SoCal FIRST TECH CHALLENGE

Outsourcing and Manufacturing With a Focus on Materials and DFM

By: Alon Belkin
Presented by Battlebots Team Horizon

DISCLAIMER

I have worked with most of these companies but some of them are active sponsors of Team horizon and when that’s the case they will be differentiated with a *

These companies are all valid options

DISCLAIMER

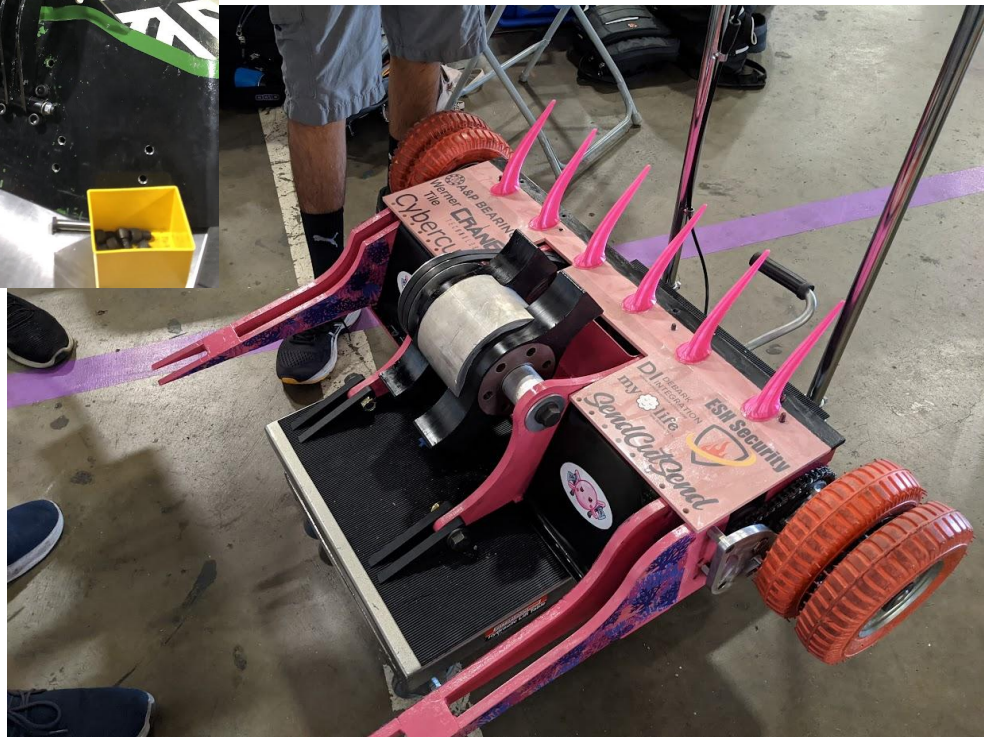
This will be **FAST** I’ve got 76 slides to get through and 40 mins total

The slideshow along with all recommended resources can be found online and in a qr code at the end

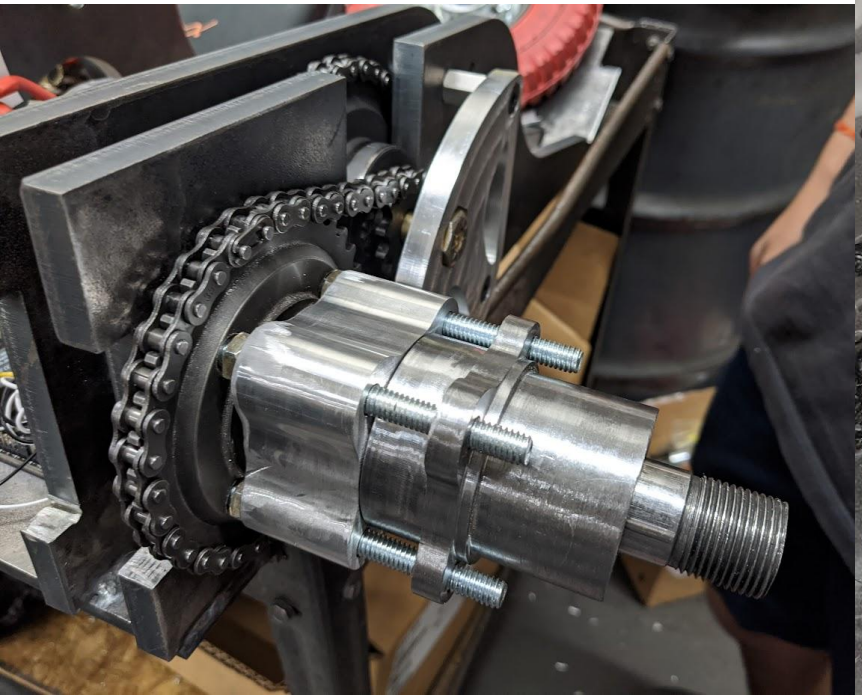
Who am I

I do battlebots!
There are a lot of examples from BB

Who am I



Who am I



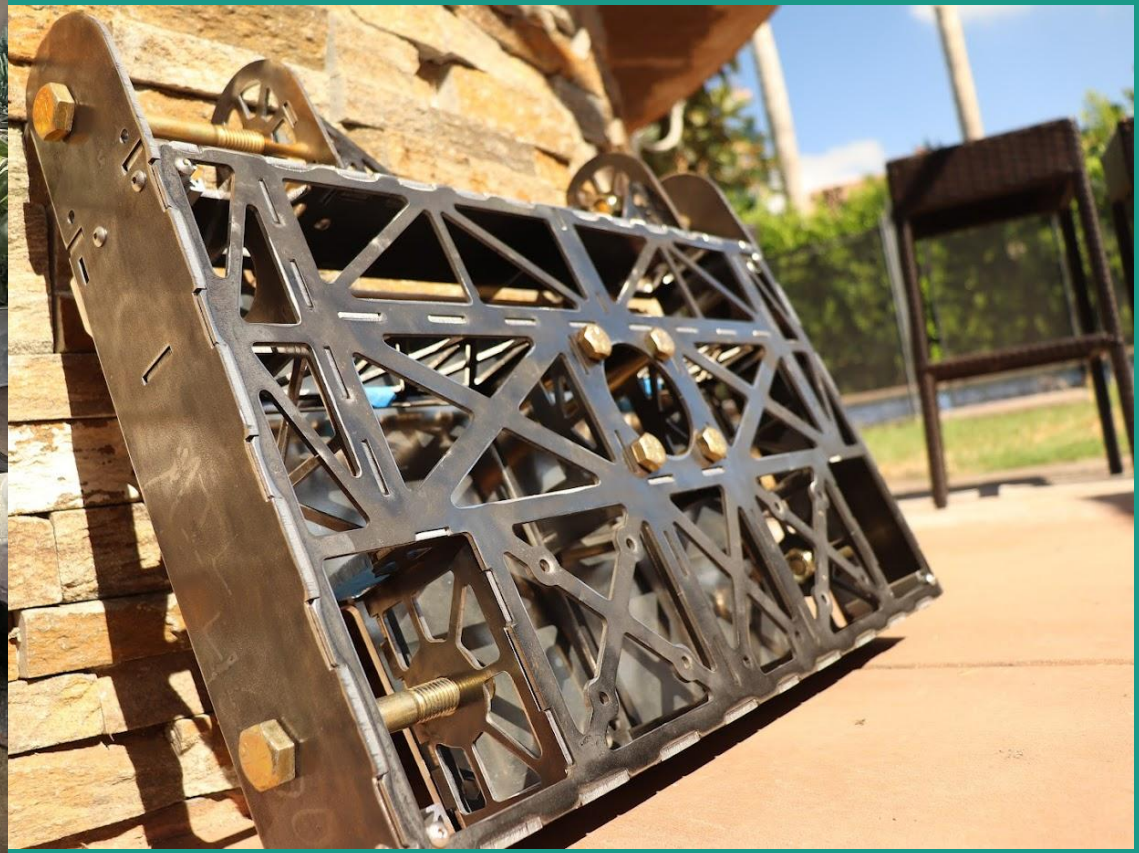
FIRST

- Involved in Edu robotics for the last 8 years
- Mentored 11 teams last year
- 3 ftc teams at worlds (last 2 years)
- Mentored 18457 during worlds win
- Mentored FLL team to worlds qual

