



**KANSAS STATE**  
**UNIVERSITY**

Technology  
Development Institute

# Product Development Process

Technology Development Institute  
510 McCall Road  
Manhattan, Kansas 66502  
[www.ksu.edu/tdi](http://www.ksu.edu/tdi)

# Background...

- Unit in the K-State College of Engineering
- Established in 1985
- Since 1995 Over 2,500 development projects with over 600 clients
- Off campus 22,000 sq. ft. facility
  - Half office & half prototyping shop facility
- 10+ full-time staff members
- Primary focus is to provide technical support in an effort to develop new technologies, grow companies and communities



# The Product Development Process ...

- **Where do you start?**

- Consumer Research

- Is there a problem?
    - How are they solving it today?
    - What does that cost them and is it painful?
    - Where do people shop for these products?
    - How much are they paying to address the issue?
    - Conducting surveys are a good way to gather information
      - Make sure the questions are structured properly to gather information and not just confirm opinions
      - How much would you pay vs. what would you expect the price to be
    - Products must have market demand to be successful



# The Product Development Process ...

- **Where do you start?**
  - Competitive Product Research
    - It's not just does this exist - what else solves this problem?
    - Just because your idea is different doesn't make it better
    - Where do people shop for these types of products?
      - Websites, Amazon, WalMart, Target, etc ...
    - Internet searches - there is lots of stuff out there!!



# The Product Development Process ...


- Intellectual Property Research
  - Trademarks
    - [www.uspto.gov](http://www.uspto.gov)
    - Pay attention to Classification Codes
      - Raven Example
  - Patents
    - Google Patents <https://patents.google.com/>
    - Enter search terms as you would normally search the web
    - [Patent Searches](#)
    - Patent Citations
    - Cited By
    - Similar Documents
    - Claims – Infringement vs. patentability



# The Product Development Process ...

- Document everything you have found in a written document that you can pull out later if needed.
  - What was the customer feedback
  - What were the competitive products, where were they sold, price points
  - Patents, Applications, Issued, Expired
- All of this information should be used to develop a product specification that is the guide for concept development.





# Engineering Design Process

# Engineering Design Process

1

## Project Scope

- Identify the problem/need
- What are the constraints?
- What is the timeline and budget?

2

## Research

- What is needed to complete the project?
- What has already been developed?

3

## Concept Generation

- Brainstorm lots of basic ideas
- Test/evaluate general concepts
- Select one or two concepts to move forward with

4

## Design and Detail

- Generate detailed models and plans
- Complete various calculations and further research to prove out design

5

## Build and Test

- Build first prototype(s)
- Test for functionality and other metrics

6

## Iterate

- Improve design based on testing and other feedback



# Engineering Design Process

1

Project  
Scope

## Hunting Product – Remote Scent Dispenser

- **Identify the problem/need**
- What are the constraints?
- What is the timeline and budget?

# Engineering Design Process

1

## Project Scope

- Identify the problem/need
- **What are the constraints?**
- What is the timeline and budget?

## Hunting Product – Remote Scent Dispenser

- Remotely triggered and/or on a timer
- Works with current scent packaging
- Battery powered

# Engineering Design Process

1

## Project Scope

- Identify the problem/need
- What are the constraints?
- **What is the timeline and budget?**

## Hunting Product – Remote Scent Dispenser

- Remotely triggered and/or on a timer
- Works with current scent packaging
- Battery powered
- Low cost of goods for production design
- Production ready design in 9 months

# Engineering Design Process

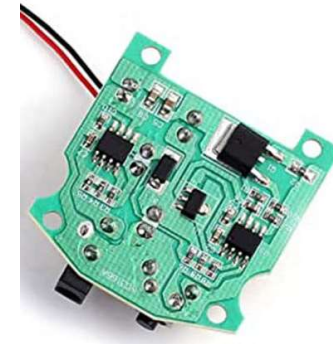
2

Research

- What is needed to complete the project?
- What has already been developed?

## Parts needed to function

- Plastic injection molded housing
- Actuator for dispensing scent
- IC board for remote and/or timer



# Engineering Design Process

2

Research

- What is needed to complete the project?
- What has already been developed?

## What else dispenses scent?

- Household air fresheners
  - Sprays
  - Diffusers
  - Heated oil/wax



# Engineering Design Process

2

Research

- What is needed to complete the project?
- What has already been developed?

## What else dispenses scent?

- Household air fresheners
  - Sprays
  - Diffusers
  - Heated oil/wax
- Hunting scent dispensers



# Engineering Design Process

3

## Concept Generation

- **Brainstorm** lots of basic ideas
- Test/evaluate general concepts
- Select one or two concepts to move forward with



# Engineering Design Process

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## Concept Generation

- Brainstorm lots of basic ideas
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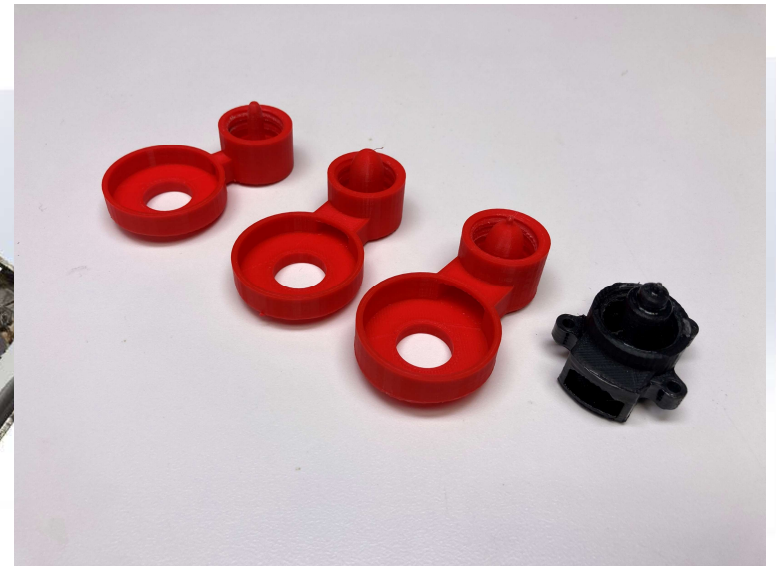


# Engineering Design Process

3

## Concept Generation

- Brainstorm lots of basic ideas
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- Select one or two concepts to move forward with



# Engineering Design Process

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## Concept Generation

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- **Select one or two concepts to move forward with**

