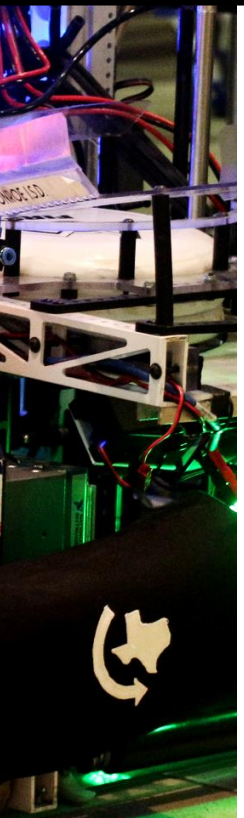
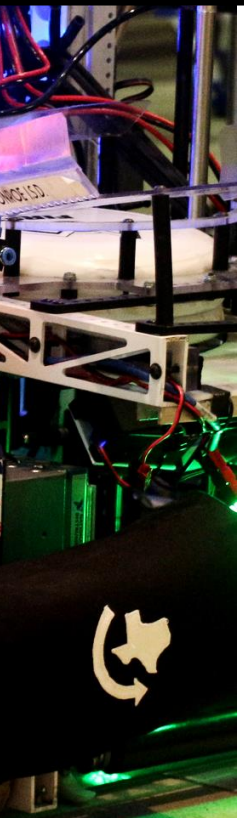
CAD GUIDE

Alex Choi



The System
The Hardware
The Prototype
The Design
The Creation

FILE HIERARCHY



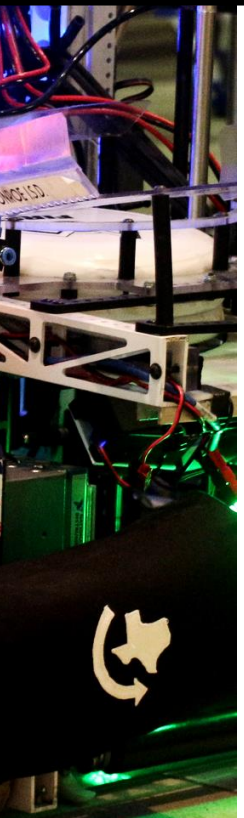
year(##)-subAssembly(#)part(##)[M]irror
Rev #

ex. 14-102M Rev 2

2014 Season - Drivetrain Part 2 Mirrored Revision 2

Generally:
1=Drivetrain 8=Bumpers 9=Electronics 2-7=As Needed

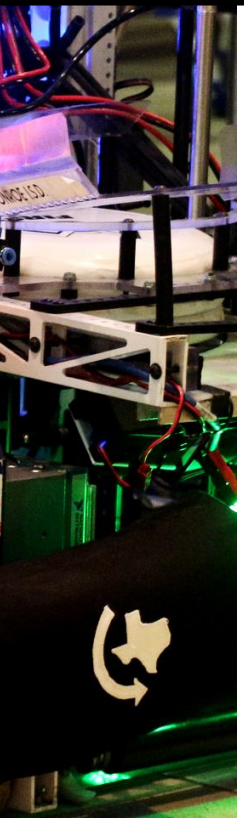
FOLDER TEMPLATE



Found in Resources Project

cam - CNC models
concept - ideas, math, and prototypes
drawing - SW drawings
exp - exports such as screenshots
old - where old parts/revisions go to die

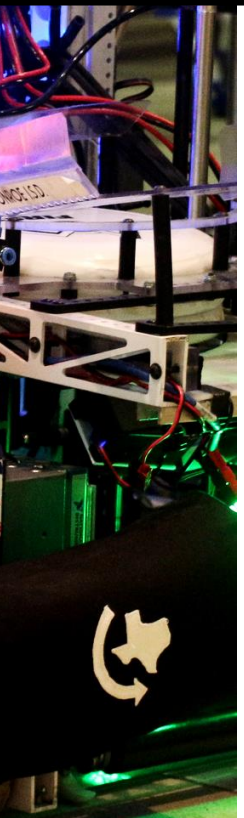
HOW NOT TO SCREW UP



If two people work on the same part and save two different versions, it's going to mess up the file a bit.

Communication is Key

THE TRIPLE ZERO

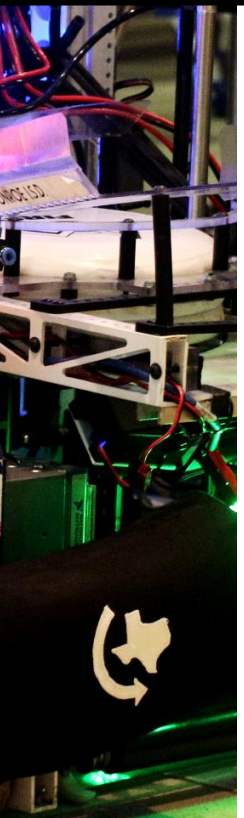


The full robot CAD is called the Triple Zero.

ex. 14-000

To avoid breaking things, please don't touch it unless absolutely necessary.

You **MUST** communicate if you're changing the 000.