Manufacturing Processes

2.5D

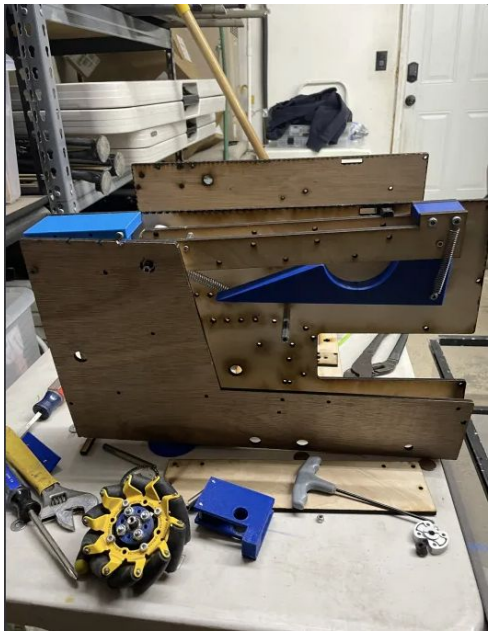
2.5d manufacturing is the act of cutting 2d parts that come together to make a 3d part

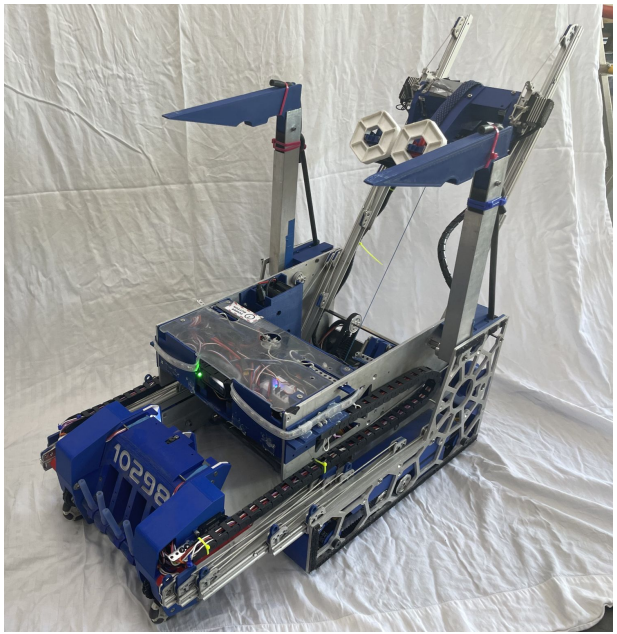


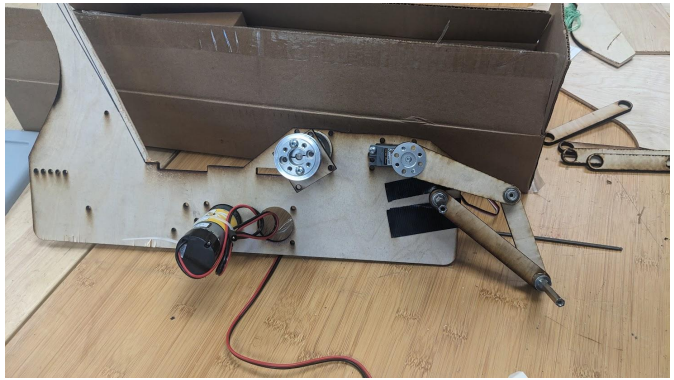

BEND
A222

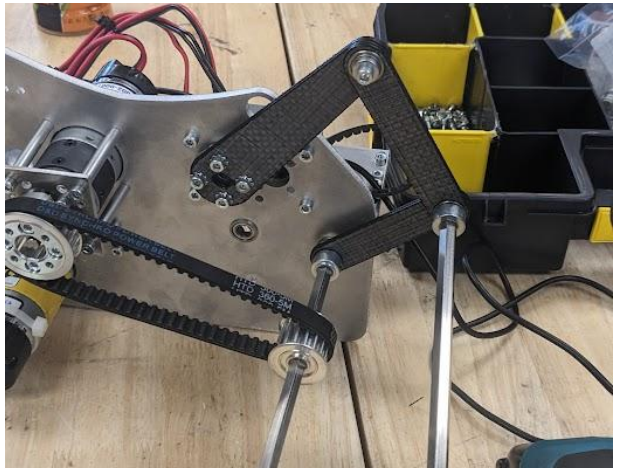

507
Mechanical Movements
Henry T. Brown

Prototyping 2d









Manufacturers

Send Cut Send

Serra Laser and Waterjet*

Oshcut

Fabworks

Cnc madness

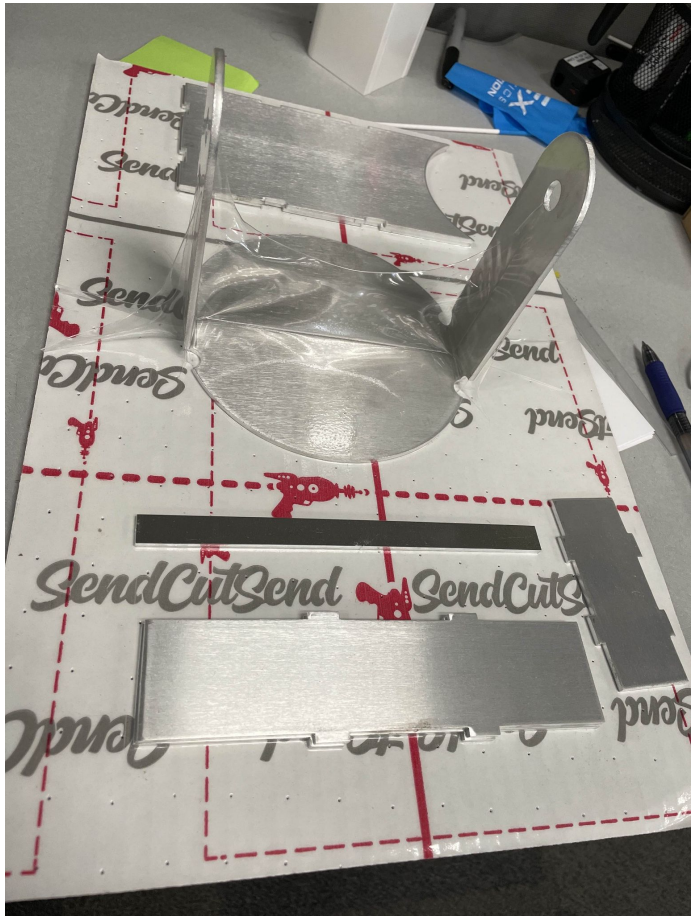
SendCutSend

Pros:

- Fast auto quoter
- Lots of material options
- Decent prices
- Easy discount codes
- Bending for some materials
- Tapping for some materials

Cons:

- Not always reliable
- One location is much slower
- Occasionally you receive other people's parts
- Price is fair but not good
- Bending and tapping is very expensive



This was not meant to be a phone holder

Oshcut

Pros:

- Quick(ish)
- Decent material selection
- Bending
- Laser Tube Cutting
- Tapping
- Online autoquoter

Cons:

- Expensive
- Can be bogged down depending on industry needs

Fabworks

Pros:

- Good autoquoter
- Fast service
- Easy to use website
- forward to purchaser is nice for schools
- local

Cons:

- Low material selection

CNC madness

Pros:

- Cheapest carbon fiber
- Shipping is pretty fast

Cons:

- Email only
- Can be slow

*sponsored

Serra laser and waterjet

Serra Laser Center

Pros:

- local
- Fast
- SOCAL FTC discount
- Good material selection
- Laser weld
-

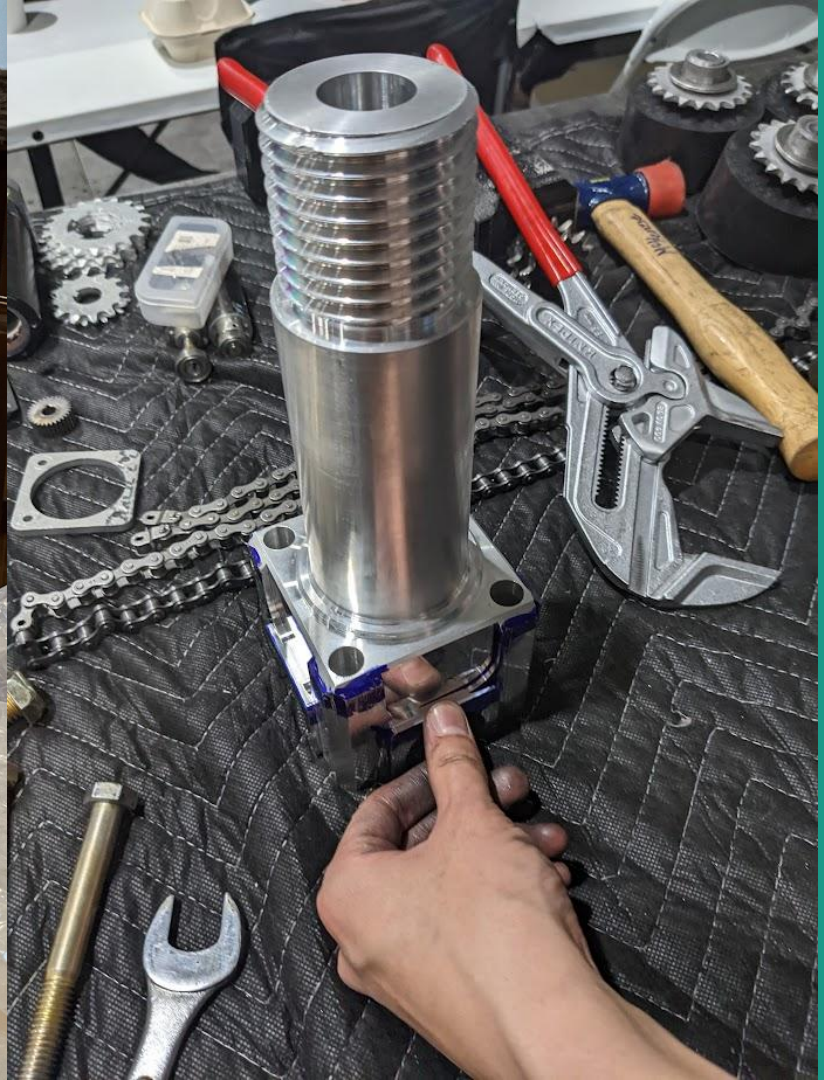
Cons:

- 185 min

3d

3d parts get machined and allow you to have features on multiple faces


RAPID
AXIS
Machining - Sheet Metal - Urethane Casting - 3D Printing - Molding
www.RapidAxis.com




RAIN
DOWN
THE
RAIN

Manufacturers

Xometry

Protolabs

Local shops

Rapid Axis*

Protolabs

Pros:

- Fast auto quoter
- Lots of material options
- Mainly 3d manufacturing with some metal 3d printing

Cons:

- **INCREDIBLY EXPENSIVE $$$**
- Internal manufacturing
-

Xometry

Pros:

- Fast auto quoter
- Lots of material options
- Almost every type of manufacturing available

Cons:

- **INCREDIBLY EXPENSIVE $$$**
- All outsourced but quality controlled

Local shops!

Pros:

- Local shops are more likely to help teams
- Trade shows

Cons:

- **No auto quote**
- You have to interact with someone
- Unknown capabilities
- Small shops have to stop running parts that make them money to help you

Rapid Axis*

Pros:

- Made in the US
- Shipping from California
- Great support
- Socal ftc discount
- Auto quote coming soon

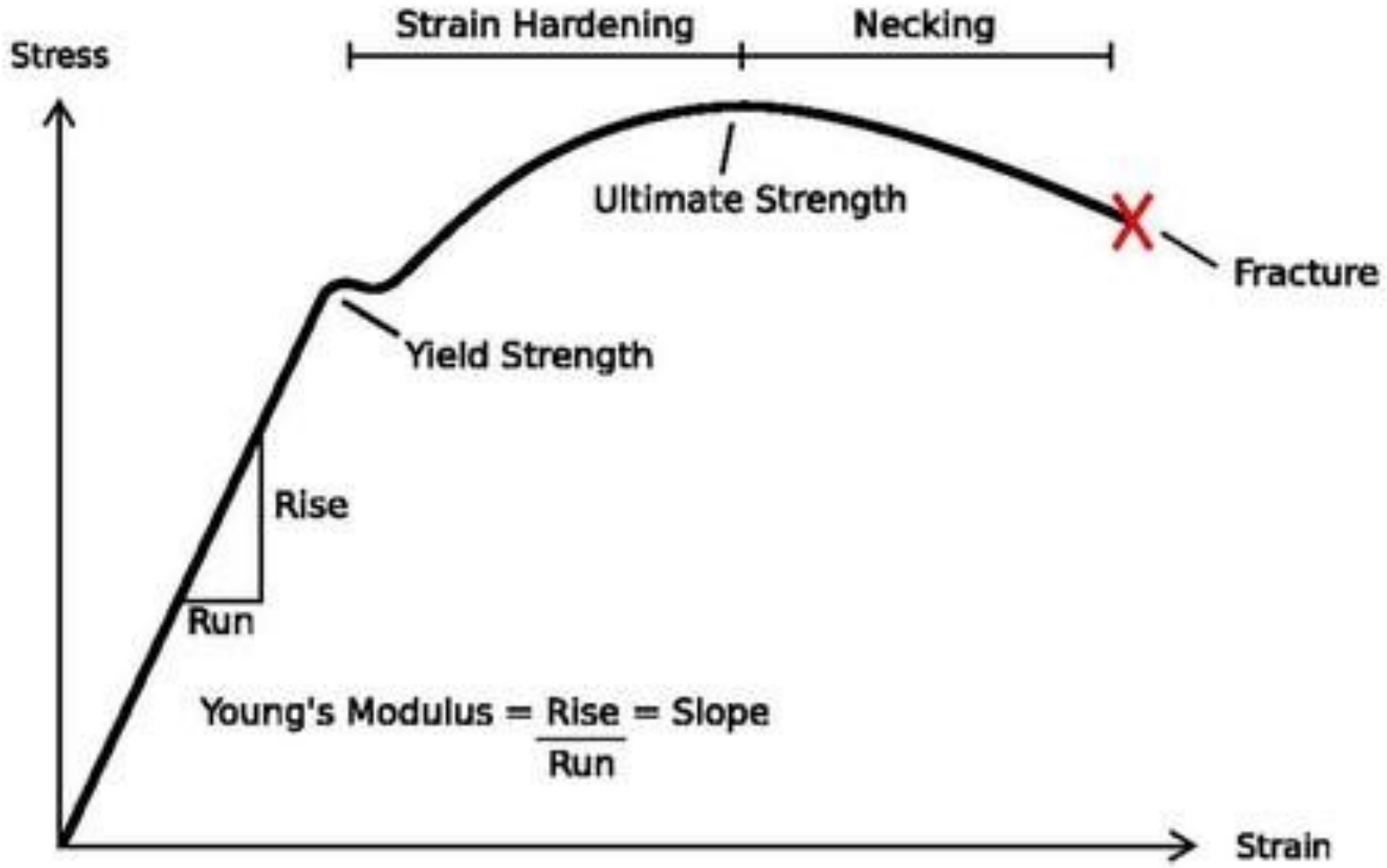
Cons:

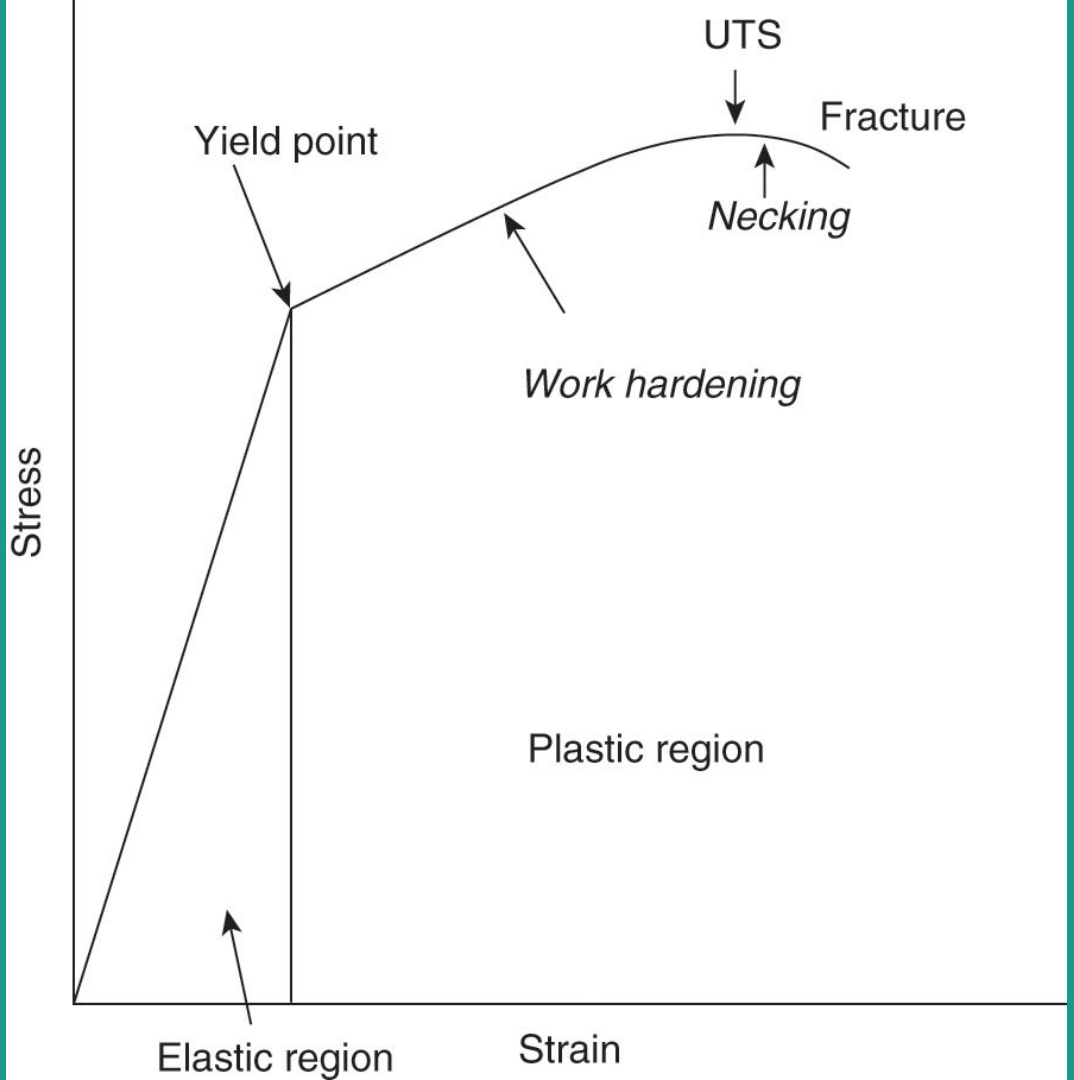
- Medium pricing

MATERIAL SCIENCE

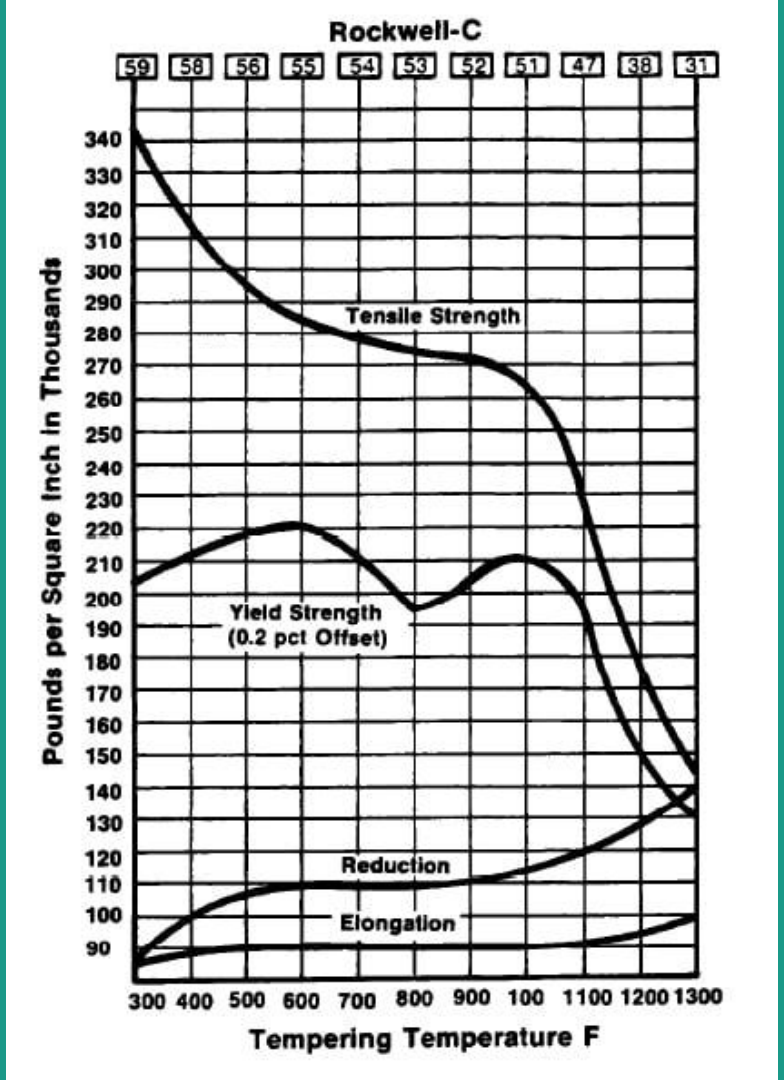
Disclaimer

I’m a material science nerd.


Strain Hardening
Necking
Stress
Ultimate Strength
Fracture
Yield Strength
Rise
Run
Young's Modulus = Rise / Run = Slope
Strain


UTS
Fracture
Yield point
Necking
Work hardening
Stress
Plastic region
Elastic region
Strain

S7 tool steel



3d Printing

Cheap easy and functional

Materials

PLA/PLA+

PETG

TPU

Nylon

Onyx

PLA

Pros:

- Strong in compression
- Easy to print
- cheap

Cons:

- Certain flavors are fragile

PLA+

Pros:

- Really strong generally
- Easy to print
- cheap

Cons:

- Not super rigid

PETG

Pros:

- Easy(ish) to print
- Cheap
- Temperature resistant
- stiff

Cons:

- Shattery
- stiff

TPU

Pros:

- Medium difficulty to print
- Cheap
- FLEXIBLE
- Indestructible in FTC

Cons:

- Flexible
- Semi slow to print
- Direct drive 3d printer highly recommended

Unfilled Nylon

Pros:

- Slightly flexible
- Stiff
- Incredible durability

Cons:

- Expensive
- Hard to print
- Needs enclosed printer
- Hygroscopic (will get wet)

Glass filled Nylon (NylonG)

Pros:

- Very Stiff
- High durability
-

Cons:

- Expensive
- Hard to print
- Needs enclosed printer

Onyx

Pros:

- Very Stiff
- High durability
- Almost the same strength as aluminum
- Continuous fiber

Cons:

- **Expensive**
- Need specific printer (that costs 15k)
- Excessive for almost everything in FTC

Metals

Strong and durable

Materials

Aluminum 5052

Aluminum 6061

Aluminum 7075

Aluminum 2024

Steel a36

AR500 steel

1075 spring steel

Brass

Titanium 6Al-4V (grade 5)