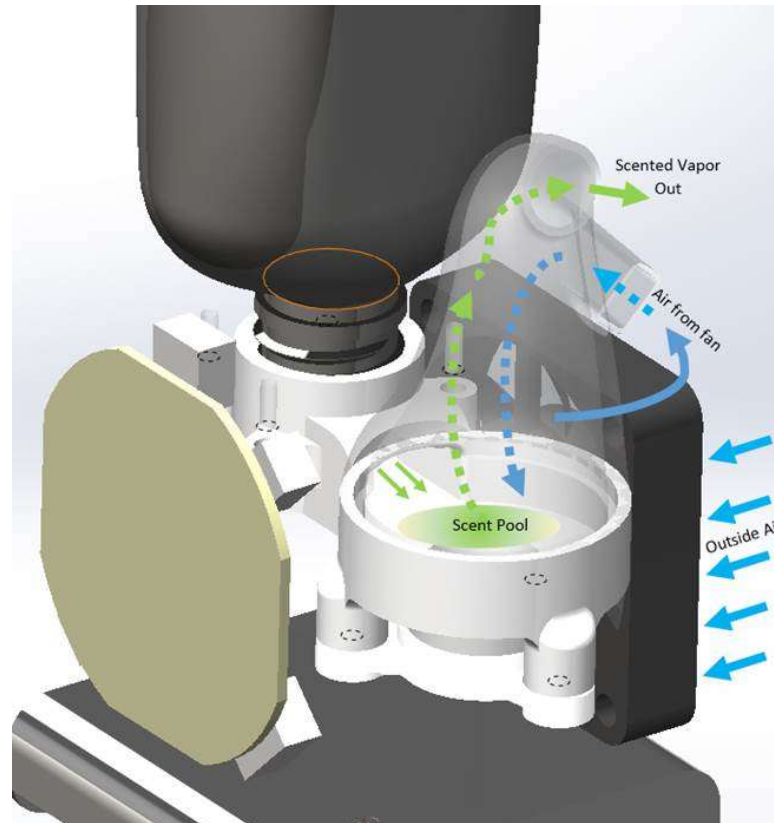


# Engineering Design Process

4

## Design and Detail

- Generate detailed models and plans
- Complete various calculations and further research to prove out design

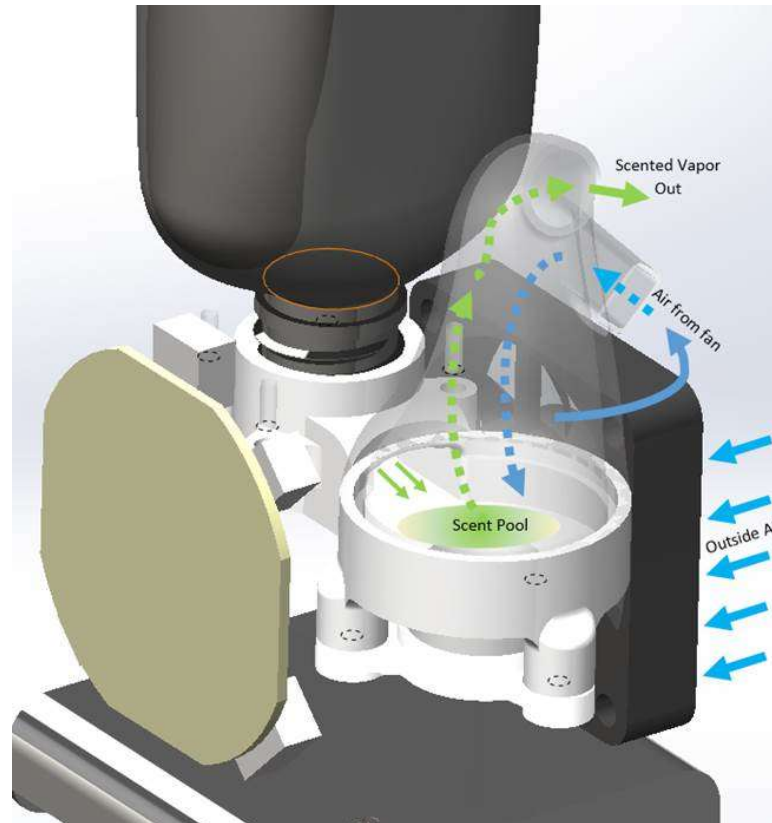


# Engineering Design Process

4

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- Generate detailed models and plans
- **Complete various calculations and further research to prove out design**



# Engineering Design Process

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Build and Test

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# Engineering Design Process

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Build and  
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# Engineering Design Process

6

Iterate

- Improve design based on testing and other feedback



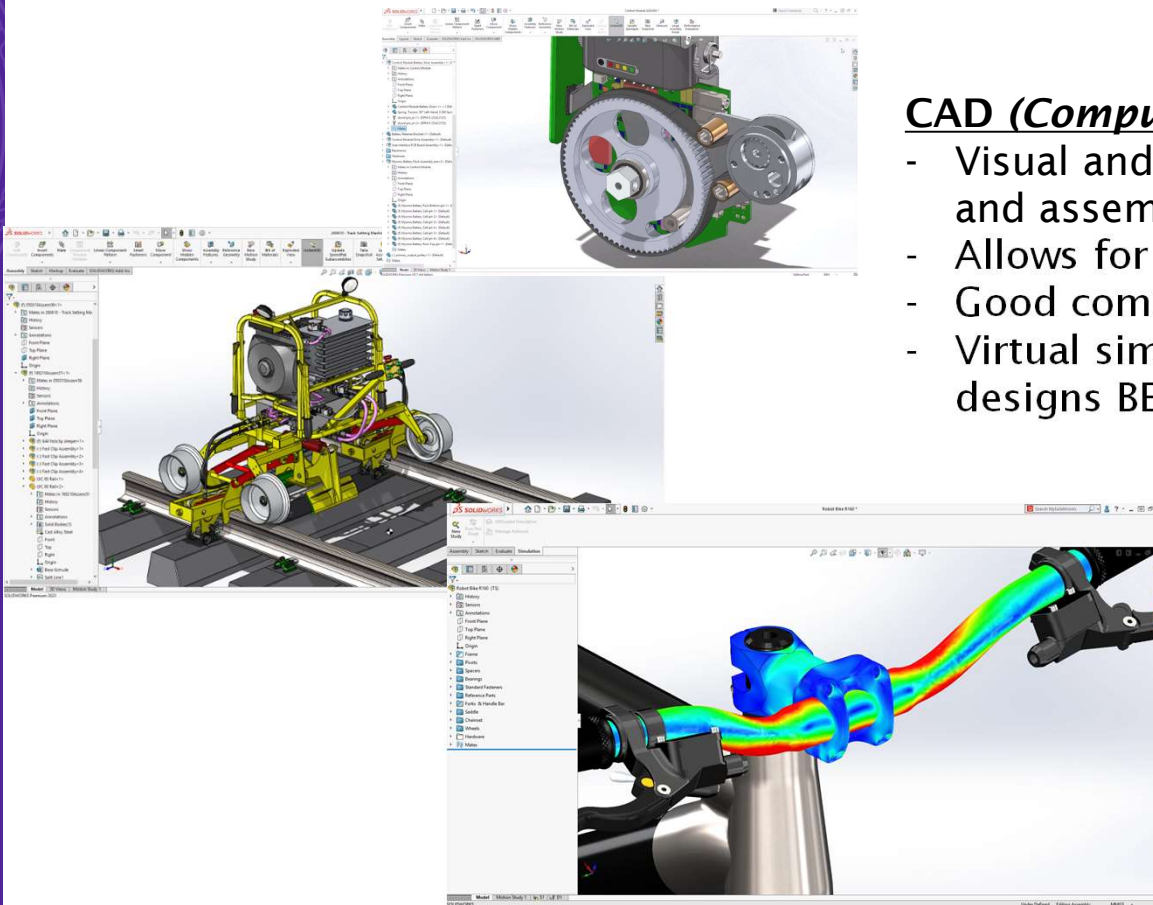
VS.



# CAD Modeling



# CAD Modeling



## CAD (Computer Aided Design)

- Visual and dimensional representation of parts and assemblies
- Allows for quick changes
- Good communication tool between groups
- Virtual simulations and calculations can validate designs BEFORE physical testing.