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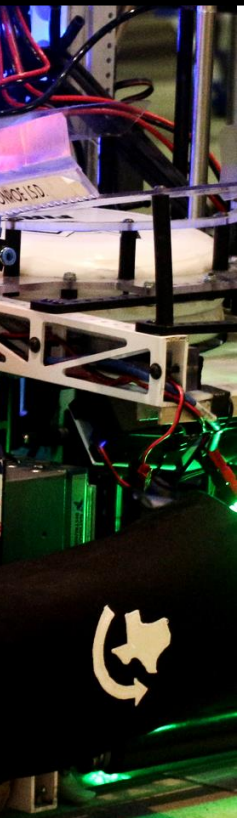
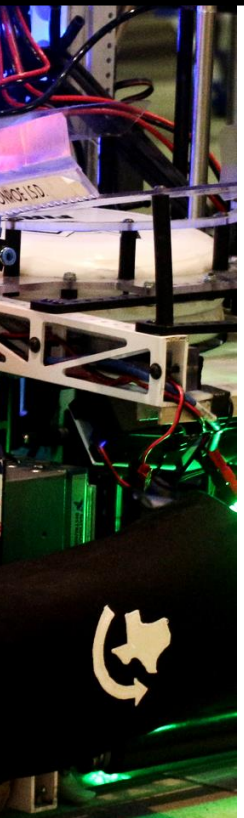
LAPTOPS



- Highly recommended to have one
- OpenGL vs DirectX
- CPU vs GPU

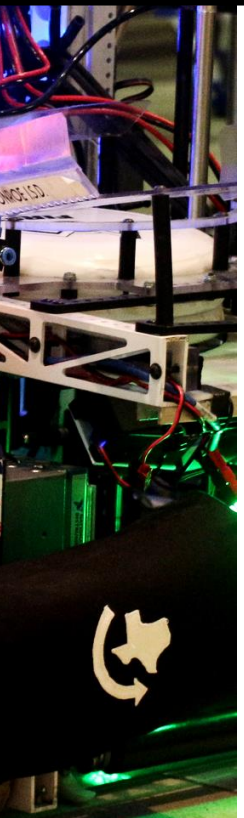
- Using a mouse is also recommended

GRABCAD - FEATURES



- Browser and Mobile Viewing
- Lockable Parts and Assemblies
- File Sharing
- Automatic Updates
- Multiple Version Parts
- Project Management

SOLIDWORKS

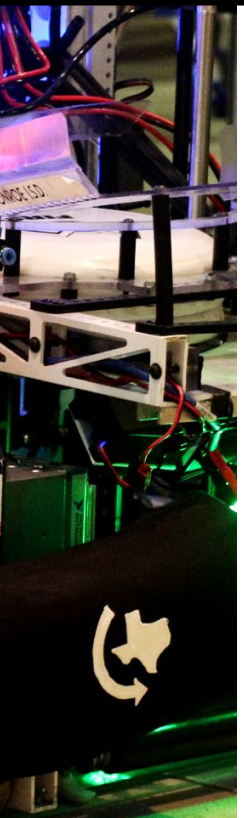


If you haven't got it yet, search your email

- CAD Software
- It's how we design the robot

SOLIDWORKS

SOLIDWORKS - SETTINGS

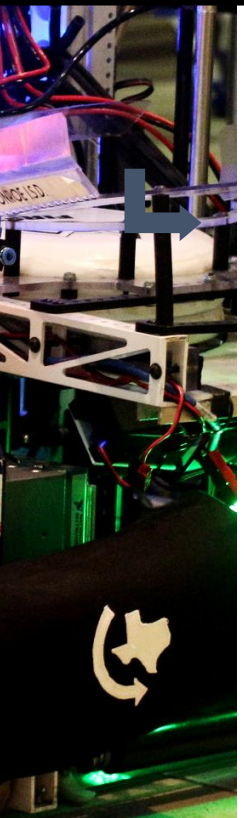


2014 - CAD - 1477 > _library > _Solidworks Templates > Solidworks Settings Files > Solidworks Settings-Rev4

Complete the wizard

- New Hotkeys
- New Properties Entries
- New Settings

SOLIDWORKS - TEMPLATES

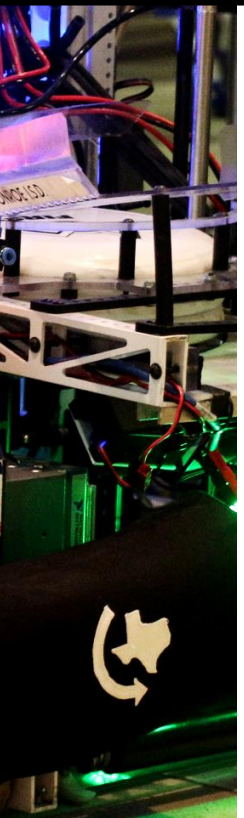


http://www.ntwind.com/software/utilities/visual-subst.html
Create a new virtual partition, link it to your CAD folder

Open SolidWorks>Options>File Locations
Add YourNewPartition>_library>_SolidworksTemplates

