

# Design for 3D Printing

*or*

“Today the replicator, tomorrow the holodeck!”

Featuring “The Ballad of the METR3800 Tank”

Paul Pounds

9 April 2013

University of Queensland

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# But first...

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Some house keeping

# Calendar at a glance

Week	Dates	Lecture	Reviews	Demos	Assessment submissions
1	25/2 – 1/3	Introduction			
2	4/3 – 8/3	Principles of Mechatronic Systems design			
3	11/3 – 15/3	Principles of Sailing			Design brief
4	18/3 – 22/3	Sensor Fusion and Filtering	Progress review 1		
5	25/3 – 29/3	Your Soldering is Terrible			
Break	1/4 – 5/4				
6	8/4 – 12/4	Design for 3D printing	Progress seminar		
7	15/4 – 19/4	By request		25% demo	
8	22/4 – 26/4				
9	29/4 – 3/5		Progress review	50% demo	
10	6/5 – 10/5				
11	13/5 – 17/5			75% demo	Preliminary report
12	20/5 – 24/5				
13	27/5 – 31/5	Closing lecture		Final testing	Final report and addendum

You are here →

OMFG!

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# FAQ Roundup

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- **None as yet**

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# Lab matters

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- People have been found in the lab without correct footwear
  - They were ejected
  - Repeat offenders will be **–banned–**
- You must be inducted to use the 3D printer!
  - Doug is in the lab every Wednesday at 1pm
  - You must also complete the online risk assessment form

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# Progress Seminar

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- Group presentation – 10 minutes per team
  - Stand up and talk about your progress
  - Each person talks for roughly equal time
- Focus on progress, not the requirements!
  - We know what the project goal is.
  - We know (loosely) what your approach is.
  - Don't waste valuable time repeating them.
  - Above all, show **EVIDENCE** of your work.

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# Seminar schedule

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- **Wednesday 10th**
  - 1:00-1:15 Team 7
  - 1:15-1:30 Team 8
  - 1:30-1:45 Team 5
  - 1:45-2:00 Team 14
  - 2:00-2:15 Team 2
  - 2:15-2:30 Break
  - 2:30-2:45 Team 4
  - 2:45-3:00 Team 1
- Thursday 11th**
  - 1:00-1:15 Team 13
  - 1:15-1:30 Team 3
  - 1:30-1:45 Team 11
  - 1:45-2:00 Team 9
  - 2:00-2:15 Team 6
  - 2:15-2:30 Team 10
  - 2:30-2:45 Team 12
  - 2:45-3:00 Team 15

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# Demos

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- The first preliminary demonstration round runs next week
  - Mark cap at 25 per cent.
  - One demo attempt per team (in this round)
- If you are ready to test your vessel, contact me now so I can arrange things.
  - Bookings must be made by 5pm Thursday.



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# But, but...

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What about the tank?

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# The Ballad of the METR3800 tank

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Come listen to a tale told  
Of a tank we dreamt water to hold!  
Our brightest minds did seek to build  
A sturdy trough that would not yield.

And build we did a mighty pool  
With tiny coastline (it's so cool!)  
Sought us then a place to rest  
Our massive tank - our ships to test.

Many places thus were found;  
We begged they let us use the ground.  
But little did we guess or know  
That *everyone* would tell us "NO."

And so like nomads did we roam  
To find our fancy tank a home.  
They said that Frank White's undercroft  
Ideally suited Wonder Trough

So sallied forth our artisans  
To place the tank with tools and hands,  
To raise our LED lights to the sky,  
Our tiny ships the stars to guide!

But darker days were yet to come,  
For scarcely was the building done  
When out should ride the brazen foe.  
With sword held high, he ordered "Go!"

Forced to leave the promised land,  
(Our LED lights there no more could stand)  
Our plans were thrown in disarray:  
The tank had nowhere else to stay!

In grim despair the people wailed.  
All hope was lost, our venture failed!  
When suddenly a shining light:  
A messenger come in the night!

Not far away, the message told,  
There was a place, our tank to hold.  
A place we could conduct our tests:  
The patio by ELCX.

But in this place there did abide  
The ENGG1100 tribe.  
A band of natives proud and fierce:  
Students (first and second years).

Prepared for battle, did we ride  
Toward the unwashed other side.  
Girt with courage, rank by rank,  
We marched for glory - "For the Tank!"

Far across the field we see  
Their mighty fearsome warrior chief.  
We raised our banner for the fray,  
But ere the chieftain bid us stay.

The chief decrees, "There's room enough  
For both our project and your trough.  
Install the tank where you think best  
Opposite the ELCX."