SOLIDWORKS File Edit View Insert Tools Window Help

Body\_Matrim.SLDPRJT

Search Commands

Features Sketch Surfaces Sheet Metal Weldments Mold Tools Data Migration Direct Editing Markup Evaluate MDO Dimensions SOLIDWORKS Add Ins MDO

Origin  
Plane1  
Plane2  
Plane4  
Sketch1  
Sketch2  
Cut-Extrude1  
Cut-Extrude2  
Cut-Extrude3  
Sketch3  
Sketch4  
Plane5  
Base-Extrude4  
Draft1  
Chamfer1  
Fillet25  
Fillet26  
Fillet30  
Fillet17  
Fillet18  
Plane6  
Base-Extrude2  
Fillet19  
Fillet20  
Fillet21  
Fillet38  
Shell1  
Cut-Extrude9  
Base-Extrude7  
Base-Extrude3  
Draft2  
Fillet23  
Cut-Extrude7  
Fillet32  
Fillet14  
Fillet11  
Fillet19  
Plane7  
Base-Extrude8  
Base-Extrude11  
Cut-Extrude10  
Cut-Extrude11  
Cut-Extrude12  
Cut-Extrude13  
Base-Extrude12  
Cut-Extrude14  
Cut-Extrude15

Model 3D Views Motion Study 1

SOLIDWORKS Premium 2021 SP4.0

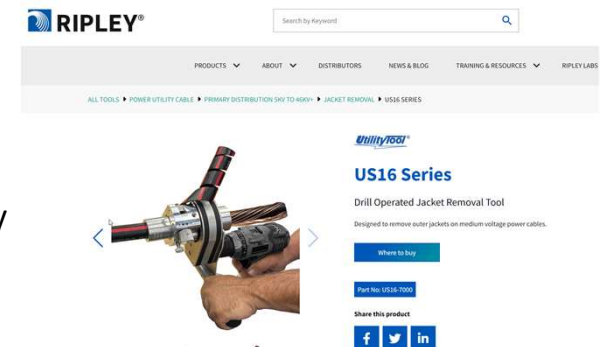
00:15

# Now that we have a product...

- What's Next?
  - Licensing vs. Manufacturing
- Licensing requires creation of some form of Intellectual Property
  - This is usually in the form of a utility patent, but may be design patent, copyright, trademark or even a trade secret
  - Conceptual model to export drawings from is enough to file a patent
  - Prior art becomes very important here ....
  - Difficult to accomplish
- Manufacturing does not require IP, but does require a business plan, marketing and sales plan, detailed engineering drawings, part specifications, BOM and people
  - Expensive
  - Time consuming
  - Much higher returns

# Licensing

- The goal behind licensing is to create IP and then offer that to a manufacturer under a license agreement where they pay a royalty on the sale of each unit
- Draft a disclosure, create patent drawings & find a good attorney to draft the claims and file the patent
  - Provisional Patent, Utility Patent, Design Patent
- Terms of the license very widely
  - Exclusive vs. Non
  - Field of Use
  - Signing Fee
  - Patent Costs
  - Minimums
  - Royalty Rates – typically range 3-8% (revenue) depending on industry
- Difficult to accomplish
  - Right company, Right time, Right dollar amount
  - 9 out of 10 licensing deals fail to find a home



# Licensing

## How do you go about licensing?

- Identify target companies with distribution channels needed to sell the product
- Conduct market research to determine the size and potential of the market
- Generate a “Technology Licensing Profile”
  - One pager that explains the product, the market, the benefits and that you are seeking to license
- Valuation Model – Spreadsheet used to determine how much the IP is worth
- Term Sheet – what are you asking for?

## FLEX SLED™

**A Better Way to Stretch ...**

The Flex Sled is a patented device (US 9,974,999) developed by Steve Land who has practiced physical therapy for over 25 years.

The driving force behind developing the Flex Sled was the limited equipment available that effectively and safely stretches muscles, especially for athletes and the aging population. As we age, we lose flexibility which greatly restricts our range of motion, balance, and ultimately mobility.

The Flex Sled is an easy to use, ergonomically designed apparatus that focuses on full body flexibility. It provides the correct mechanics to entire muscle groups for proper tissue flexibility, creating improved joint range of motion and reducing pain in preventing or recovering from injury. The unit was designed to be compact and versatile with a small footprint to minimize the amount of floor space required in a clinic or gym.

**Stretches**

The Flex Sled is designed for the completion of a full body stretch targeting specific muscle groups:

- Calf (gastrocnemius and soleus)
- Knee (hamstring and quadriceps)
- Hip (IT band, TFL, hip flexors, adductors and piriformis)
- Lumbar spine (latissimus dorsi and quadratus lumborum)
- Shoulder complex (pectoralis, biceps, rhomboids and rotator cuff muscles)



**Target Markets**

According to a market report by Knowledge Sourcing Intelligence, in 2019 the rehabilitation equipment market was valued at \$3.7 billion, with CAGR of 4.05% by 2026. The Flex Sled can be marketed towards:

- Hospital rehab and outpatient therapy clinics
- Chiropractic clinics
- High school, college, and professional sporting venues
- Retirement and nursing homes

**Benefits**

- Enables patients to perform warm up stretching correctly prior to physical therapy sessions
- Enables patients to perform warm up or cool down flexibility routine involving rehab or athletic performance
- Full body stretching routine that can be performed in 10-15 minutes or isolate a specific muscle group
- Proper joint positioning to isolate muscle groups that were previously difficult to reproduce without assistance
- Adaptable for all patients, from athletic to geriatric, and those who need more mobility support

The Flex Sled is adaptable to an individual's height and flexibility level. It provides stability and balance throughout the stretch and the ability to stretch in positions we actually use, such as walking. This allows for controlled but dynamic stretches that do not strain muscles.

The Flex Sled is designed with the three-dimensional aspect of muscle orientation in mind. The ability to stretch within all planes of a muscle position is necessary to functionally apply adequate stretch to each aspect of the muscle. Decreased flexibility or muscle imbalance impacts joint function and places the individual at a higher risk for injury.

**Demonstration Video**

Click [HERE](#) to view an online demonstration video of the prototype device in use.