Try making a new part, see what happens

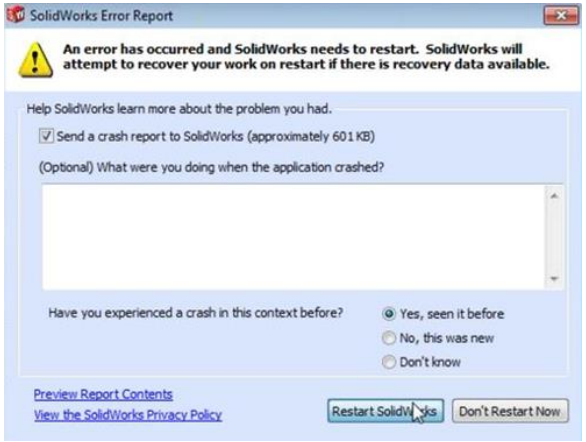
SOLIDWORKS - DISCLAIMER

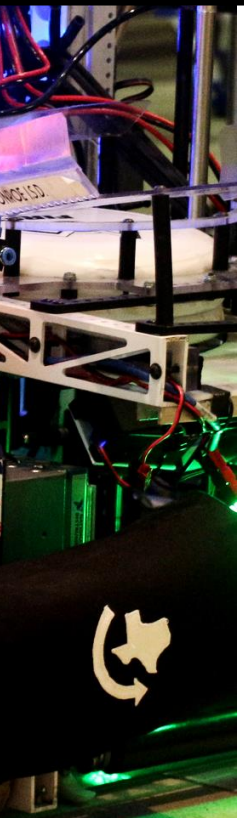


It’s great, it’s cool, but it can still crash

Your client *will* crash
(probably, maybe, eventually)

So don’t forget to save





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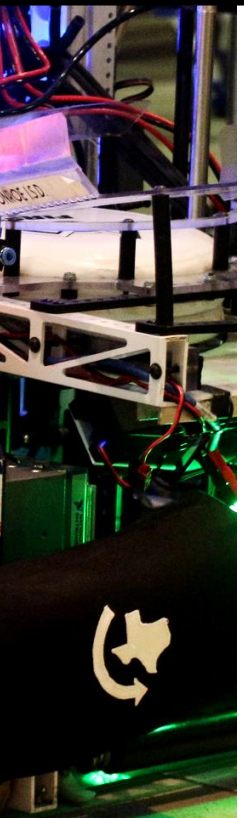
PROTOTYPING - HIERARCHY



Mechanical Lead

Oversight
Project Management
Confirmation

Project Lead

Project Oversight
Preliminary Design
Data Analysis

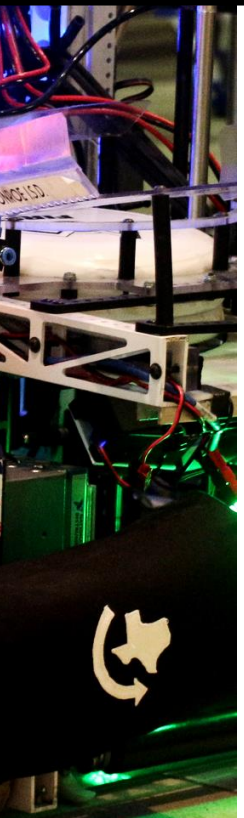
Build Member

Construction
Experimentation
Data Collection

Rough CAD
Req. Meas.
Sketches
Concepts

CAD

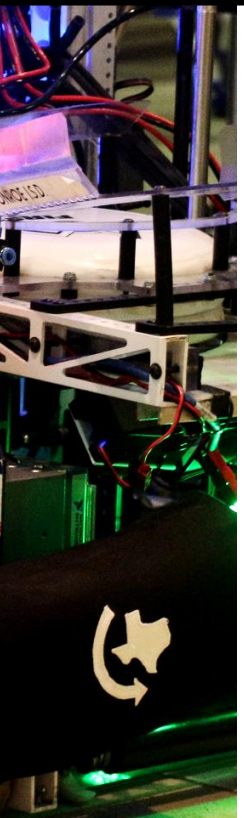
PROTOTYPING - PURPOSE



Prototyping for the final product:
Measure what Matters!

There's no point in gathering data for something that will behave differently on the final robot.

(Usually)



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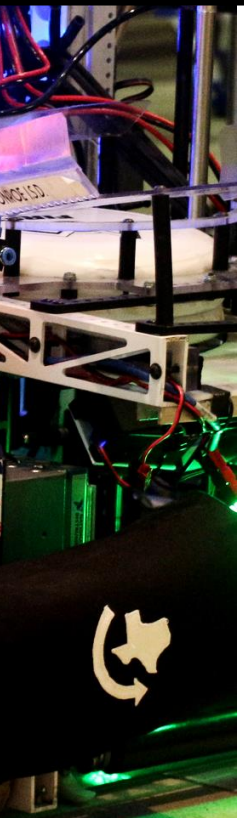
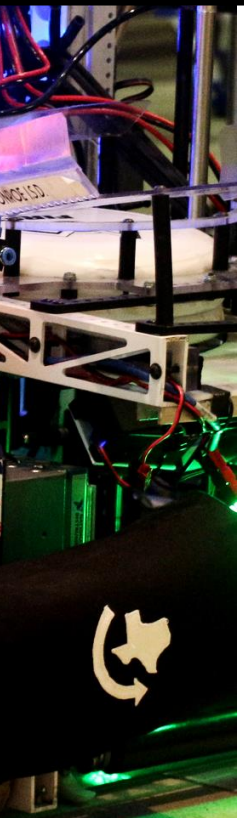
PARAMETERS



