Prototyping in Mechanical Engineering

WILL FISCHER

Hackaday.io

Engineering feels like:

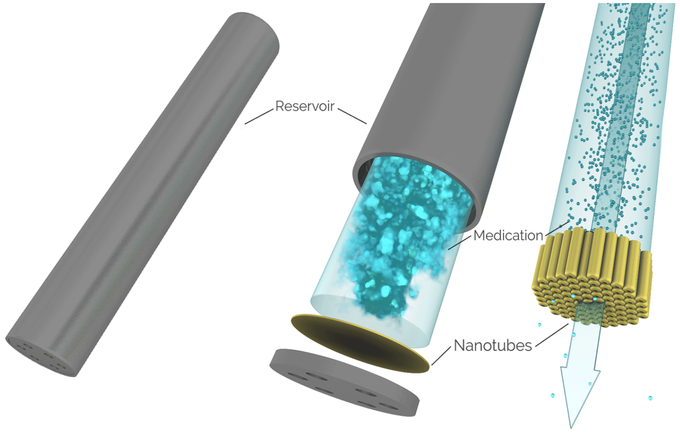
My Background

Rice University

NASA

WILL FISCHER Hackaday.io

My Background

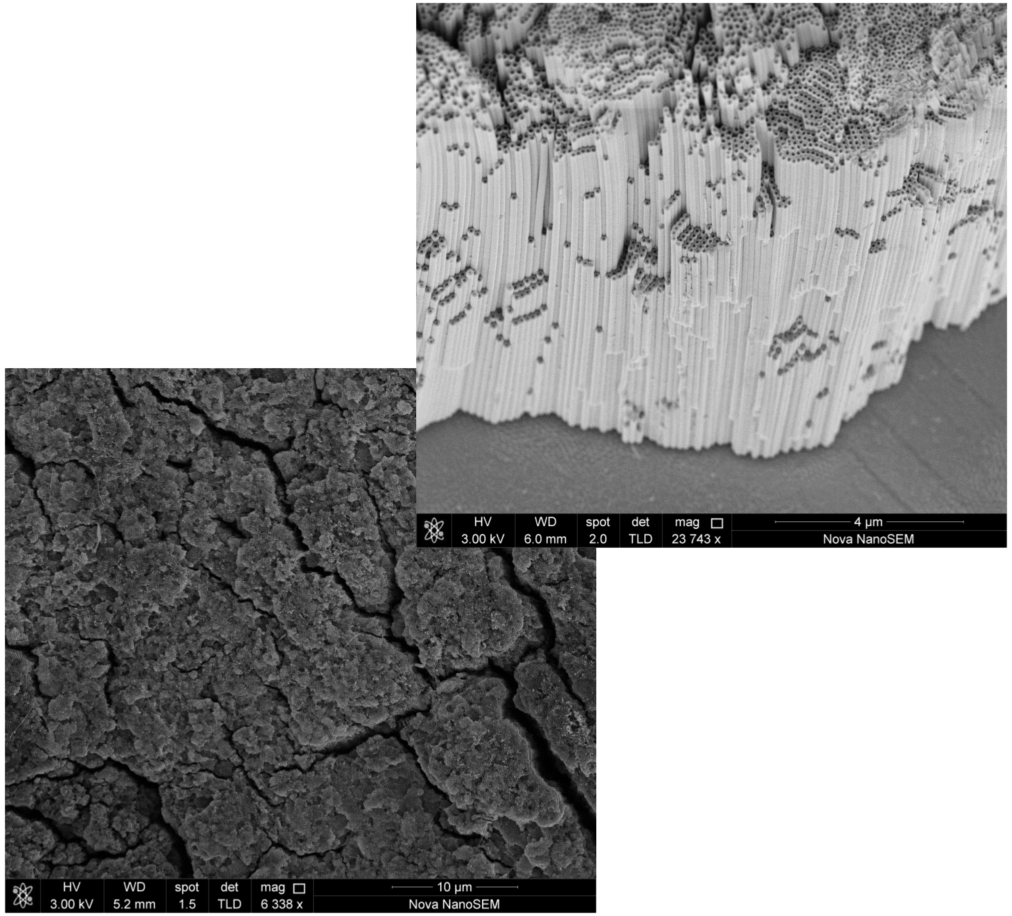


Rice University

NASA

Nano Precision Medical

My Background

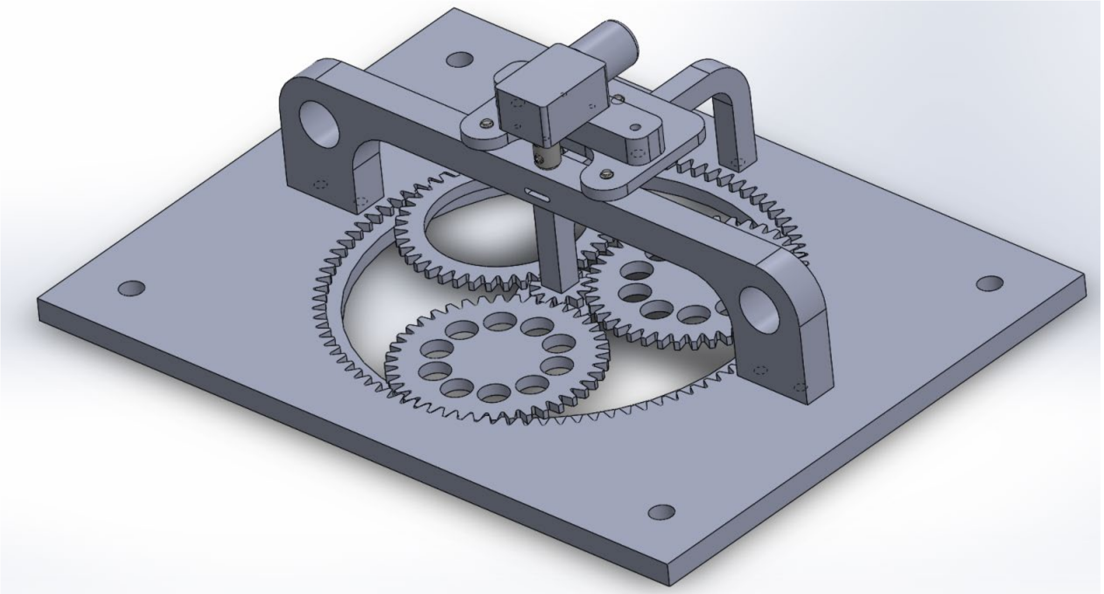


Rice University

NASA

Nano Precision Medical

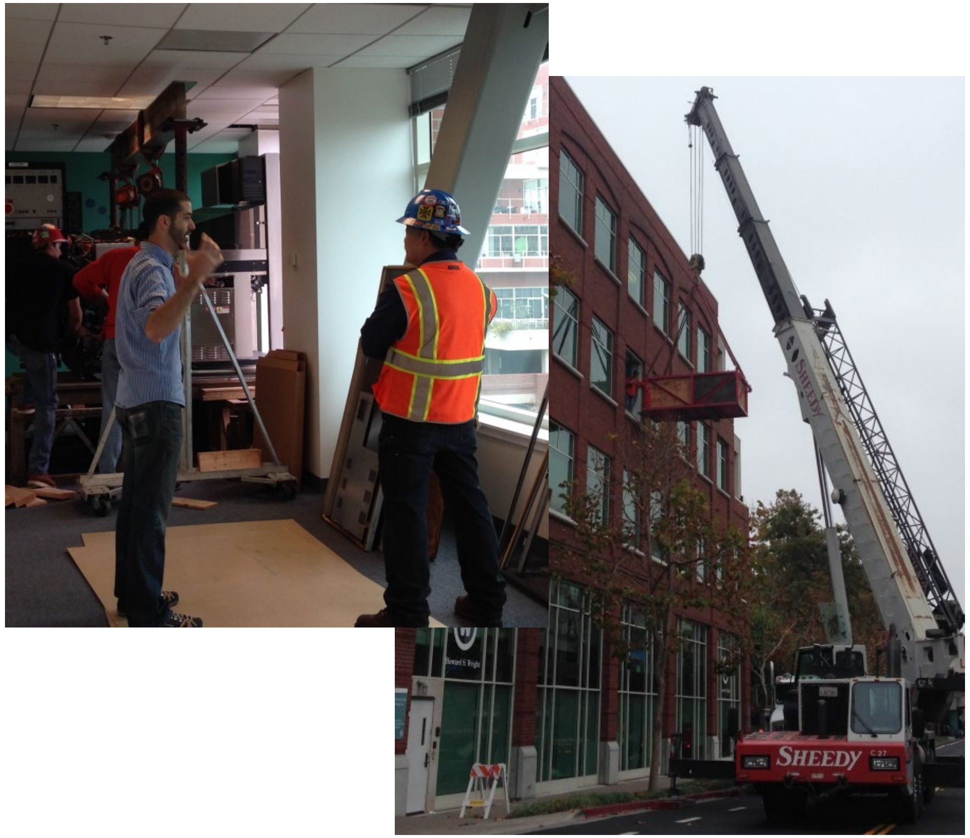
My Background



* Rice University
* NASA
* Nano Precision Medical

Patent Agent

My Background



* Rice University

* NASA

* Nano Precision Medical

Patent Agent

My Background

* Rice University

* NASA

* Nano Precision Medical

Patent Agent

* D20 Robotics

My Background

* Rice University
* NASA
* Nano Precision Medical
Patent Agent
* D20 Robotics
Chicago Booth MBA
* Rinckl

WILL FISCHER
Hackaday.io

My Background

* Rice University

* NASA

* Nano Precision Medical

Patent Agent

* D20 Robotics

Chicago Booth MBA

* Rinckl

* Freelancer

Improviser

WILL FISCHER Hackaday.io

My Background

* Rice University
* NASA
* Nano Precision Medical
  Patent Agent
* D20 Robotics
  Chicago Booth MBA
* Rinckl
* Freelancer
  Improviser

Hackaday Instructor!