And so we sang in joyous song,  
"Our tank has somewhere to belong!"  
And someday soon in it will float  
your tiny mechatronic boat

So that's the news, as of today.  
(We apologise for the delay!)  
Now lift us all our glass in thanks,  
For the METR3800 tank!

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Uhhh....

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...Okaaay.

Should be filled and ready to go today.

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# Onwards...

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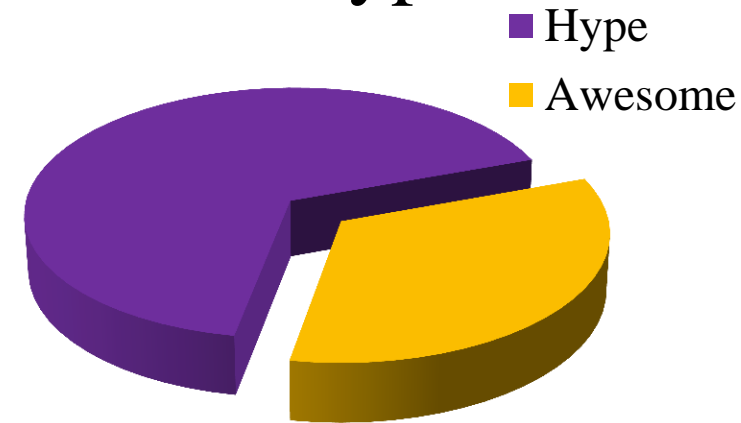
Now about that 3D printing stuff...

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# Caveat

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- 3D printing is 1/3<sup>rd</sup> awesome, 2/3<sup>rds</sup> hype
- 3D printing lets you make many things you can't machine in other ways



- But it isn't the right process for everything
  - ABS/PLA/UV-cure resin are weak
  - SPM is expensive

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# Many types of processes

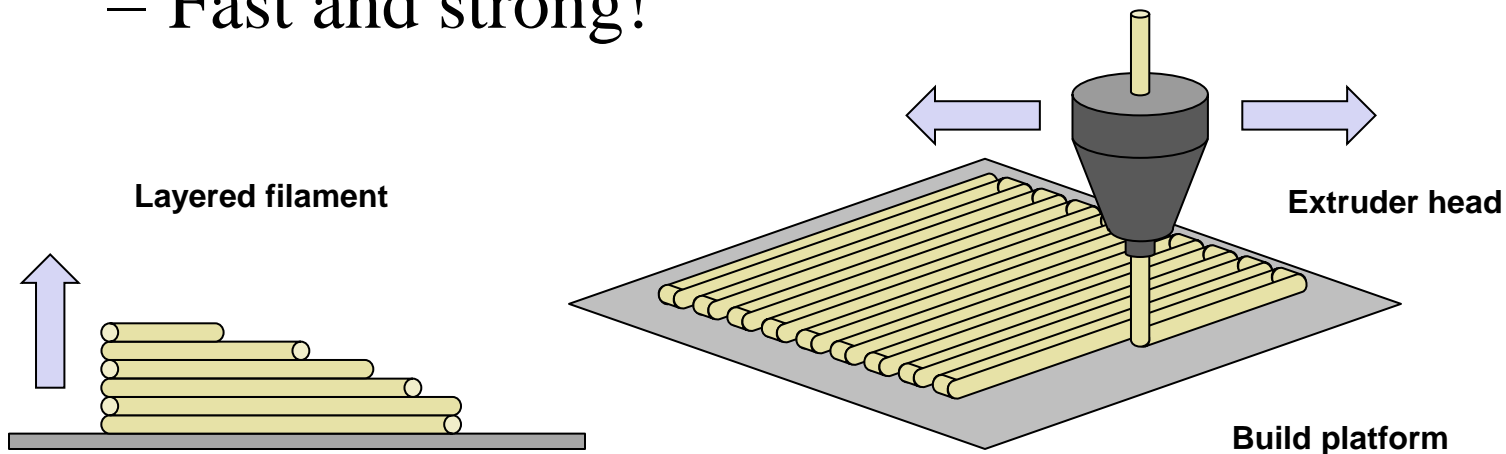
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- FDM – Fused Deposition Modelling
- SLA – Stereolithography
- SLS – Selective Laser Sintering
- SPM – Sintered Powder Metallurgy

Each has its own pros and cons

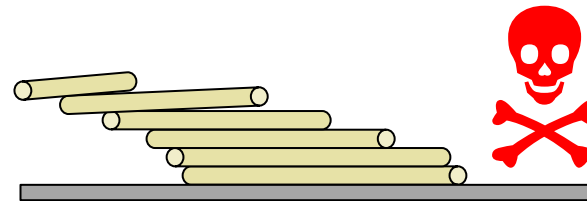
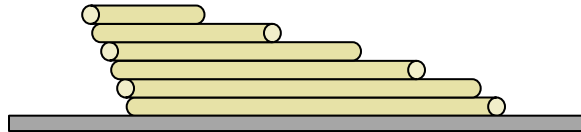
# Fused Deposition Modelling

- The 3D printing most of you know and love
  - Shapes constructed from resin strands laid down by the print-head
  - Vertical shapes produced by layering strands
  - Fast and strong!