Assumptions		Financial Analysis											
Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14
Revenue	Revenue	Revenue	Revenue	Revenue	Revenue	Revenue	Revenue	Revenue	Revenue	Revenue	Revenue	Revenue	Revenue
Expenses	Expenses	Expenses	Expenses	Expenses	Expenses	Expenses	Expenses	Expenses	Expenses	Expenses	Expenses	Expenses	Expenses
Net Income	Net Income	Net Income	Net Income	Net Income	Net Income	Net Income	Net Income	Net Income	Net Income	Net Income	Net Income	Net Income	Net Income
NPV	NPV	NPV	NPV	NPV	NPV	NPV	NPV	NPV	NPV	NPV	NPV	NPV	NPV

# Business Planning

- Manufacturing is expensive and typically requires capital to be raised
- If you need to raise capital – a business plan is going to be required to illustrate to investors how you plan to manufacture product, sell and generate revenue
- Financials are also needed to show how much investment is required
- Determine exit strategy for investors
- Kansas Small Business Development Centers provide assistance in drafting the business plans

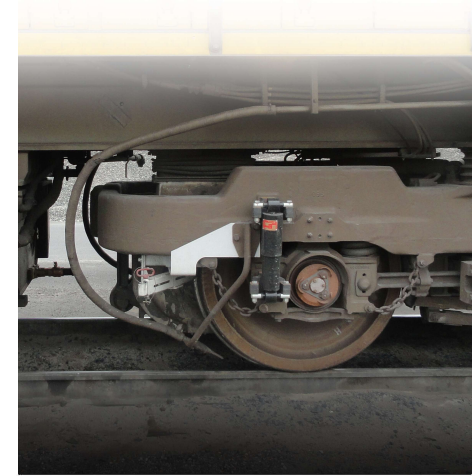
# Marketing and Sales

- This is the single most important aspect of planning and something that you cannot control
- “Selling it on my website” is not a sales and marketing plan
  - How are you driving traffic to the website? How much does that cost?
- Distributors vs. direct sales?
- Pricing
- Sales projections and cash flow



# Manufacturing

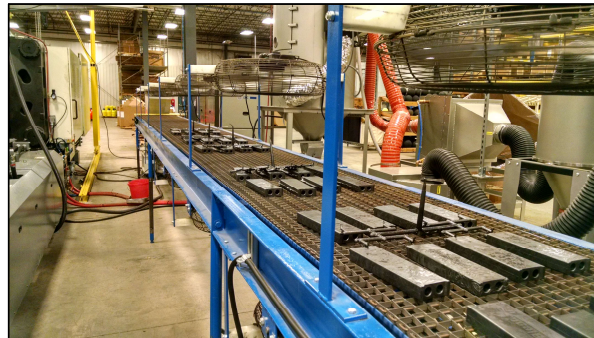
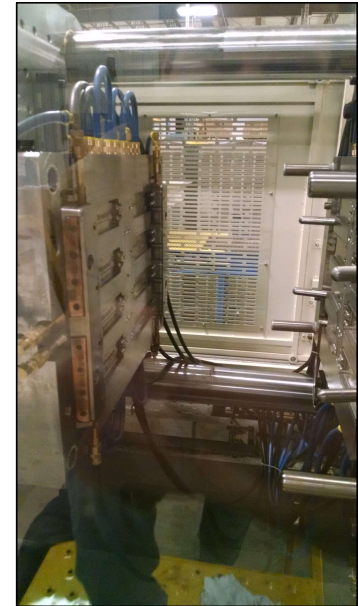
- It really has to work – and be able to be produced!
- Design for manufacturability comes into play
- Tooling – what is required to put the project into production
- Machines – In-house vs. toll processing
- Supply chain development
  - Landing correct materials at the correct time
  - Outbound shipping to customers
- Do you produce in the US or overseas?
- Once everything is lined up, time to Launch





# Product Scale-Up

- EXPENSIVE!
- Tooling cost for injection molding can easily cost \$50k - \$100k
- Packaging tooling costs
- Labor
- Facilities
- Inventory costs



# Other Resources in Kansas

- KDOC – [Proof of Concept Grant](#)
  - Up to \$25k to design and prototype a new idea
- TDI – Innovation Funds provided through K-State 105 funding
  - 50/50 matching grant up to \$25k to help offset the cost of development for a new product or technology for Kansas based businesses
- KDOC – [Small Business R&D Acceleration Grants](#)
  - 50/50 matching grant to cover costs of doing research with higher education institutions up to \$25k
- KDOC – [Angel Investor Tax Credits](#)
  - Obtain Kansas tax credits to assist in raising capital from angel investors
- Network Kansas – [GrowKS Program](#)
  - GrowKS loan and equity program - \$69 million
- Numerous other local programs designed to support the development of new products & technologies
  - Talk with local economical development representatives

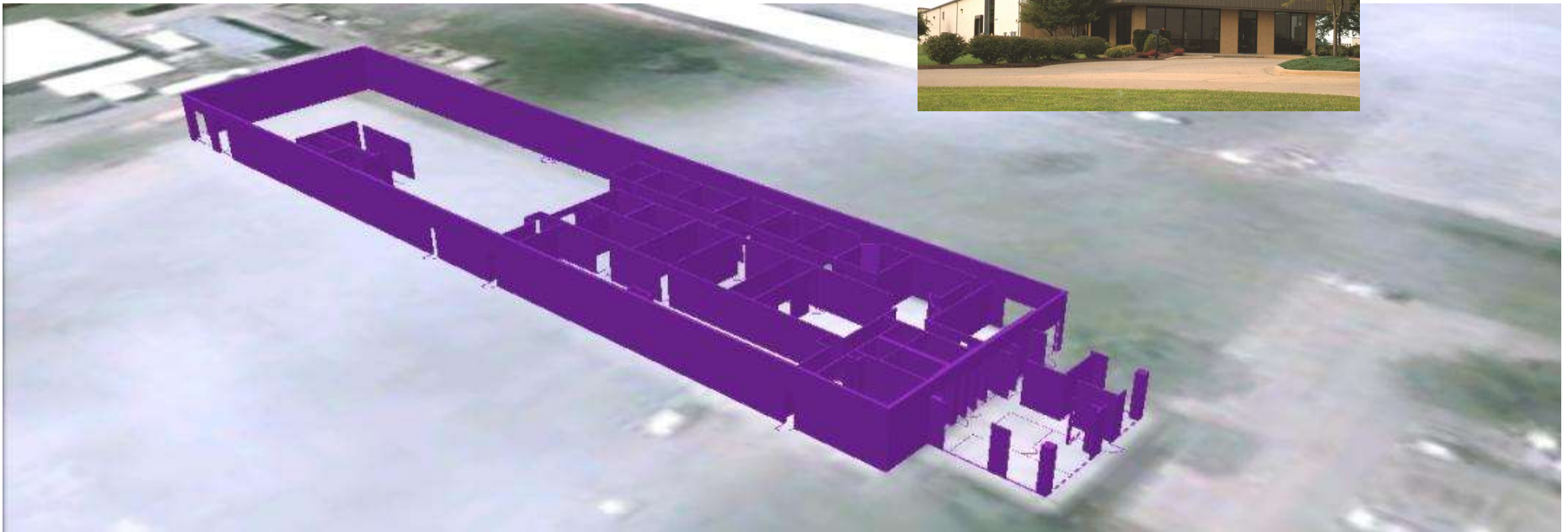
# Questions & Thank You!!



