Introduction to CAD* for FTC & FRC teams

Curtis Volin, Ph.D.

Georgia FTC Steering Committee Member

Grant Terry

Eagle Robotics Carbon Fiber FTC 7373

* Computer-Aided Design

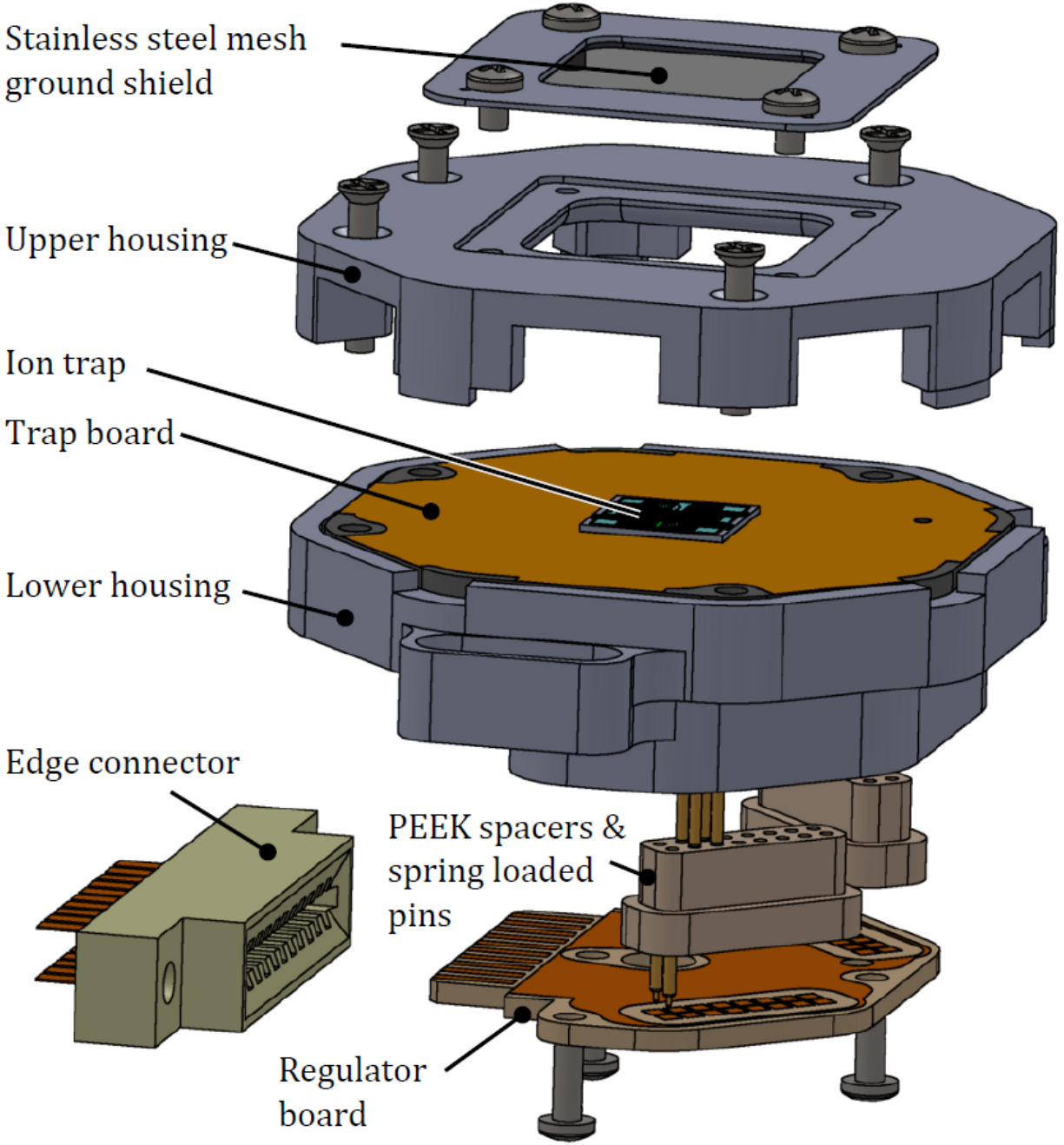
Summary

- Why are we here?
- I am NOT going to:
  - tell you which CAD software to use
  - teach you how to use a CAD software

- Outline
  - About CAD
  - Ways to make things
  - Project examples

Why CAD?

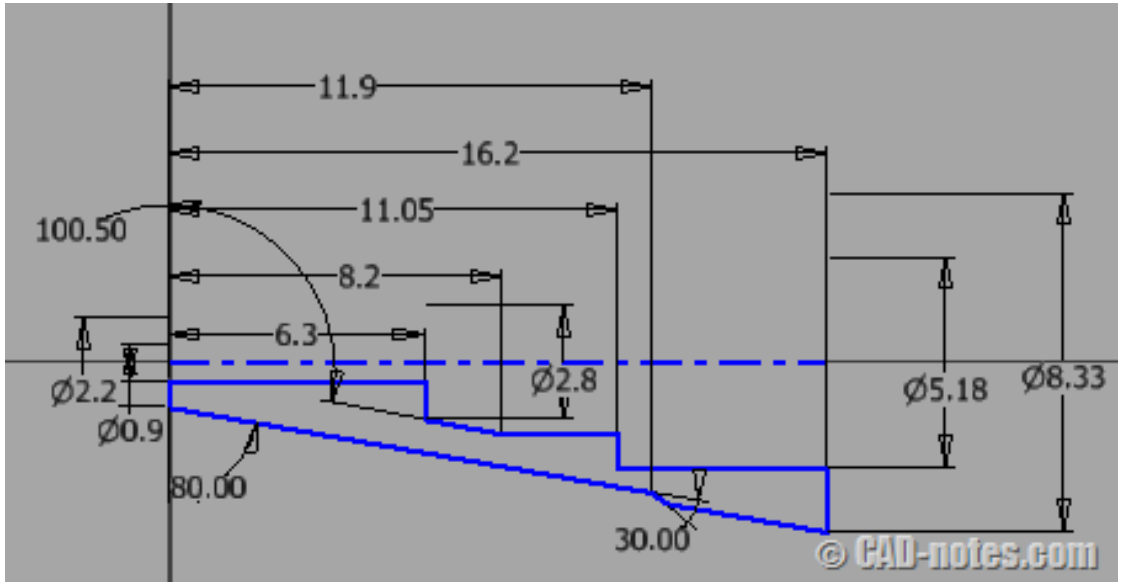
- Drawing things for design and prototyping
- Can also use models as input to numerical simulations
  - Electromagnetic
  - Mechanical
  - Fluid dynamics
  - Aerodynamics
  - Thermal
  - Optical



