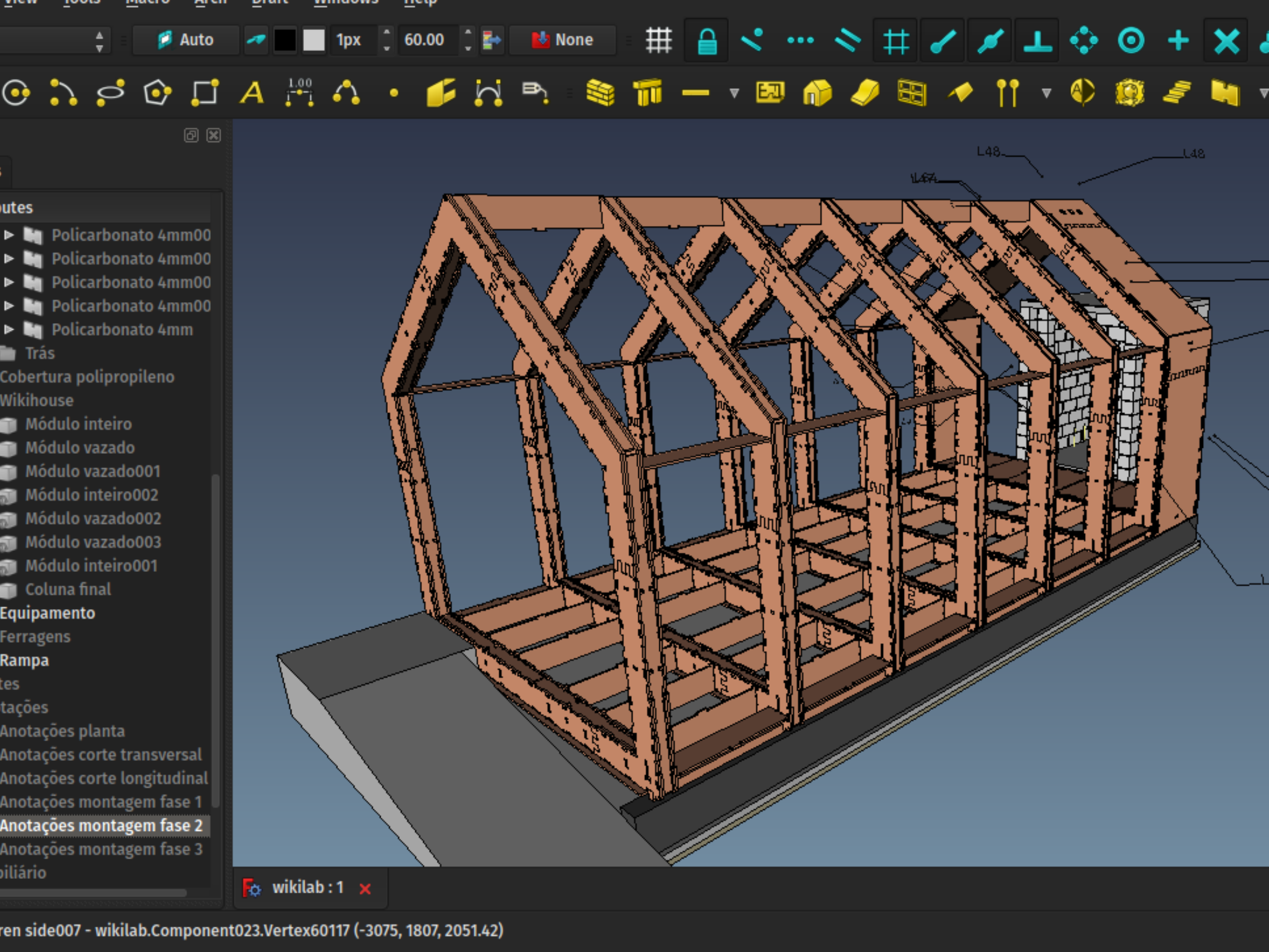
- wikilab
  - Wikilab
    - Alvenaria
    - Caixilhos
    - Fundação
    - Caibros
    - Vigas - guia
    - Lajes
    - Paineis frontais
    - Cobertura polipropileno
    - Wikihouse
      - Módulo inteiro
      - Módulo vazado
      - Módulo vazado001
      - Módulo inteiro002
      - Módulo vazado002
      - Módulo vazado003
      - Módulo inteiro001
      - Coluna final
    - Equipamento
    - Ferragens
    - Rampa
  - Cortes
  - Anotações
  - Mobiliário
  - Descartados
  - Materials