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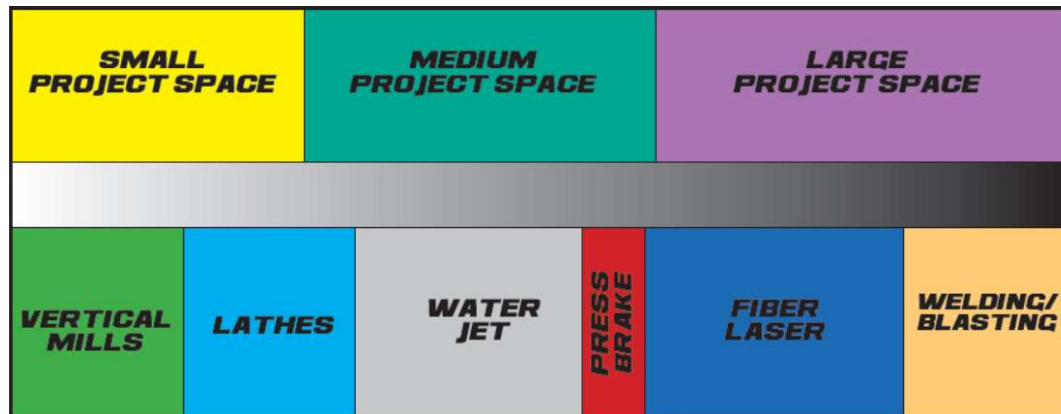
# TDI Development Facilities

- *22,000 sq. ft. Off-Campus Facility*
- *11,000 sq. ft. Project Offices/Meeting Space*
- *11,000 sq. ft. Prototyping Shop*



# TDI Development Facilities

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# Plastic 3D Printing



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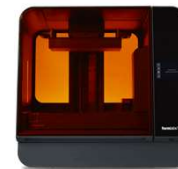
Technology  
Development Institute

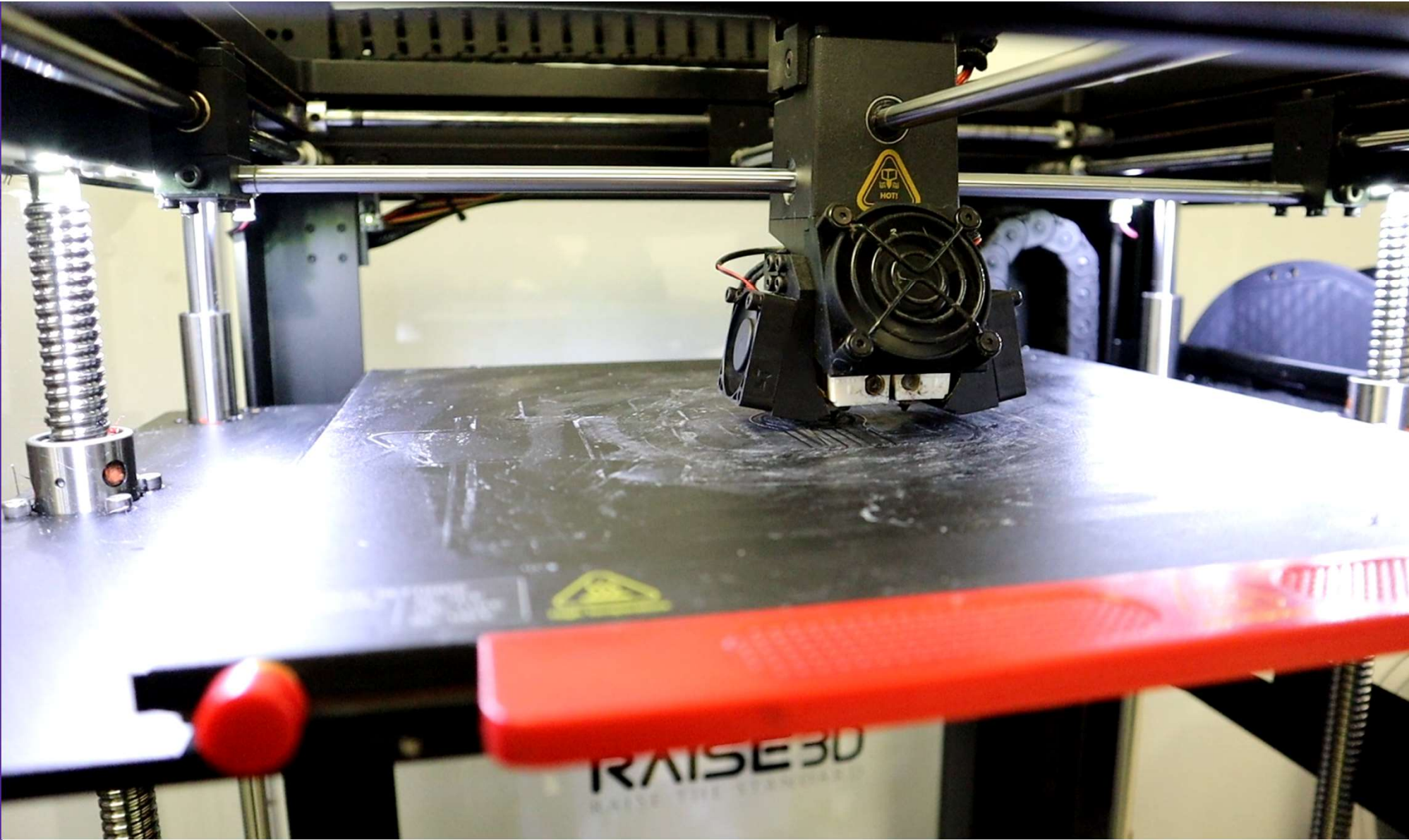
# Plastic 3D Printing



## FDM (Fused Deposition Modeling)

- Pushes melted plastic through a nozzle
- Material comes on a spool
- Easy to use and cheap







