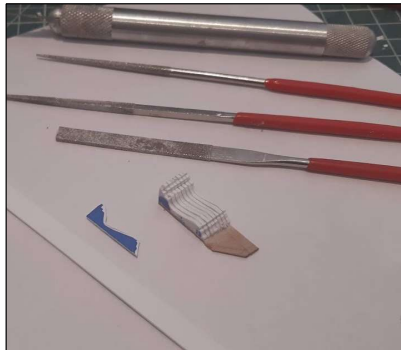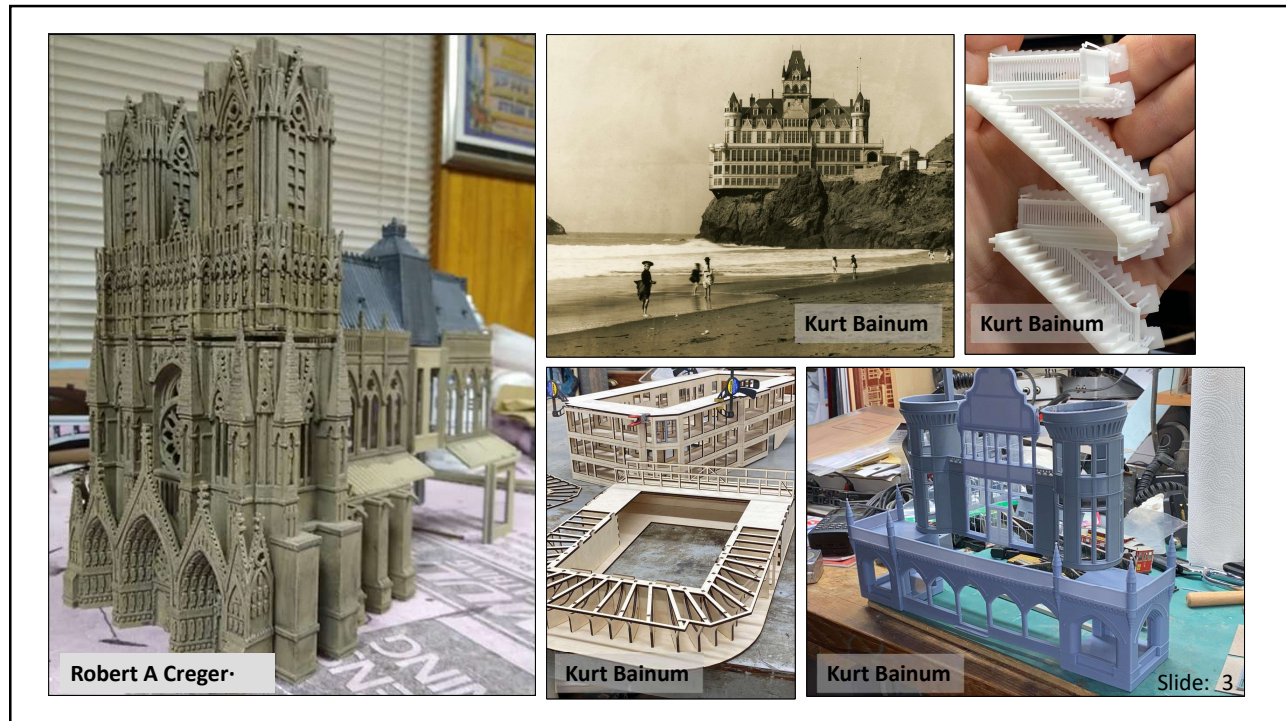# 3-D Printing for Model Railroading

Slide: 1

This technology is a game-changer

- Scratchbuilding & Kitbashing only get you so far
  - Time
  - Complex Shapes
  - Accuracy
  - Repeated Parts (see Time above)
- Previous solutions
  - Assembly-line production of parts
 - Scratch-built master, resin castings (Westerfield, F&C, others)

This building is scratch-built except for the 4/4 windows. The corbels and cornice trim are what drove me to 3D printing