CAD program types

Explicit: draw and edit surfaces and shapes

Parametric: design tree, all design parameters are retained



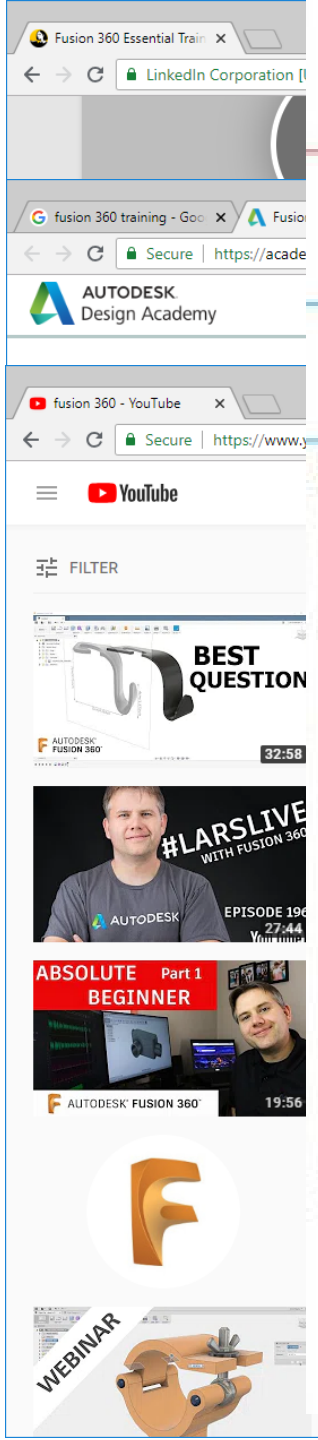
CAD programs

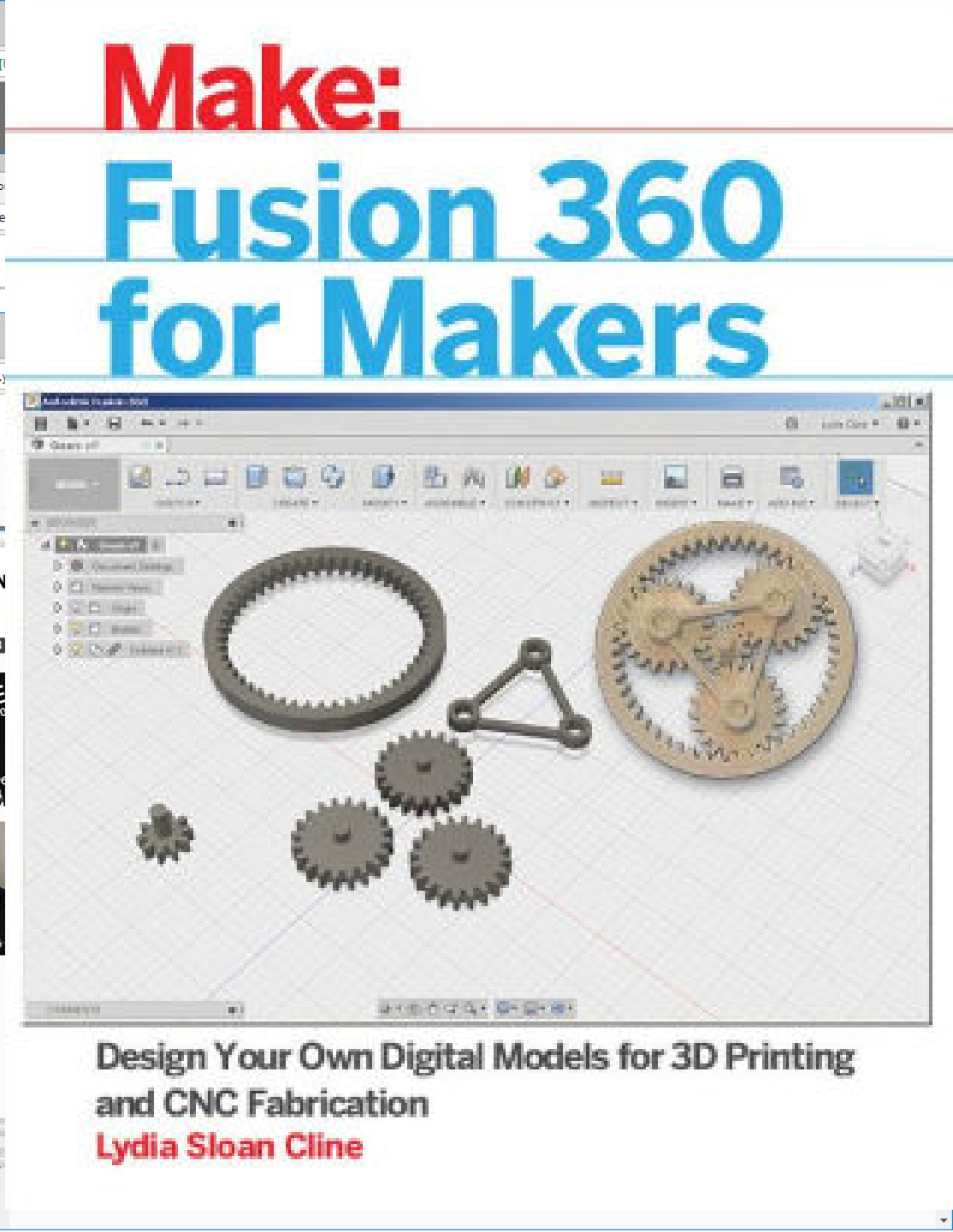
- Solidworks https://www.solidworks.com/
- Autodesk Inventor, AutoCAD, Fusion 360 https://www.autodesk.com/
- PTC Creo https://www.ptc.com/en/products/cad
- SketchUp, IronCAD, Onshape, Many other programs...
- Professional-grade tools are free for FTC/FRC students and mentors

- Other useful design tools
- Inkscape https://inkscape.org/
  - free, 2D vector drawing program
  - Graphics, drawings for laser cutting, engraving, waterjet

CAD Training Tools

- Lynda.com
  - Free access through many public libraries
- Training tools from software vendors
- YouTube
  - Not a total wasteland
- Books
  - Not free, but you won't constantly have to pause and rewind the video!





What can your team do with CAD?

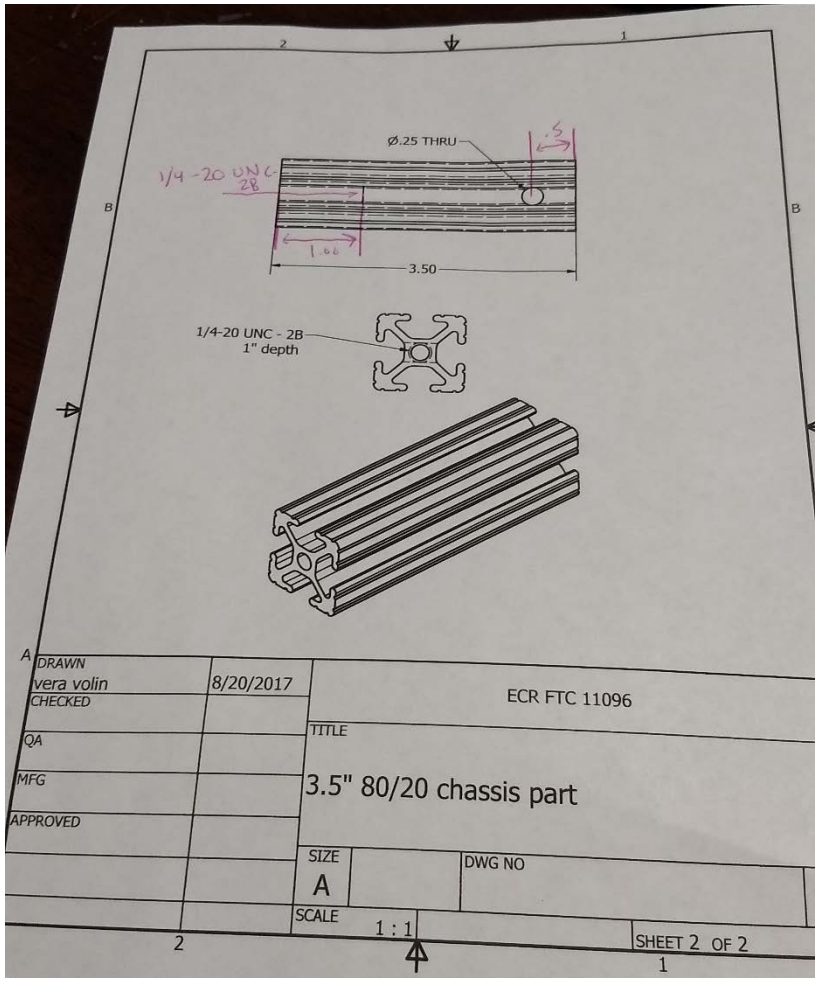
1. Learn to CAD. Document your learning process in your notebook!
   - CAD your robot (or components of your robot) as-built.
2. Download and 3D print other people's designs
   - GrabCAD, Thingiverse
   - replacement parts from vendors
3. Make accessories and aesthetic elements for your team/robot (numbers, markers, covers, jewelry, logos)
4. Design simple things that improve your robot's performance
5. Find projects that promote STEM in your community.

Thingiverse, VCHS Robotics, FTC 2844

Rockin' Robots, FTC 5940

Document your CAD

- Make notebook entries for all CAD sessions
  - Even if you are just learning, or you do not make anything useful.
- Explain the underlying design and fabrication choices
- Learn how to make drawings



CAD & Part Suppliers

- Rev Robotics supplies CAD for each part they sell.
  - Each individual part has its own CAD on the product's page
- Textrix supplies CAD for each part.
  - Each individual part has CAD that can be found after clicking on the part.
- McMaster-Carr provides CAD drawings for only some of their products.
  - There is a small CAD symbol by the part name if CAD is available
- VEX Robotics provides CAD for each part.
  - The individual product pages have CAD files for the pieces
- Actobotics (Servo City) supplies CAD for their products
  - https://www.servocity.com/step-files
- Andymark supplies CAD for their products

15MM PLASTIC 135 DEGREE BRACKET - 8 PACK

$5.00

SKU: REV-41-1310

Quantity:
1

ADD TO CART

Add to Wishlist

Description | Documentation & Resources | Reviews | Also Viewed

This 135 degree plastic bracket is used with the REV 15mm Extrusion System. Each bracket includes a set of alignment ribs designed to seat the bracket into the extrusion channel increasing joint alignment, strength, and rigidity.