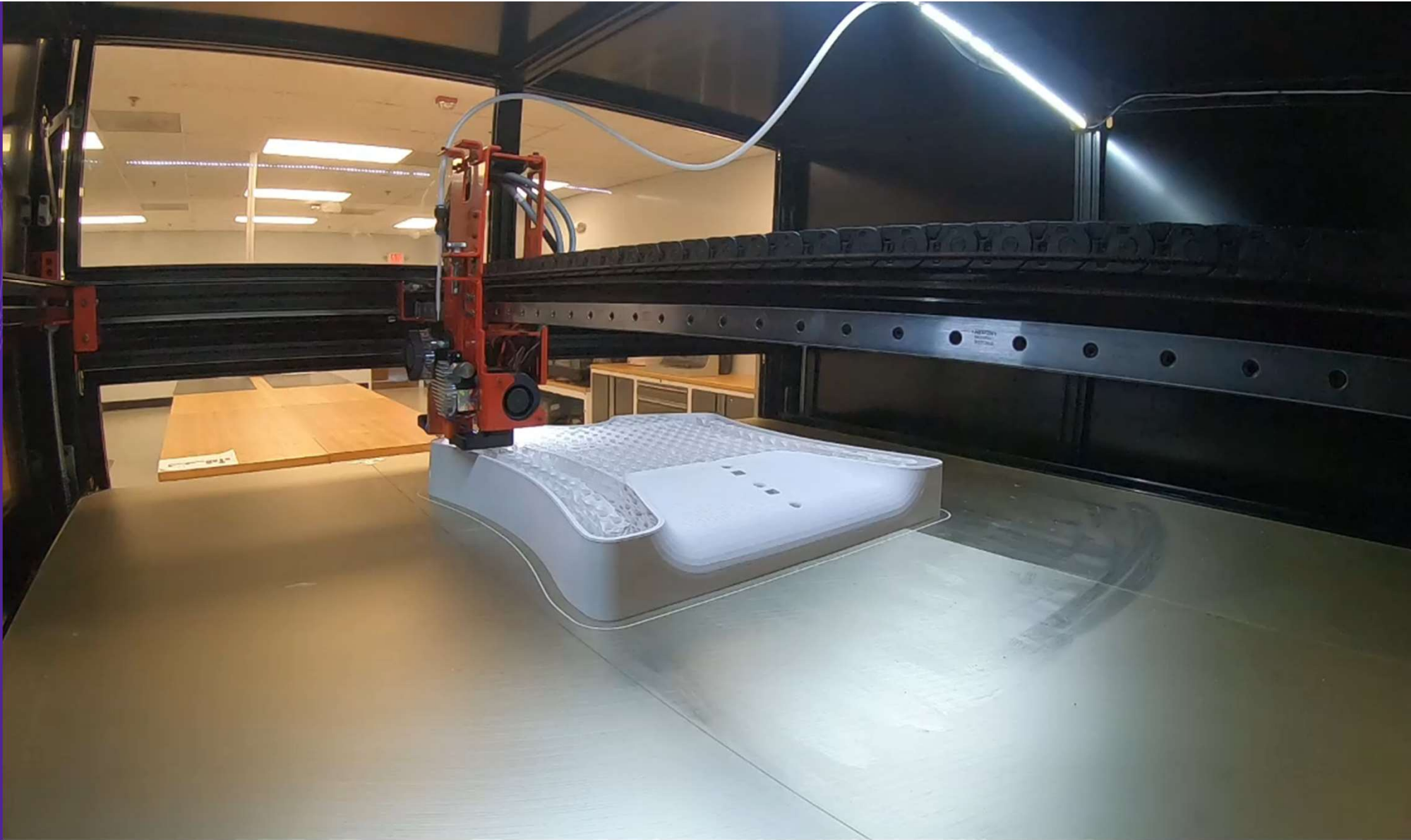
# Plastic 3D Printing



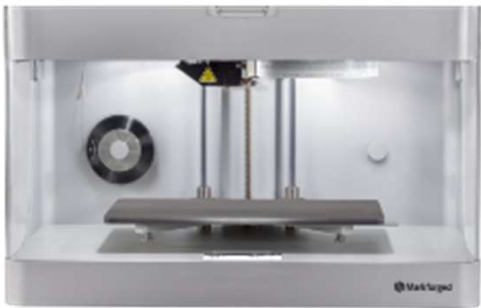
## Large Format FDM

- Works the same as smaller machines





# Plastic 3D Printing



## Continuous Carbon Fiber

- Very similar to FDM printing
- Additional nozzle “irons” down a continuous fiber within each layer
- Can make parts that are as strong as aluminum





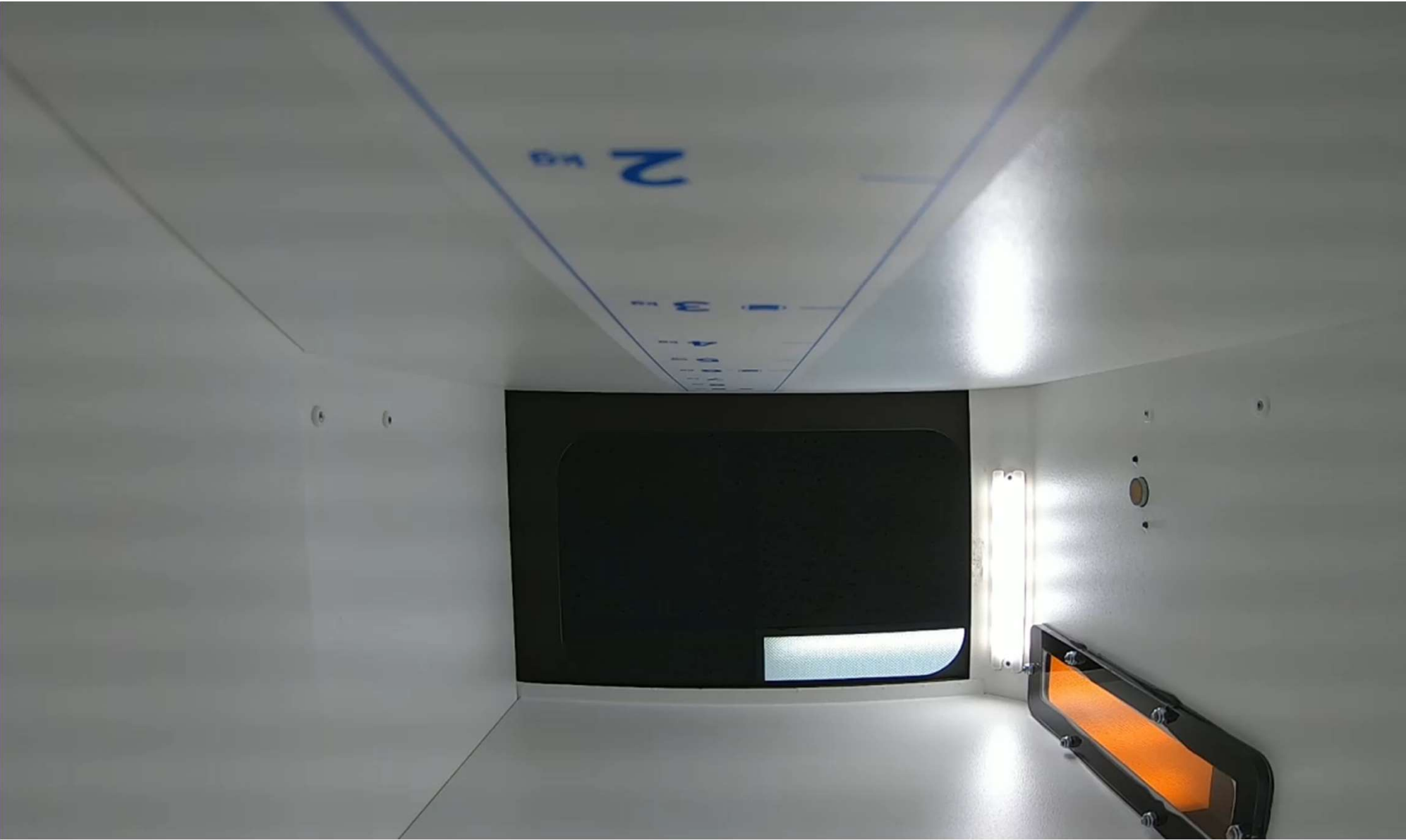
# Plastic 3D Printing



## SLS (Selective Laser Sintering)

- Melts part profiles on a flat layer of fine plastic powder and repeats with a new layer of powder
- No supports required to hold up part while printing
- Medium to high detail with good performance
- Post processing requires powder recovery station