Slide: 2

Robert A Creger·

Kurt Bainum

Kurt Bainum

Kurt Bainum

Kurt Bainum

Slide: 3

Konrad Szwab

Konrad Szwab

Slide: 4

Why 3D printing

- Detail parts that aren't commercially available
- Unusual prototypes
- Multiple copies
- Applications – locomotives, rolling stock, structures, detail parts

Structure Details, HO
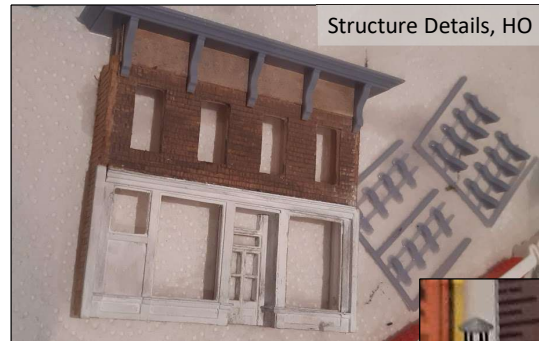
Toma Monson Forney #4, HOn30

SR&RL Combine 11, HOn30

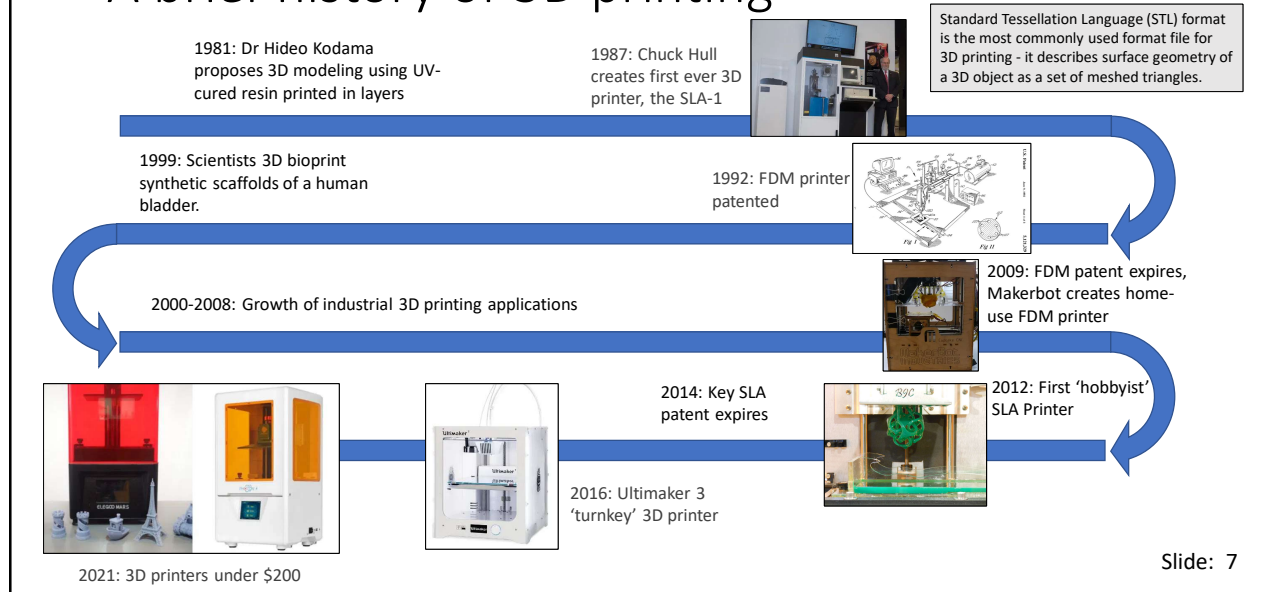Smokejack, HO

Slide: 5

Advancing Technology

- 3D printing has been available for a while, but resolution hasn't always been great
- Example to right from 2018
  - Probably an FDM printer (more on that later)
  - Obvious layering
  - Lots of finish work required

Today's state of the art has overcome early limitations, and outstanding detail is easily achievable.