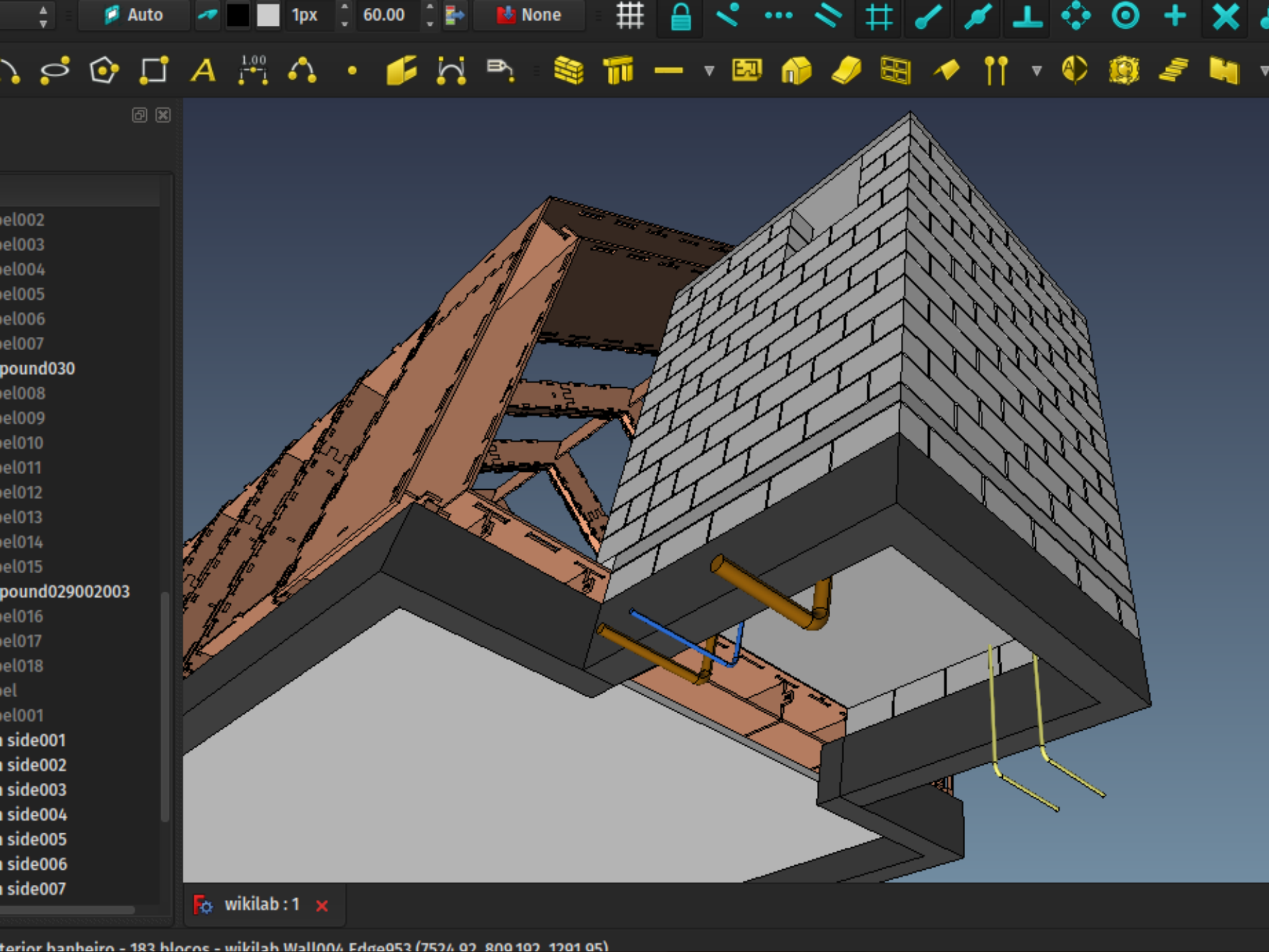


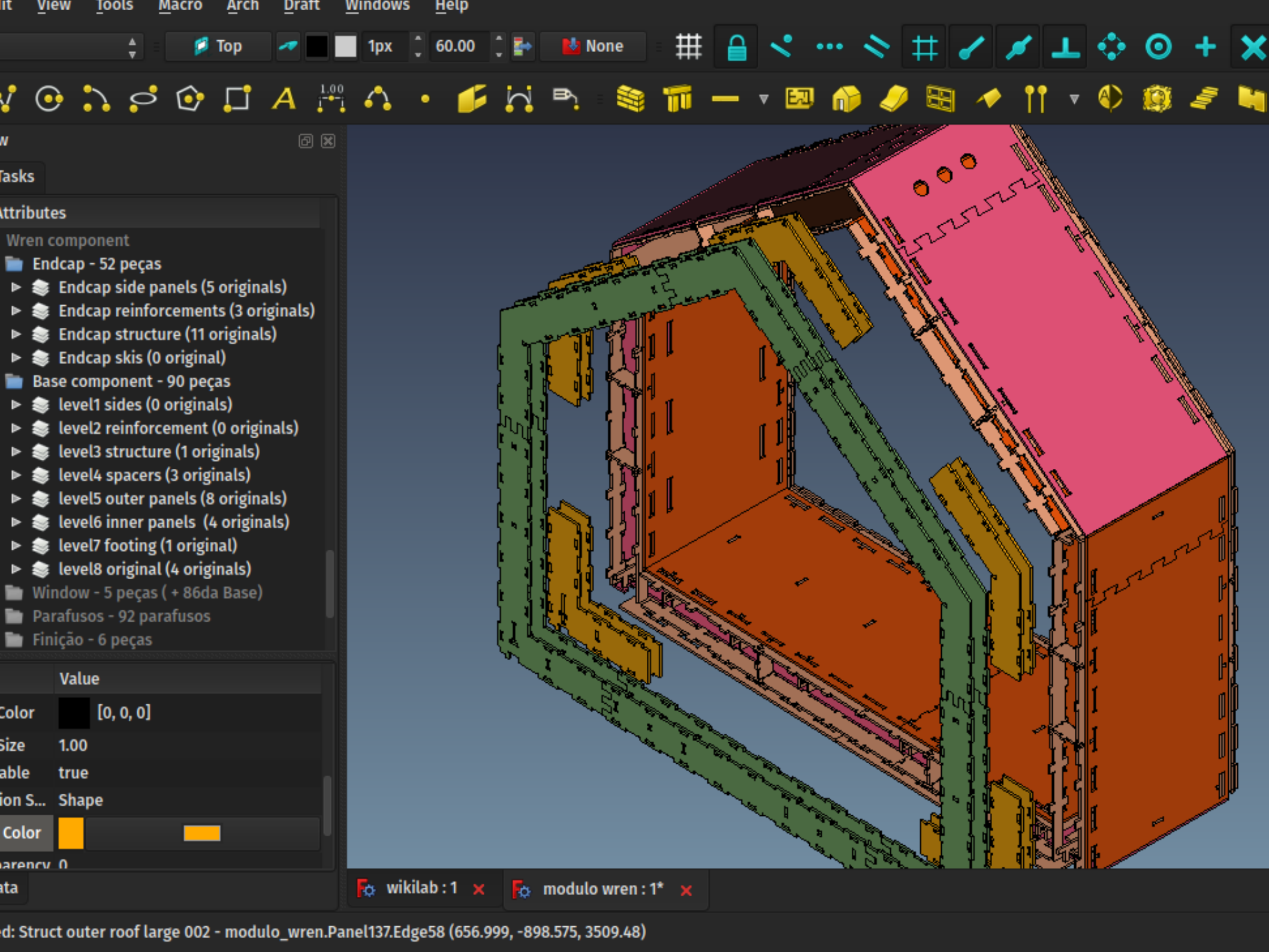
wikilab : 1

Valid, Internal name: Component001


Edit View Tools Macro Arch Draft Windows Help
Auto
1px
60.00
None
Tasks
Attributes
Wikilab
Alvenaria
Caixilhos
Fundação
Caibros
Vigas - guia
Lajes
Paineis frontais
Frente
Caibro
Caibro 083
Caibro 084
Caibro 085
Caibro 086
Caibro 087
Caibro 088
Caibro 089
Caibro 090
Policarbonato 4mm00
Policarbonato 4mm00
Policarbonato 4mm00
Policarbonato 4mm00
Policarbonato 4mm00
Policarbonato 4mm00
Policarbonato 4mm00
Policarbonato 4mm
wikilab : 1


View Tools Macro Arch Draft Windows Help
Auto
1px
60.00
None
utes
Policarbonato 4mm00
Policarbonato 4mm00
Policarbonato 4mm00
Policarbonato 4mm00
Policarbonato 4mm
Trás
Cobertura polipropileno
Wikihouse
Módulo inteiro
Módulo vazado
Módulo vazado001
Módulo inteiro002
Módulo vazado002
Módulo vazado003
Módulo inteiro001
Coluna final
Equipamento
Ferragens
Rampa
tes
tações
Anotações planta
Anotações corte transversal
Anotações corte longitudinal
Anotações montagem fase 1
Anotações montagem fase 2
Anotações montagem fase 3
biliário
L48
L48
wikilab : 1
ren side007 - wikilab.Component023.Vertex60117 (-3075, 1807, 2051.42)

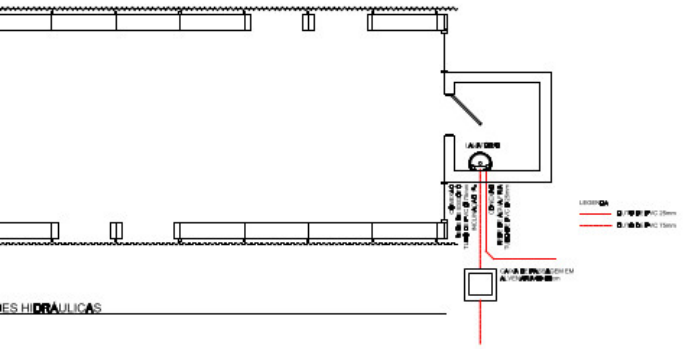

Auto
1px
60.00
None
wikilab : 1


View
Tools
Macro
Arch
Draft
Windows
Help
Top
1px
60.00
None
Tasks
Attributes
Wren component
Endcap - 52 peças
Endcap side panels (5 originals)
Endcap reinforcements (3 originals)
Endcap structure (11 originals)
Endcap skis (0 original)
Base component - 90 peças
level1 sides (0 originals)
level2 reinforcement (0 originals)
level3 structure (1 originals)
level4 spacers (3 originals)
level5 outer panels (8 originals)
level6 inner panels (4 originals)
level7 footing (1 original)
level8 original (4 originals)
Window - 5 peças (+ 86da Base)
Parafusos - 92 parafusos
Finição - 6 peças
Value
[0, 0, 0]
1.00
true
Shape
wikilab : 1
modulo wren : 1*
d: Struct outer roof large 002 - modulo_wren.Panel137.Edge58 (656.999, -898.575, 3509.48)

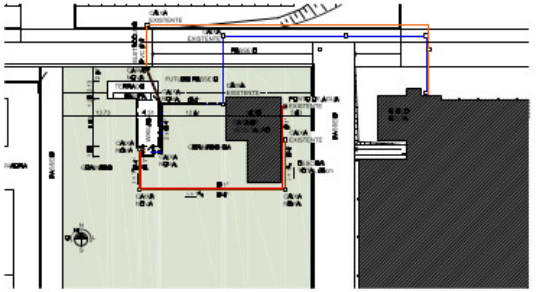
Producing:

- 2D plans
- Mesh models for rendering
- Spreadsheets for quantities / pricing
- CNC code

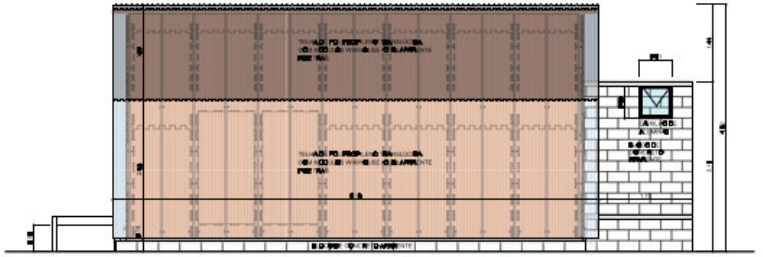
- ...And FreeCAD code!



