Aalto University
School of Engineering

Topology Optimization for AM

MEC-EV - FITech Summer Boost: Additive Manufacturing and 3D printing29.5.2019
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Learning outcomes – For this session

Understand:

Different Design approaches

Topology optimization

Design approach

- **Multiscale structure design**
- **Multi-material design**
- **Design for mass customization**
- **Parts consolidation**
- **Topology optimization**

Multiscale structure design

Example: cellular structures or lattice structures

https://www.netfabb.com/capabilities/design-optimization

Multi-material design

Example: Manufacture the material properties – combining 2 different materials

http://www.javelin-tech.com/3d-printer/materials/polyjet-photopolymer/stratasys-polyjet-technology/

Design for mass customization

Individual

10 million hearing aid shells

Manufacturing from 1 week to 1 day

Customized character

for world of Warcraft

Parts consolidation

Original

20 parts

Welded together

New:

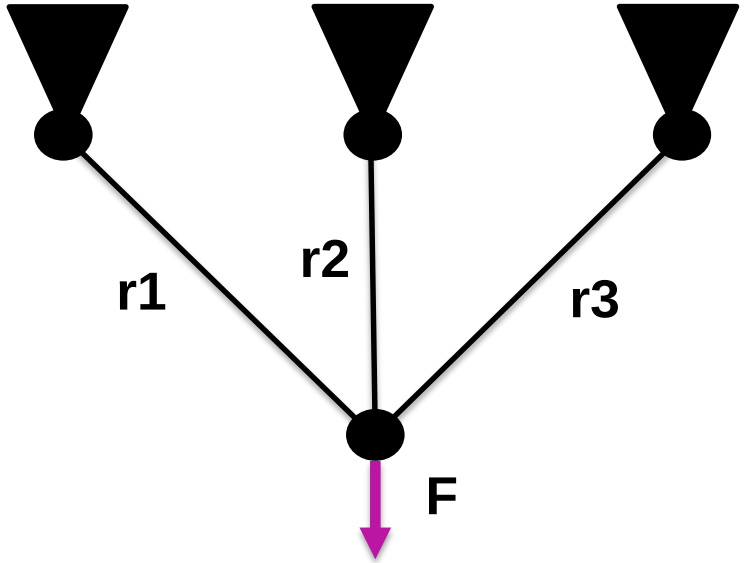
1 part

5 time stronger than original

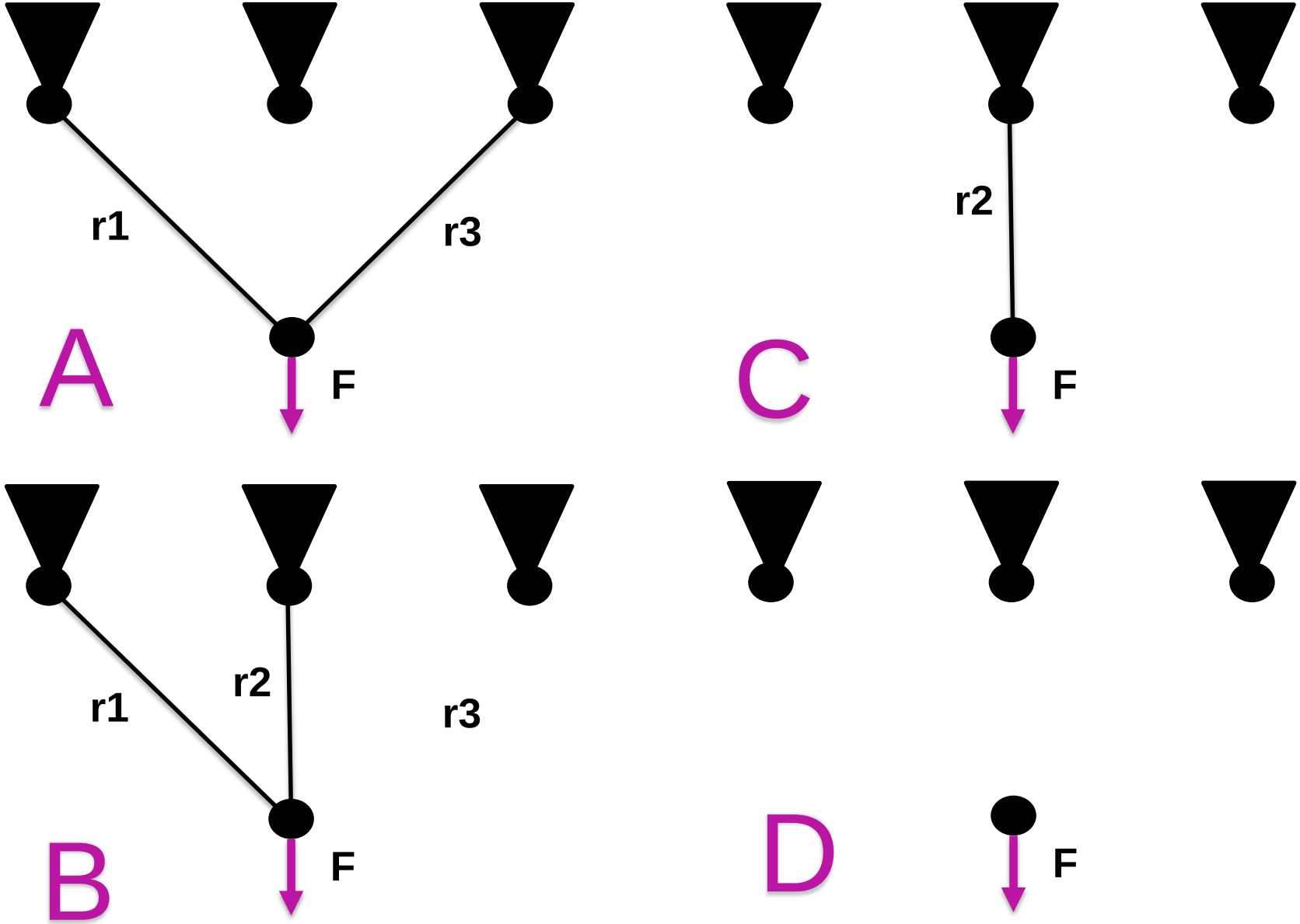
Powder bed fusion - metal

Source: GE

Topology optimization

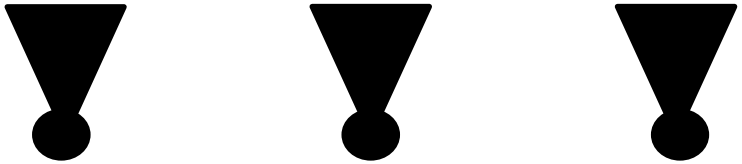


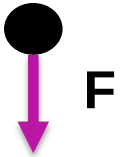
Minimize mass of rods?



Solutions ??

Topology optimization

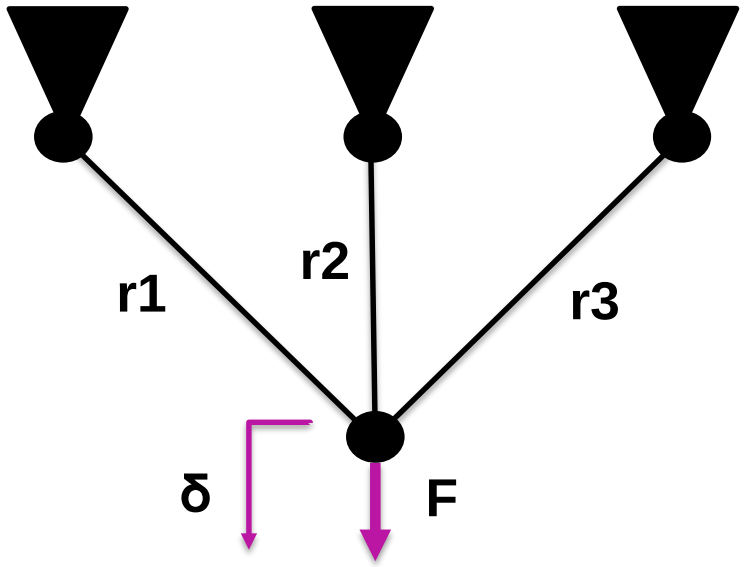




No material, no stress.

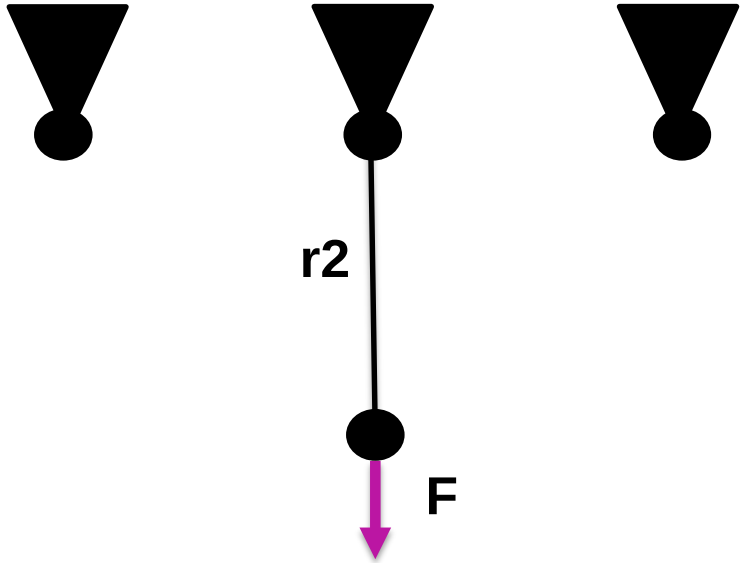
But ball start moving away?