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A brief history of 3D printing

1981: Dr Hideo Kodama proposes 3D modeling using UV-cured resin printed in layers

1987: Chuck Hull creates first ever 3D printer, the SLA-1

Standard Tessellation Language (STL) format is the most commonly used format file for 3D printing - it describes surface geometry of a 3D object as a set of meshed triangles.

1999: Scientists 3D bioprint synthetic scaffolds of a human bladder.

1992: FDM printer patented

2009: FDM patent expires, Makerbot creates home-use FDM printer

2000-2008: Growth of industrial 3D printing applications

2014: Key SLA patent expires

2012: First 'hobbyist' SLA Printer

2016: Ultimaker 3 'turnkey' 3D printer

2021: 3D printers under $200

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3D Printer Types

• Stereolithography Additive (SLA)

• Fused Deposition Modeling (FDM)

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4

Strengths & Weaknesses

Resin-based SLA Printer

Filament-based FDM Printer

Part strength ✓

✓ Color options ✓

✓ Material options ✓

Print size ✓

✓ Resolution

✓ Print speed

Low Mess/odor ✓
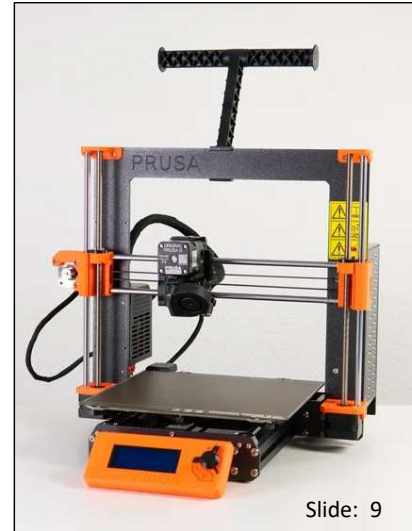
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"Best" 3D SLA Printers

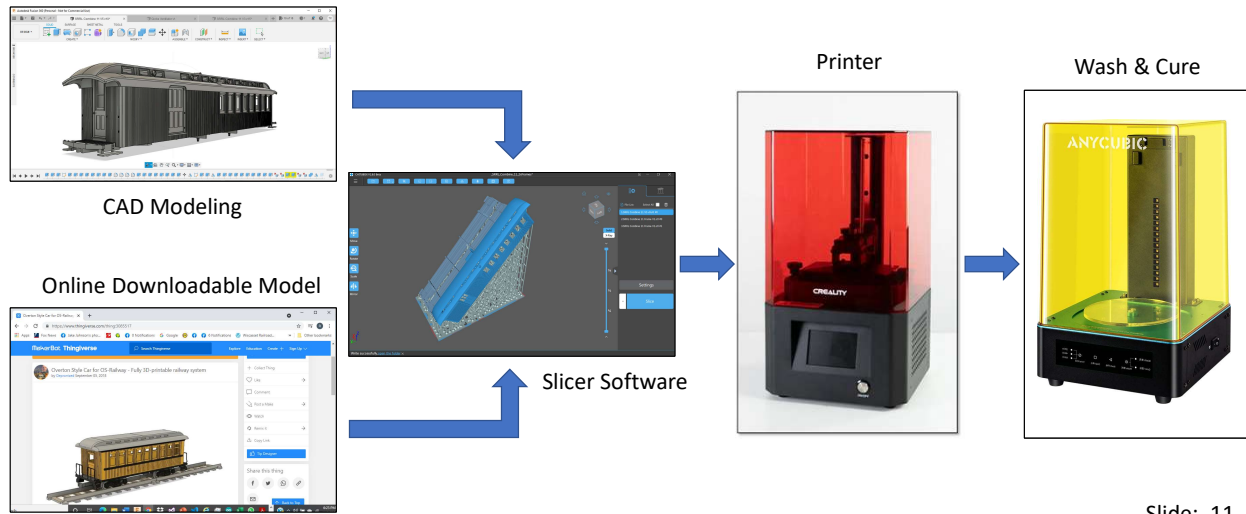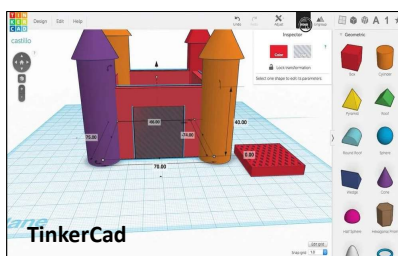| 3D Printer	Build Vol (mm)	Resolution (μm)	Approx Price
Elegoo Mars	120 x 68 x 155	XY: 47, Z: 10	$190
Voxelab Proxima	130 x 82 x 155	XY: 50, Z: 25	$219
Elegoo Mars 2	129 x 80 x 150	XY: 50, Z: 10	$230
Creality LD-002H	130 x 82 x 160	XY: 51, Z: 30	$239
Phrozen Sonic Mini 4K	135 x 75 x 130	XY: 35, Z: 10	$399
Nova3D Bene4 Mono	130 x 80 x 150	XY: 50, Z: 10	$399
Phrozen Sonic Mighty 4K	200 x 125 x 220	XY: 52, Z: 10	$599
Anycubic Photon Mono X	192 x 120 x 245	XY: 50, Z: 10	$759
Original Prusa SL1	120 x 68 x 150	XY: 47, Z: 10	$1,699
Peopoly Phenom	276 x 155 x 400	XY: 72, Z: 20	$1,999