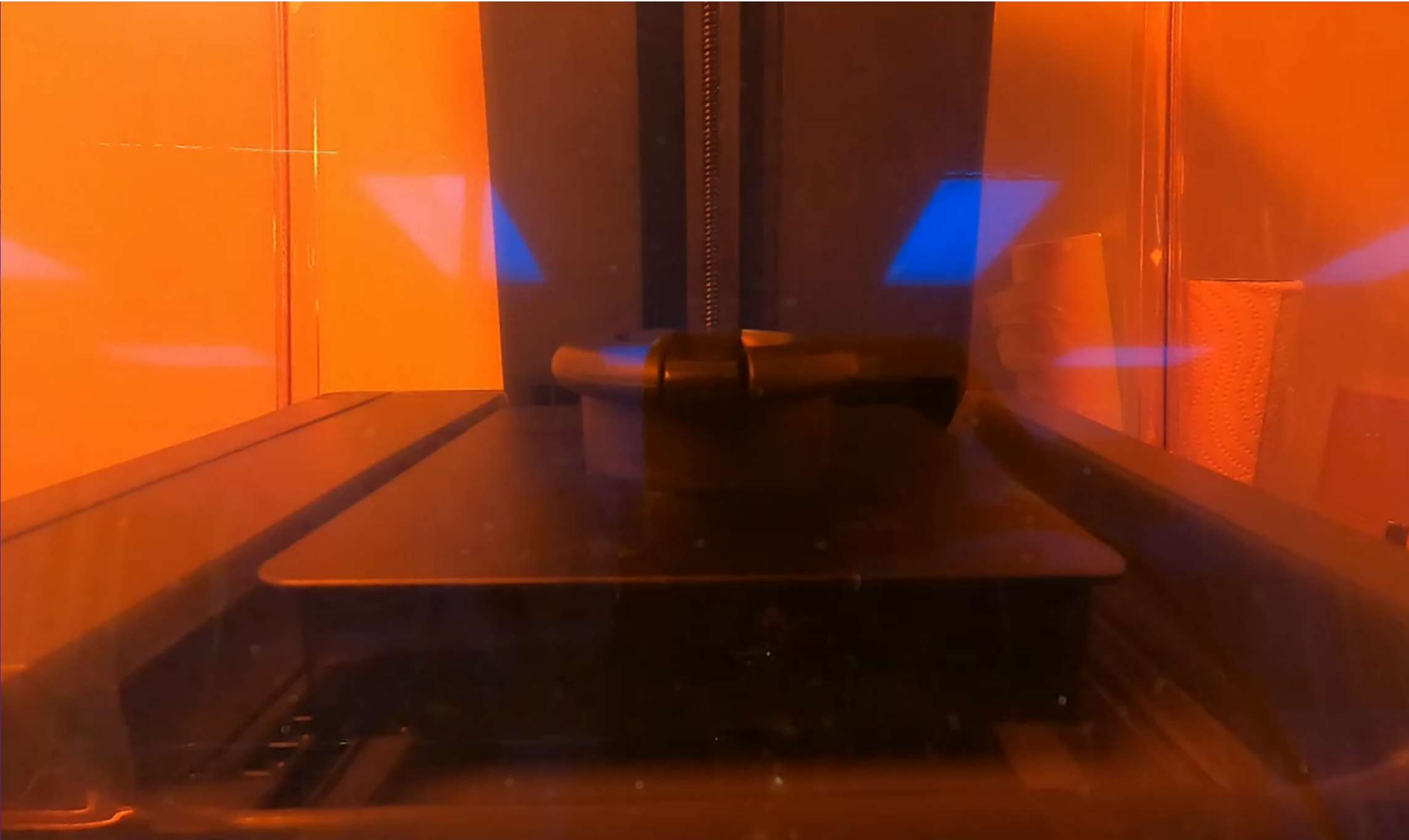
# Plastic 3D Printing



## SLA (Stereolithography)

- Liquid resin is in a vat on the bottom and is cured layer by layer using a UV laser
- High detail and functional parts
- More expensive than FDM





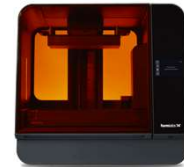


# Plastic 3D Printing


















## Polyjet

- Deposits liquid resin from a print head and uses UV light to cure each layer
- Can print multiple materials and colors all at once
- High Detail and smooth finish
- Expensive material and operating costs

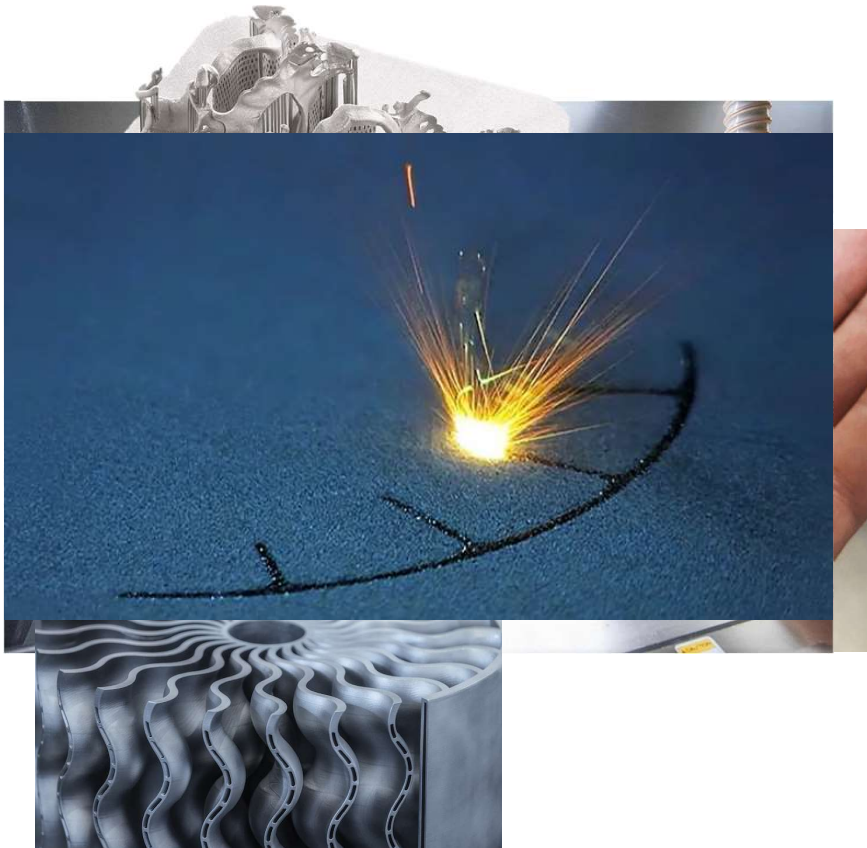




# Plastic 3D Printing Comparison

	FDM	CCF	SLA	SLS	Polyjet
Print Speed					
Cost	\$	\$\$\$	\$\$	\$\$\$	\$\$\$\$
Part Size					
Surface Finish	★	★★	★★★	★★	★★★
Functional, End use parts	★★	★★★	★★★	★★★	★
Flexible Material Option	✓	✗	✓	✗	✓
Multi-material/color print	✗	✗	✗	✗	✓
					

# Metal 3D Printing



## Laser Powder Bed Fusion (LPBF)

- Uses a high powered laser to melt together metal powder layer by layer
- Unused powder is cleaned off of parts and reused
- Allows for complex shapes and internal structures not possible using traditional manufacturing

# Metal 3D Printing



## Direct Energy Deposition (DED)

- Uses lasers an/or electricity to heat metal material depositing it in a bead (similar to welding)
- Can be mounted on a robot, CNC machine, or other frames
- Useful for making large parts





# Metal Fabrication



# Metal Fabrication



## Fiber Laser

- Uses a high powered laser and assist gas to cut sheet metal
- Cuts plain steel, stainless steel, and aluminum sheets
- High precision and fast cutting
- Tube function cuts high precision profiles in tube stock







# Metal Fabrication



## Waterjet

- Uses high pressure water and garnet to cut various materials.
- Cuts steels, aluminum, plastic, rubber, stone, etc.
- Slower than a laser, but more precise than using a jigsaw or other hand tools