WILL FISCHER

Hackaday.io

My Background

What does this all mean?

This class about
Mechanical Engineering will
be ***prototyping focused***.

Today's Agenda

- ~~My background~~
- Course Intro
- What/why is prototyping?
- Schematics and drawings

WILL FISCHER Hackaday.io

Course Introduction

WILL FISCHER Hackaday.io

What is Mechanical Engineering?

"Mechanical Engineers build the weapons

What is Mechanical Engineering?

"Mechanical Engineers build the weapons and Civil Engineers build the targets"

What is Mechanical Engineering?

- Engineering?
  - Using science, logic, and empathy to design useful things
- Mechanical?
  - Stuff that moves
    - Robots, gears, etc.
    - Spaaaaaace (also planes, boats, dirigibles)
    - Manufacturing equipment
    - Fluids
    - Thermodynamics

What is Mechanical Engineering?

- What do they teach us in school?
  - Statics
  - Kinetics
  - Kinematics
  - Materials (also fracturing, material failure, etc.)
  - Electro-mechanical systems (also mechatronics, robotics, etc.)
  - Fluids (also acoustics, aerodynamics, etc.)
  - Thermodynamics (also Heat Transfer, Psychrometrics, etc.)
  - Vibration
  - Control Theory
  - A lot of math

A quick aside

Metric

VS

English

WILL FISCHER

Hackaday.io

A quick aside

Metric

VS

English

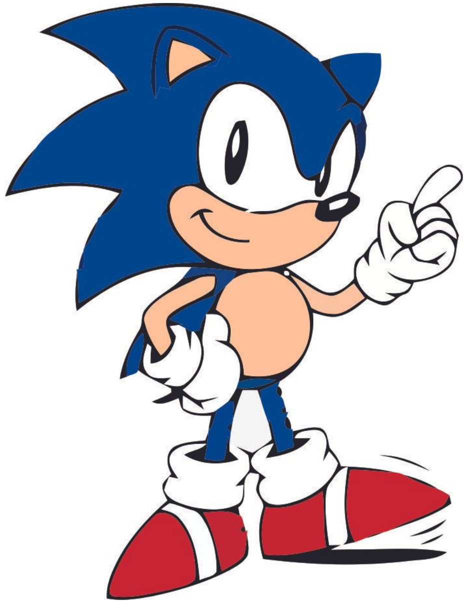
What to expect to learn

- An overview of:
  - Class 1 – Prototyping, schematic drawings
  - Class 2 – Materials
  - Class 3 - Fabrication
  - Class 4 – Fluids
  - Class 5 – Motion

- High level look at these fields
- Teach a ‘style of thinking’
- Prototyping perspective

Pace

Fast
Fast
Fast



To learn these more in depth, ask in the office hours, or check out YouTube to learn specific skills from other people. You can also email me directly.

Today's Agenda

- ~~My background~~
- ~~Course Intro~~
- What/why is prototyping?
- Schematics and drawings

WILL FISCHER Hackaday.io

What is Prototyping?

"Genius is one percent inspiration, ninety-nine percent perspiration."
-Thomas Edison

Crud. Now what?

Inspiration

???

Genius!

Has to teach you something

You need some way to learn

Inspiration

???

???

Teaches

Proves/Disproves

Prototyping

Inspiration

???

???

Teaches

Proves/Disproves

Prototyping!

WILL FISCHER

Hackaday.io

Prototyping

Inspiration

Rapid

???

Teaches

Proves/Disproves

Prototyping!

WILL FISCHER

Hackaday.io

Prototyping

Inspiration

Rapid

Imperfect

Teaches

Proves/Disproves

Prototyping!

WILL FISCHER

Hackaday.io

Prototype toward a Question

- What can make or break this project?
- What questions need to be answered before it “works”?
- Can I get just this little widget working?

Rapid & Imperfect

- **Goal:**
  - Create a prototype as quickly as possible so that it can still answer your question
  - It doesn’t have to be perfect

Rapid & Imperfect

- **Goal:**
  - Create a prototype as quickly as possible so that it can still answer your question
  - It doesn't have to be perfect

- **Ask:**
  - Seek the advice of experts (respectfully and efficiently)

Rapid & Imperfect

- **Goal:**
  - Create a prototype as quickly as possible so that it can still answer your question
  - It doesn't have to be perfect

- **Ask:**
  - Seek the advice of experts (respectfully and efficiently)

- **Fail:**
  - Often the biggest value in a prototype is in its failures
  - We learn more from our mistakes than from our successes

Fail

- Failure is a skill
  - Fail quickly
  - Fail gracefully
  - Fail usefully (answer a question!)