Easy to work with:

- Fixable
- Ergonomic
- Pragmatic
- Realistic
- Reliable

DESIGN

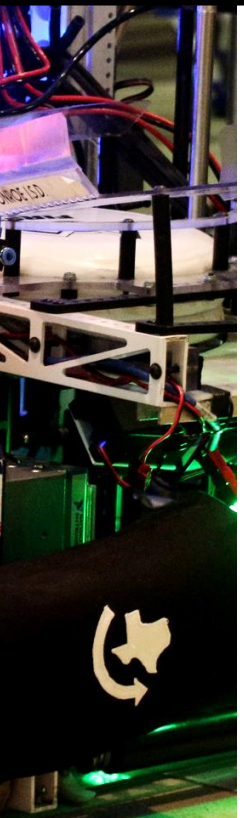


Everything is being made and fixed by humans

Avoid:

- Impossible bolts
- Unreachable fasteners
- Permanent fixtures

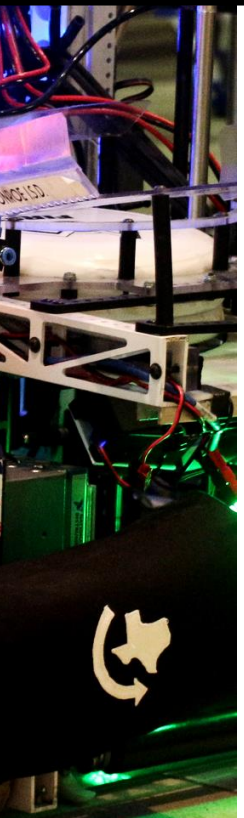
DESIGN - IDEAL VS REALITY



SolidWorks represents the perfect world
We do not live in a perfect world :(

Keep in mind tolerances, behaviors, and shoddy workmanship.

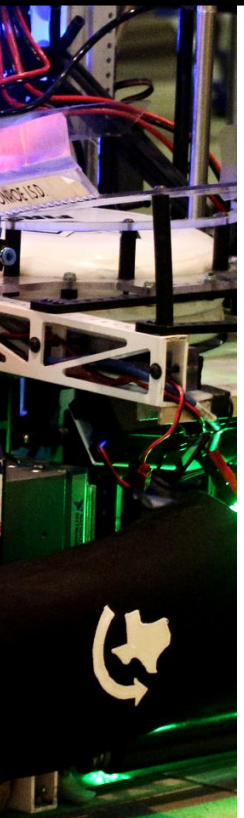
DESIGN



Don’t forget the end goal, you can have the prettiest CAD ever made, but if it doesn’t work then what’s the point?

Focus on the final product.

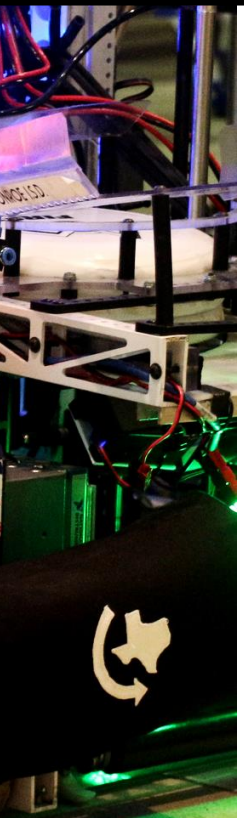
INTEGRATION



When making sub-assemblies, keep in mind everything around you.

You have to design around other things, so the optimal may not be possible.

MATH



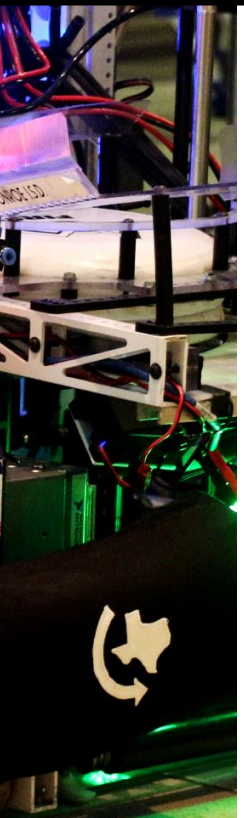
Good designs have good math

- Gear Ratios
- Power Draw
- Currents
- Motor Combining
- Torque Calculations
- Chain/Belt Center Distancing
- Velocity
- Air volume
- Weight Distribution
- So on and so forth...

Use your resources:

- JVN Calculator
- Copioli Useful Calculations Sheet
- Previous Robots
- Other team CADs

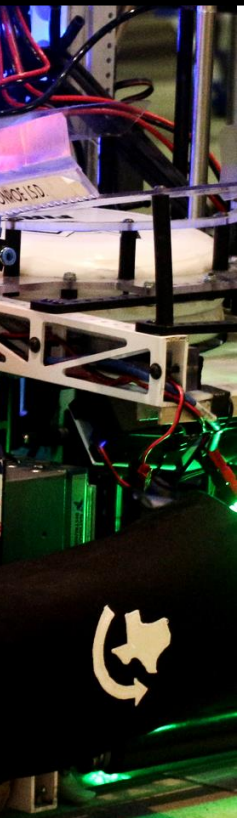
GEOMETRY



Remember back to math class:

- 2 points define a line
- 3 points define a plane

If you have shafts or plates, keep in mind your degrees of freedom.