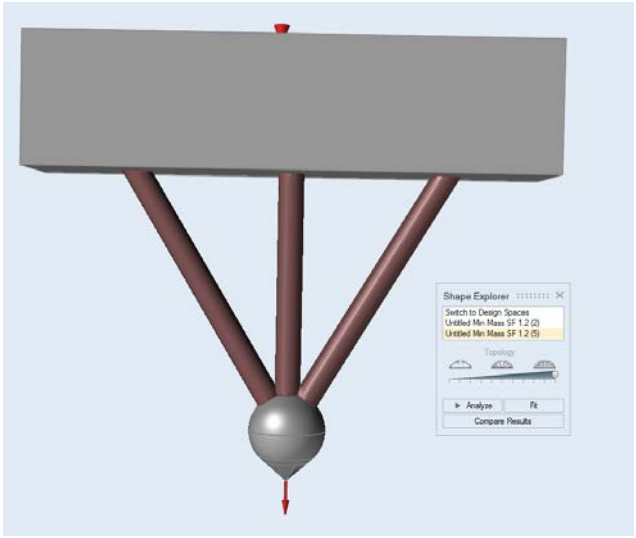
Reality?

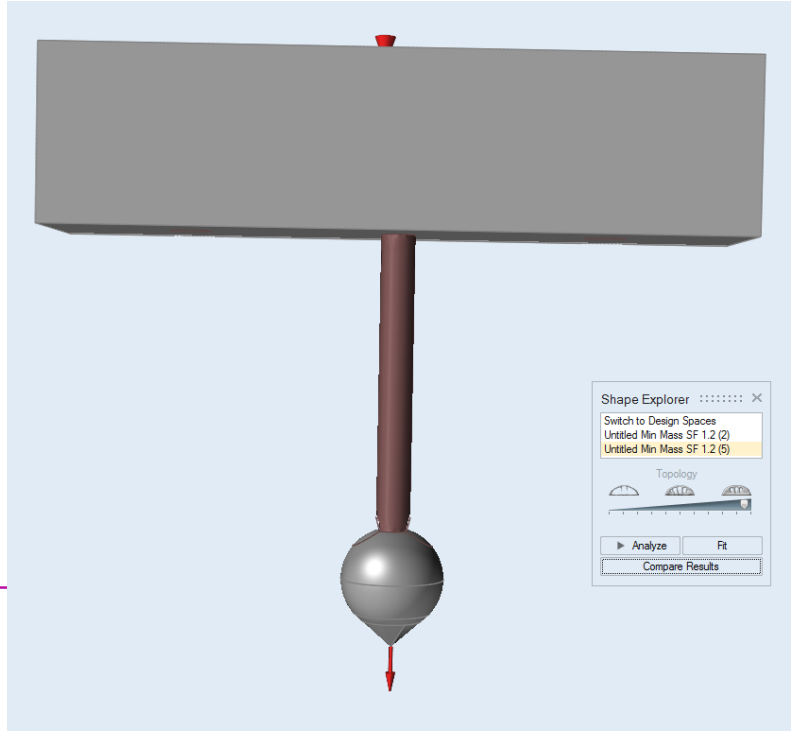


Displacement constraint needed

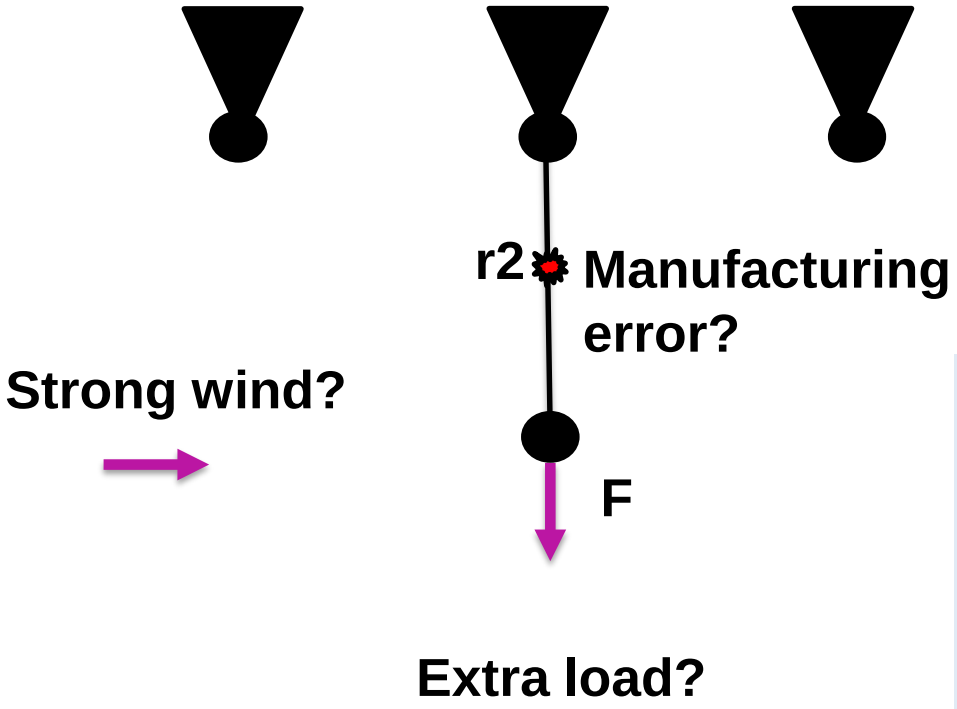