SPECIFICATIONS

Not secure | www.revrobotics.com/rev-41-1310/

$5.00

SKU: REV-41-1310

Quantity:
1

ADD TO CART

Add to Wishlist


Pin it

Description | Documentation & Resources | Reviews | Also Viewed

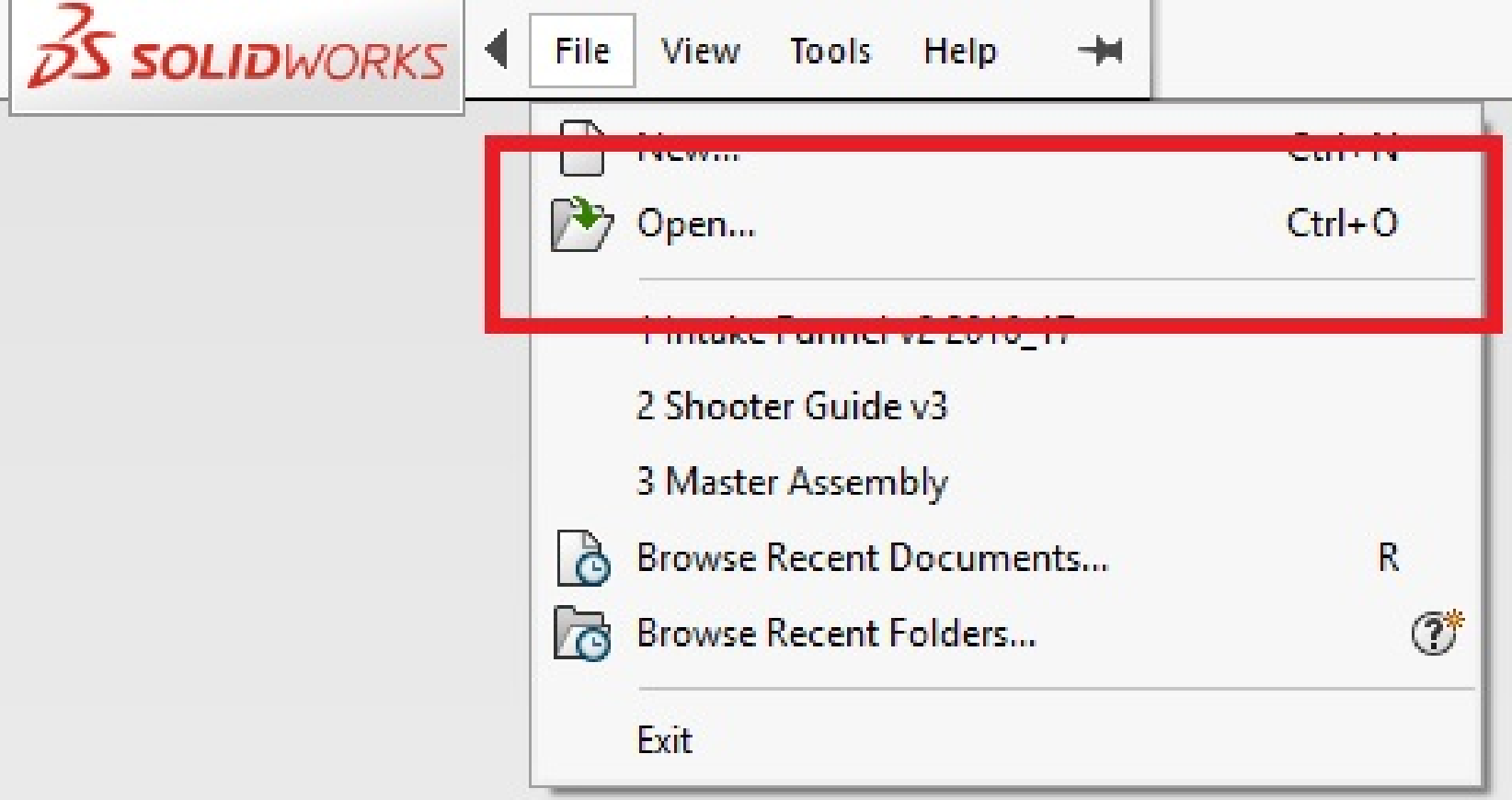
CAD

- REV-41-1310 STEP File

DOCUMENTATION

RESOURCES

- Building System Guide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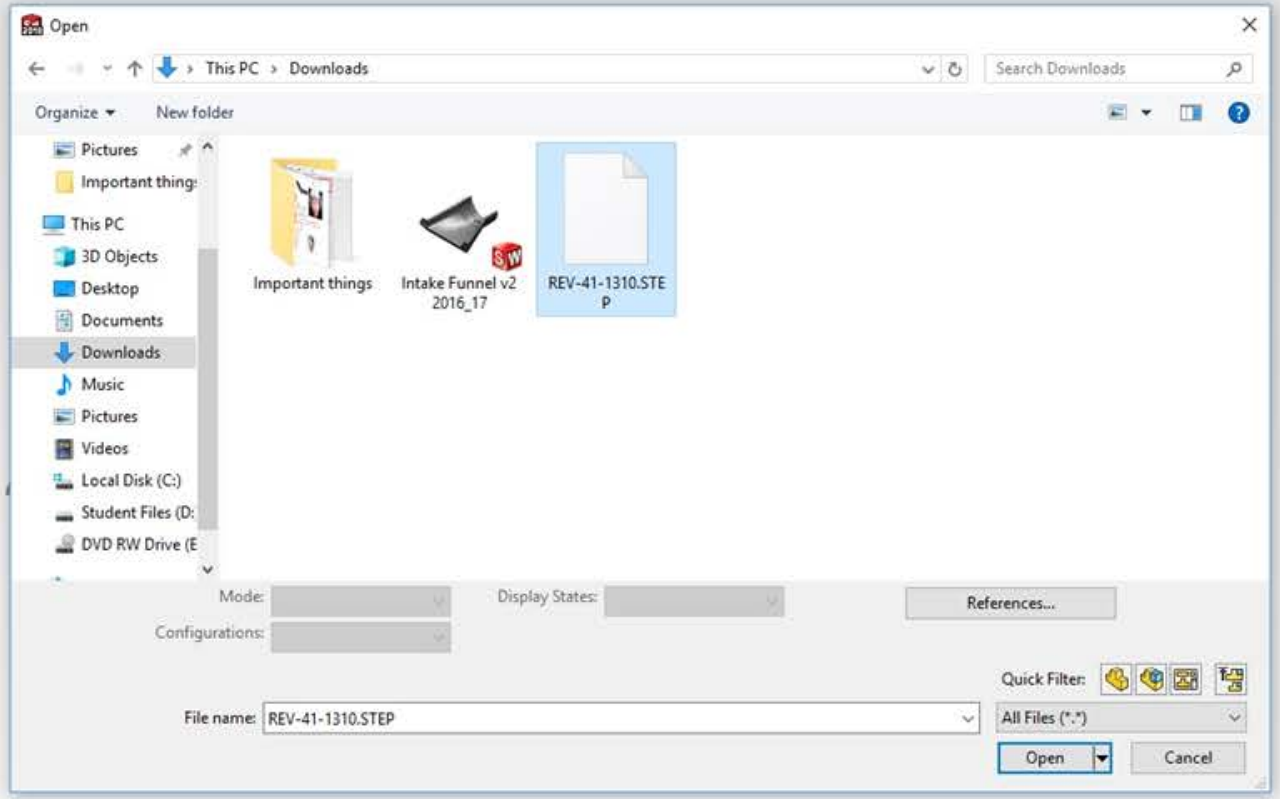