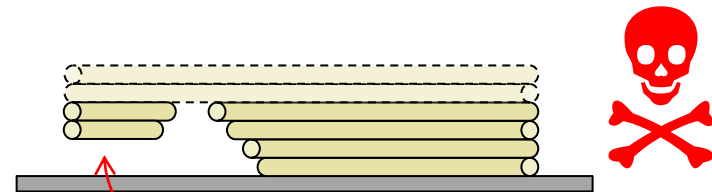
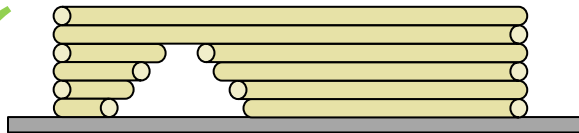


# FDM dos and don'ts

- Only small overhangs permitted



- No floating geometry

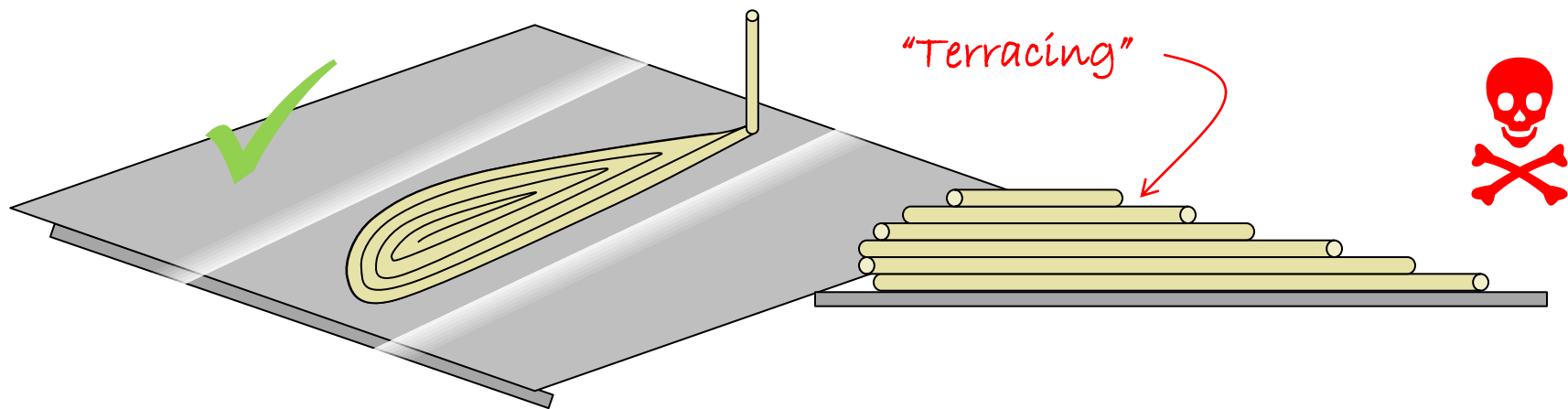


*Anti-grav required*



# FDM dos and don'ts

- Lay curves, holes and contours horizontally

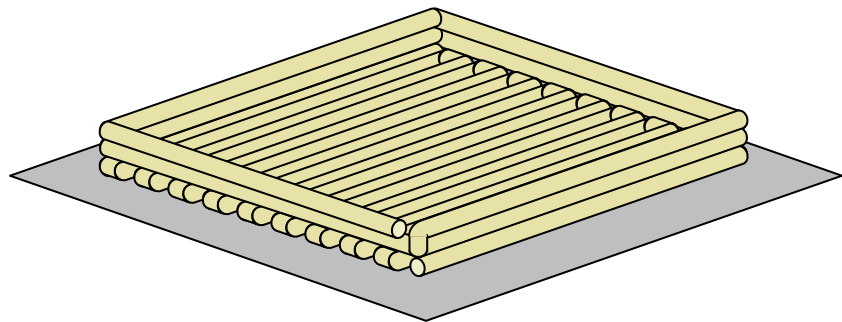


- Build stress axes horizontally; fillet corners

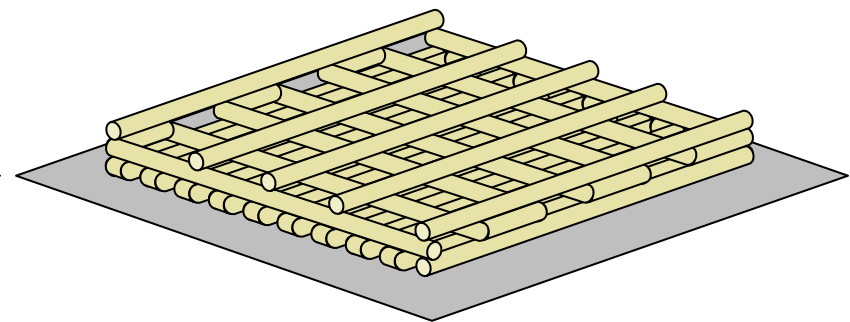


# FDM dos and don'ts

- Make pieces hollow when possible
  - If non-structural, consider leaving empty space