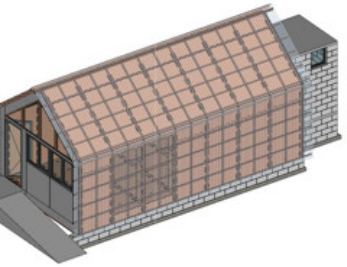
ES HIDRÁULICAS



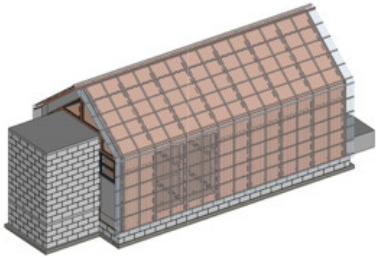
IMPLANTAÇÃO 1:500



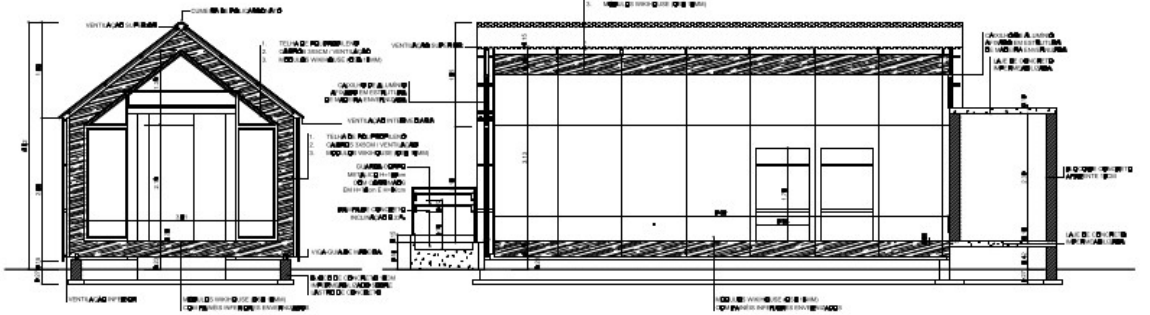
ELEVAÇÃO TIPO



IVA FRONTAL / NO

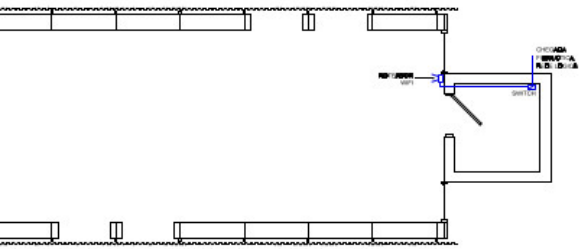


PERSPECTIVA TRASEIRA / SE

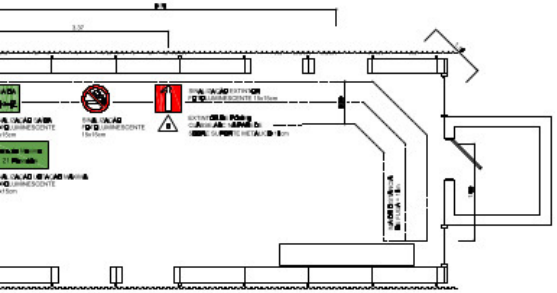


CORTE AA

CORTE BB



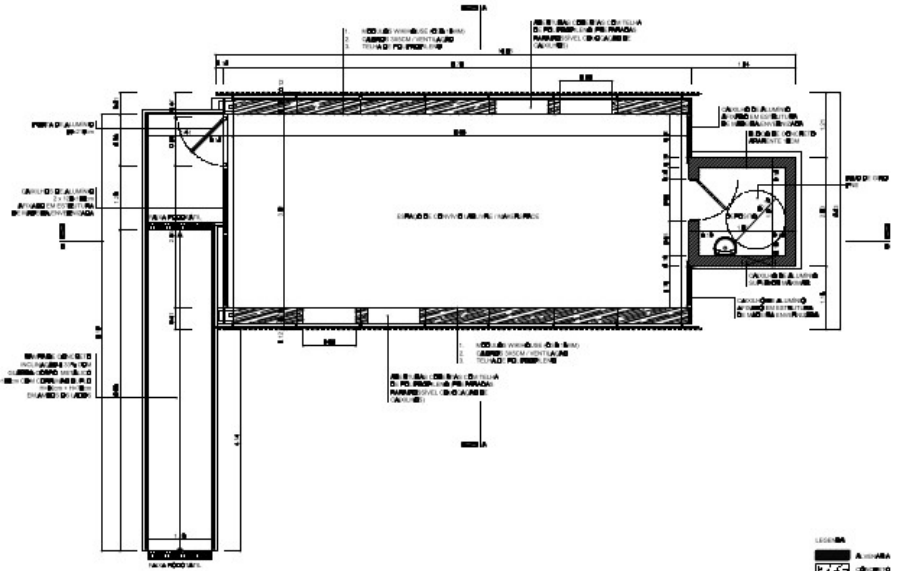
ES DE REDE LÓGICA



ES DE PROTEÇÃO CONTRA INCÊNDIO

ATENDIMENTO À NBR 9077 E INSTRUÇÕES TÉCNICAS DO CORPO DE BOMBEIROS DO ESTADO DE SÃO PAULO

ADEQUAÇÃO À INSTRUÇÃO TÉCNICA 42 (PROJETO TÉCNICO SIMPLIFICADO) DO CORPO DE BOMBEIROS DO ESTADO DE SÃO PAULO



PLANTA BAIXA

PROJETO EXECUTIVO
ESCALA 1:50

FOLHA ÚNICA
SETEMBRO 2017

WikiLab

LABLIVRE / UFABC CAMPUS SÃO BERNARDO

UNCREATED.NET ARQUITETOS
(11) 3214 0330 contato@uncreated.net

File Edit View Insert Format Sheet Data Tools Window Help

Liberation Sans 16

E2

Lablivre **Wikilab**

Orçamento definitivo

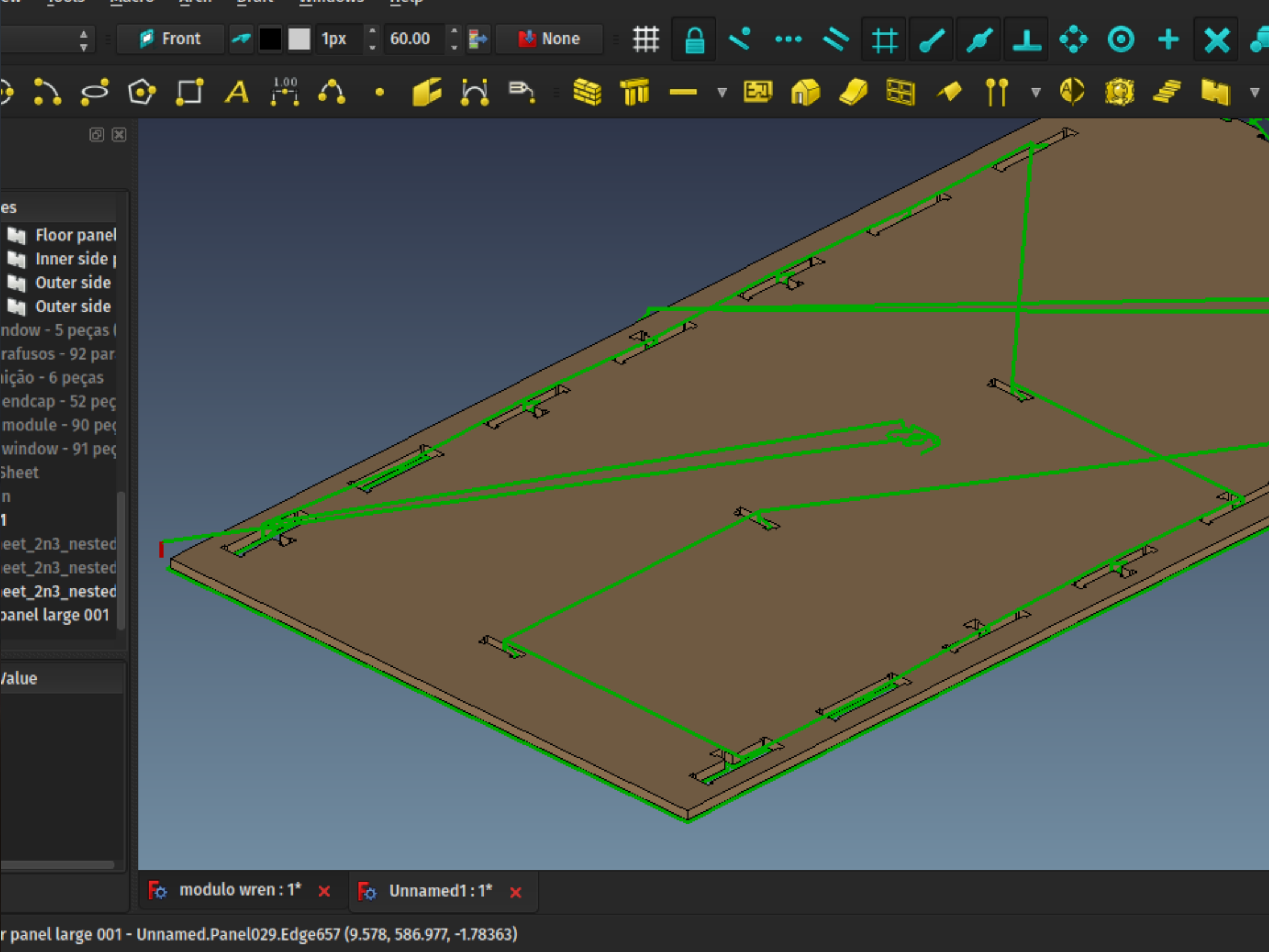
data: **31.01.2018** fonte PMSP: http://www.prefeitura.sp.gov.br/cidade/secretarias/obras/tabelas_de_cus