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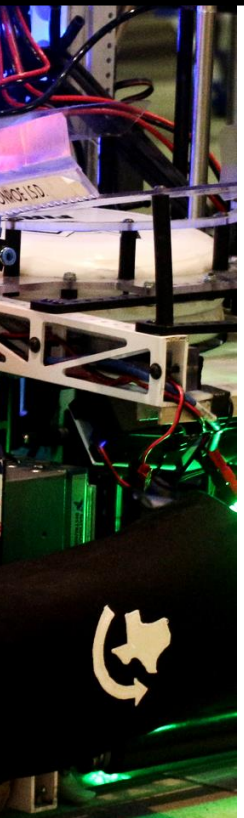
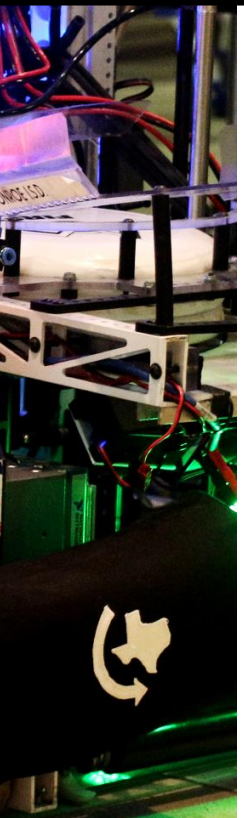
TUTORIALS



- Introduction to SW
- Parts
- Assemblies
- Patterns
- Filleting
- Sheet Metal

BRIEF REVIEW

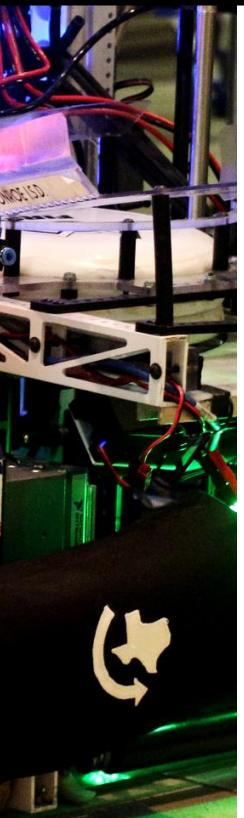


Assemblies>Parts>Features>Sketches

You have 3 Reference Planes (Front, Top, Right)

Know what a mate is

Also, try to learn your hotkeys



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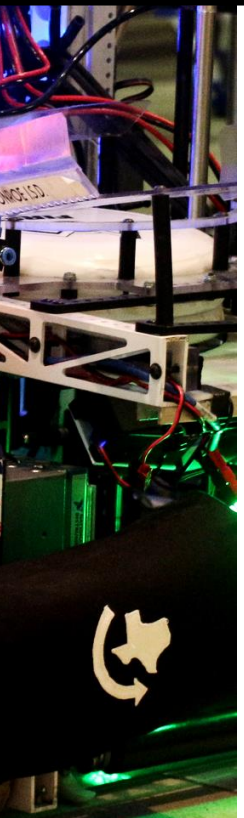
The Creation - Sketches

SKETCHES

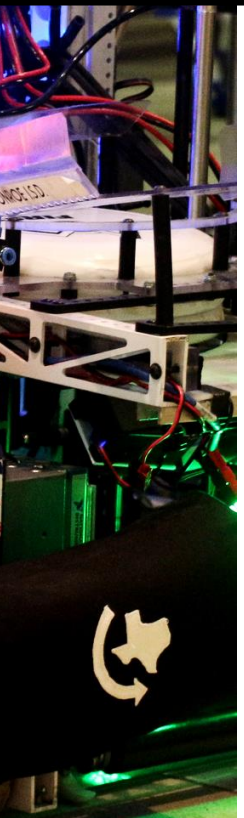


What is it?
A 2-Dimensional drawing used to define features for a given plane.

A good sketch is fully defined and can be easily redefined.

Don’t have your sketch do too much
They can take a while to open up, make the sketch to fit the features, don’t try to do it all at once.

CONSTRUCTIONAL GEOMETRY

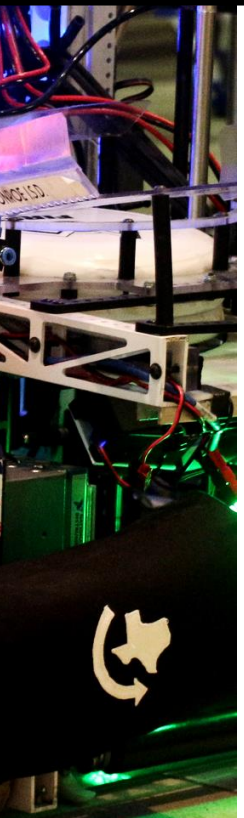


Try to maximize relationships and minimize dimensions
This usually increases ease of adjustability (usually)

Centerlines are your friend!