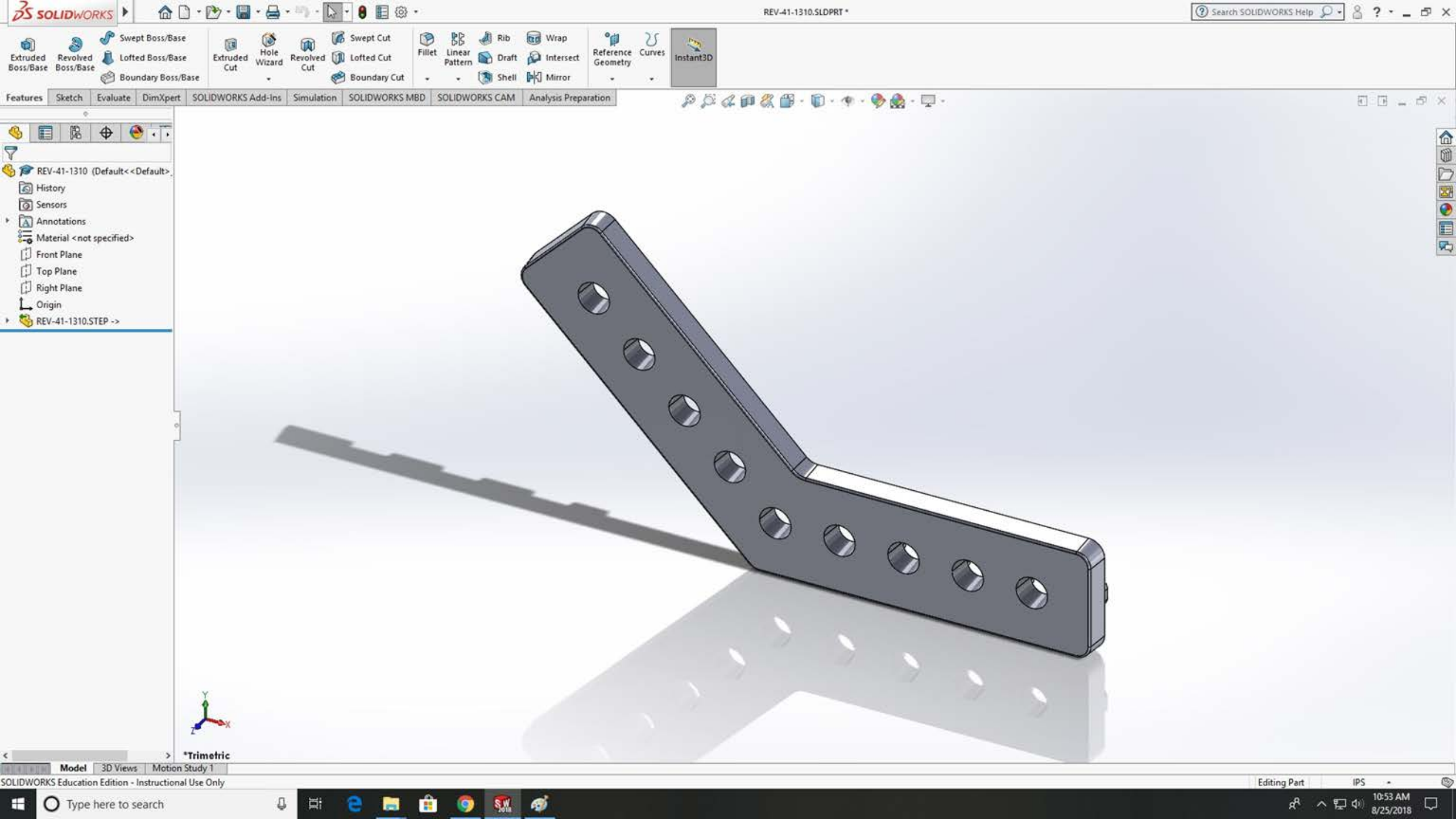
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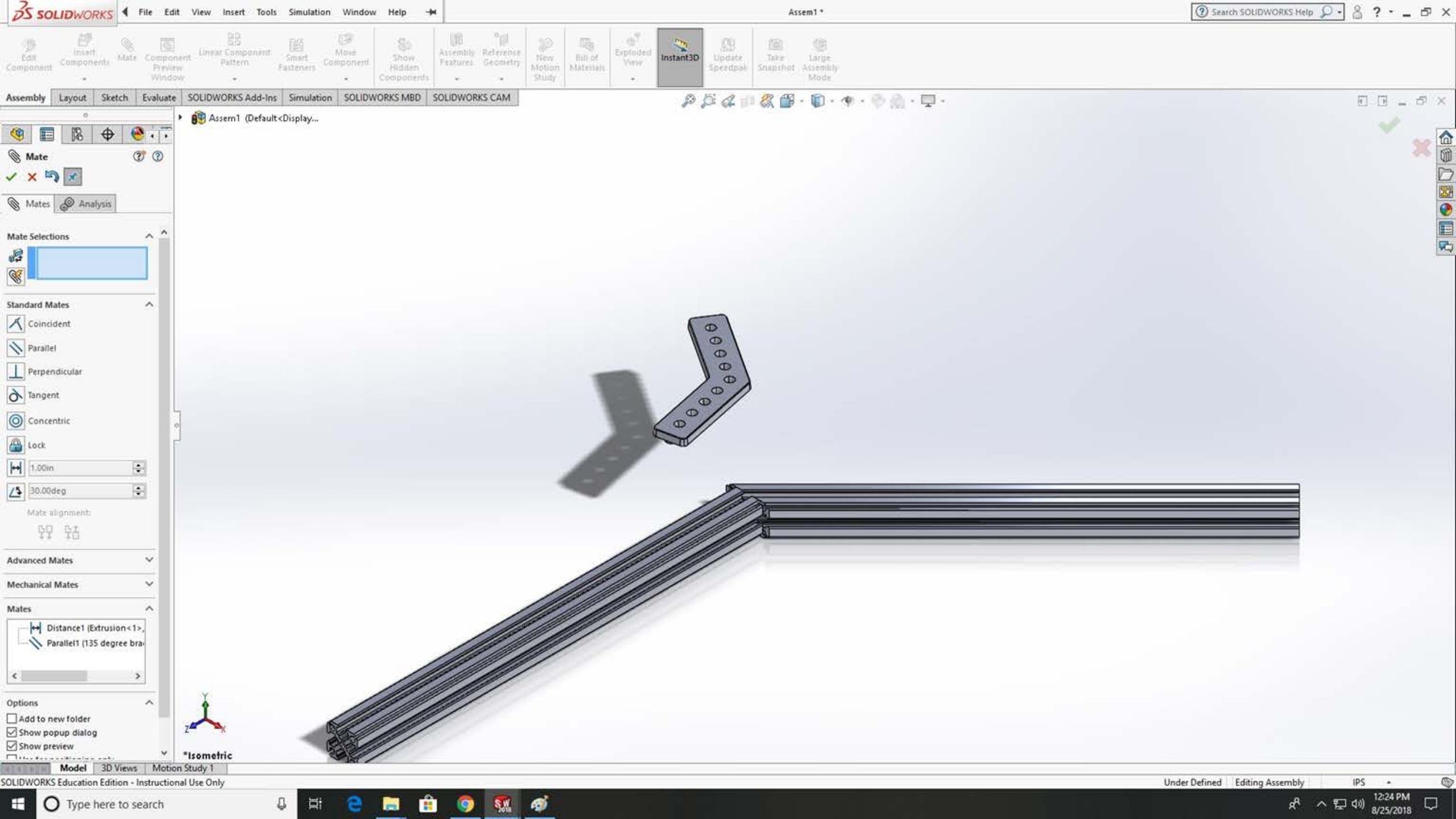
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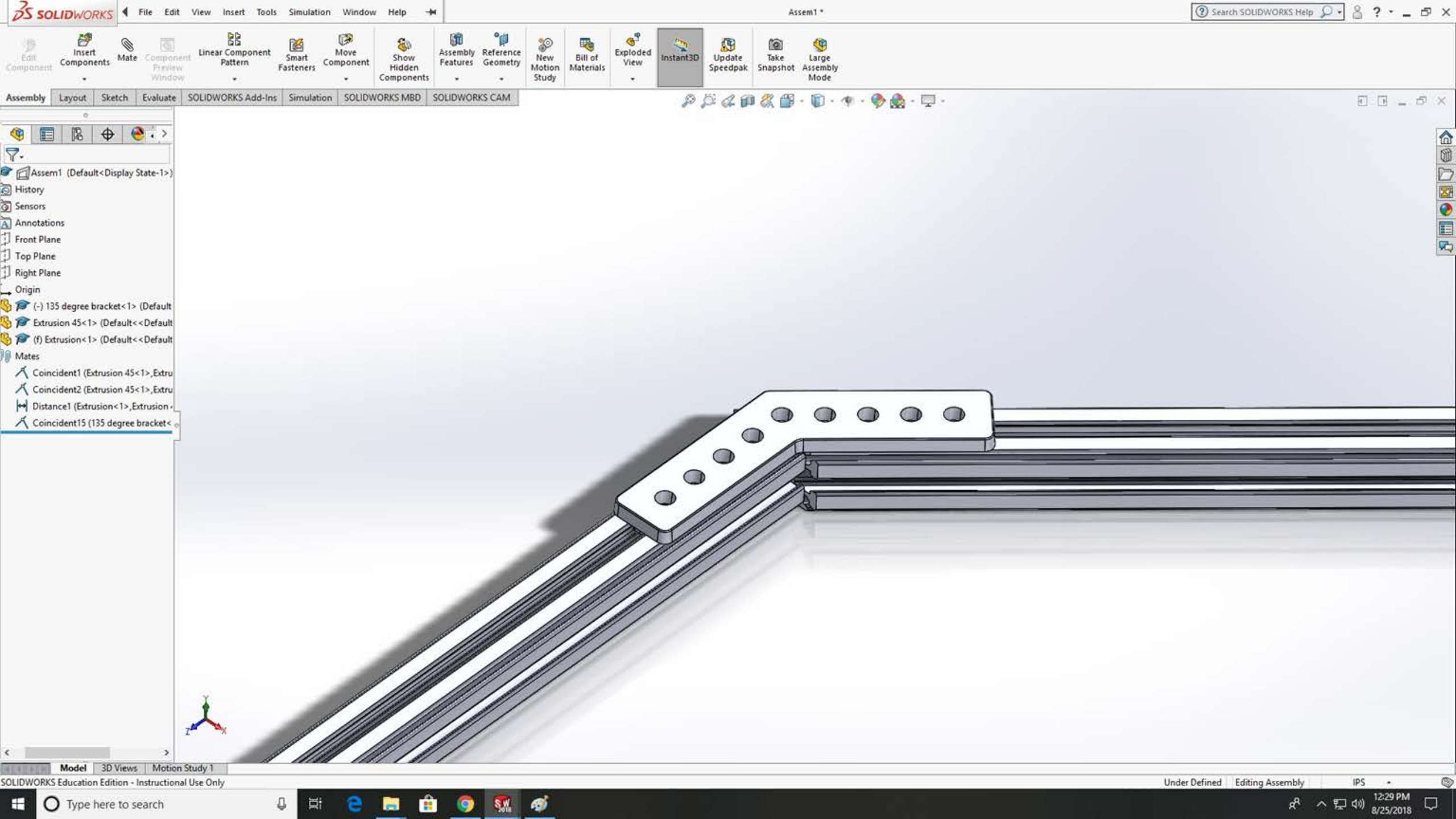
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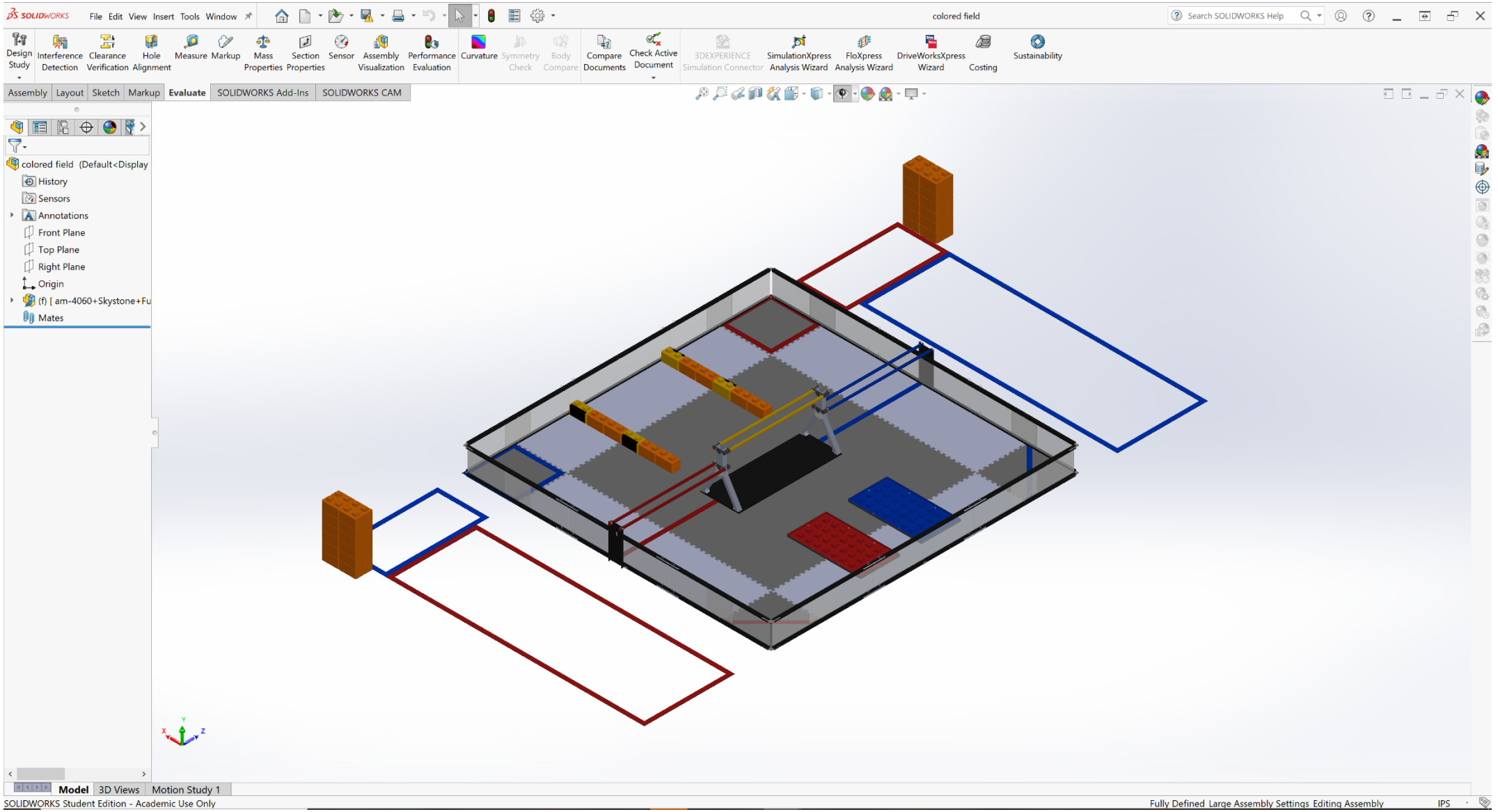
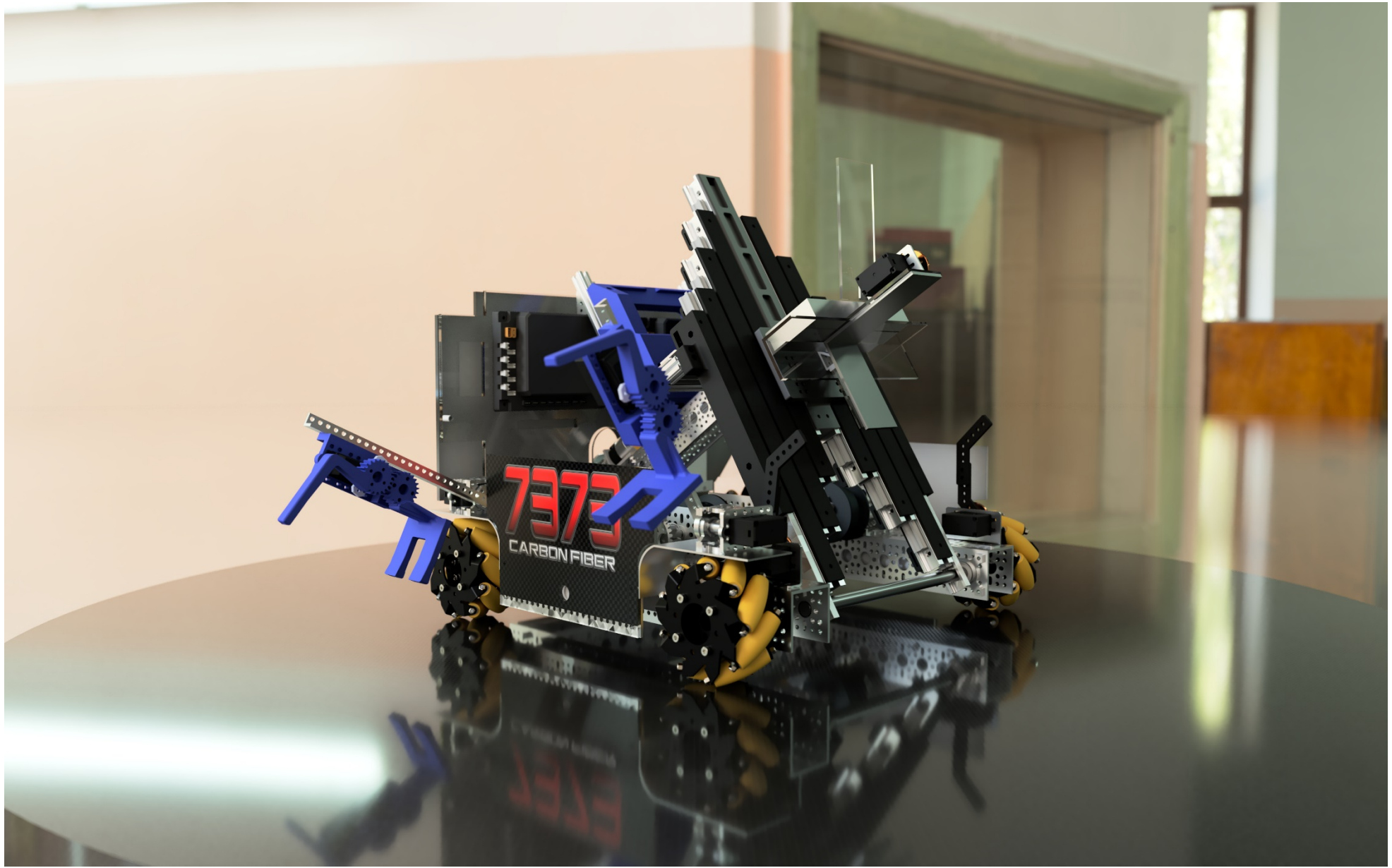
Field Download - AndyMark.com