Don’t be afraid to fail

WILL FISCHER

Hackaday.io

Practice Prototyping

Prototyping is a practiced skill

Get a better sense of building stuff

WILL FISCHER Hackaday.io

Today's Agenda

- ~~My background~~
- ~~Course Intro~~
- ~~What/why is prototyping?~~
- Schematics and drawings

Schematics: Disclaimer

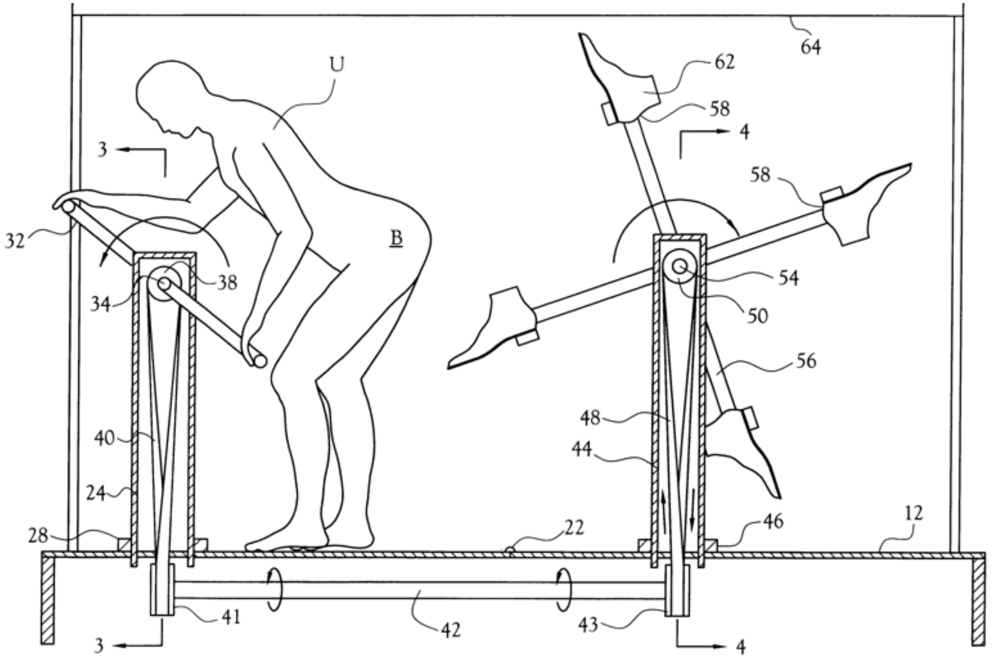
Creating drawings for mechanical parts is an entire career (draftsperson)

