Stratasystems

pocketRULER

[*Link to site for animation*]

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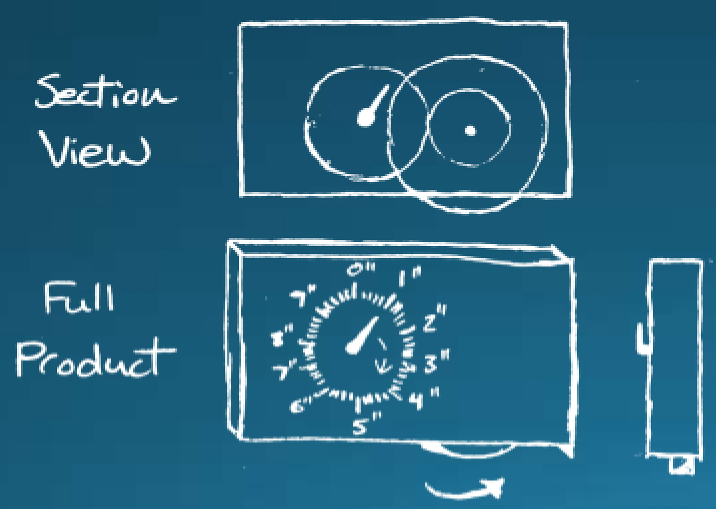
Background

- Problem:
  - Rulers are not compact measuring devices
  - Tape measures are limited to measuring straight lines
- Wanted a compact device that measures curves and complex geometries for long distances (at least a foot)
- Concept was inspired by a tool called a surveyor's wheel
  - Used for measuring distances on the scale of hundreds of feet

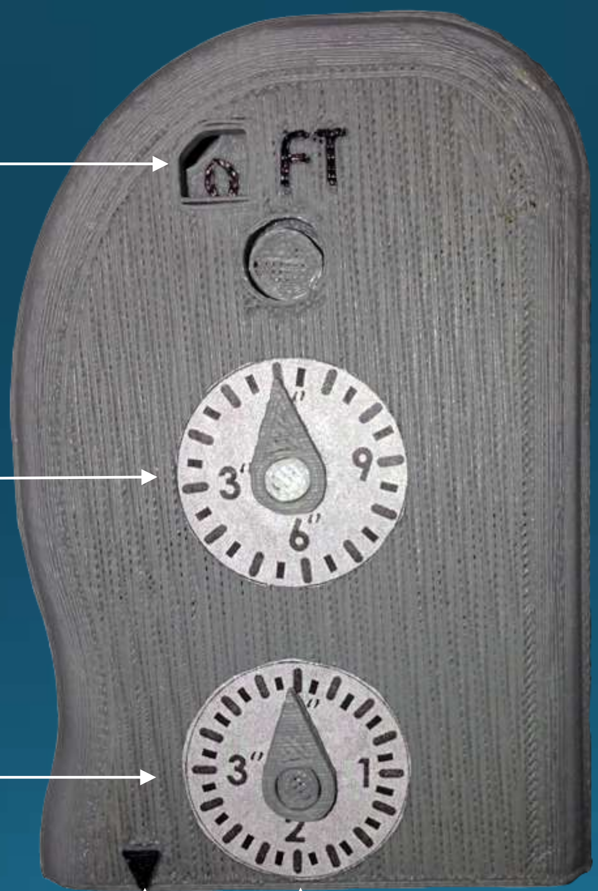


The Product: pocketRULER

Feet Indicator
(up to 5 ft)

Inches indicator
(up to 12 in)

Precision indicator
(resolution of up to 1/8 in)