Fusion 360 Renders



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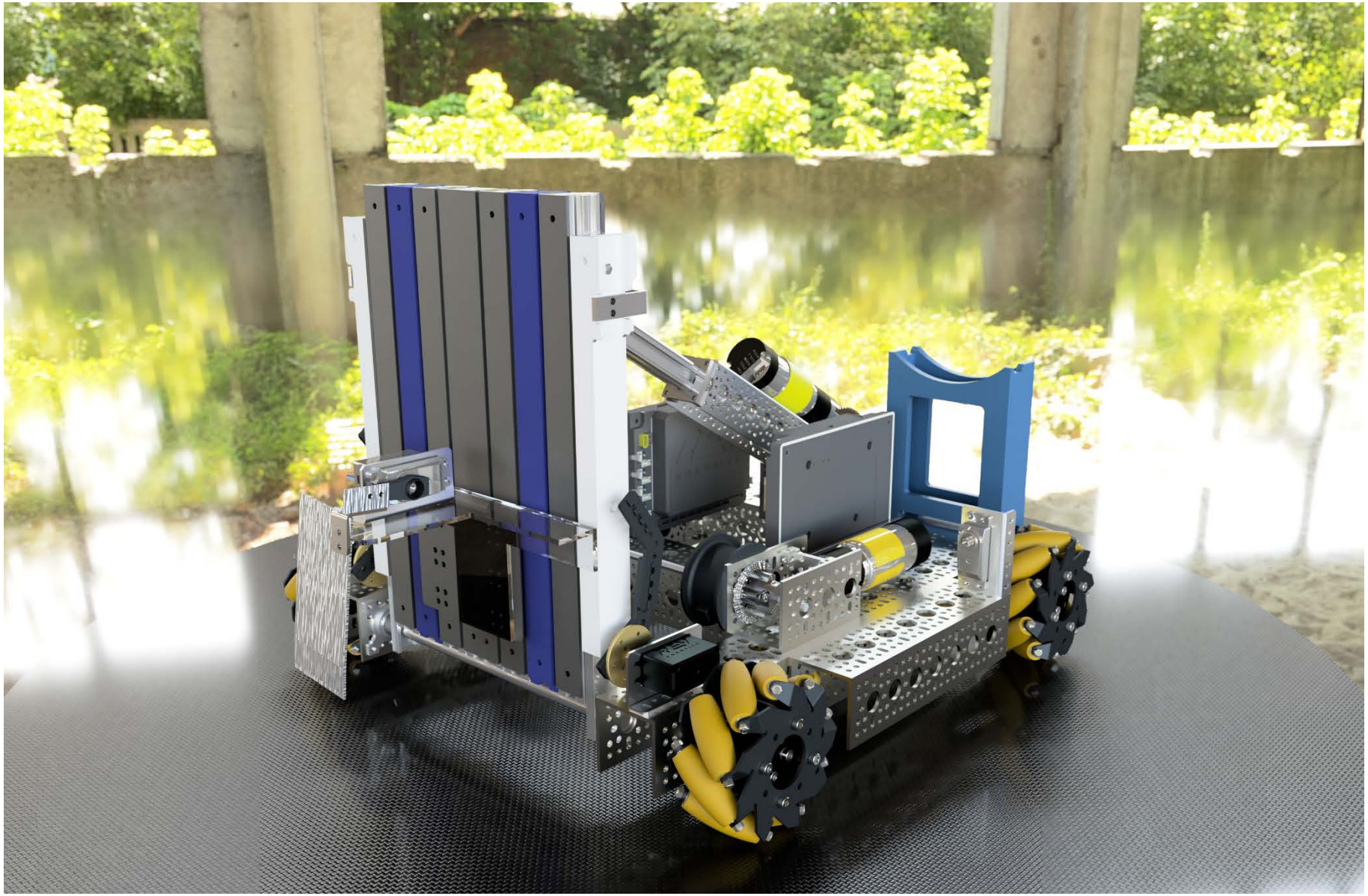
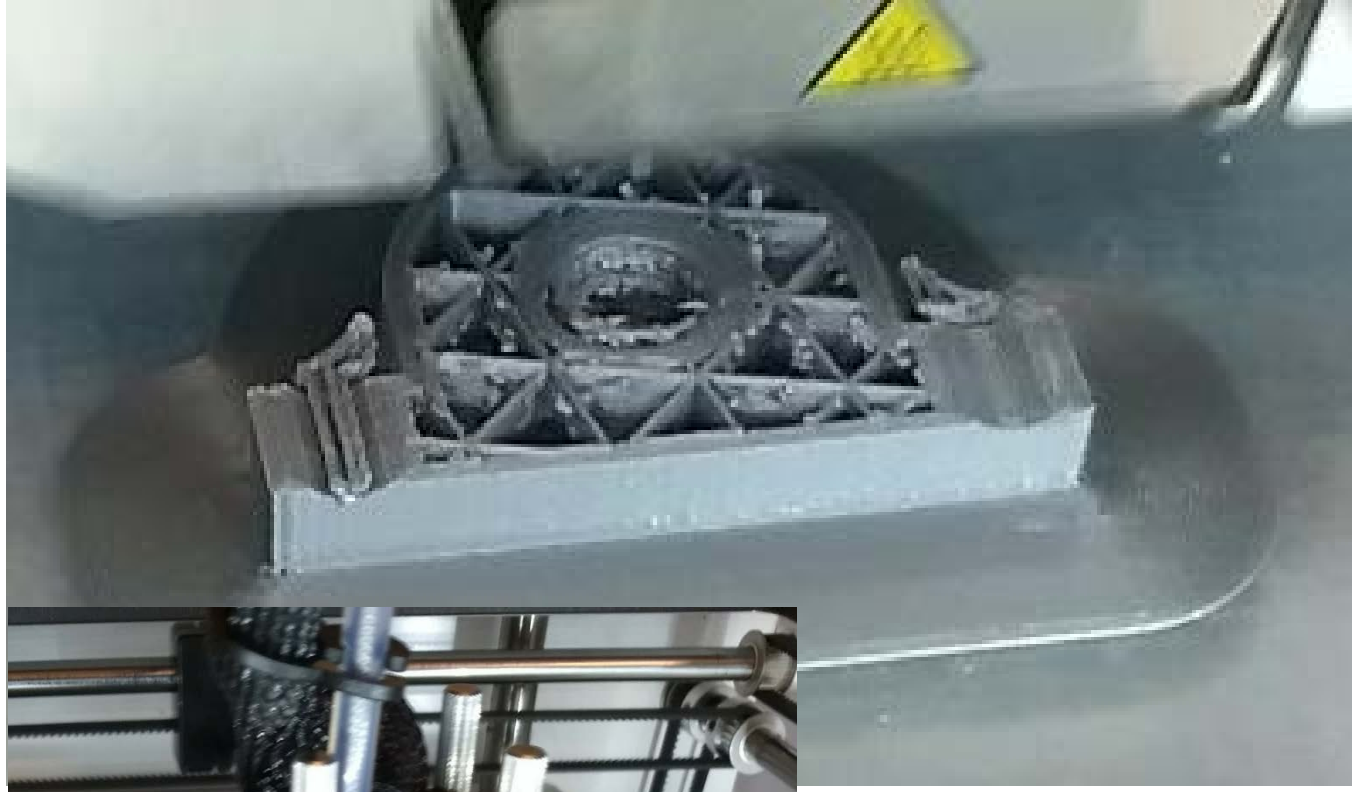


