

Stratasystems

pocketRULER



[Link to Site for working animations](#)

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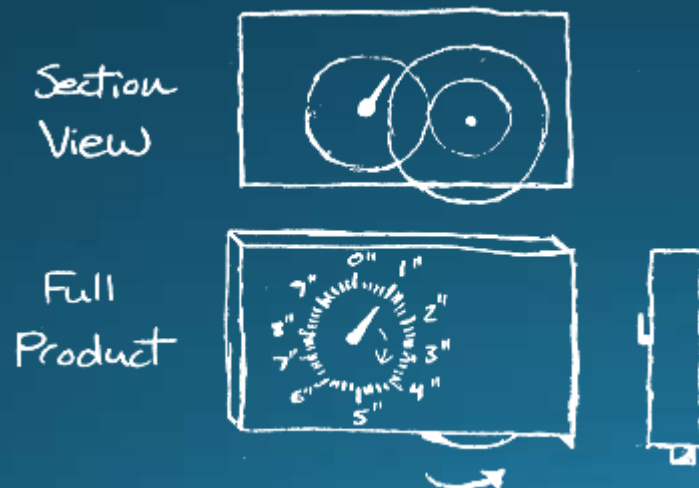
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Background

- 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)

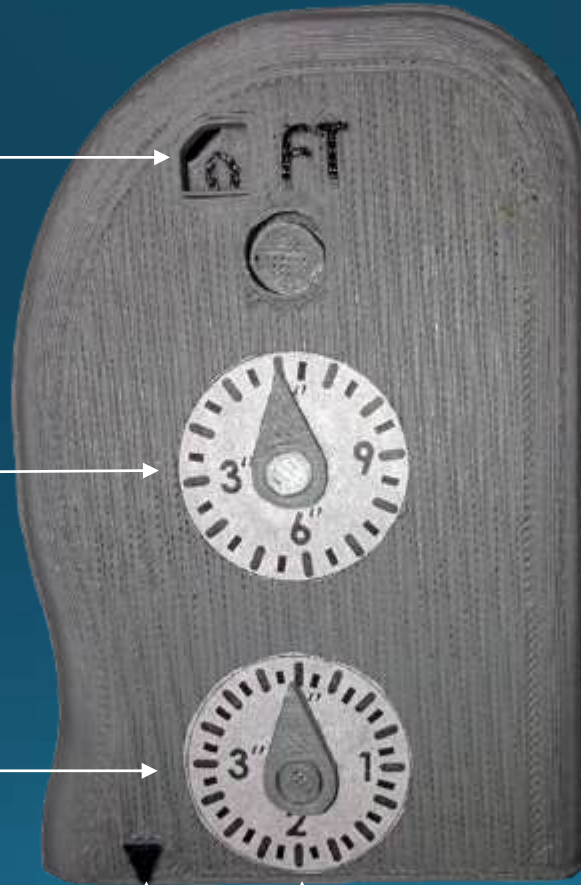
Inches indicator
(up to 12 in)

Precision indicator
(resolution of up to $\frac{1}{8}$ in)

Alignment
arrow

PULL TO MEASURE

Measuring wheel



Design Iterations: Overview

Max distance:
Height:

4 feet
4.5 inches

1 foot
3.2 inches

5 feet
3.9 inches



Cycle 1



Cycle 2



Cycle 3

Design Changes: Cycle 1 to Cycle 2



Shafts are not center



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



Lessons Learned from Cycle 2

- MakerBot is capable of printing functional gears

Changes from Cycle 2 to Cycle 3

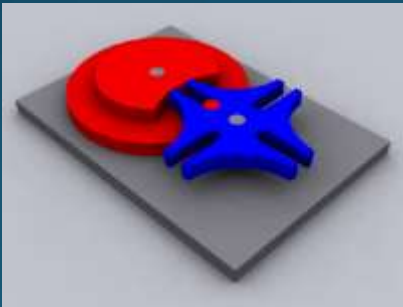
- Added Geneva Gear to increase functionality up to 5 feet
- Ergonomic contours