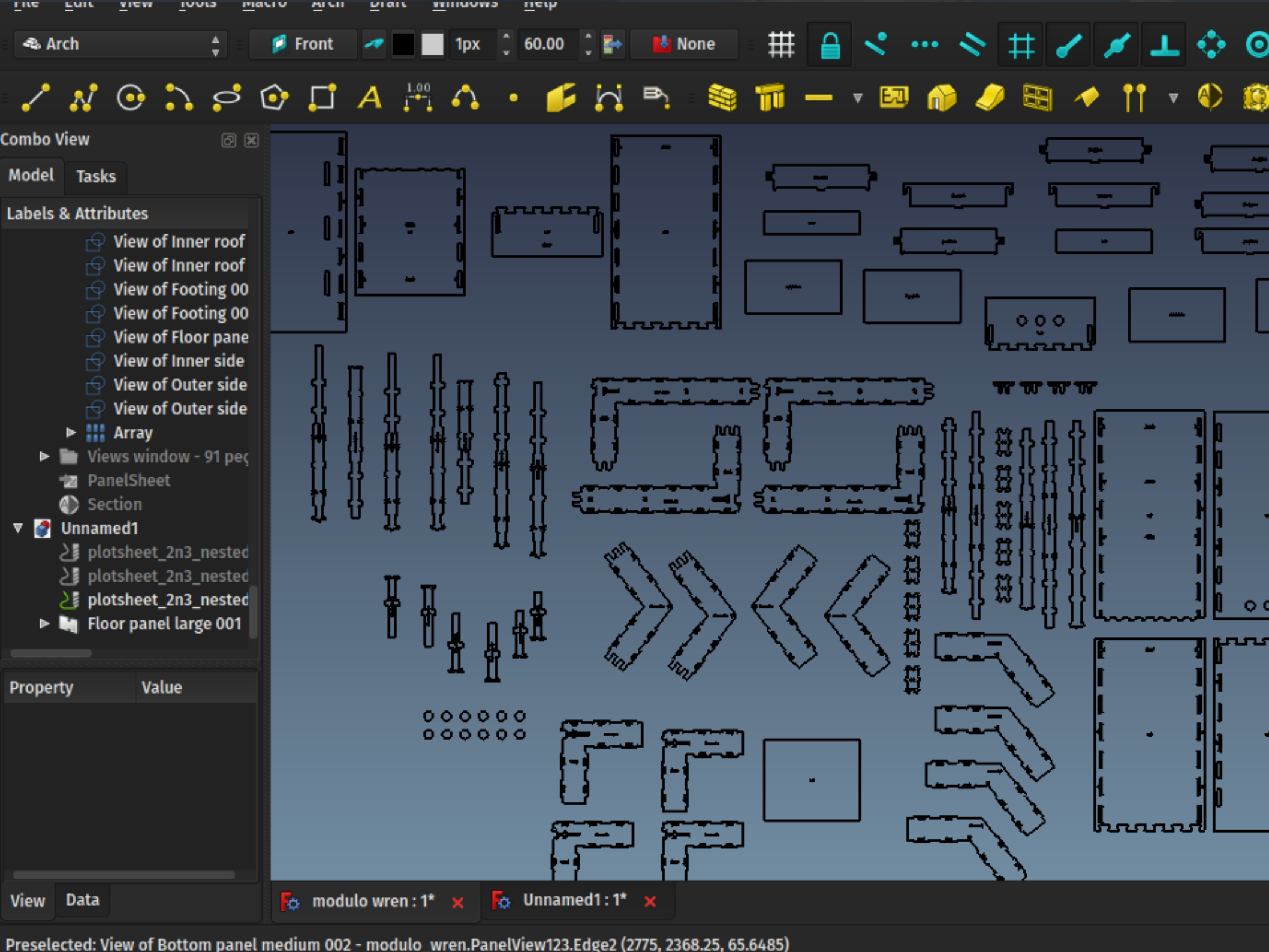
Escopo	Seção	Item	Descição	Quantidade	Unidade	Preço material	Preço mão de obra	Total material	Total mão de obra	Preço total
Empreiteira	1		**Fundação, alvenaria e estrutura**							
		1.1	Limpeza do terreno + remoção da camada vegetal em toda a área da construção (11m x 4.20m)	46.37	m²	R$ 0.00	R$ 4.15	R$ 0.00	R$ 192.43	R$ 192.43
		1.2	Escavação manual das valas de 30cm x 30cm	2.55	m³	R$ 0.00	R$ 49.81	R$ 0.00	R$ 127.22	R$ 127.22
		1.3	Lastro de concreto de 7cm no funda da vala	0.60	m³	R$ 173.62	R$ 140.24	R$ 103.36	R$ 83.49	R$ 186.86
		1.4	Lastro de concreto de 5cm no terreno todo	1.58	m³	R$ 173.62	R$ 140.24	R$ 273.52	R$ 220.94	R$ 494.46
		1.5	Sapata corrida em alvenaria de bloco de concreto estrutural de 19cm (duas fileiras, fileira de cima em bloco canaleta)	10.28	m²	R$ 52.69	R$ 29.53	R$ 541.65	R$ 303.57	R$ 845.22
		1.6	Grauteamento dos blocos	0.98	m³	R$ 219.27	R$ 400.41	R$ 214.14	R$ 391.04	R$ 605.18
		1.7	Ferragem de reforço em alvenaria: 2 barras bitola 5mm CA-50 (total 65m)	11.07	kg	R$ 3.37	R$ 3.09	R$ 37.30	R$ 34.19	R$ 71.48
		1.8	Impermeabilização da sapata com cimentagem e pintura betuminosa (topo da sapata)	10.28	m²	R$ 28.19	R$ 35.81	R$ 289.79	R$ 368.13	R$ 657.92
		1.9	Lona de polietileno 4x3m de baixo da laje	1.00	un	R$ 16.00	R$ 0.00	R$ 16.00	R$ 0.00	R$ 16.00
		1.10	Forma para lajes de concreto em tábuas de madeira	7.33	m²	R$ 8.54	R$ 44.52	R$ 62.60	R$ 326.33	R$ 388.93
		1.11	Concreto estrutural 20Mpa em duas lajes de 2m x 2m x 9cm	0.79	m³	R$ 260.60	R$ 121.96	R$ 206.86	R$ 96.81	R$ 303.68
		1.12	Ferragens – malha 20x20 bitola 4.2mm – 2 peças de 2m x 2m	5.62	kg	R$ 4.34	R$ 1.55	R$ 24.39	R$ 8.71	R$ 33.10
		1.13	Impermeabilização de laje	4.45	m²	R$ 28.19	R$ 35.81	R$ 125.45	R$ 159.35	R$ 284.80
		1.14	Alvenaria de bloco de concreto de 19cm aparente (12 fileiras, fileira superior em bloco canaleta)	26.00	m²	R$ 52.69	R$ 29.53	R$ 1,370.11	R$ 767.87	R$ 2,137.98