PULL TO MEASURE

Alignment
arrow

Measuring wheel

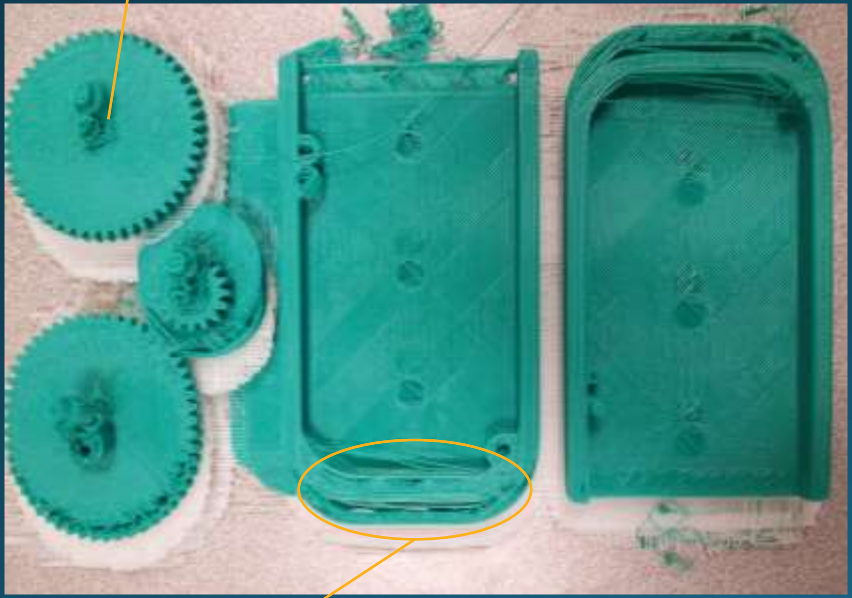
Design Iterations: Overview

Max distance:	4 feet	1 foot	5 feet
Height:	4.5 inches	3.2 inches	3.9 inches

Cycle 1 Cycle 2 Cycle 3

Design Changes: Cycle 1 to Cycle 2

Shafts are not center



Shifted printing

Print 1

Lessons Learned from Cycle 1

- MakerBot has trouble handling prints that take up most of the working surface
- Need to increase tolerances

Changes from Cycle 1 to Cycle 2

- Removed large gear (measured up to 4 feet)
- Can only measure up to 1 foot

Design Changes: Cycle 2 to Cycle 3

Print 2

Lessons Learned from Cycle 2

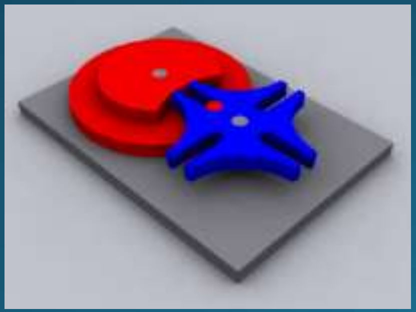
- MakerBot is capable of printing functional gears

Changes from Cycle 2 to Cycle 3

- Added Geneva Gear to increase functionality up to 5 feet
- Ergonomic contours

Final Design

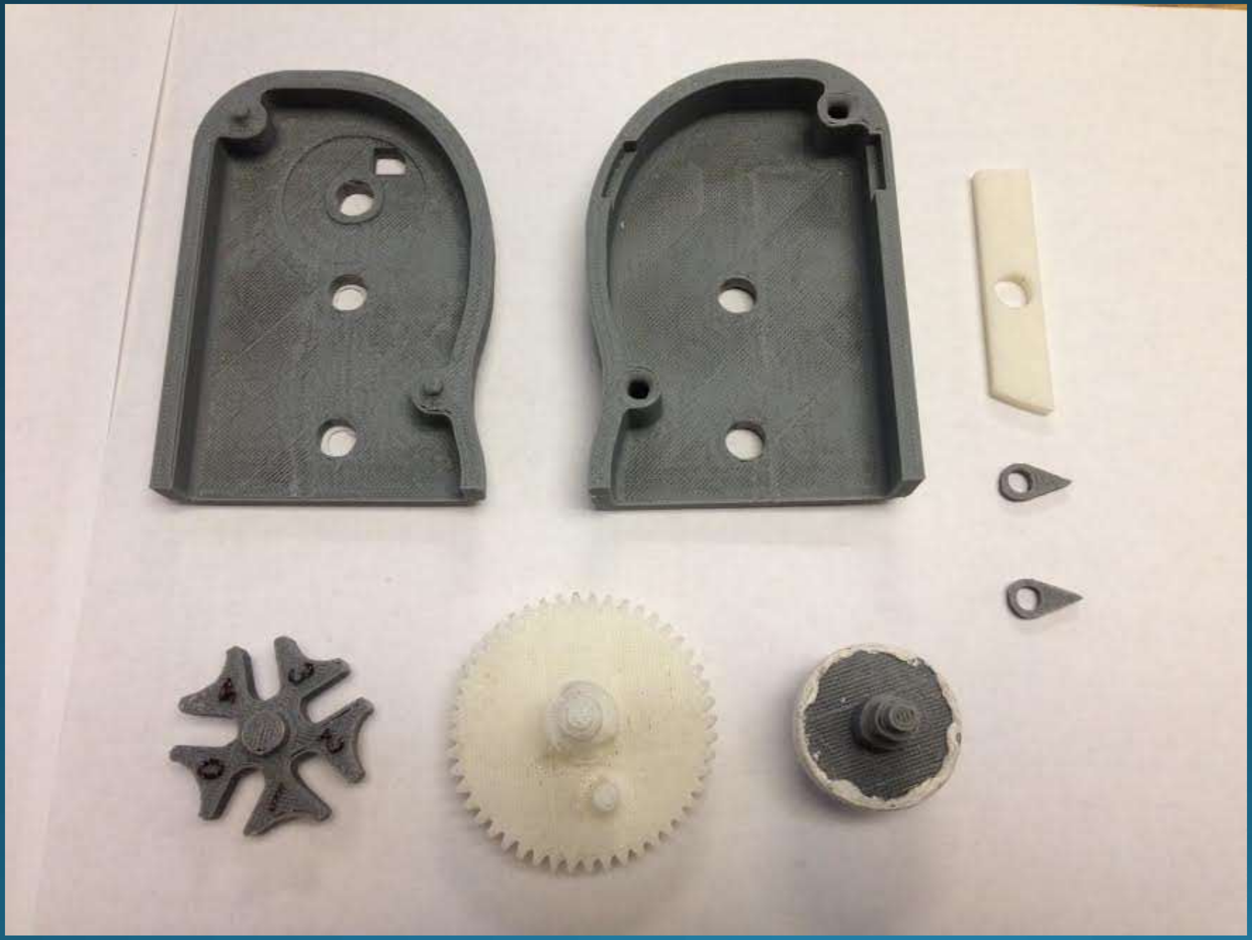
- Purpose of Geneva gear
  - Moves in intervals, unlike a traditional gear, thus smaller size
  - Easier for MakerBot to print
  - Did not need feet indicator to displayed in between feet
- Increased measurement capability from 4 feet to 5 feet from Cycle 1 Design, while decreasing size 15%