Print 2

Final Design

Geneva
Gear

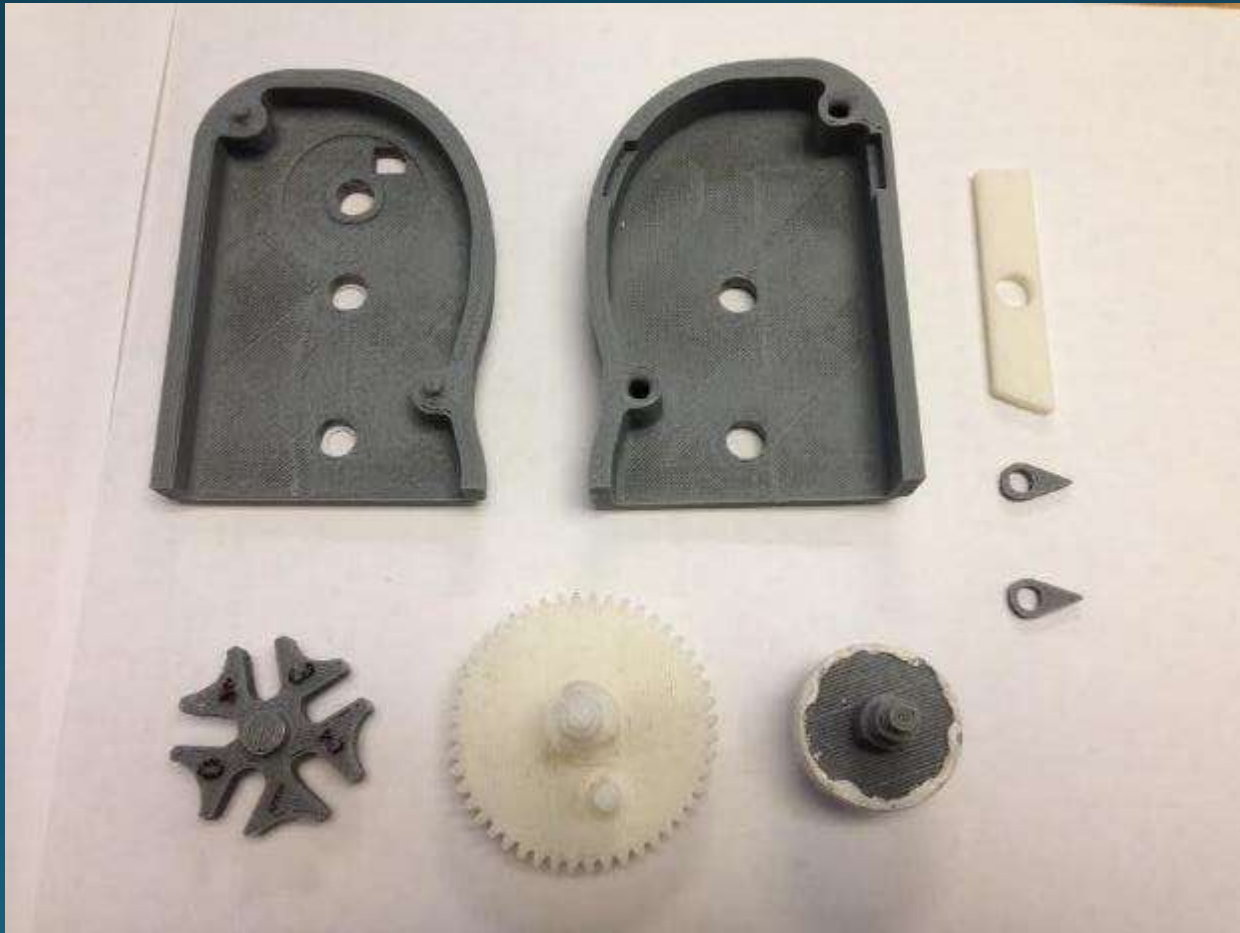


- Purpose of Geneva gear
 - Moves in intervals, unlike a traditional gear, thus smaller size
 - Easier for MakerBot to print
 - Did not need feet indicator to displayed in between feet
- Increased measurement capability from 4 feet to 5 feet from Cycle 1 Design, while decreasing size 15%

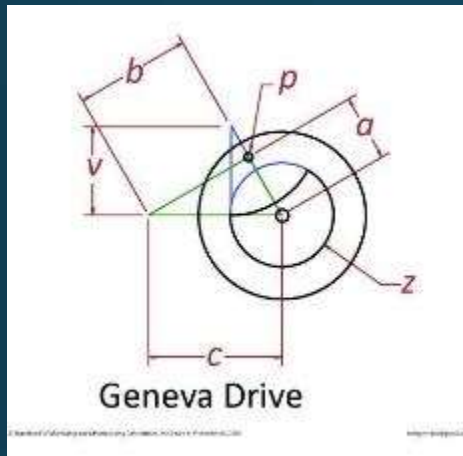


Final Print Results

- Printed well
- Correct tolerances



Geneva Gear Analysis



Determine Geneva wheel radius b

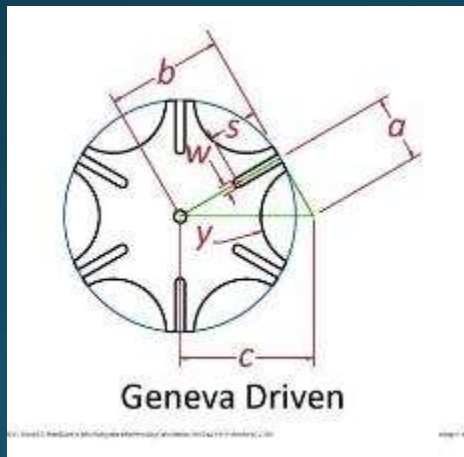
a = drive crank radius
 n = driven slot quantity
 p = drive pin diameter
 t = allowed clearance