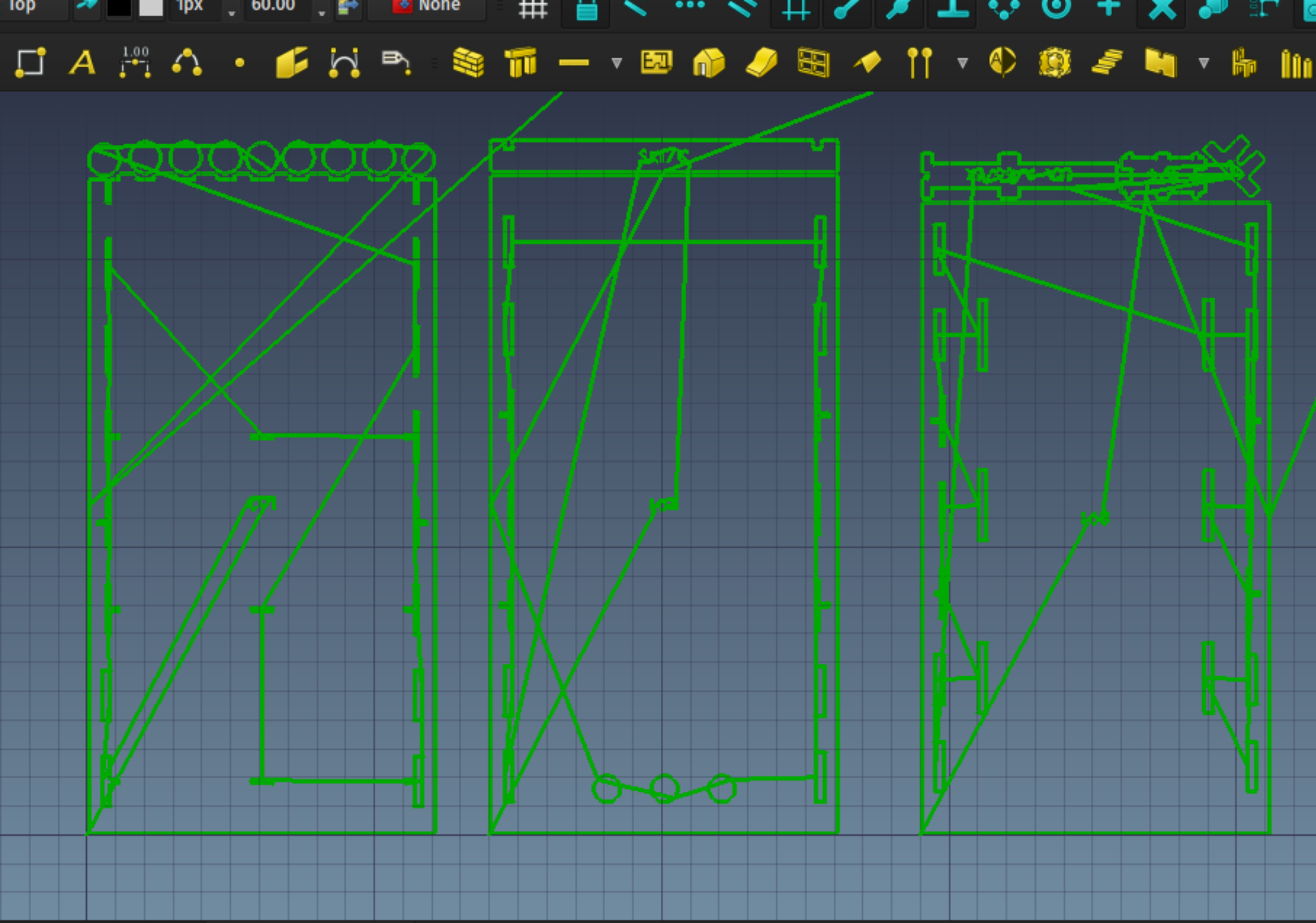
orçamento

Find Find All Formatted Display Match Case

Sheet 1 of 1 Default


Front
1px
60.00
None
Floor panel
Inner side
Outer side
Outer side
ndow - 5 peças
rafusos - 92 par
ição - 6 peças
endcap - 52 peç
module - 90 peç
window - 91 peç
Sheet
eet_2n3_nested
eet_2n3_nested
eet_2n3_nested
panel large 001
Value
modulo wren : 1*
Unnamed1 : 1*
r panel large 001 - Unnamed.Panel029.Edge657 (9.578, 586.977, -1.78363)


File Edit View Tools Macro Arch Draft Windows Help
Arch
Front
1px
60.00
None
Combo View
Model
Tasks
Labels & Attributes
View of Inner roof
View of Inner roof
View of Footing 00
View of Footing 00
View of Floor pane
View of Inner side
View of Outer side
View of Outer side
Array
Views window - 91 pe
PanelSheet
Section
Unnamed1
plotsheet_2n3_nested
plotsheet_2n3_nested
plotsheet_2n3_nested
Floor panel large 001
Property
Value
View
Data
modulo wren : 1*
Unnamed1 : 1*
Preselected: View of Bottom panel medium 002 - modulo_wren.PanelView123.Edge2 (2775, 2368.25, 65.6485)



modulo wren : 1*

Unnamed1 : 1*

Edit View Tools Macro Arch Draft Windows Help

ch Auto 1px 60.00 None

iew

Tasks

& Attributes

- Wire082
- Wire083
- Wire073
- Wire072
- Wire086
- Wire074
- Wire085
- Wire070
- Job
- Default Tool
- Operations
  - Contour
  - Profile_Edges
  - Profile_Edges001
- Base-Part
- Stock
- SetupSheet

ty Value

Data

Unnamed2 : 1*

cted: Panel - Unnamed1.Panel.Edge279 (267.163, -440.749, 285.999)

File Edit View Tools Macro Arch Draft Windows Help

Arch | Auto | 1px | 60.00 | None

Combo View

Model Tasks

Cancel OK

Nesting

Container

Pick selected

Shapes

Add selected Remove

Nesting parameters

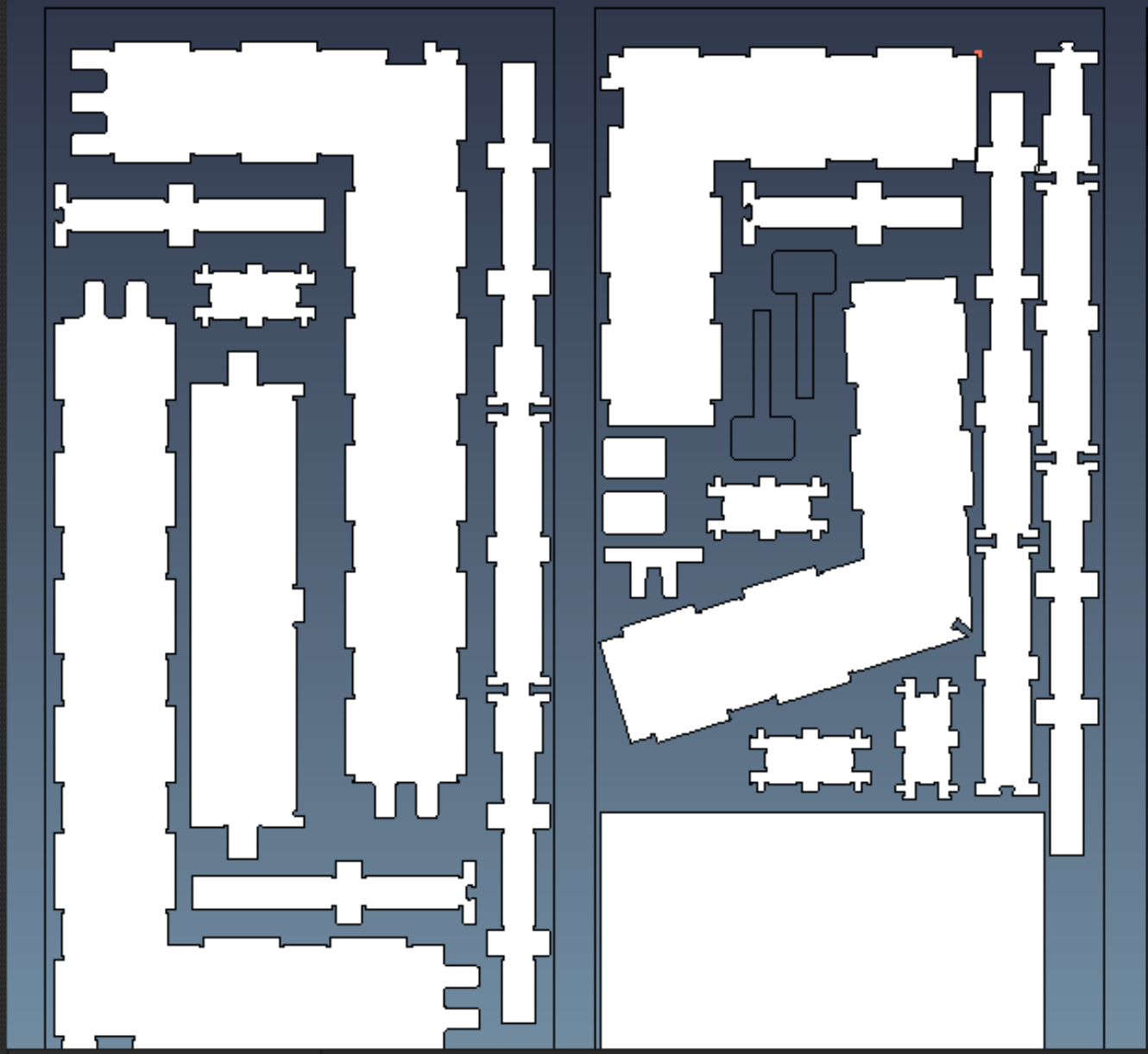
Tolerance 0.00010000

Arcs subdivisions 4

Rotations 0,90,180,270

Nesting operation

Start Stop Preview



teste cut sheet : 1*

Preselected: OUTLINES - teste_cut_sheet.OUTLINES.Vertex947 (-1.29663e+06, 1.39085e+06, 0)