We are covering just the *very* beginning

We won't cover GD&T

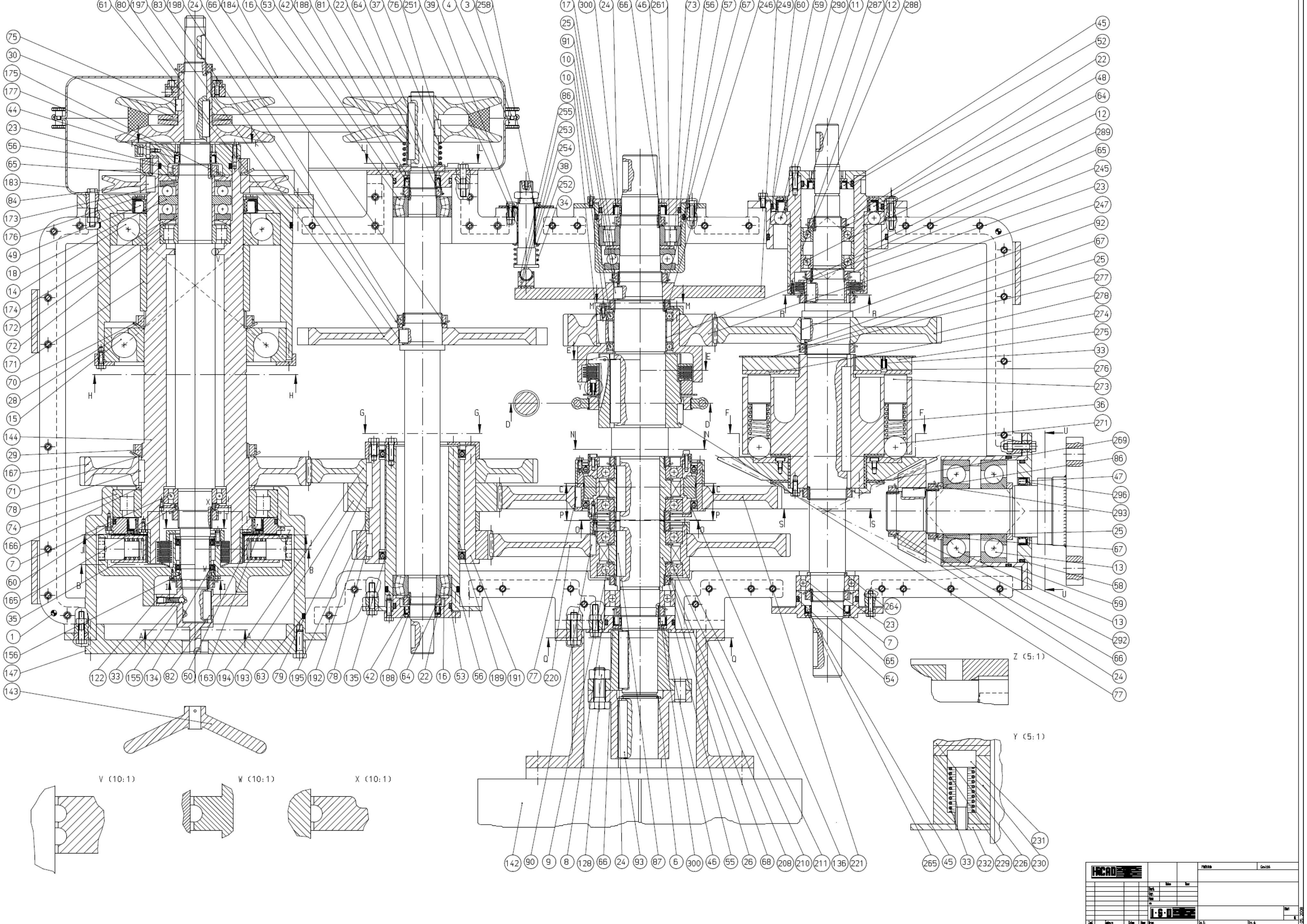
Schematic Drawings

- Why are drawings important?
  - Communication
  - Specification for manufacturing
  - Specification for assembly
  - Identification
- What are the stakes?
  - Money
  - Time
  - Reputation
  - DEATH?