As of May 2021
Source: https://all3dp.com/1/best-resin-dlp-sla-3d-printer-kit-stereolithography/

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The printer is only part of the process…

CAD Modeling

Online Downloadable Model

Slicer Software

Printer

Wash & Cure

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Building the model - CAD Programs

TinkerCad

Fusion 360

SketchUp Free
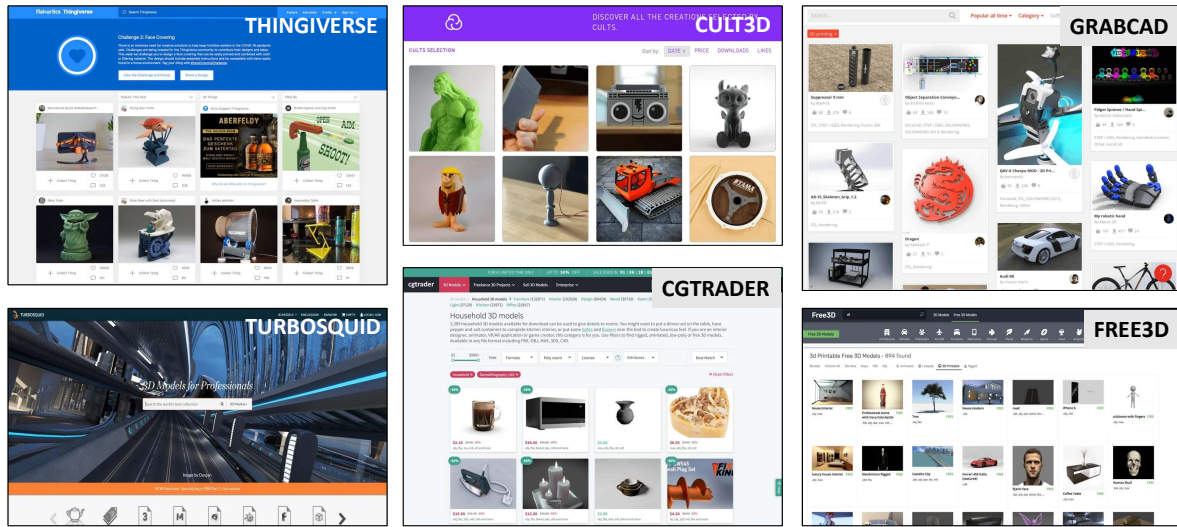
CAD programs really unlock the power of your 3D printer and allow you to create those custom pieces you really want.

All these are free to download and use. The top 3 are for mechanical design, the lower two for figures and organic designs.