File Edit View Tools Macro Path Windows Help

Path

Combo View

Model Tasks

Cancel OK

Job Edit

General Output Setup Tools Workplan

Stock

Extend Model's Bound Box

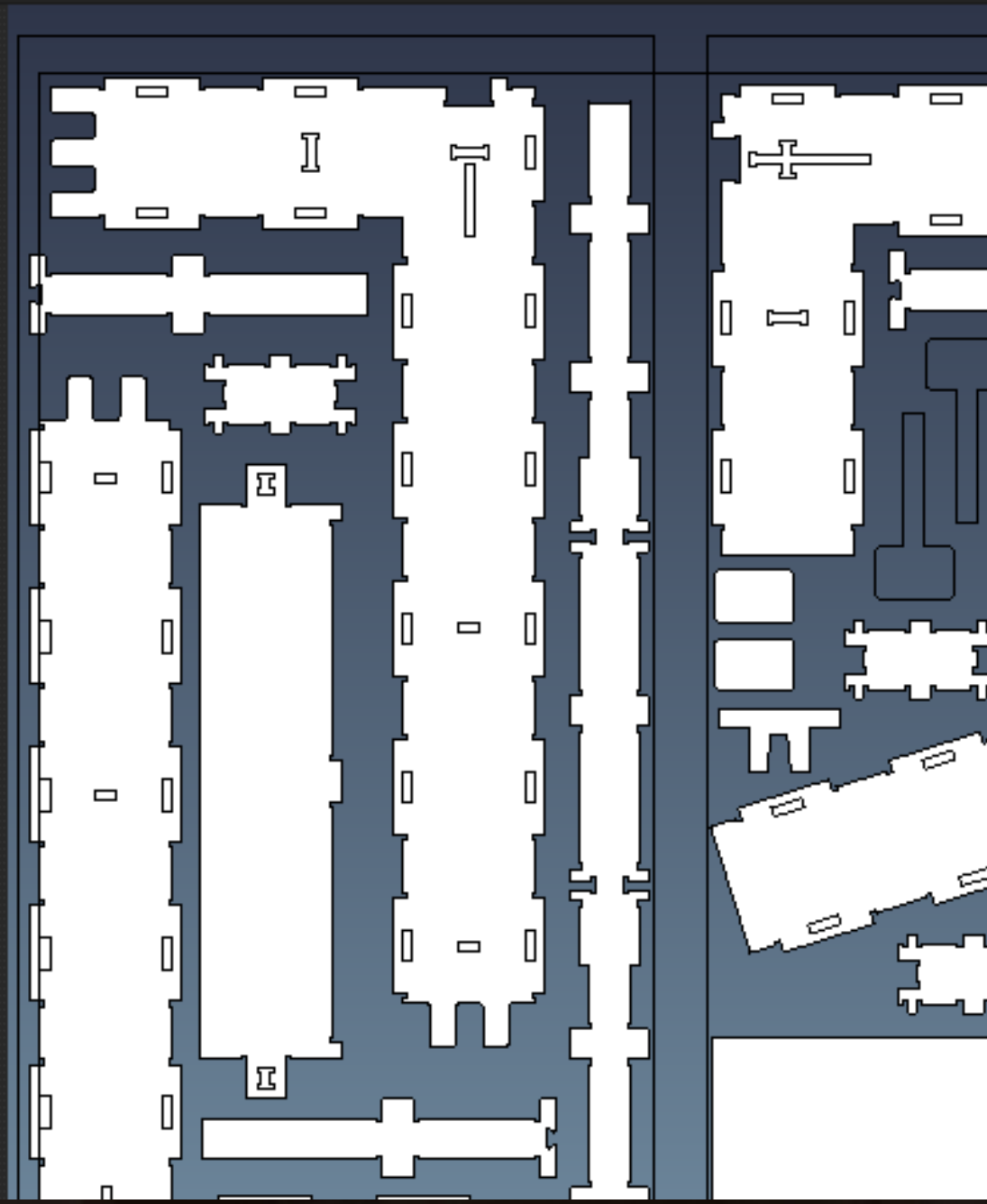
Ext. X	0.10 cm	0.10 cm
Ext. Y	0.10 cm	0.10 cm
Ext. Z	0.10 cm	0.10 cm