Ways to make things you design

3D Printing

- Inexpensive machines
  - materials can be expensive
- Industrial use is mainly for prototyping
  - Slow
  - Imprecise
  - Limited material set
  - Parts are not thermomechanically durable
  - Reworking is difficult
- Critical concepts/settings:
  - Orientation
  - Support
  - Fill density, wall thickness
  - Print speed
  - Layer thickness


ultimaker.com



Water Jet

- Primarily 2D (angle cuts are possible)
- Works for almost any material
  - Can cut through many inches of metal/stone
- Precise feature location, imprecise sizing due to beam shape and walk-off
- Machine is extremely expensive
- Materials and operation are cheap

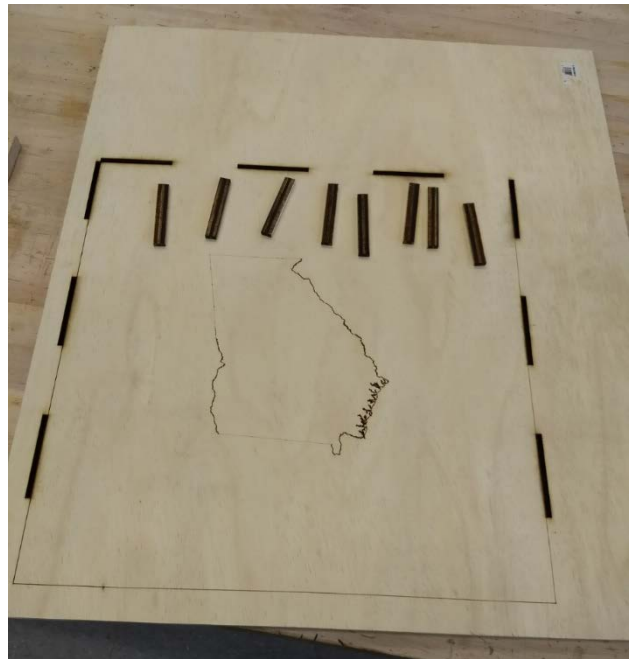
CNC mill/router

- Computer Numeric Control
  - extremely expensive 3D milling machines
  - inexpensive consumer-grade tools with lesser capability
  - Everything in between
- Inexpensive CNCs cut wood, plastic, and aluminum
- Usually 2D with variable relief
- Precise feature location and sizing

http://shop.nextwaveautomation.com

Laser cutting and engraving

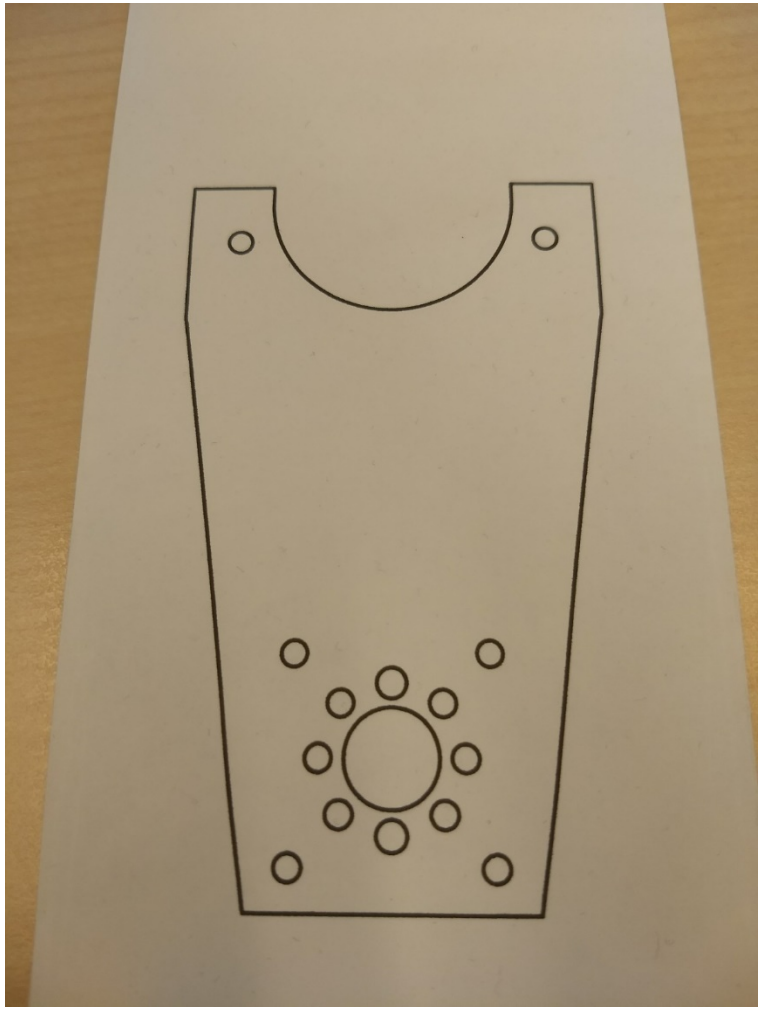
- 2D cutting/relief only (+ curved surfaces)
- Limited material set (paper, wood, acrylic)
- Uses SVG files (inkscape, Fusion 360)
- Machines are expensive
  - Materials and operation are cheap
- Very precise cutting
  - difficult to control width and depth of the cut



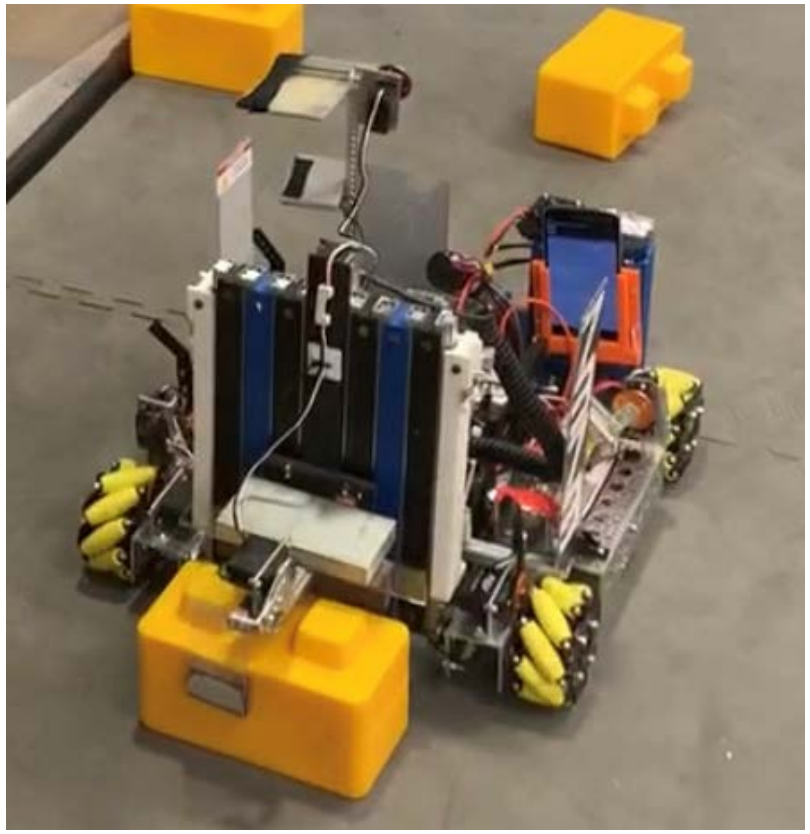
troteclaser.com

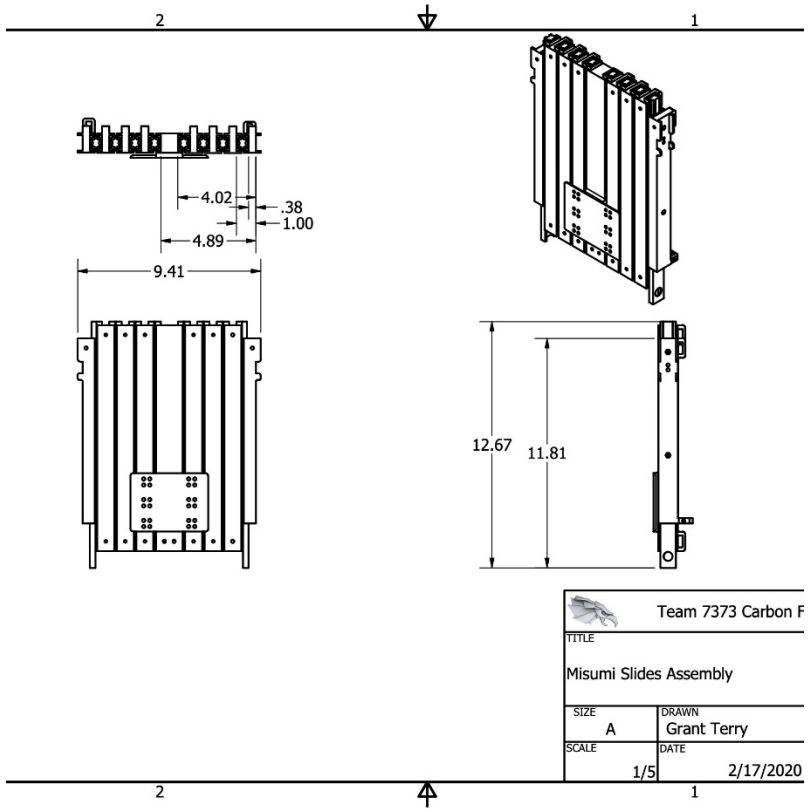
Hand Working

- Outline: hack saw, bandsaw, jigsaw, bench grinder, shear
- Drilling: center punch, cordless drill, drill press
- Finishing: bench sander, hand file, tap, reamer, countersink, deburring tool