**Blender**

MeshMixer
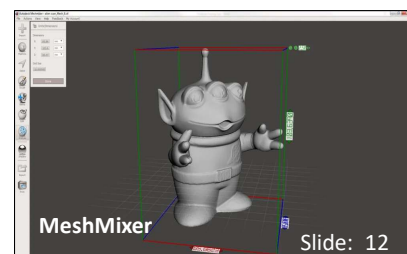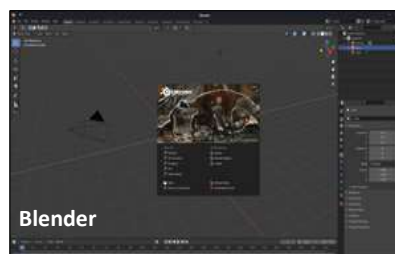
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Building the Model - Free download sites

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Slicers

1) Combine different models into the same print session
2) Set orientation to allow bigger models than the size of the build plate (and better prints)
3) Add supports
4) Set print settings for your printer
   1) Layer depth
   2) # of Bottom layers
   3) Exposure time (bottom and print layers)
   4) Lift speed
   5) Anti-Aliasing
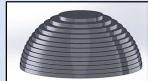5) All these slicers are free. Fan favourites are Lychee and Chitubox

Cura

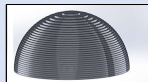PrusaSlicer

Chitubox

LycheeSlicer
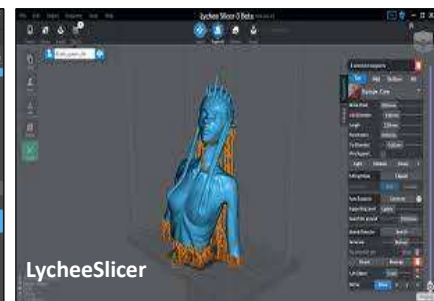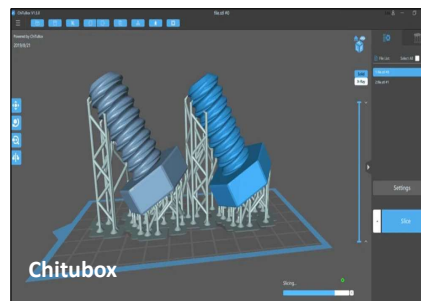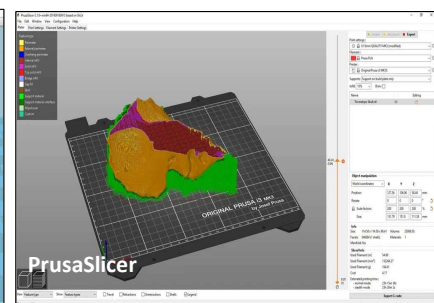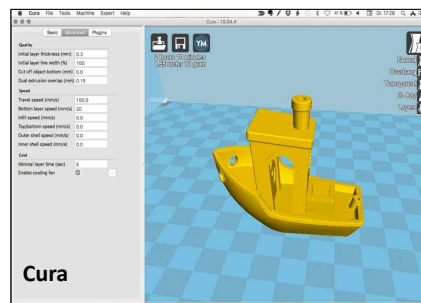
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Slicer Settings

Layer Height

Layer height is the exact height of each cured layer

100µm layers

50µm layers

Exposure Time

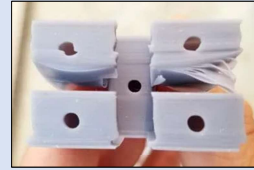Depends on the type of resin being used and power of the light in the machine.

3.5s — Over

2.5s — Correct

1.5s — Under

Lift Speed
Too fast, and supports break, parts delaminate; too slow increases print time required
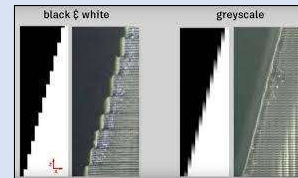
Part Orientation
Can improve print quality by minimizing changes in cross-section from layer to layer and taking advantage of better z-axis control versus x-y axis

Anti-Aliasing
Improves curved edges by adjusting power used on edge pixels

black & white   greyscale

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Now it's time to print!