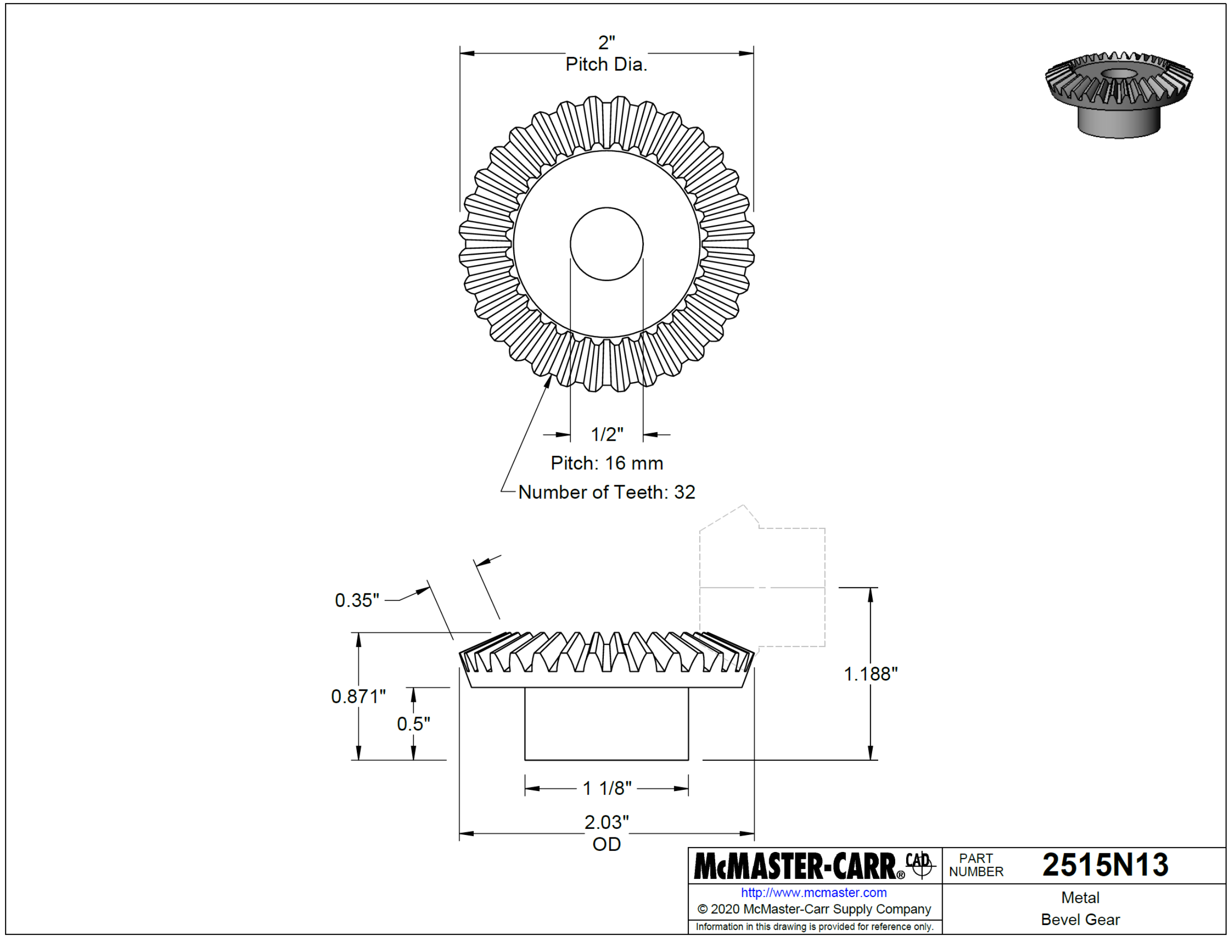
WILL FISCHER

Hackaday.io


Z (5:1)
Y (5:1)
V (10:1)
W (10:1)
X (10:1)
HiCAD

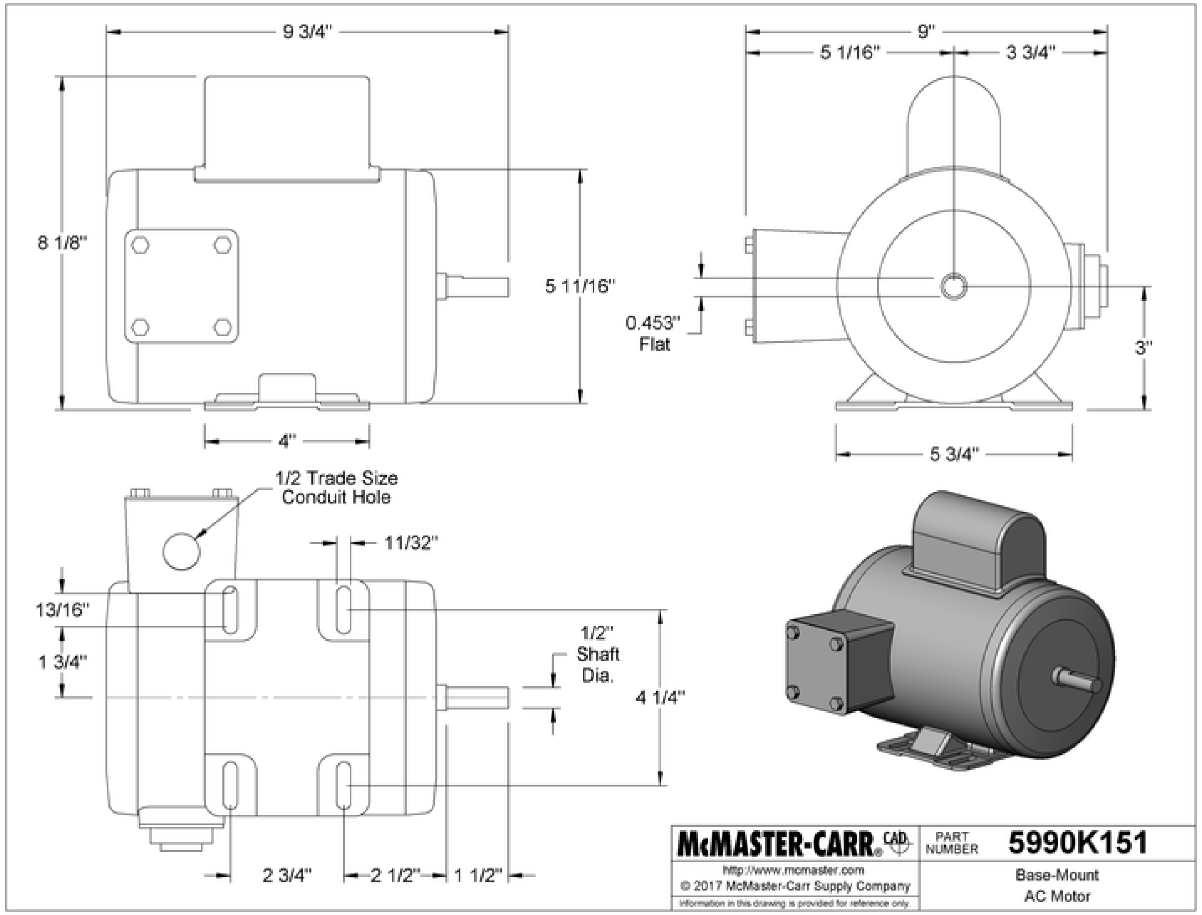
How to read a drawing

- Views
- Dimensions, notes, and tolerances
- Title Block



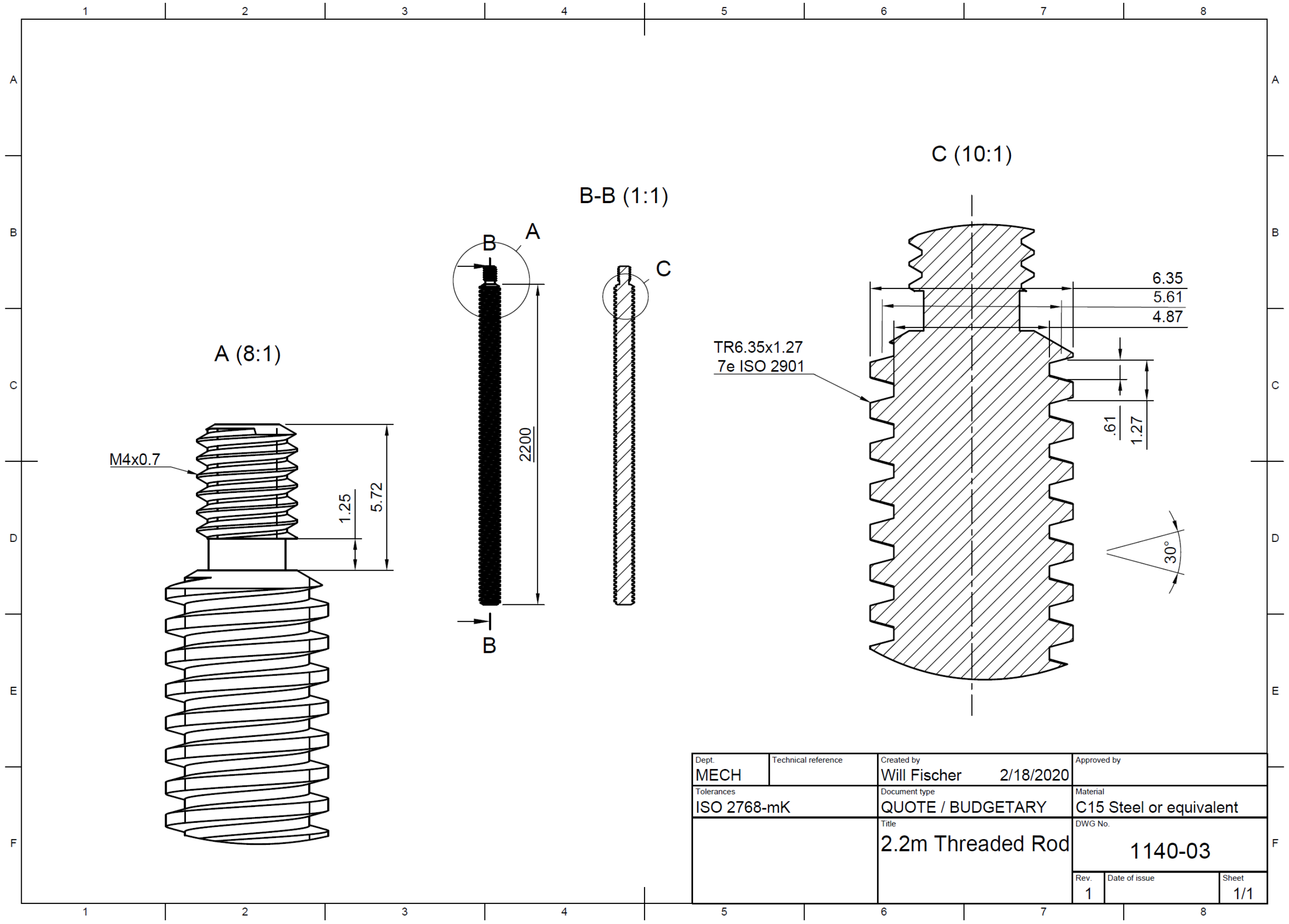
How to read a drawing: Views