- Constructional Geometry
- Allow for mirroring
- Other stuff I'm probably forgetting

FULLY DEFINING

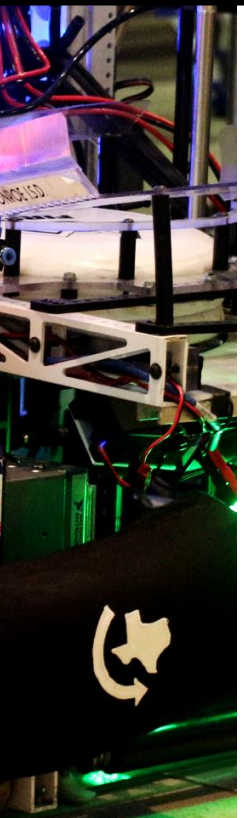


If a sketch is “fully defined” then there is only one state in which it can exist.

Achieving this can be relatively difficult to do without making weird relations.

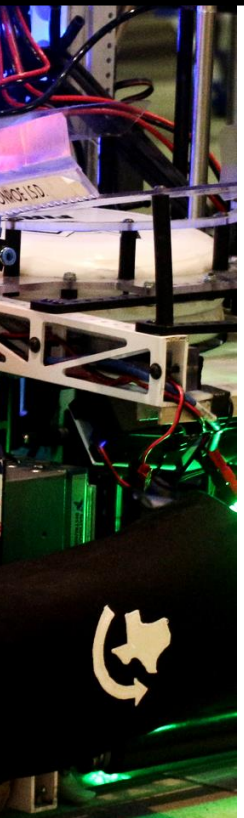
All sketches for final parts should be fully defined (unless used for geometry)

GEOMETRY



Knowing your properties, axioms, and theorems can help you a lot.

Triangles, Parallel Lines, Intersections, all that jazz



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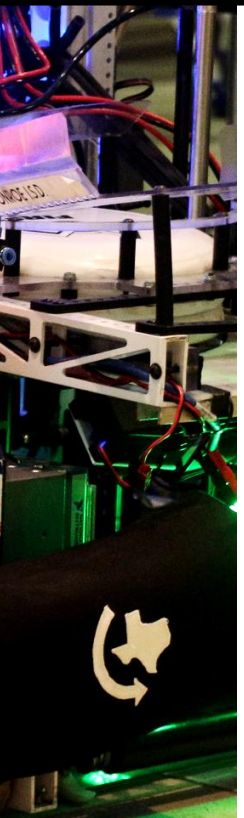
The Creation - Features

FEATURES

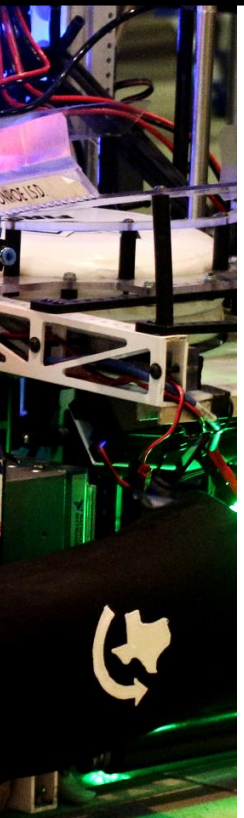


What is it?

3-Dimensional elements created by using sketches

Being good at features means creating what you need without redundancies. Make your features with the end goal in mind.

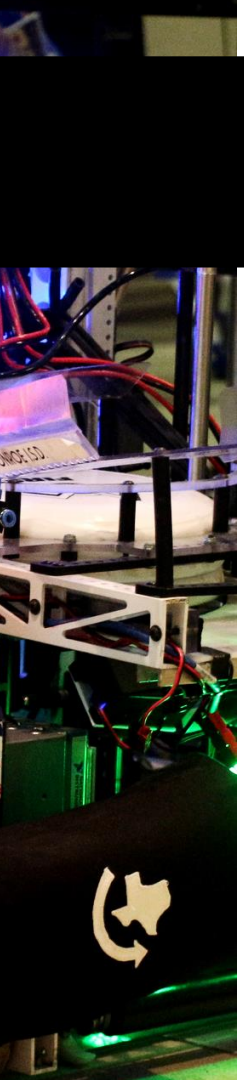
FEATURES



Don’t make everything in a single feature.