Safety – ventilation, nitrile gloves (resin is nasty stuff)

Resin choices – balance colour, detail, toughness

Oh yeah – how do we get the file from the slicer to the printer? (most current SLA printers are not Wifi capable)

Best Overall:
Siraya Tech Fast

Best Bulk Buy:
AnyCubic UV sensitive resin 1 Litre

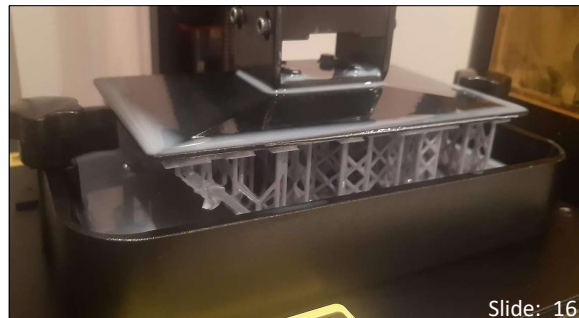**Great All-rounder:**
eSUN General Purpose Photopolymer Resin

Best Budget resin:
ELEGOO 3D Rapid Resin

Best for Toughness:
Siraya Tech Tough (blu)

https://www.windowscentral.com/best-resin-your-3d-printer

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Printing

The most recent printers use a monochromatic LED light source, which gives a much faster exposure time than older full-color LEDs

Best to use in a room with little direct sunlight, good ventilation

Level printer, level print bed, set zero
- Process varies from printer to printer

Fill the vat with resin, select model on screen
- Shake resin first to mix
- Let it settle a bit to reduce bubbles

After every layer, you'll hear the sound of the model pulling away from the FEP – that's normal

The resin vat hides progress – so you aren't really sure how it's going for at least an hour

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Post-print: Wash & Cure

- The first thing that needs to happen is to wash excess resin off the print – best practice is 99% isopropyl alcohol as the wash agent
- Mars, Anycubic, Elegoo, Creality all make 'wash and cure' machines
  - Provides a stirrer for the alcohol bath
  - Also provides a rotating base and a 405 nm UV light source
- There are inexpensive homemade options
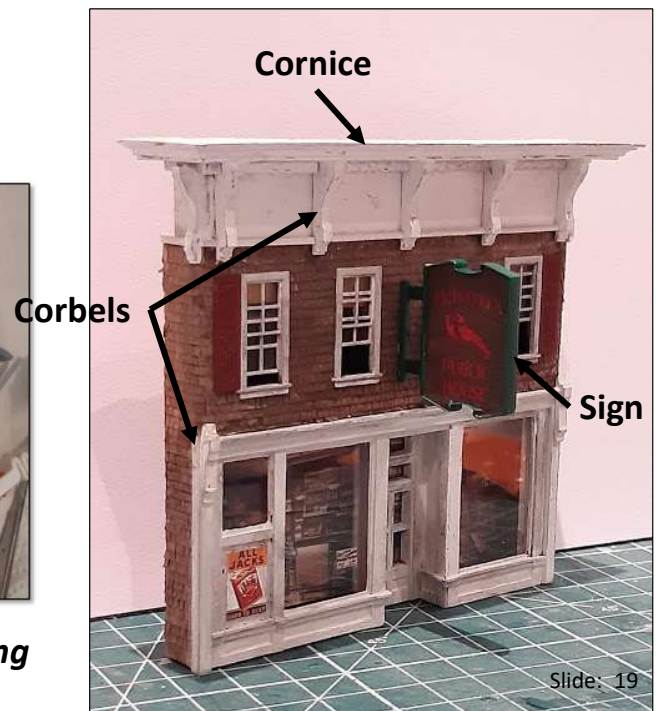 - Tradeoff is time-savings - hand-washing versus automatic washing

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So – what can I do with this?