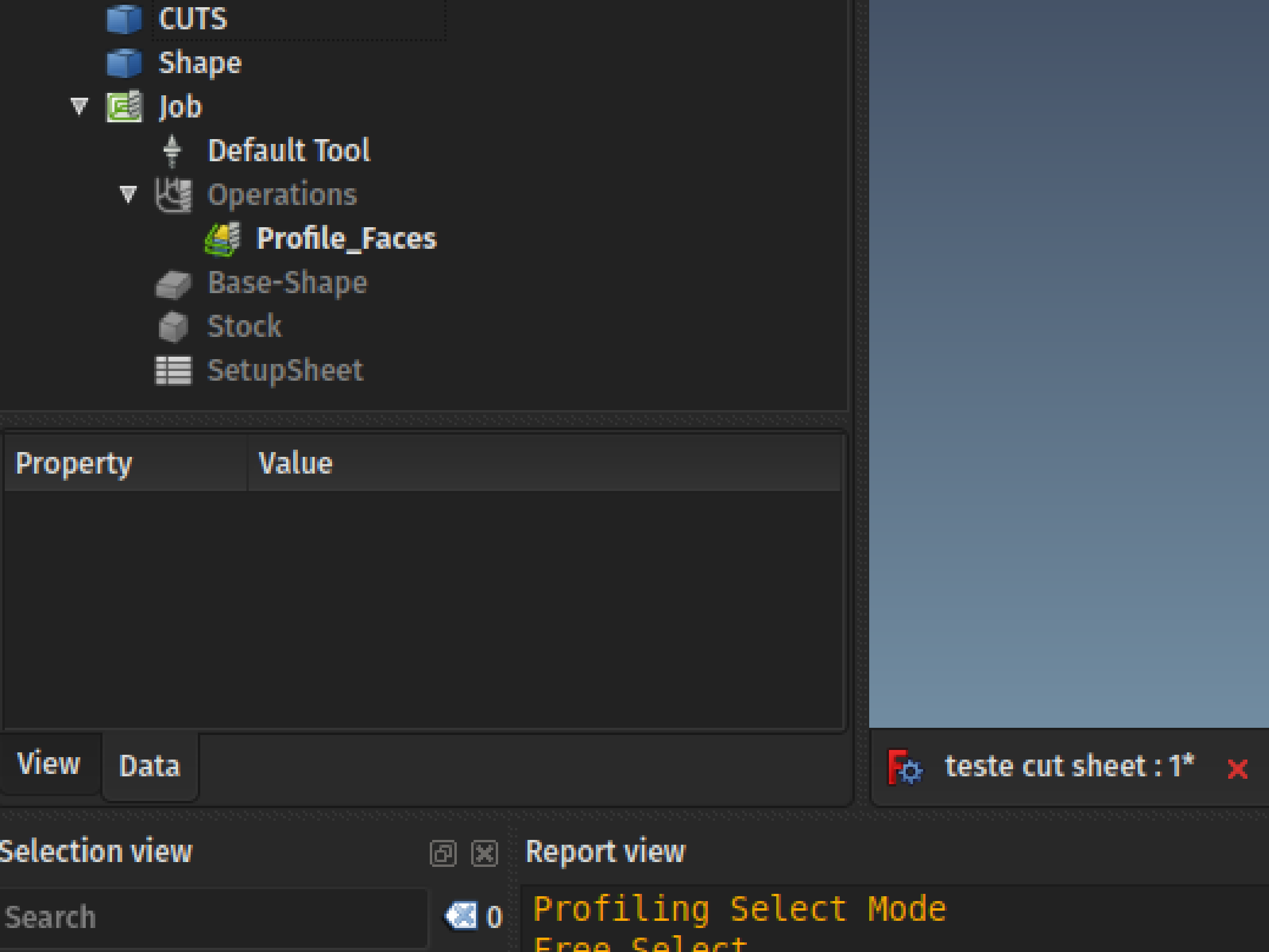
Orientation

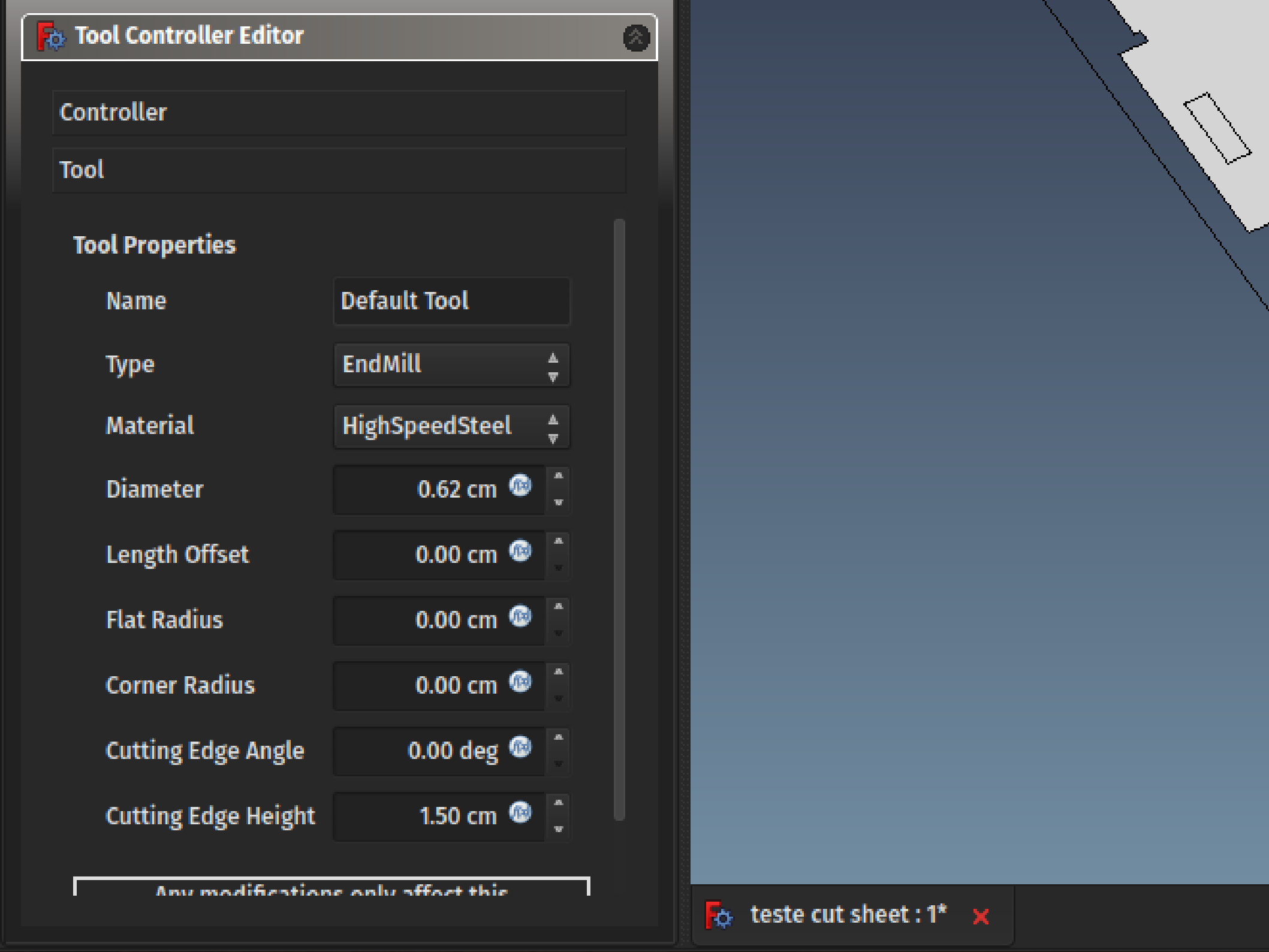
X-Axis Y-Axis Z-Axis

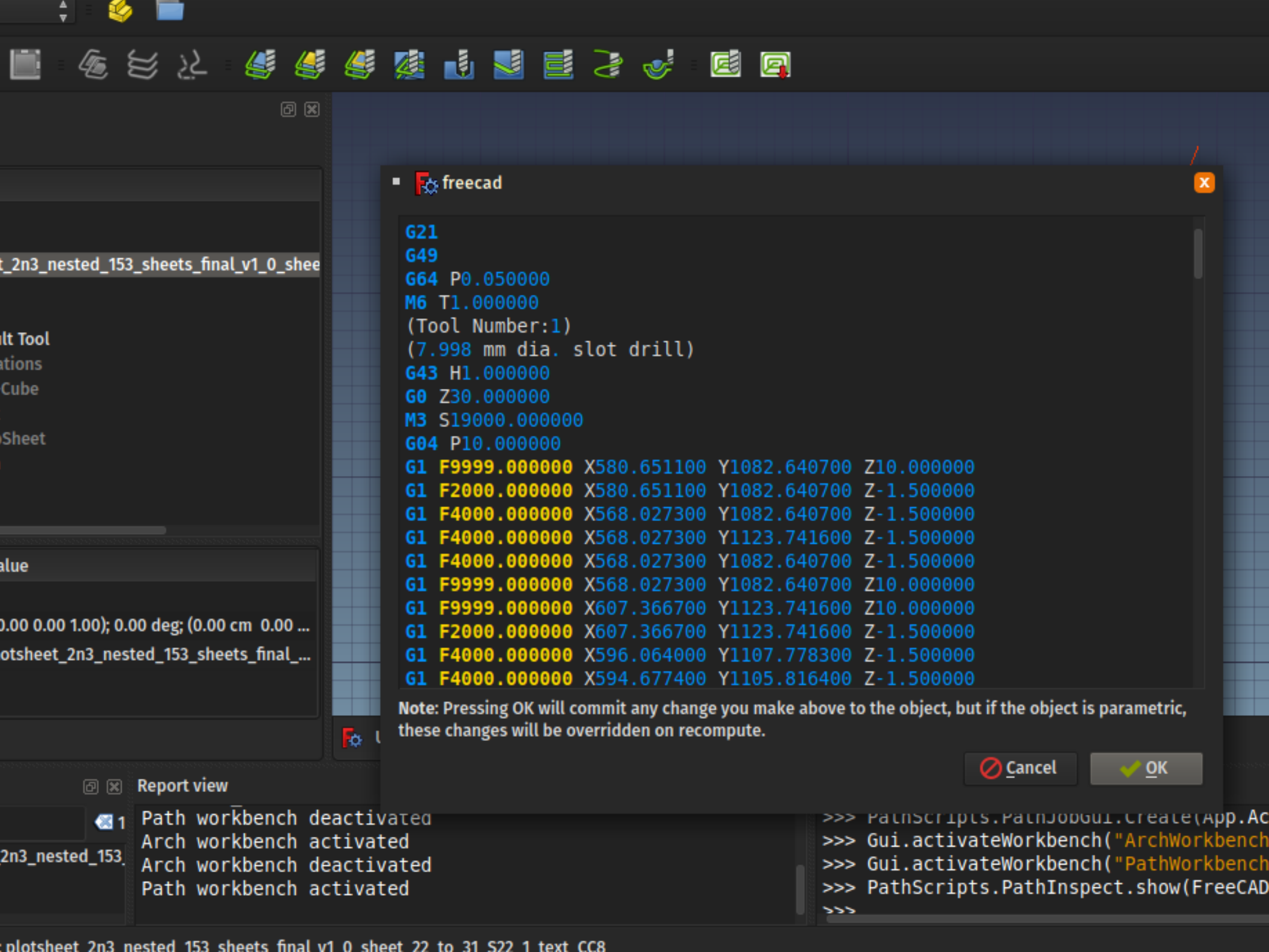
Alignment

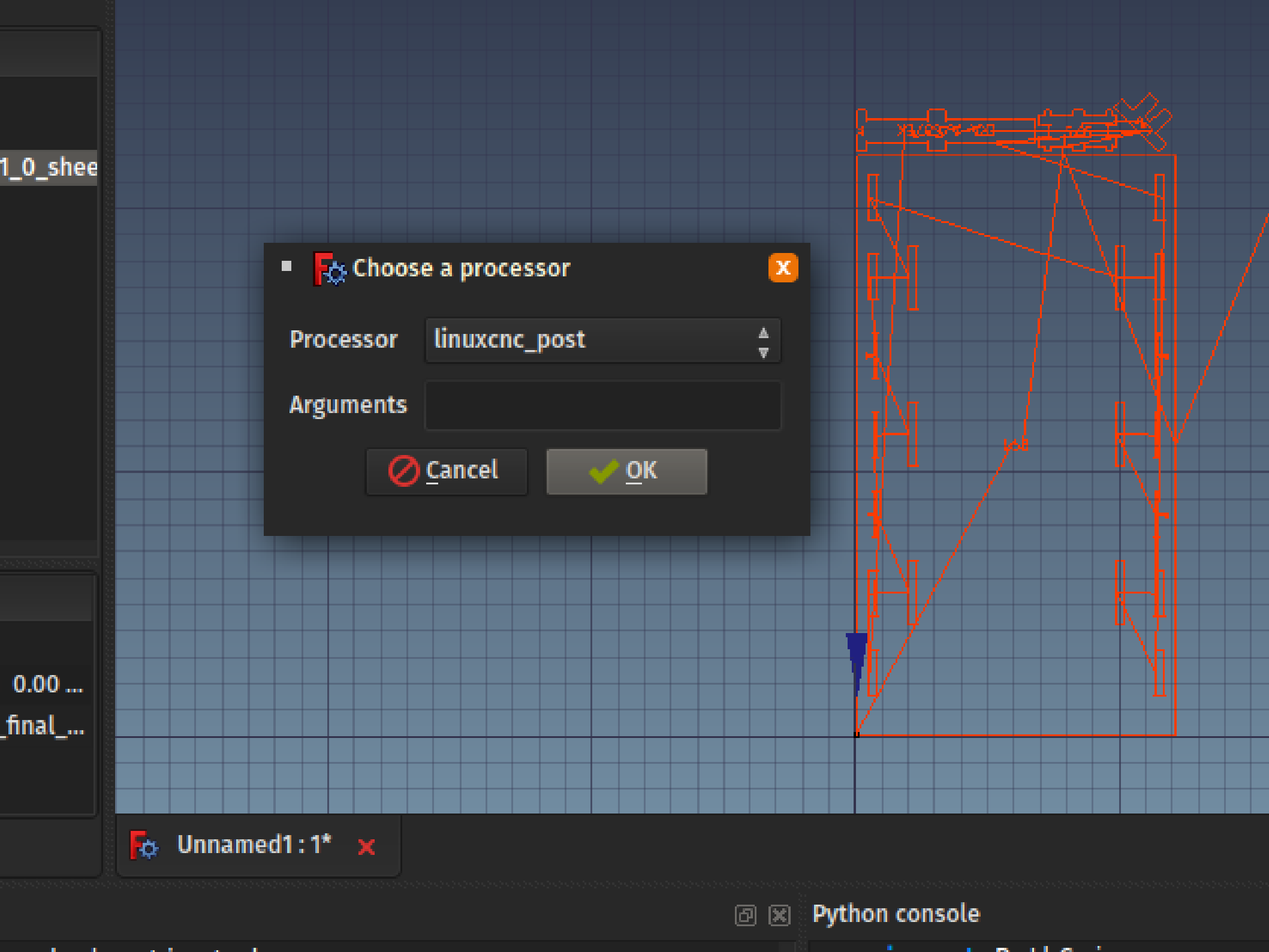
Set Origin Move to Origin

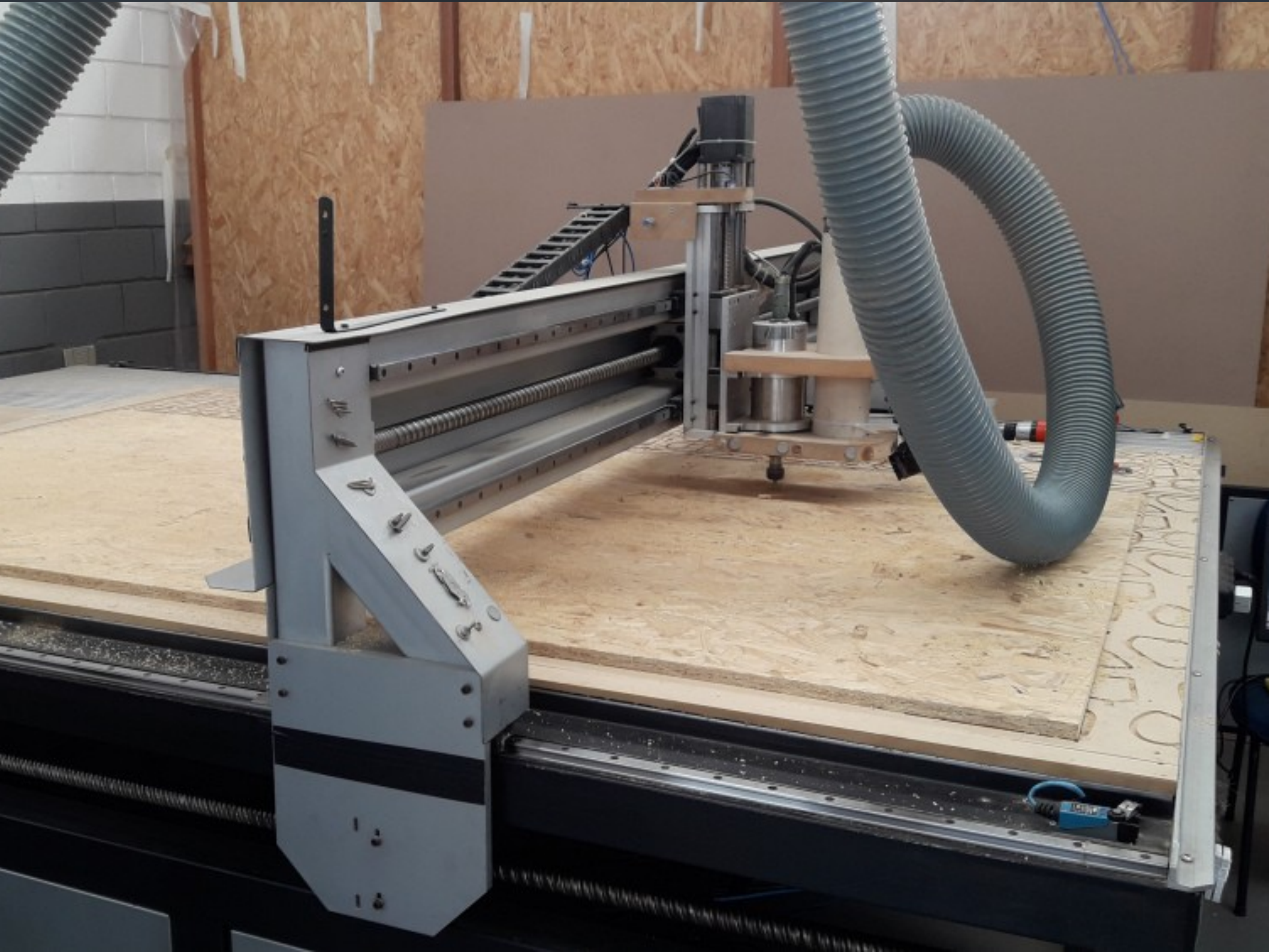



CUTS
Shape
Job
Default Tool
Operations
Profile_Faces
Base-Shape
Stock
SetupSheet
Property
Value
View
Data
teste cut sheet : 1*
Selection view
Search
0
Report view
Profiling Select Mode
Free Select


Tool Controller Editor
Controller
Tool
Tool Properties
Name
Default Tool
Type
EndMill
Material
HighSpeedSteel
Diameter
0.62 cm
Length Offset
0.00 cm
Flat Radius
0.00 cm
Corner Radius
0.00 cm
Cutting Edge Angle
0.00 deg
Cutting Edge Height
1.50 cm
teste cut sheet : 1*


freecad
G21
G49
G64 P0.050000
M6 T1.000000
(Tool Number:1)
(7.998 mm dia. slot drill)
G43 H1.000000
G0 Z30.000000
M3 S19000.000000
G04 P10.000000
G1 F9999.000000 X580.651100 Y1082.640700 Z10.000000
G1 F2000.000000 X580.651100 Y1082.640700 Z-1.500000
G1 F4000.000000 X568.027300 Y1082.640700 Z-1.500000
G1 F4000.000000 X568.027300 Y1123.741600 Z-1.500000
G1 F4000.000000 X568.027300 Y1082.640700 Z-1.500000
G1 F9999.000000 X568.027300 Y1082.640700 Z10.000000
G1 F9999.000000 X607.366700 Y1123.741600 Z10.000000