5052 aluminium

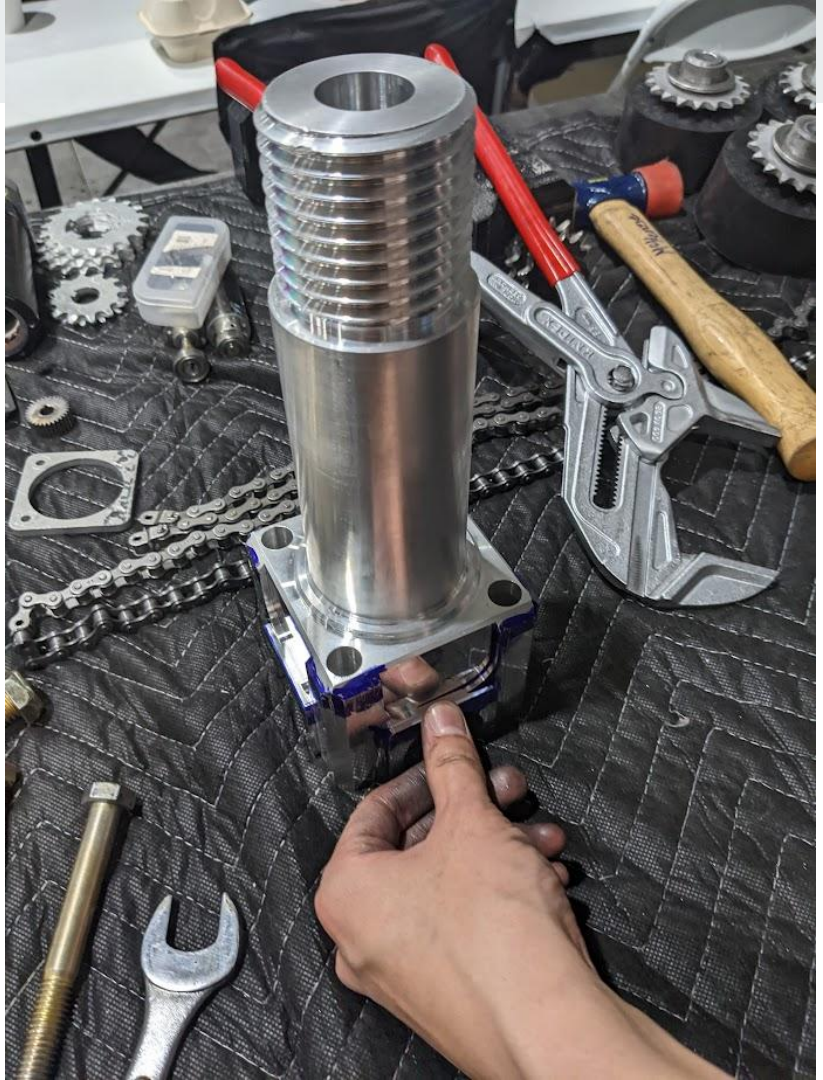
5052 is cheap and bendable

Weldable

6061

6061 is decently priced and stiff

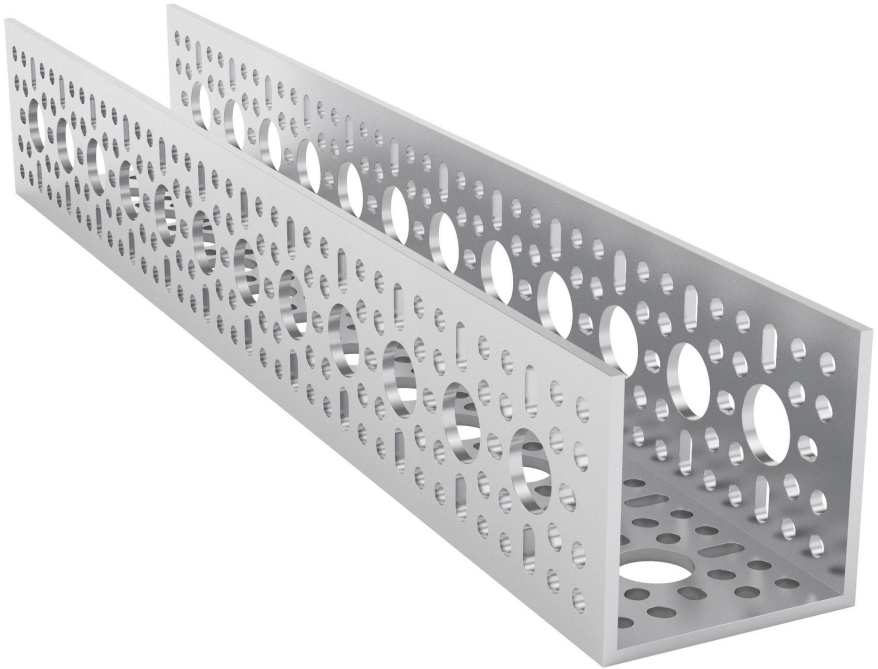
weldable



7075

7075 is expensive and very stiff

Non weldable



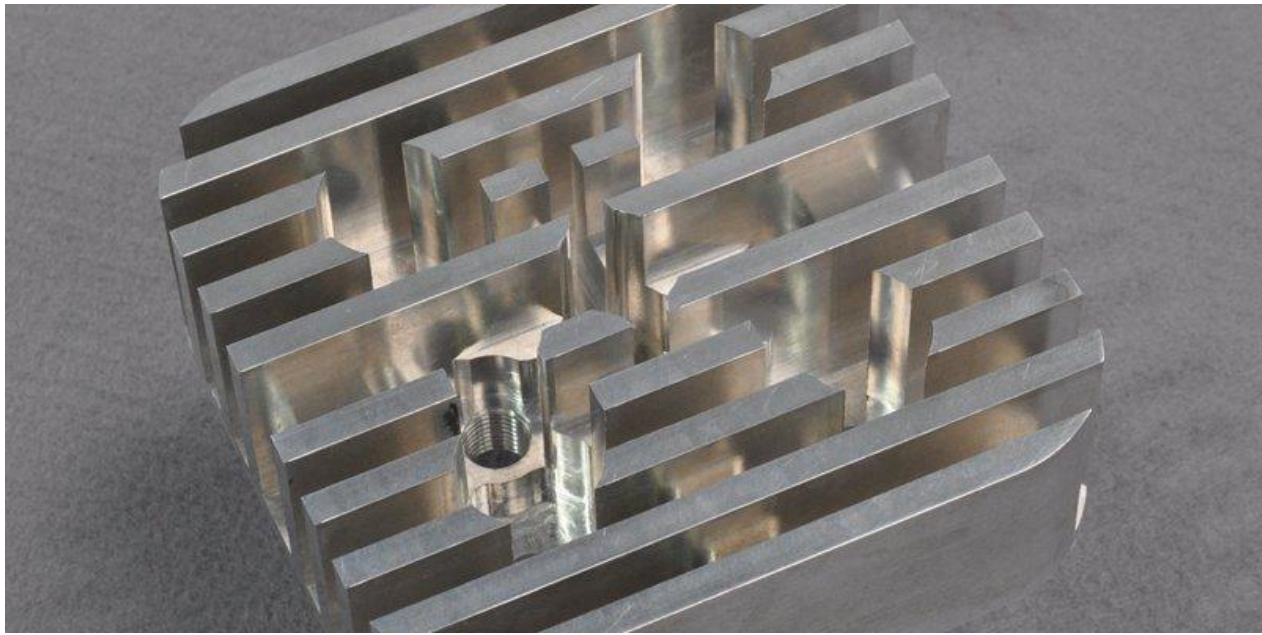
Patented

2024

2024 is expensive and pretty stiff

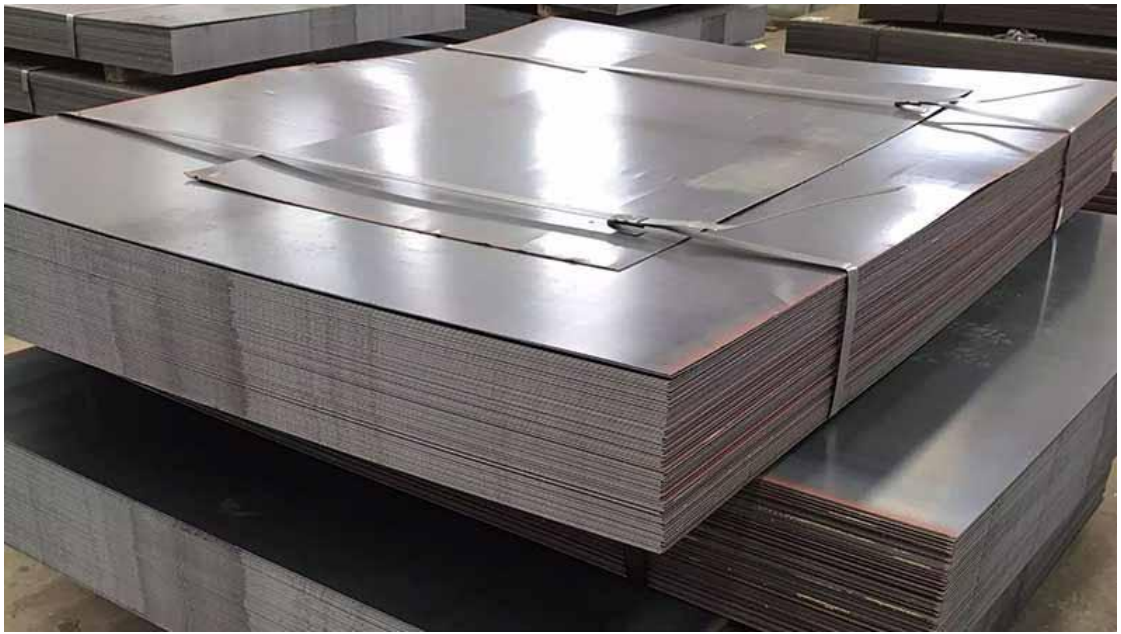
Non weldable

Excessive for any ftc parts



A36 (mild steel)