Project examples

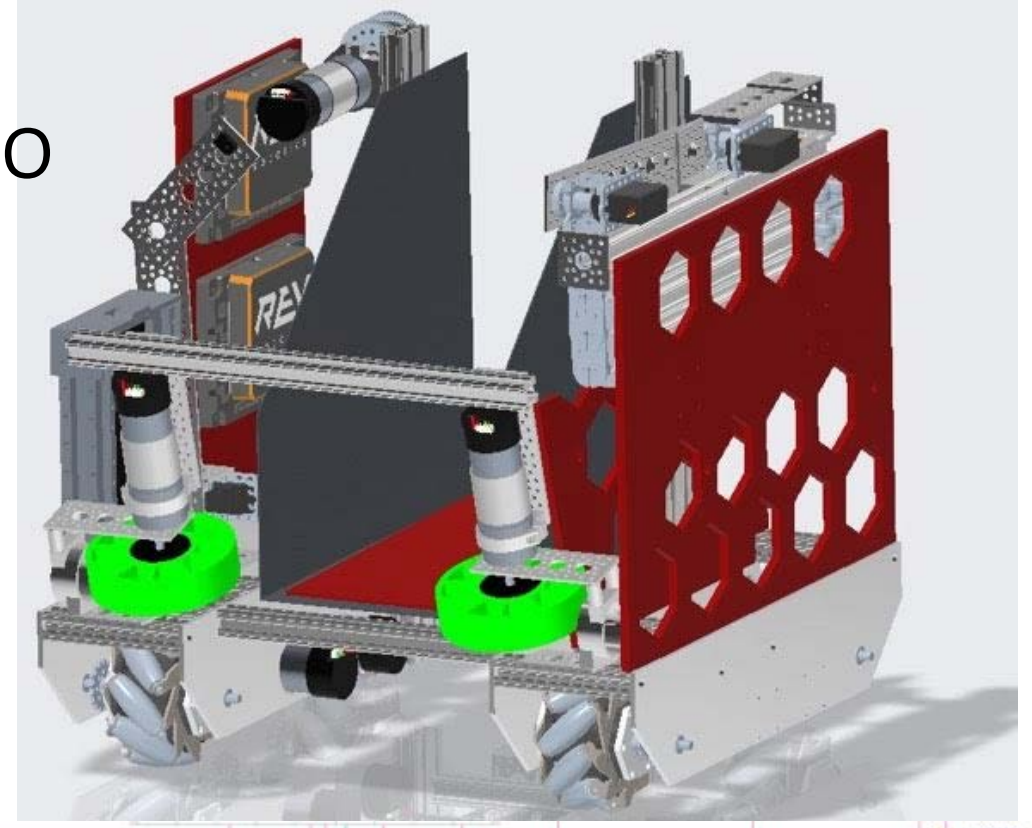


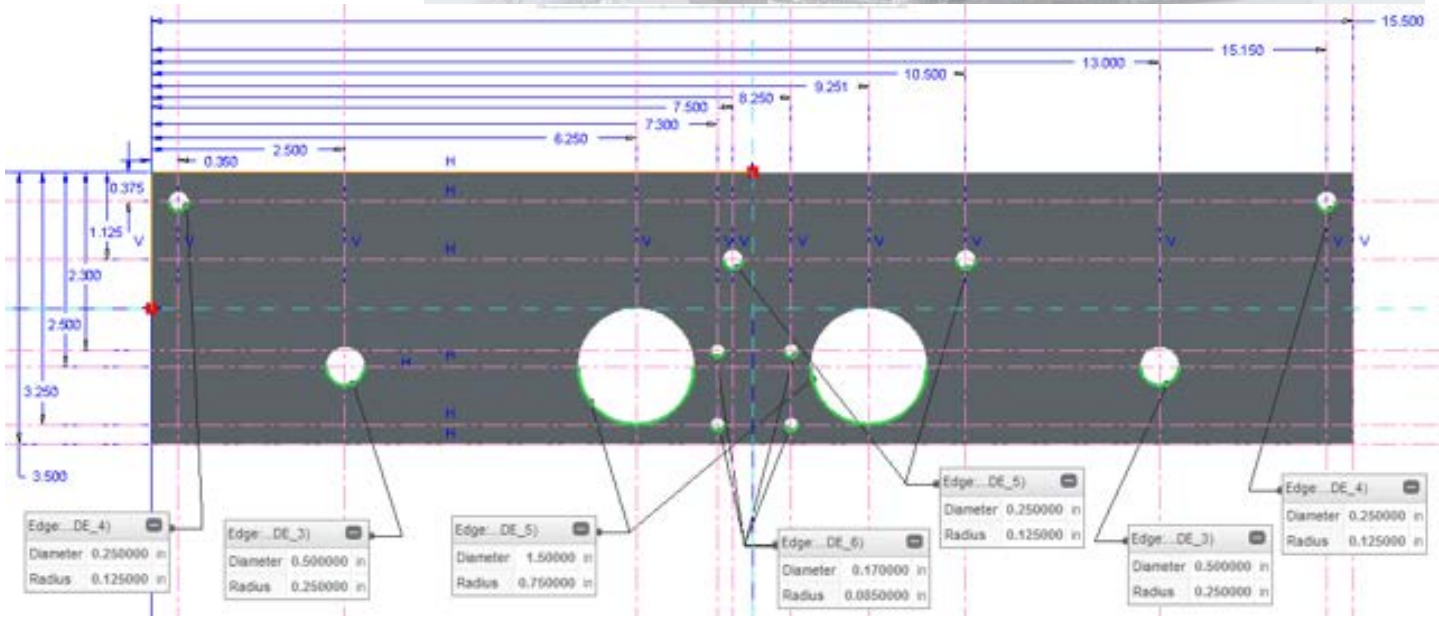


Linear Slide Spacers – Eagle Robotics 7373

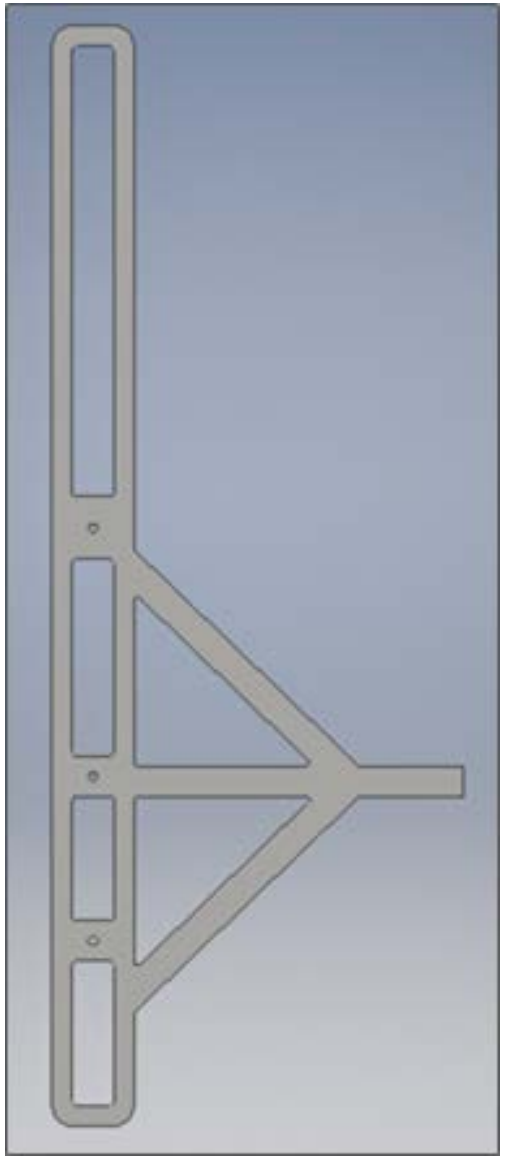
Robot Chassis Design – PTC Creo

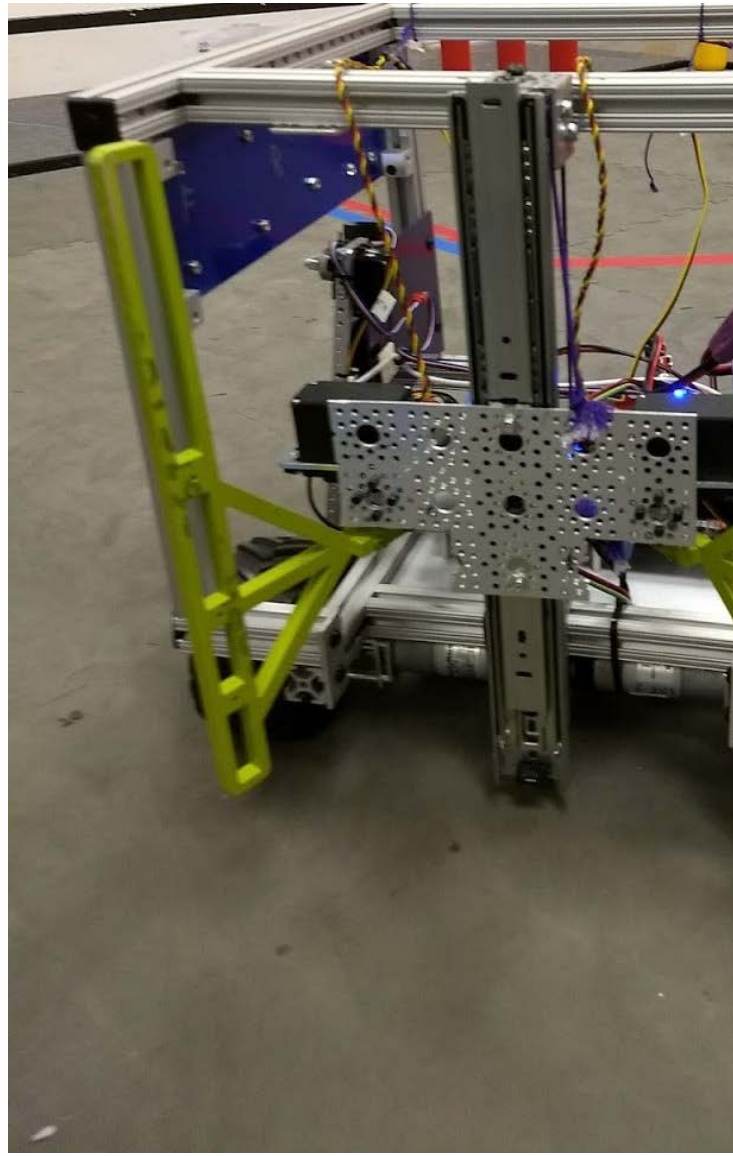
- Twisted Axles, FTC 6047
- Scrap metal from Res-Q
- Hand-worked outline, local shop drilled holes using a mill
- Key features
  - Lightweight
  - Open robot interior
  - Easily modified to add mounting points