Use the feature tree

- Make features in a logical progression
- Find an elegant solution
- Break it into bite-sized pieces



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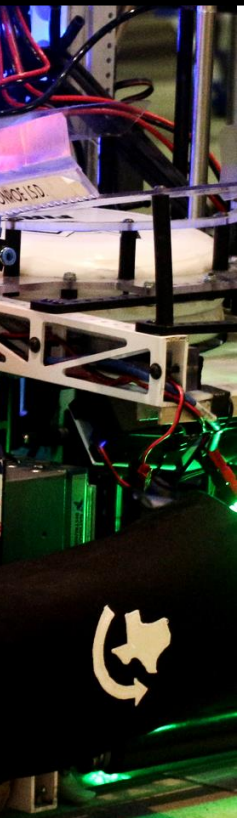
PARTS

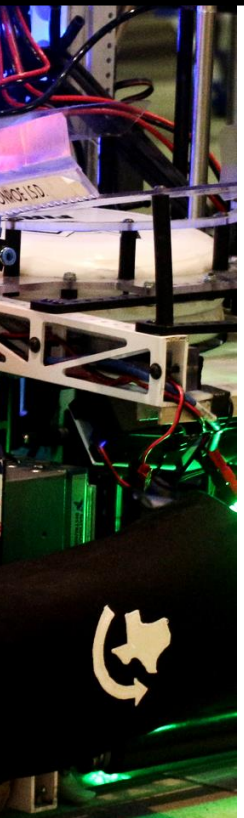


What is it?

A collection of features which form a single body

Parts are solid bodies, ie. made from a single piece of stock

ORIGIN & REFERENCE FRAMES

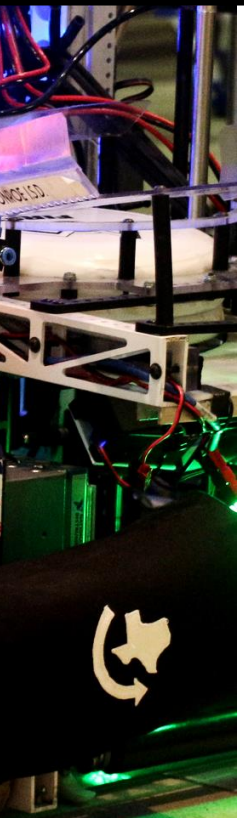


Make your origin logical:

- center of piece
- center of main bearing
- important edge/face

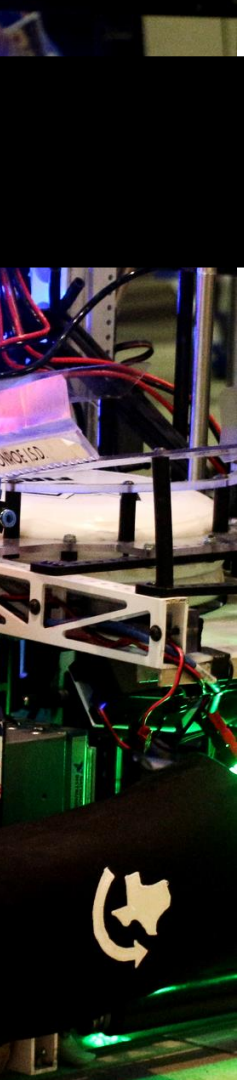
This allows for logical mating of reference frames

PART PROPERTIES



Don’t forget them

Description - Layman’s name of file (structured)
“Drivetrain, Frame, Left Strut”
Material - Official stock name “Versatube 2x1”
Finish - “As Stock” “White Powder Coat”
“Deburred”



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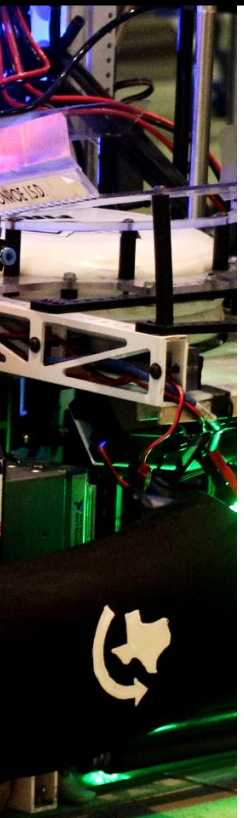
ASSEMBLIES

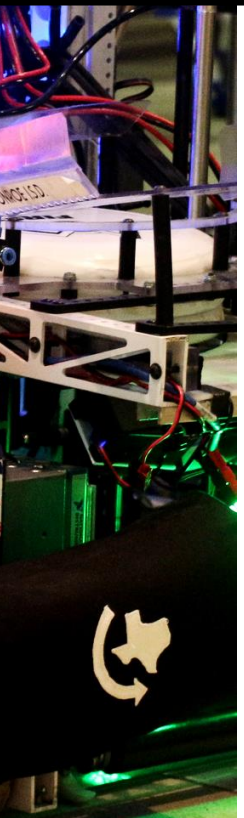


What is it?

An amalgamation of parts that may include actuations and motion

An assembly is only as good as its mates. Mating is one of the most difficult parts of CADing.