Very ductile and heavy



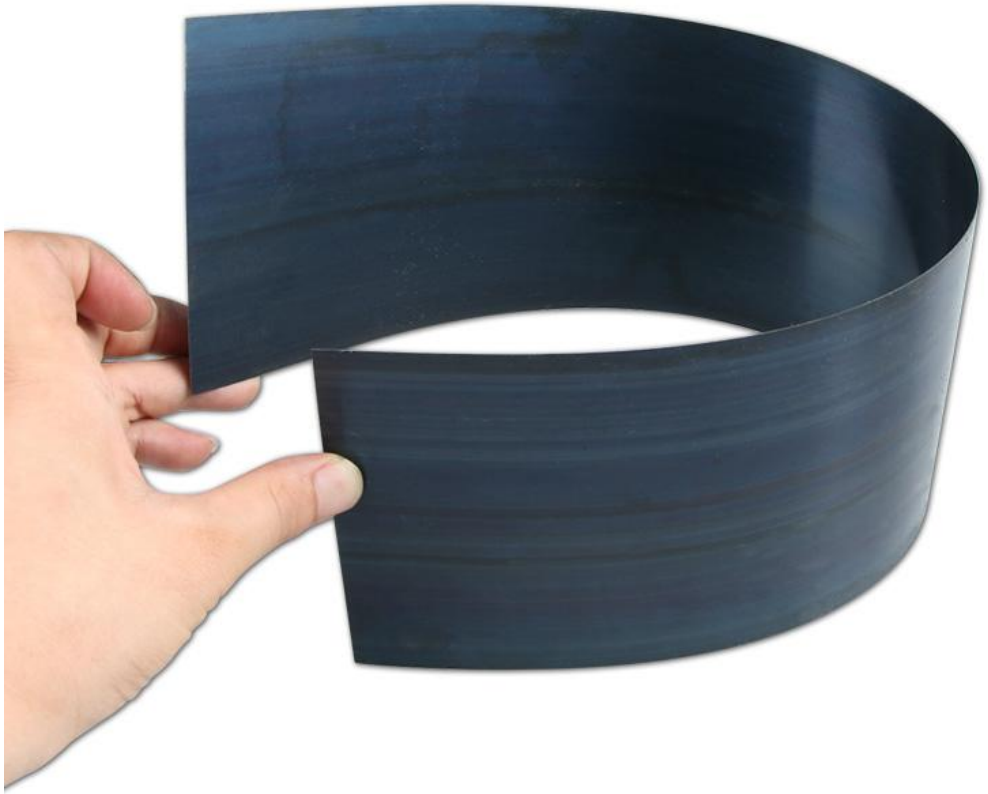
AR500

Heavy and absolutely indestructible for ftc

1075 spring steel

Thin and flexible

Can be used as a spring or as a flexible part

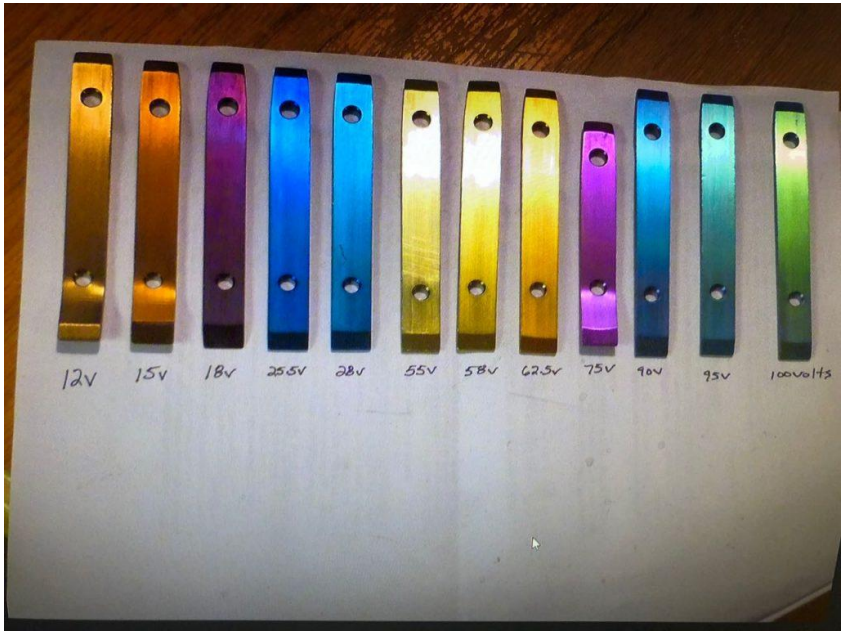


Titanium 6Al-4V (grade 5)

Springy but stiff

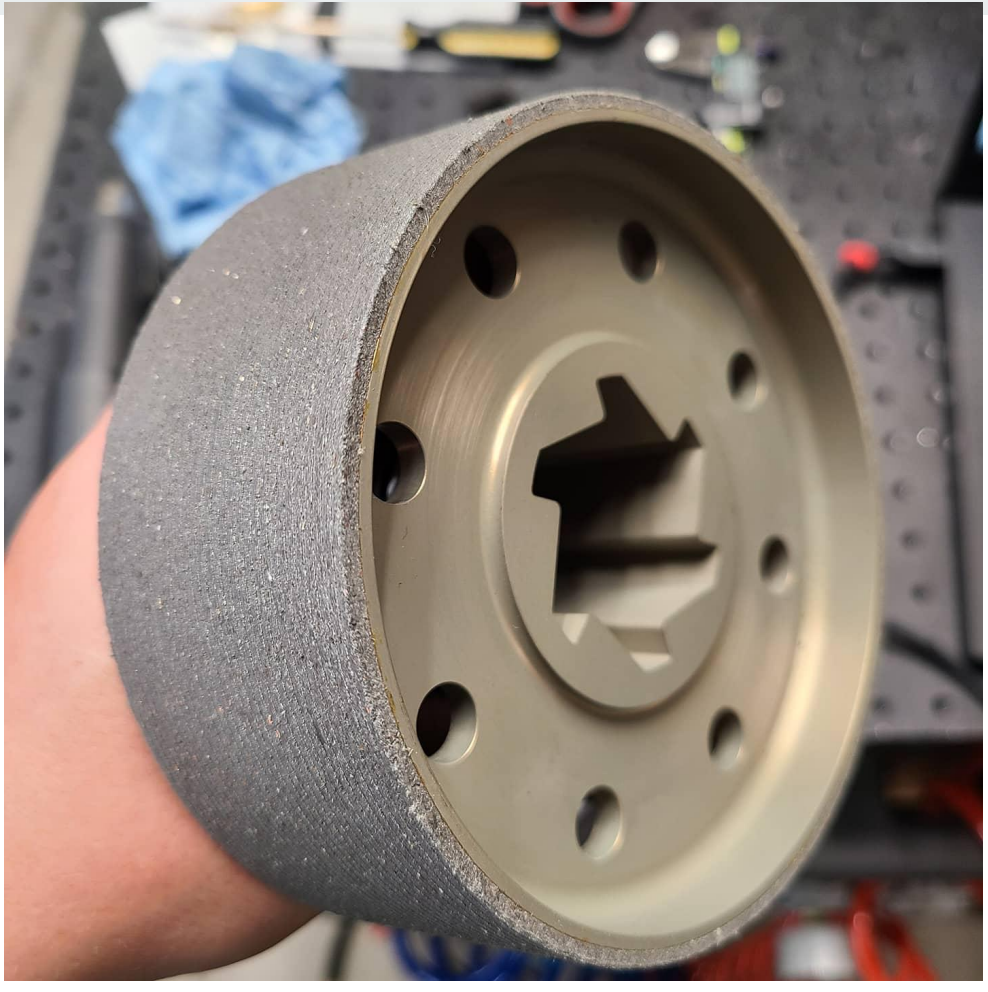
Can be much thinner for same strength as aluminum

Very easy to anodize



Brass

heavy very ductile



Other Plastics

Durable Cheap and easy

Materials

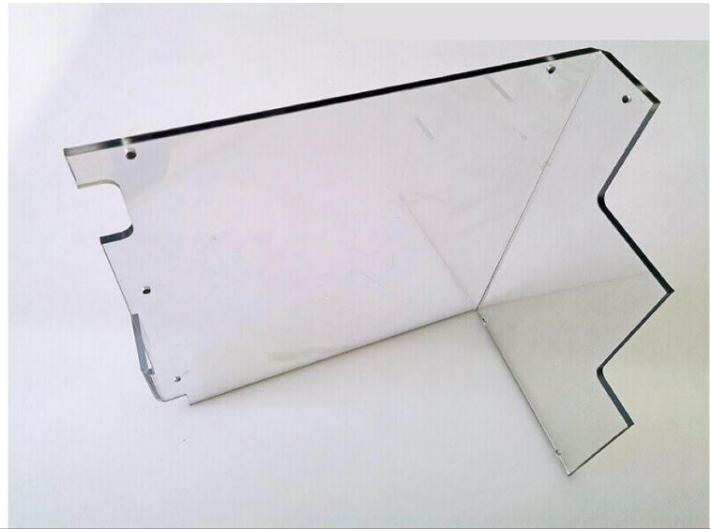
Polycarbonate

UHMW/HDPE

Tegris

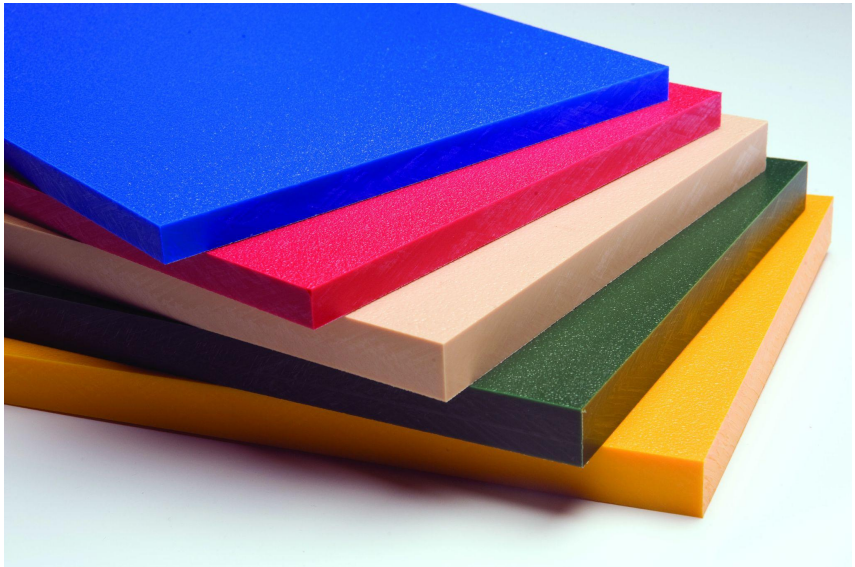
Polycarb

Light and see through, can be bent easy doesn’t shatter but does break



UHMW/HDPE

Strong but flexible not bendable very gummy works like wood



Tegris

Strong and stiff until it’s flexible not bendable when thick very bendable when thin very gummy works like wood