Optimal topology

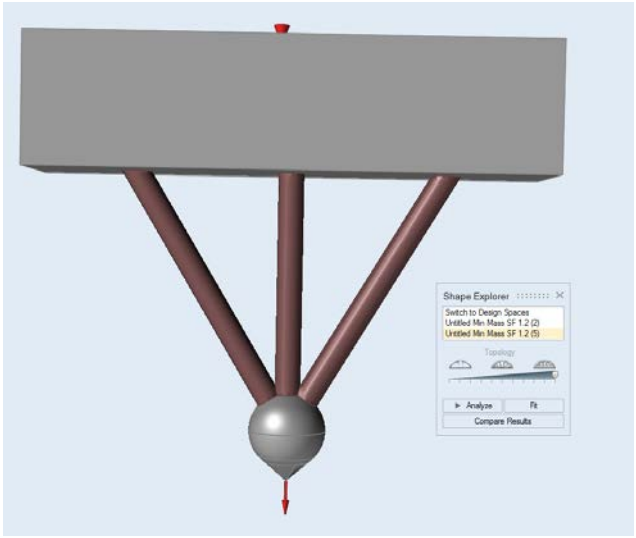


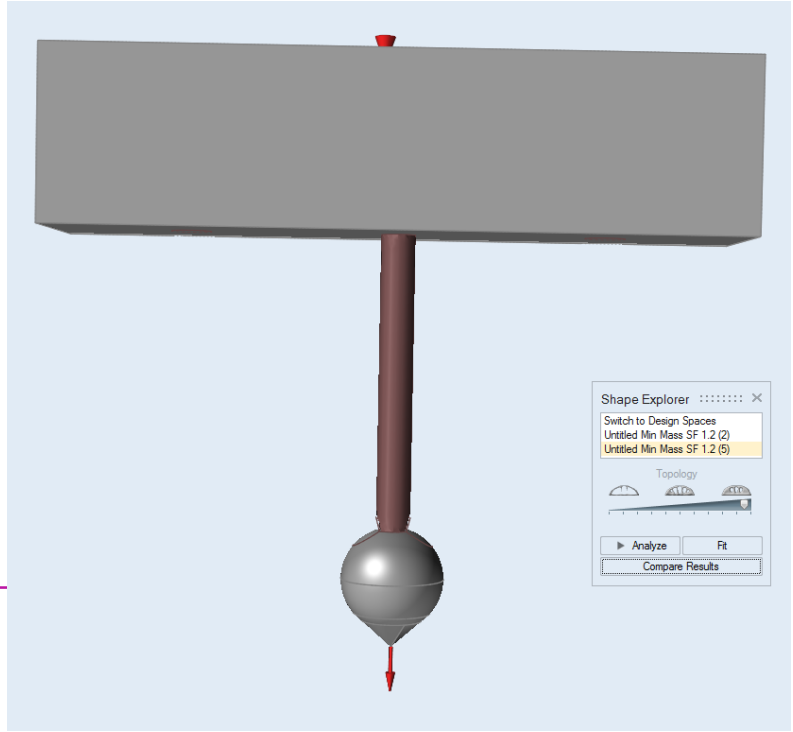




But what if?


r2
Manufacturing error?
Strong wind?
F
Extra load?