G1 F2000.000000 X607.366700 Y1123.741600 Z-1.500000
G1 F4000.000000 X596.064000 Y1107.778300 Z-1.500000
G1 F4000.000000 X594.677400 Y1105.816400 Z-1.500000
Note: Pressing OK will commit any change you make above to the object, but if the object is parametric, these changes will be overridden on recompute.
Cancel
OK
Report view
Path workbench deactivated
Arch workbench activated
Arch workbench deactivated
Path workbench activated
>>> Gui.activateWorkbench("ArchWorkbench
>>> Gui.activateWorkbench("PathWorkbench
>>> PathScripts.PathInspect.show(FreeCAD


Choose a processor
Processor
linuxcnc_post
Arguments
Cancel
OK
Unnamed1 : 1*
Python console



What I learned:

- Fabricating is EASY
- Cost control is very precise
- Lots of optimizations possible
- A big part of the production chain is under control
- Lots more to do: integrate electrical appliances, make doors and windows, cut plastic pieces too, etc
- Give less to professioanl builders and more to the community. Building houses is FUN
- Experimentation, hacking, actual building and fun are back into architecture

Thanks for watching!

FreeCAD

http://www.freecadweb.org
http://forum.freecadweb.org
Facebook, Google+,etc...

Yorik van Havre

http://yorik.uncreated.net
yorik@uncreated.net
@yorikvanhavre