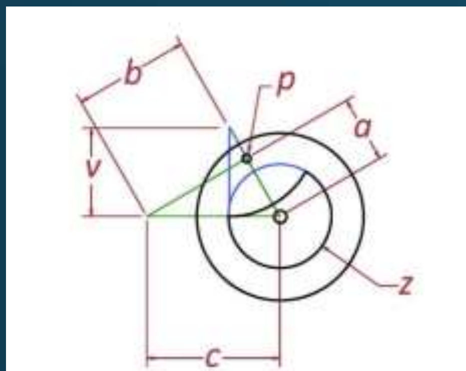
http://ilovesmesomeska.deviantart.com/art/Geneva-Drive-63040772

Final Print Results

- Printed well
- Correct tolerances



Geneva Gear Analysis



Geneva Drive

Determine Geneva wheel radius b

a = drive crank radius
n = driven slot quantity
p = drive pin diameter
t = allowed clearance

c = center distance = a / sin(180 / n)
b = Geneva wheel radius = $\sqrt{c^2 - a^2}$
s = slot center length = (a + b) - c
w = slot width = p + t
y = stop arc radius = a - (p 1.5)
z = stop disc radius = y - t
v = clearance arc = bz / a

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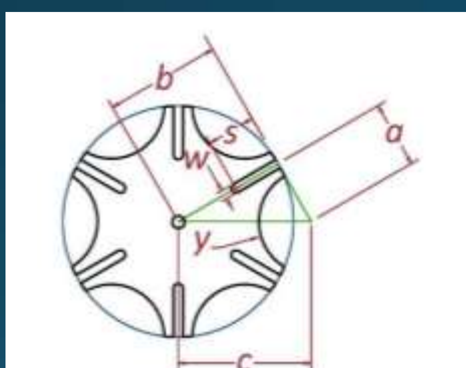


Geneva Driven

Our Numbers

	Define (youself)	Geneva wheel radius b	Calculation
a: drive crank radius	**0.55**	c: center distance	0.936
n: driven slot quantity	**5**	b: Geneva wheel r	0.757
p: drive pin diameter	**0.25**	S: slot center lengh	0.371
t: allowed clearance	**0.025**	w: slot width	0.275
		y: stop arc radius	0.175
Geneva shaft diameter	0.4	z: stop disc radus	0.150
		v: clearance arc	0.206

*inches

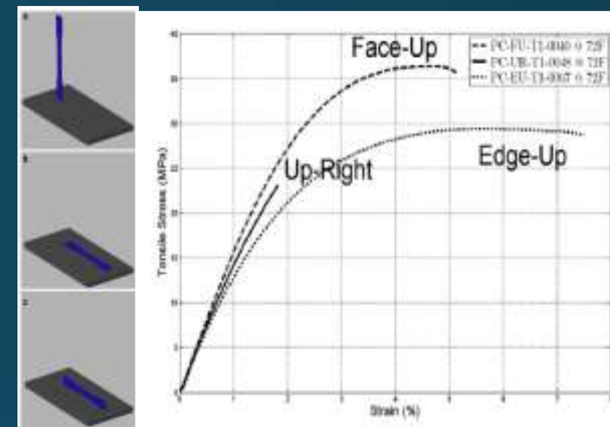
http://newgottland.com/2012/01/08/make-geneva-wheels-of-any-size/