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 = $a \cdot (p / 1.5)$
 Z = stop disc radius = $y \cdot t$
 V = clearance arc = bz / a

Determine drive crank radius a

b = Geneva wheel radius
 n = driven slot quantity
 p = drive pin diameter
 t = allowed clearance

C = center distance = $b / \cos(180 / n)$
 a = drive crank radius = $\sqrt{C^2 - b^2}$
 S = slot center length = $(a + b) - C$
 W = slot width = $p + t$
 y = stop arc radius = $a \cdot (p / 1.5)$
 Z = stop disc radius = $y \cdot t$
 V = clearance arc = bz / a



Our Numbers

	Define (yourself)	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 length	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 radius	0.150
		v: clearance arc	0.206

*inches

FEA on Wheel

- There are 3 main print orientation:

- Up-Right (shown)
- Edge-Up
- Face-Up



Reaction Force
from Surface

- Average Human Arm-Hand Weight:

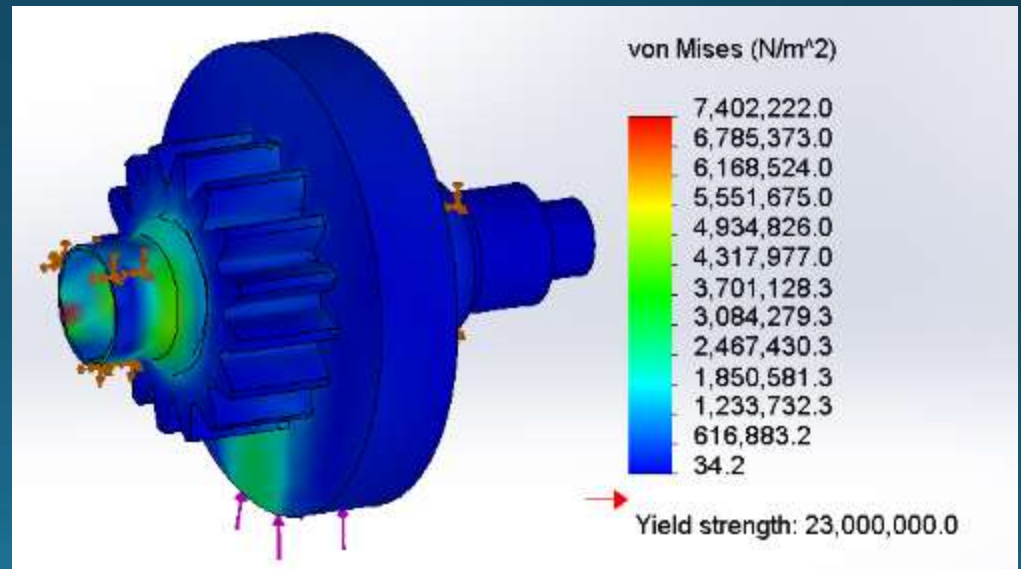
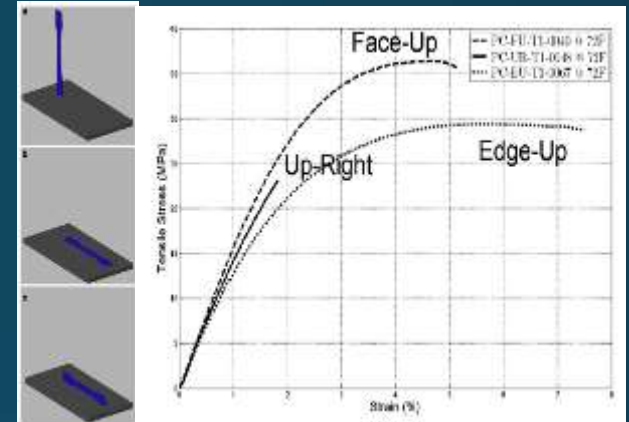
- 3.35 kg (7.39lb) \rightarrow 33 N

- FEA Tested at:

- 10.2 kg (22 lb) \rightarrow 100 N

- Maximum Load

- 60 lb



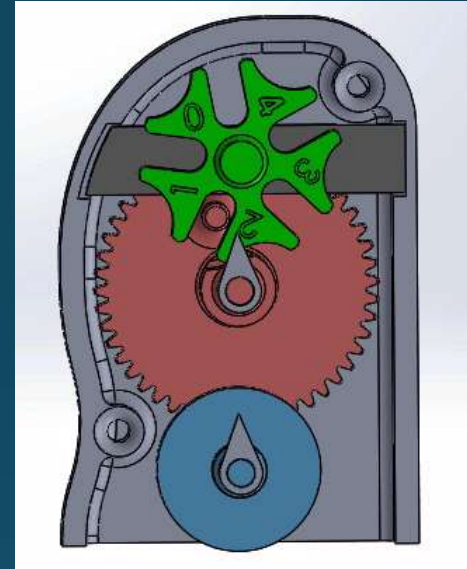
Functionality

- 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?