- There are three orthographic ("Third Angle") views
  - Top
  - Front
  - Side
- Detail Views
- Section Views



How to read a drawing: Views

- Detail Views
- Section Views

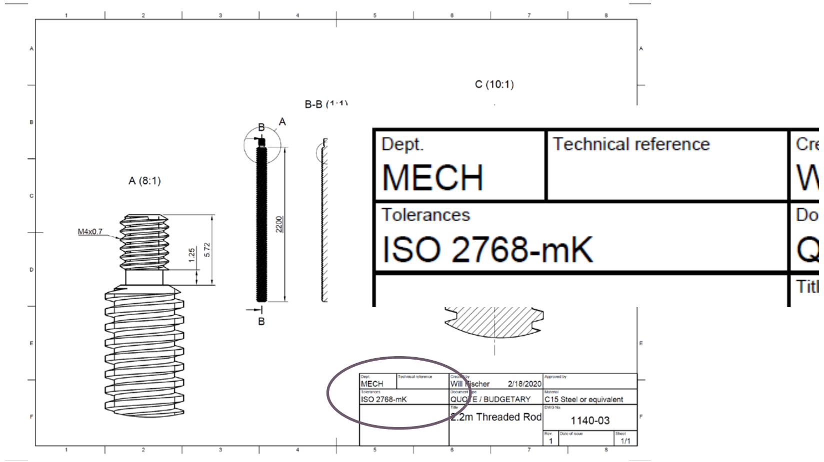


ISCHER

Hackaday.io

How to read a drawing

- Dimensions
- Tolerances
  - Document-wide, unless otherwise specified
  - ISO 2768