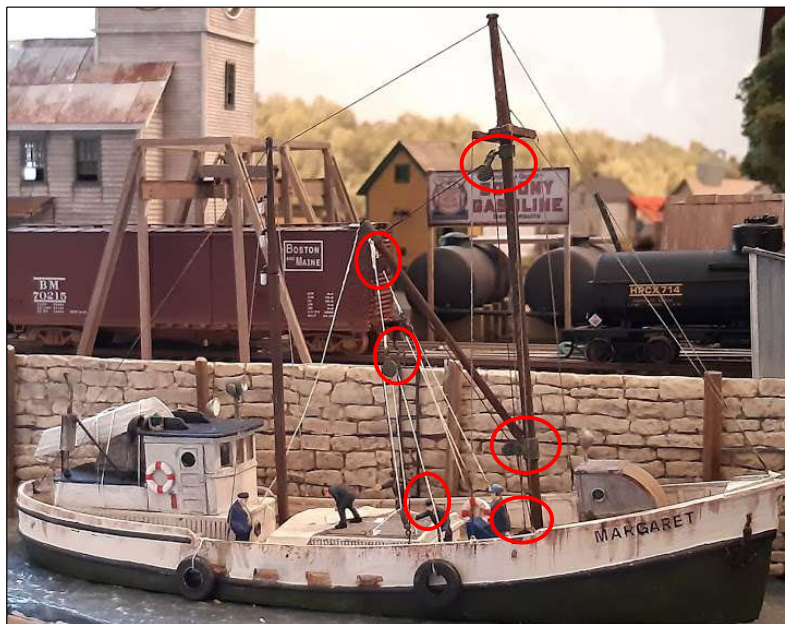*This was my first foray into 3D printing*

Cornice

Corbels

Sign

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Kitbashing Help

I wanted to convert a drag fishing trawler into a freighter – and needed a shipboard derrick crane.

3D print components – winch, head block, monkey face, pulleys, etc

I was able to iterate on the part size until I hit the right one, quickly

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Exterior Details

Chimney

Tokheim 850 pumps

Test print for narrow gauge combine

Car repair ramp

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Structure Parts

Skylights

Gable & Window

Cornice

Door track

Window Sashes

Interior Details

Bay Doors

These parts count as AP scratch-built, if you do the CAD design work yourself

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Interior Details

Fireman's Helmet (Thingiverse)

Alarm (Fusion 360)

Clothing Rack (Fusion 360)

Boots (Thingiverse)

Desk, Phone, Cup (Thingiverse)

Chairs (Thingiverse)

Slide: 23

Cars

Slide: 24

Locomotives

Slide: 25

Other Stuff

Slide: 26-

Other Stuff

Slide: 27

Other Stuff

Slide: 28

Useful References

- https://all3dp.com/ - all things 3D printing related; reviews, tips and techniques, and much much more
- https://3dprinteruniverse.com/ - another useful all-purpose site
- https://www.thingiverse.com/ - tons of free stl models; so much stuff its sometimes hard to find what you're looking for
- https://www.facebook.com/groups/3DModelTrains - Facebook group for 3D printing specially for model railroading
- https://www.youtube.com/ - tutorials for CAD & 3D printing; just do a search for what you're interested in

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"What I wish I'd known when I started"

- I put this question to the FB 3D Printing for Model Trains group

"3d printing is a massively revolutionary technology. It completely changes the status quo in product development, manufacturing, and prototyping. But... It is not replicator technology from Star Trek. You almost never can simply push a button, walk away, and come back to an item a few hours later."

"Though it may seem hard at first it can become quite a reliable tool in our arsenal. Not everyone's going to make a fantastic print their first time. It will take trial, effort, fine tuning, and maybe some cursing..."

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"What I wish I'd known when I started"

"The printer is at the centre of things, but there's a whole lot more to the process."

"Don't expect it to replace the whole modeling process, 3D printing is a tool like any other, resin is excellent for fine modeling but still has limitations requiring traditional modeling skills to make it great."

"Just like regular modeling it takes time to get the most out of it."

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Questions?

If you have other questions for me, I can be reached at trpersing@gmail.com. Please use the subject NMRA 3D PRINT CLINIC.

I hope you enjoyed this!

Ray Persing

"My dad recently got a 3D printer and made a stool sample for his doctor." New dad joke level = unlocked.

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