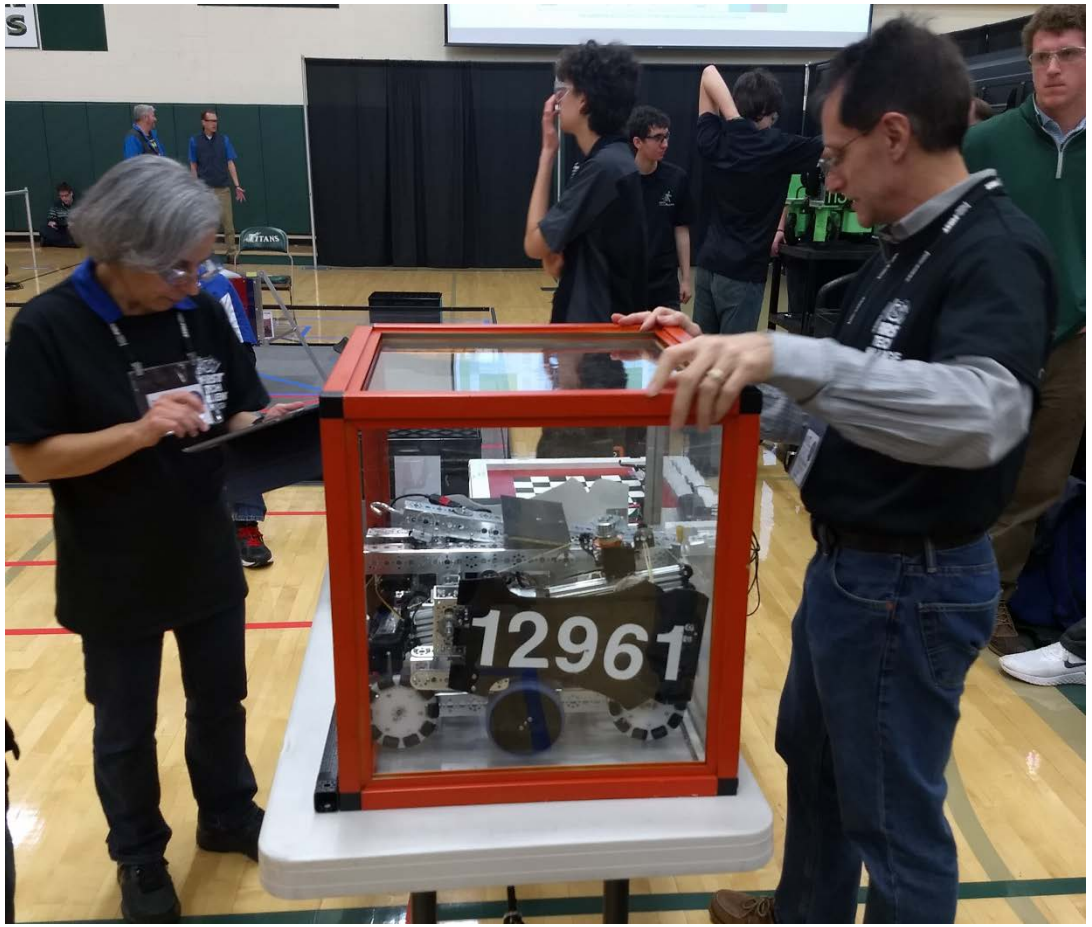
Glyphter Arms – Inventor - Water Jet





Robot crate and sizing box – Inventor – 80/20 kit

- Prototype was hand-cut (bandsaw, bench sander, panel saw)
- Any team can buy this as a prefabricated kit



80/20® Inc.
*The **Industrial** Erector Set®*

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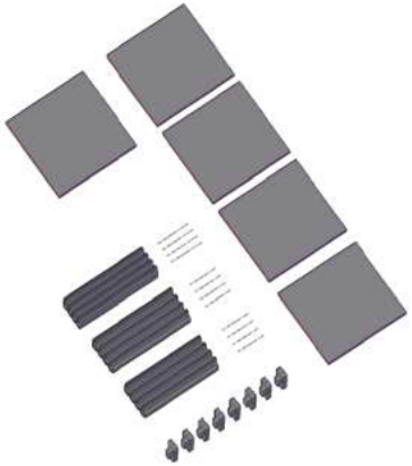
QUOTATION # : Q-74421
Project Description / Reference:



Distributor:	**ADVANCED CONTROL SOLUTIONS**
Attn:	**Steven Spence**
Address:	**1400 Williams Drive**
	Marietta, GA 30066
Phone:	**770-956-7202**
Fax:	
Mobile:	
E-Mail:	**sspence@acs-ga.com**
Customer:	
Attn:	

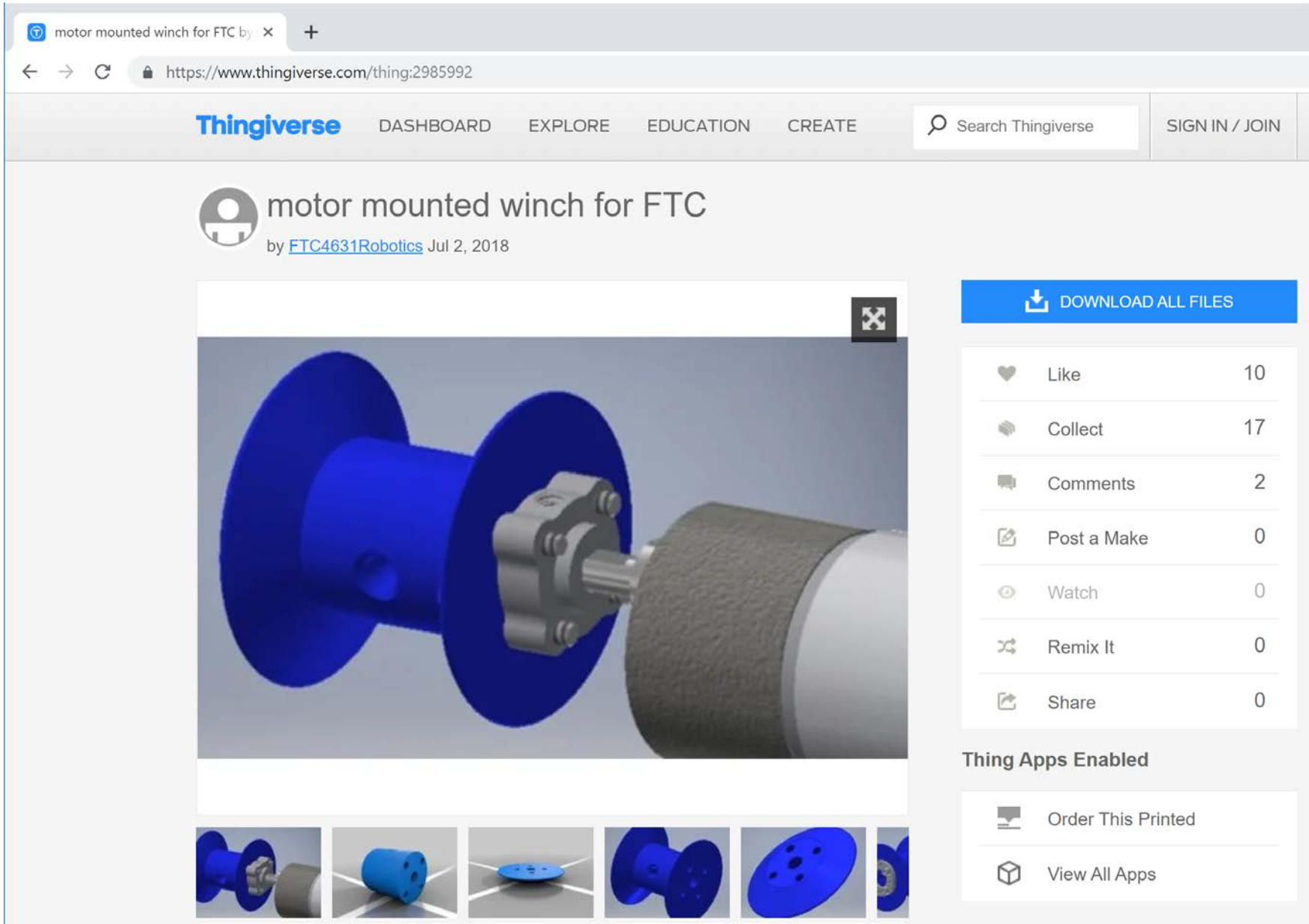
QUOTE MUST BE ORDERED WITH THE FOLLOWING LINES (1 KIT UNLESS OTHERWISE SPECIFIED).			
	80/20 Standard Material and Machining (KIT FORM): $	**244.55**	LIST PRICE
	Outsourced Items (Listed Below): $	**0.00**	NET price to distributor
	Total Estimated Weight:	**24 lbs**	(Does not include CMs or purchased parts)
OPTIONAL 80/20 BUILDS ASSEMBLY SERVICE			
0.00	Hours of Assembly (80/20 Builds): $	**0.00**	LIST PRICE

FTC team markers

- Lots of creative designs from FTC teams

Motor-mounted winch – Inventor – 3D printer

- 3D printed parts compatible with actobotics hub
- Prints in three separate pieces
- Use of metal hub improves durability



Robot Assembly – Inventor