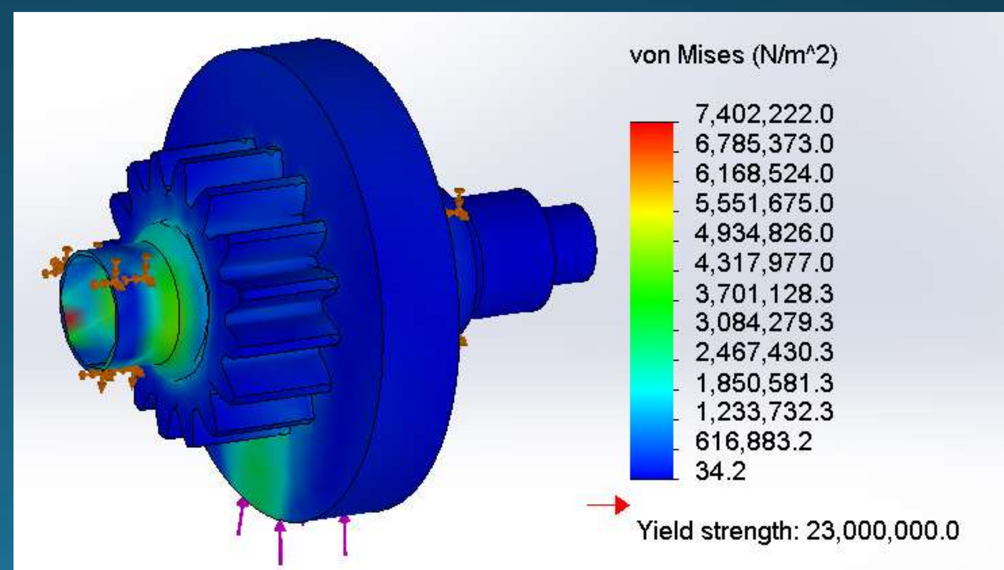
FEA on Wheel

- There are 3 main print orientation:
  - Up-Right (shown)
  - Edge-Up
  - Face-Up

- Average Human Arm-Hand Weight:
  - 3.35 kg (7.39lb) → 33 N
- FEA Tested at:
  - 10.2 kg (22 lb) → 100 N
- Maximum Load
  - 60 lb

Reaction Force
from Surface



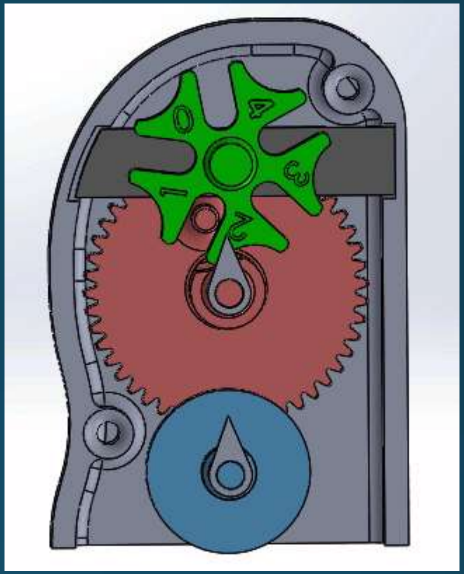


Functionality

- Can measure up to 5 feet
- Accurate to within 1% (only 1/8" deviation when measuring 1 foot)
- Meets our objective of being able to accurately measure lines and curves

Complexity and Difficulty

- 2 different types of mechanisms
  - Spur gear
  - Geneva gear
- 8 separate parts
  - 2 housings
  - 2 indicators
  - 1 intermediate support wall
  - 2 spur gears
  - 1 Geneva gear
- Tight tolerances needed for gear to mesh properly



Aesthetics

- Housing has ergonomic contours to better fit the user's hand
- Large radius fillets are used to make housing edges more comfortable
- Product name is embossed on housing

Future Improvements

- Reduce size of product
  - The gears limited the minimum size we could make our product. They needed to be printed large enough such that their teeth were well defined
  - By gaining access to a machine with tighter tolerances, it should be possible to reduce the size of our product by 50%
  - Possibility of using two Geneva gears
- Increase accuracy from 1% to 0.05%
- Increase maximum length device can measure
- Reset mechanism to go to back to 0 feet

Questions?

Special thanks to

- Professor Li
- Injoo Hwang