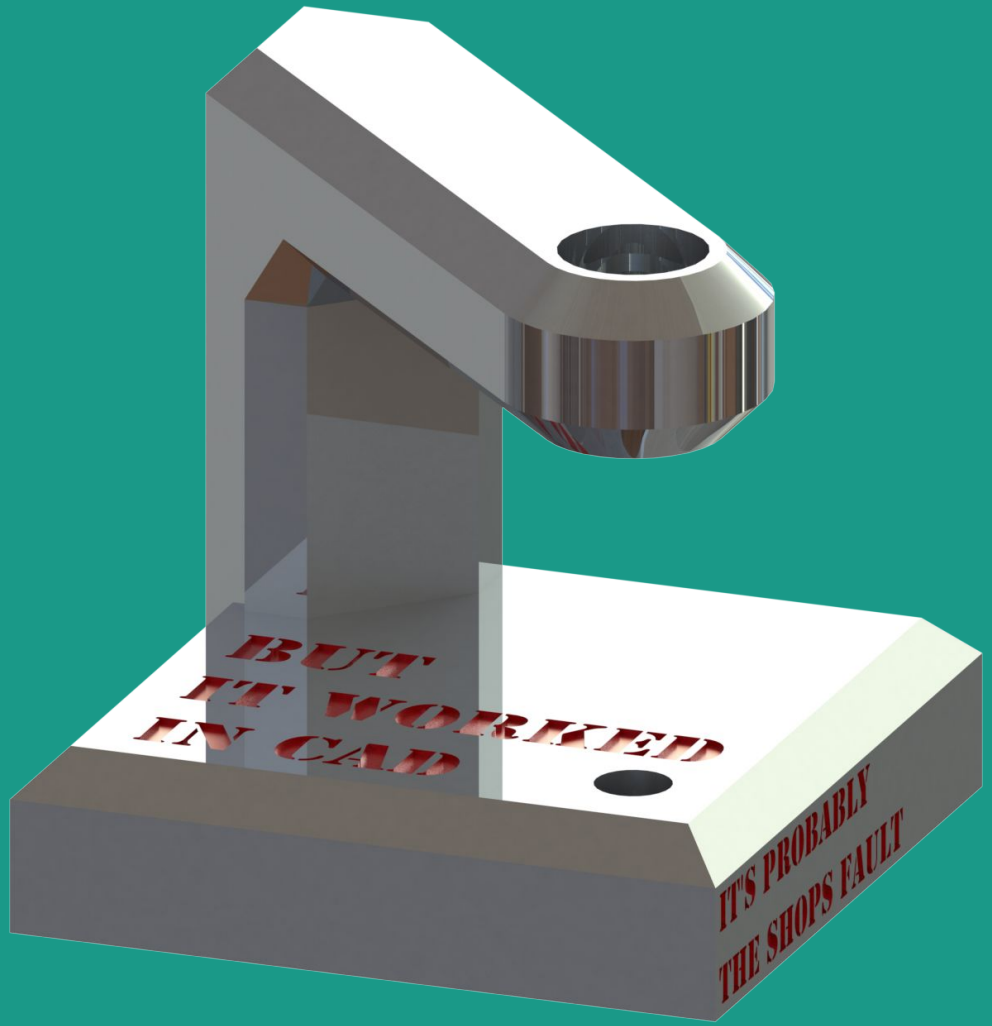
REV ROBOTICS

DFM

DESIGN FOR MANUFACTURING!

Please do it, save your machinists

And your wallets

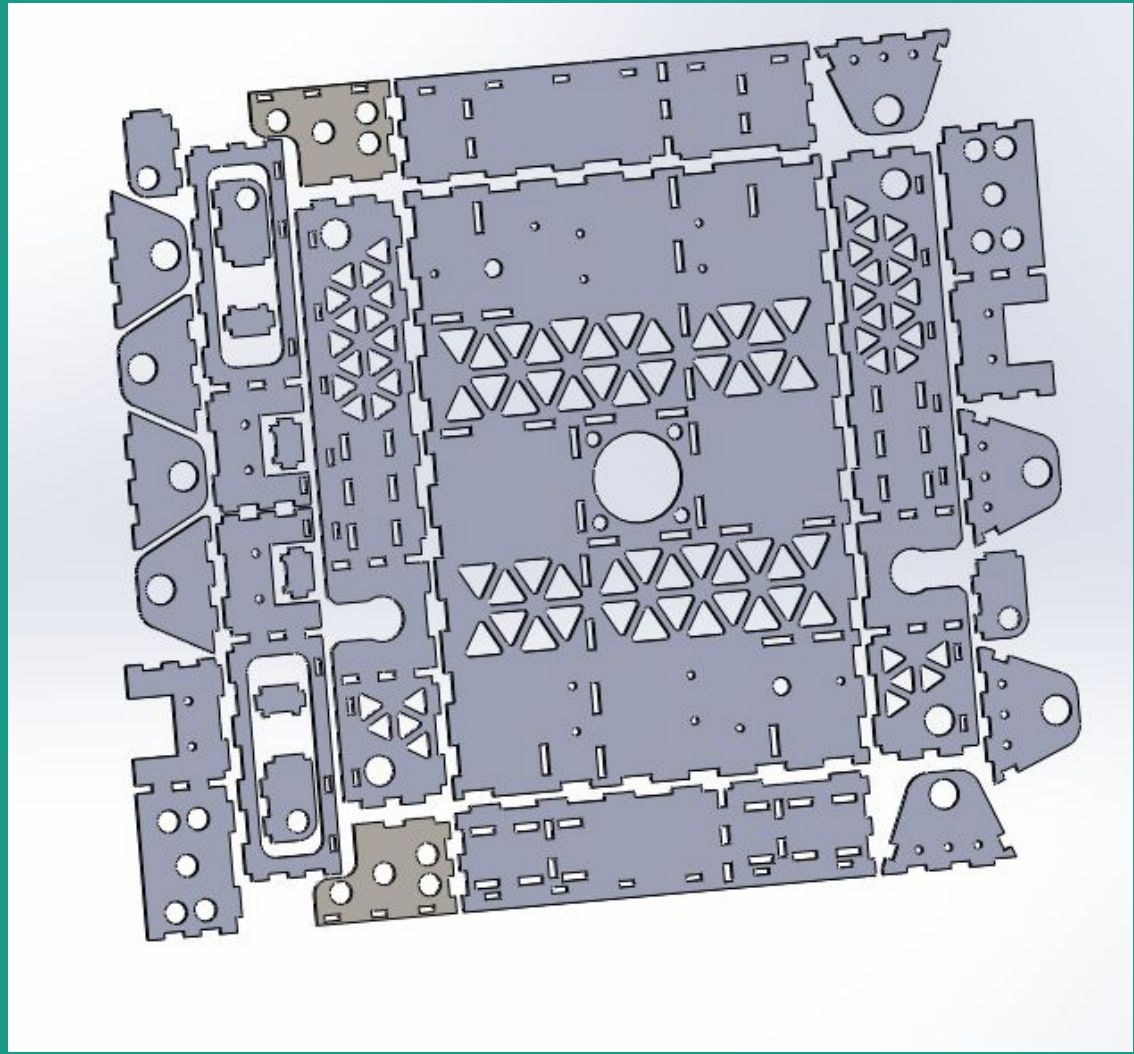

BUT
IT WORKED
IN CAD
IT'S PROBABLY
THE SHOPS FAULT

Think about how it's made

2d laser/waterjet

Cut only from the top

The more of a sheet you use the cheaper it can be (per part)