**IN REAL TIME**

# Metal Fabrication



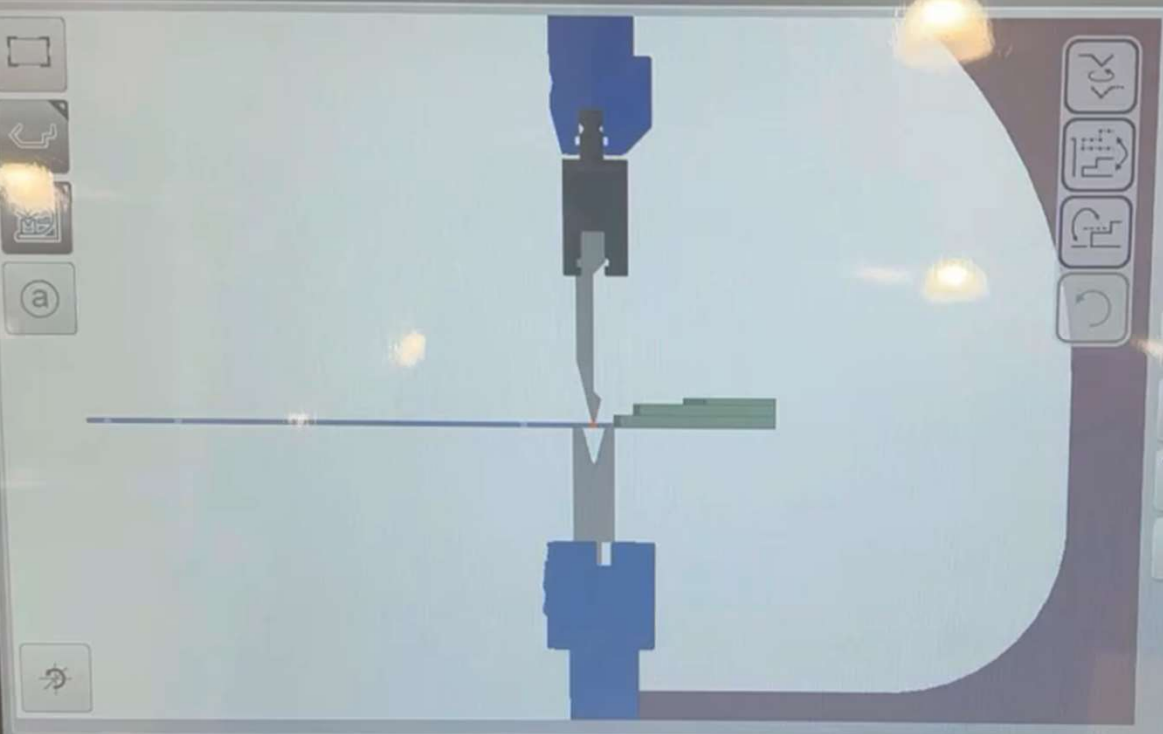
## Press Brake

- Bends sheet metal at precise lengths and angles
- Various supports and stops on the machine help position the part for bending





1 2 3 4



The main interface displays a 2D schematic of a metal sheet being bent. A blue punch tool is positioned above the sheet, and a die is below it. A hand icon is visible on the right side of the sheet, indicating the direction of the bend. The background is light blue.

unbend  
bend  
assignm.  
+ bend sequence  
+ compute sequence  
show bendseq.

Products Drawing Tool setup Bend sequence Program Auto Manual Settings Machine Help



# Metal Fabrication



## CNC Machines

- Parts are positioned in machine workspace and cut using various bits and tools
- Vertical mill, 5-axis mill, and a lathe are common machine types



Operation: MEM 14:32:28

NET .NC N840

N800 G3 X2.876 Y.4275 I-.1875 J0.;

N810 X2.4485 Y0. I0. J-.4275;

N820 X2.876 Y-.4275 I.4275 J0.;

N830 X3.3035 Y0. I0. J.4275;

**N840 X2.876 Y.4275 I-.4275 J0.;**

N850 X2.6885 Y.24 I0. J-.1875;

N860 G1 G40 Y.0525;

N870 G0 Z1.;

N880 X1.6255;

N890 Z.1;

N900 G1 Z-1.0455 F100.;

N910 G41 D3 Y.24 F50.;

N920 G3 X1.438 Y.4275 I-.1875 J0.;

N930 X1.01 I0. I0. J-.4275;

N940 X1.438 Y-.4275 I.4275 J0.;

N950 X1.8655 Y0. I0. J.4275;

N960 X1.438 Y.4275 I-.4275 J0.;

N970 X1.2305 Y.24 I0. J-.1875;

N980 G1 G40 Y.0525;

N990 G0 Z1.;

N1000 X.1875;

N1010 Z.1;

N1020 G1 Z-1.0455 F100.;

N1030 G41 D3 Y.24 F50.;

N1040 G3 X0. Y.4275 I-.1875 J0.;

N1050 X-.4275 Y0. I0. J-.4275;

N1060 X0. Y-.4275 I.4275 J0.;

N1070 Y.4275 Y0. I0. J.4275;

Active Program

Active Codes

G03 CCW Circular Fe

G90 Absolute Position

G41 2D Cutter, Comp Left

G80 Cycle Cancel

G54 Work Offset #54

Active Tool

Tool: 3

Offset: 3

Type: End Mill

Tool Group: -----

Max Load: 31

Life: 100%

Next Tool

Pocket: 25

Tool #: 31



D03 H03 M03 T3

Main Spindle



Spindle Speed: 5000 RPM

Spindle Power: 0.4 KW

Surface Speed: 31 FPM

Chip Load: 0.003 IPT

Feed Rate: 50.0000 IPM

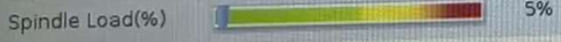
Active Feed: 50.0000 IPM

Overrides

Feed: 100%

Spindle: 100%

Rapid: 50%



Positions Program G54 G43 H3

	(IN)	Load
X	2.9052	20%
Y	0.4382	11%
Z	-1.0455	33%

Timers And Counters

This Cycle: 0:00:42

Last Cycle: 0:01:05

Remaining: 0:00:22

M30 Counter #1: 830

M30 Counter #2: 830

Loops Remaining: 0

POWER OFF

OP



# 3D Scanning



# 3D Scanning



## CMM Arm and Laser Scanner

- Use probe or laser to measure and inspect parts
- Laser is useful for complex or organic geometry
- Useful for scanning all sizes of parts







# 3D Scanning



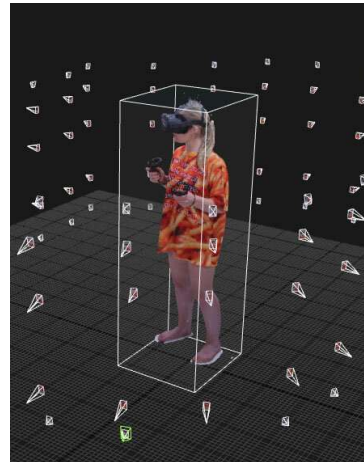
## Wide Area Scanner

- Gathers point cloud and picture data all at once (similar to a Google car)
- Useful for capturing layouts of large objects, buildings, and outdoor areas





# 3D Scanning



## Other technologies

- Handheld scanners
- Desktop setups
- Terrestrial Lasers
- Photogrammetry\*