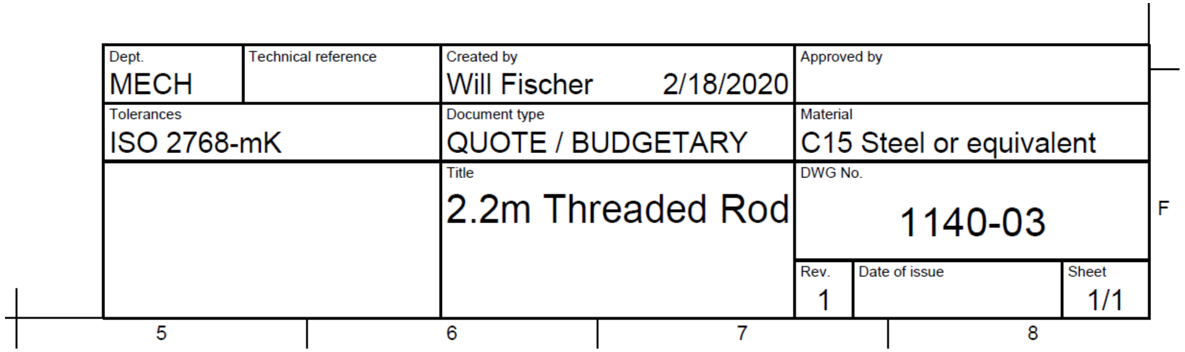
GENERAL TOLERANCES FOR LINEAR AND ANGULAR DIMENSIONS (DIN ISO 2768 T1)

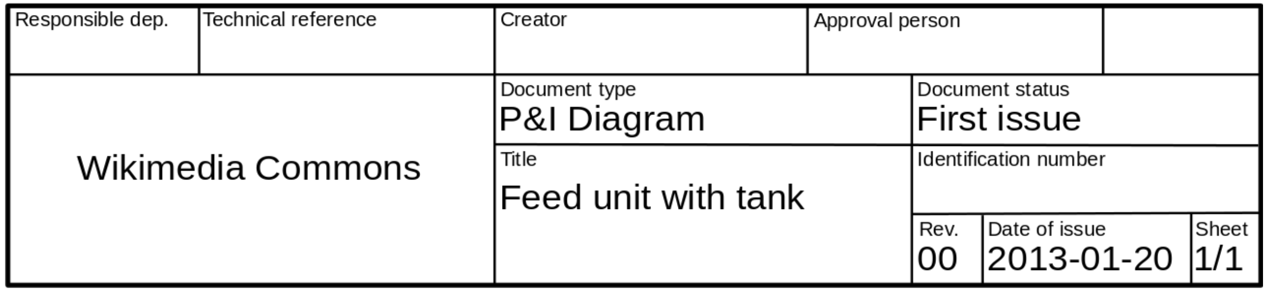
LINEAR DIMENSIONS:

Permissible deviations in mm for ranges in nominal lengths	Tolerance class designation (description)			
	f (fine)	m (medium)	c (coarse)	v (very coarse)
0.5 up to 3	±0.05	±0.1	±0.2	-
over 3 up to 6	±0.05	±0.1	±0.3	±0.5
over 6 up to 30	±0.1	±0.2	±0.5	±1.0
over 30 up to 120	±0.15	±0.3	±0.8	±1.5
over 120 up to 400	±0.2	±0.5	±1.2	±2.5
over 400 up to 1000	±0.3	±0.8	±2.0	±4.0
over 1000 up to 2000	±0.5	±1.2	±3.0	±6.0
over 2000 up to 4000	-	±2.0	±4.0	±8.0

Title Blocks

- ISO 7200:2004
- Usually include:
  - Title
  - Part number
  - Tolerances
  - Units
  - Material
  - Paper size
  - Scale
  - Designer
  - Company/organization
  - Approval information
  - Appropriate dates
- Include as necessary:
  - Sheet number
  - Notes
  - Revision number
  - Signatures
  - Confidentiality





WILL FISCHER

Hackaday.io

Let’s look over a drawing

When creating a drawing

- Think about how this will be made (more in Class 3!)
- Visual clarity
  - Don't overlap tolerances
- Inspection
- Don't over-specify
- Don't overcommunicate (especially if there's valuable IP!)
- Tolerance Stackups
- Check with your machinist or manufacturer

Tolerance Stackups

Inspection

- Always inspect parts
  - Measure measurable dimensions
  - Fit parts together
  - Check threads with known fasteners
- Common inspection tools:
  - Calipers
  - Pin gauges
  - Granite Flat
- Optical inspection 😬

Today's Agenda

- ~~My background~~
- ~~Course Intro~~
- ~~What/why is prototyping?~~
- ~~Schematics and drawings~~

Engineering is about humility.

Don't underestimate the people you work with.

Questions? Office Hours!

Will Fischer
will@wfisch.com

WILL FISCHER Hackaday.io