FIXED AND FLOAT

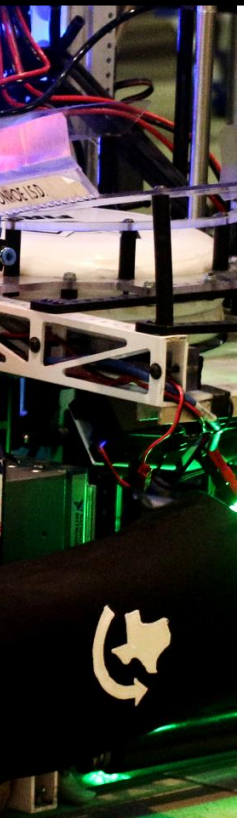


Nothing should be fixed (ignores the origin)

Instead, match reference frames to fully define

This matches the origins

MATING

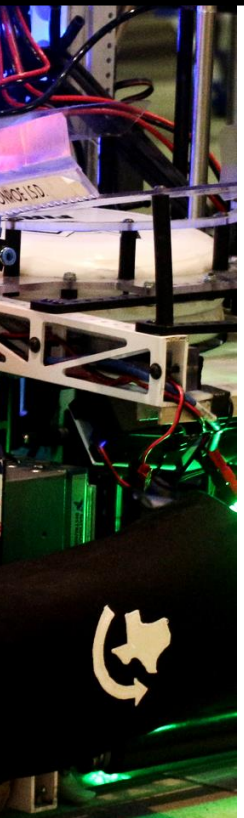


Try to mate reference frames before you mate faces.

- Prevents Breaking

Don’t mate edges, don’t mate vertices.

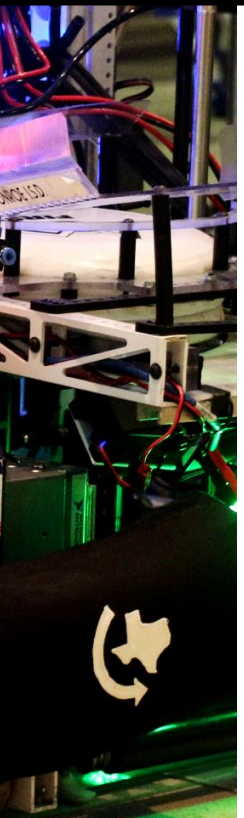
MATES - BASIC



When mating parts into frame try not to rely on body faces.

If you change a part to alter the face, it has a higher chance of causing errors.

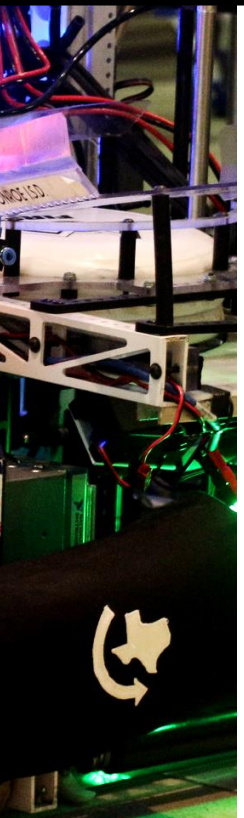
MATES - BASIC



Concentric mates should be done on the shaft, not the edge

Use distance mates to emulate powder coat tolerances or if defining a part based off of the reference planes.

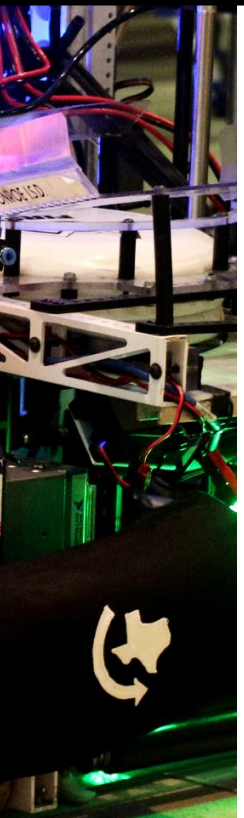
MATES - ADVANCED



Useful for defining things geometrically

Symmetric and Width mates are great for mirrorable parts

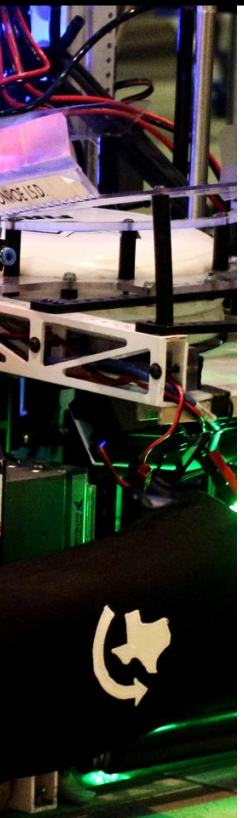
MATES - MECHANICAL



Don’t use these

Doesn’t help much and uses up a lot of processing power in higher level assemblies

MATE DIFFICULTIES

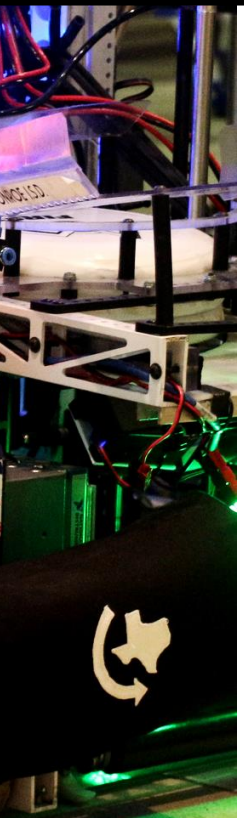


The hardest part is keeping it clean

It’s easy and tempting to do mates fast and messy. Good mating takes time and thought.

Think of the Big Picture

THE TRIPLE ZERO



In order to avoid breaking the 000, we only mate via reference planes. This allows for modular design.

Top Plane = Top of Drive Train
Origin = Center of Robot