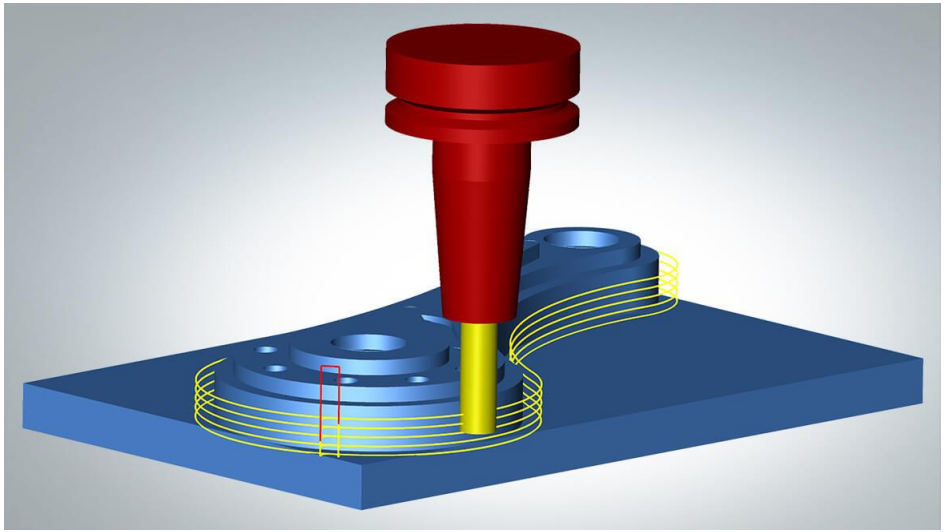


Think about how it's made

3d parts

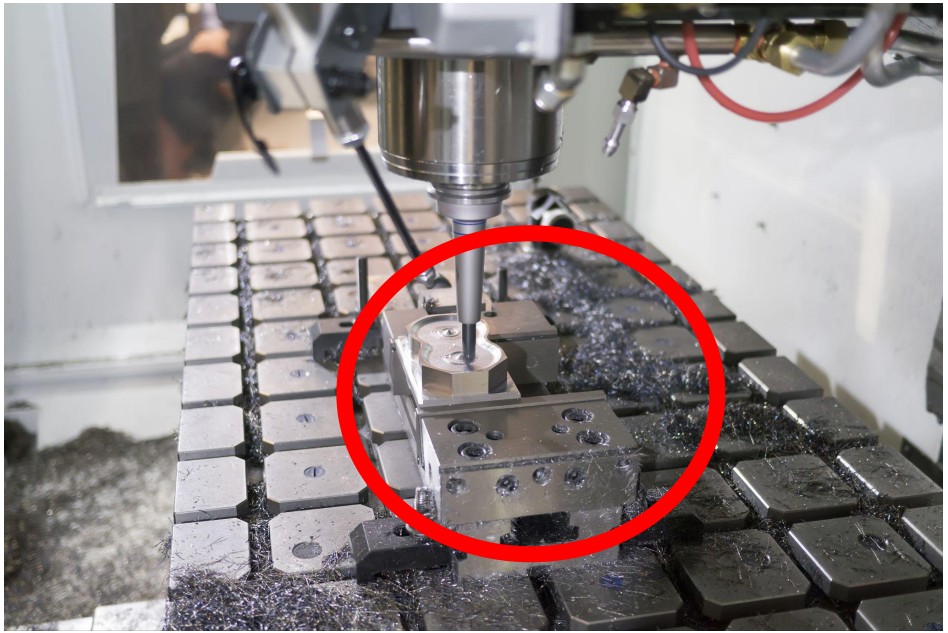
A tool has to travel to cut

Think about radius of the tools



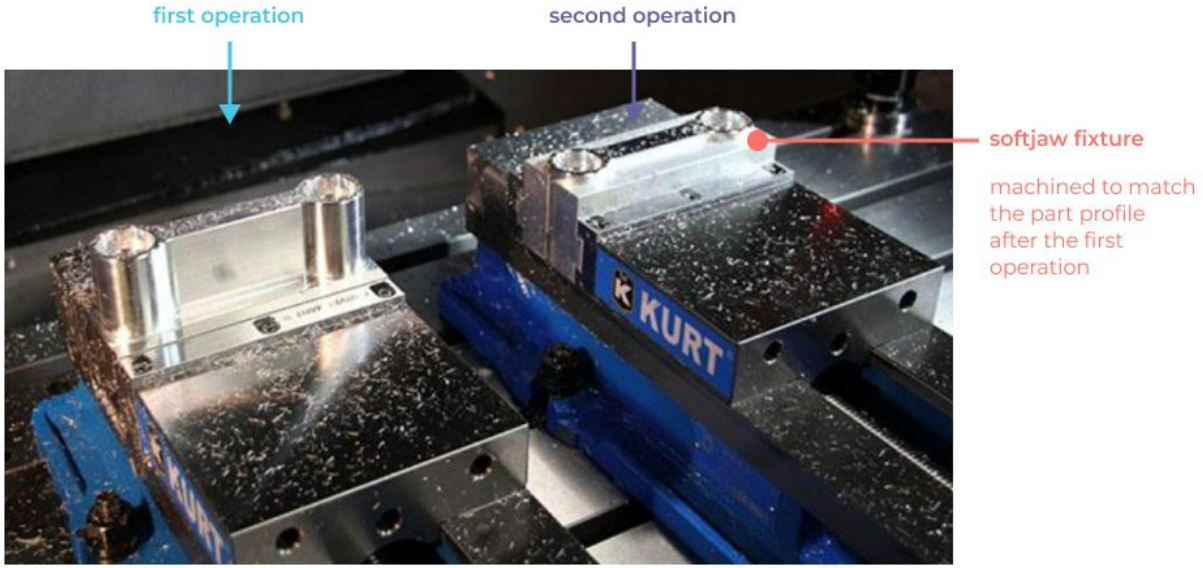
Think about how it's made

You need to hold the part in the machine



Think about how it's made

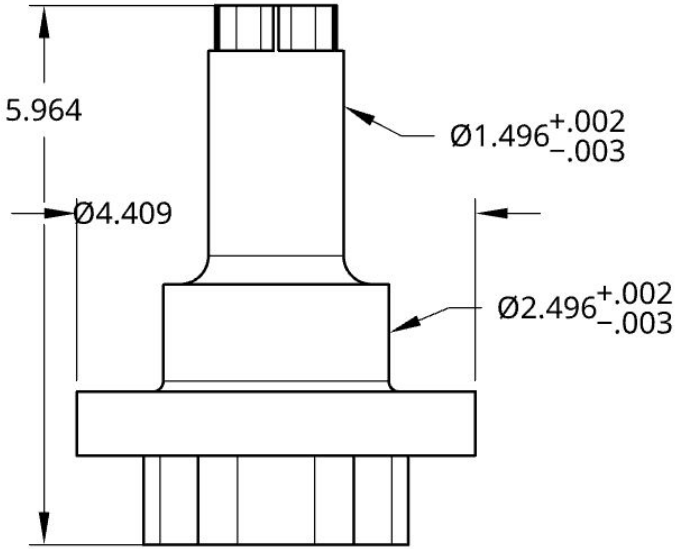
The less time operators have to setup the part in the machine the cheaper it will be

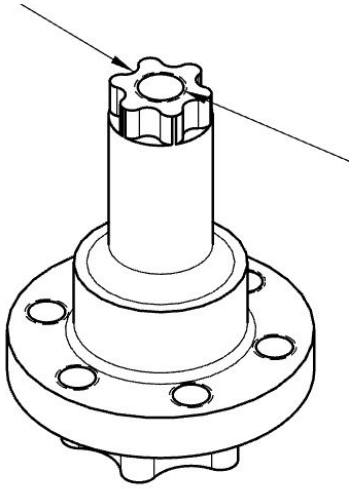


Think about how it's made

Your stock must be as large as your widest part of the part

This part is designed to use stock that is 4.5” x 6”





Think about how it's made

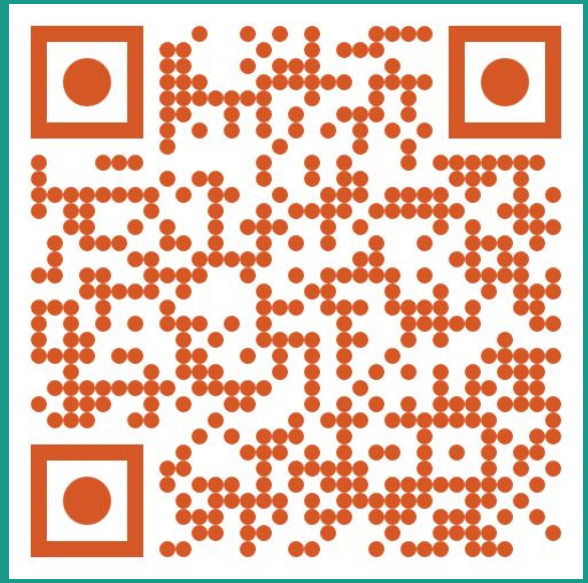
5 axis parts

A tool has to travel to cut

The table and part can move

Parts are more expensive as programing time goes up

Resources →



Thank you!

Any questions:

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https://horizon250.com/pages/ftc-resources