Shape Explorer
Switch to Design Spaces
Untitled Min Mass SF 1.2 (2)
Untitled Min Mass SF 1.2 (5)
Topology
Analyze
Fit
Compare Results


Shape Explorer
Switch to Design Spaces
Untitled Min Mass SF 1.2 (2)
Untitled Min Mass SF 1.2 (5)
Topology
Analyze
Fit
Compare Results

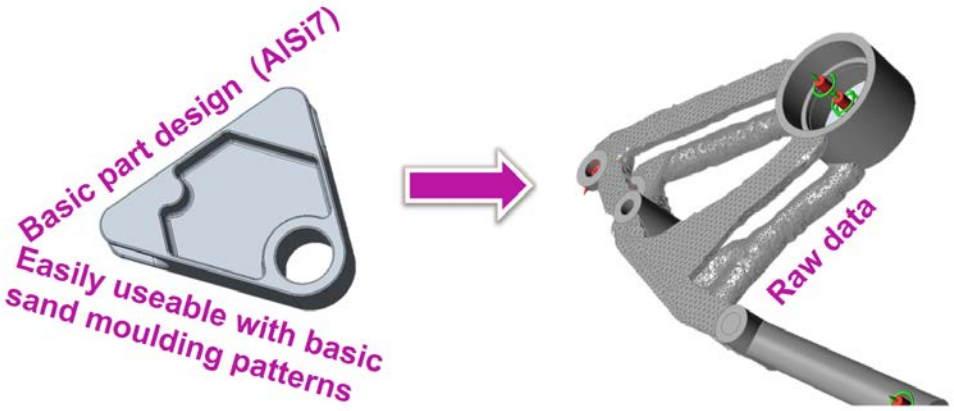
Examples: Sand castings

Suspension linkage for formula student

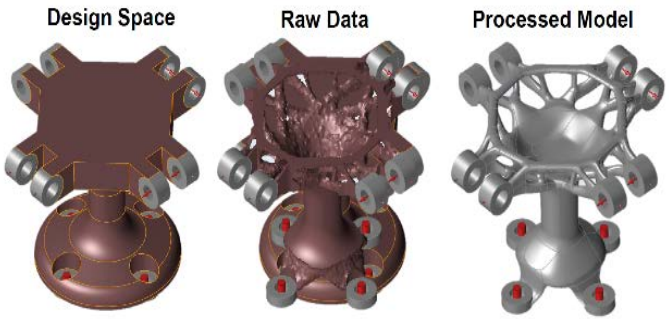
Base part 130g

Raw part 85g **35 % reduction**

Re-design 105g **20 % reduction**



Examples: Investment casting



CF8M / 1,4408

316L

AM

316L

Standart pipe lathe

AM wax + investment casting

Laser welding with AM Jig

Jalava, K., Salmi, M., Kukko K., & Orkas J. Multi-scale topologically optimized components made by casting and additive manufacturing. 73rd World Foundry Congress 23-27 September, Krakow, Poland, 2018.

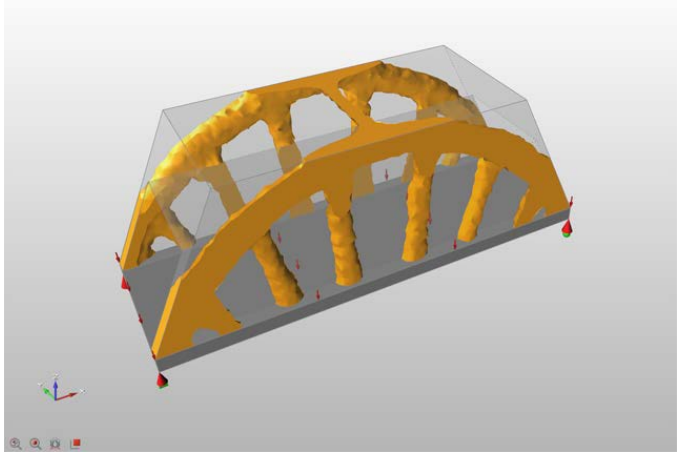
Summary about topology optimization

Loads and boundaries are very important and need to know very well – better than in normal FEM

All extra material is removed – no place for mistake

In reality are those so well known? Unexpected events?

Questions?



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DEMO:

Sketching and Optimizing a Bridge

https://www.youtube.com/watch?v=FgbBRVCNebk

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https://solidthinking.com/AcademicLicenseRequest/?edition=student