  - Many software packages will automatically create cross-hatched voids to save time/material without compromising strength
  - But don't assume it's water tight



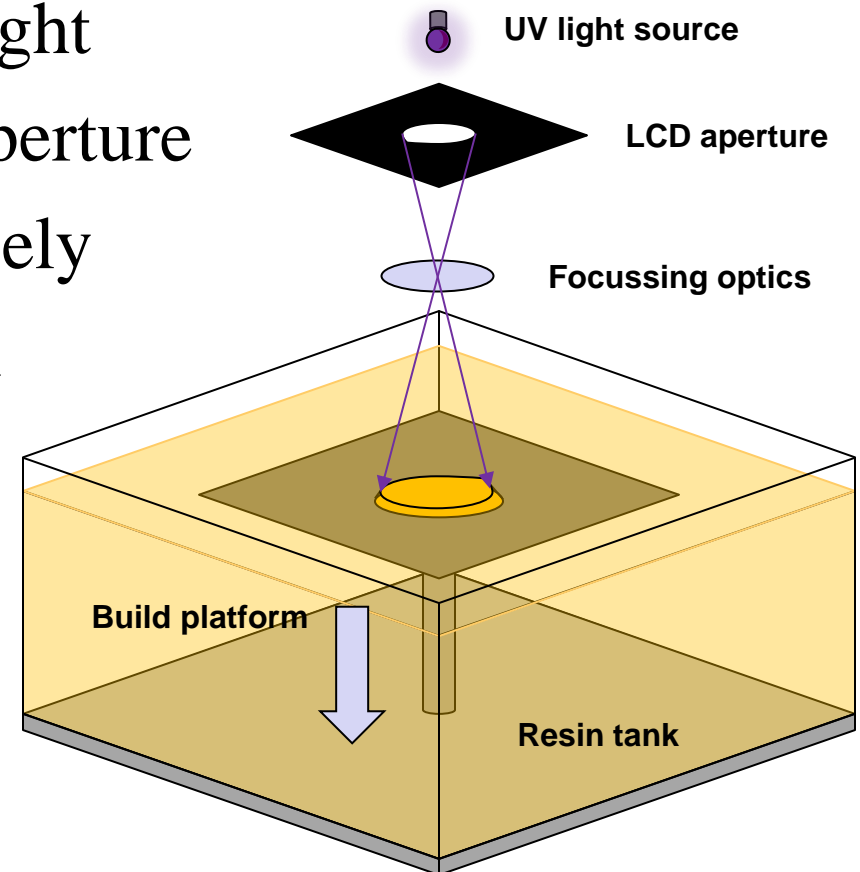
Hollow interior



Cross-hatched interior

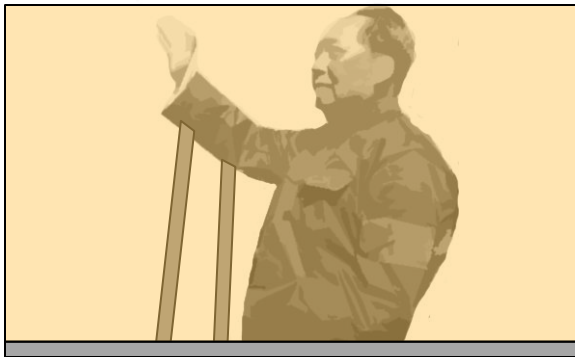
# Stereolithography

- 3D shape projected into UV-cure resin
  - Blacklight emits UV light
  - LCD panel forms an aperture
  - Projected light selectively cures top layer of resin
  - Build platform lowers as each layer is cured
  - Excellent precision



# SLA dos and don'ts

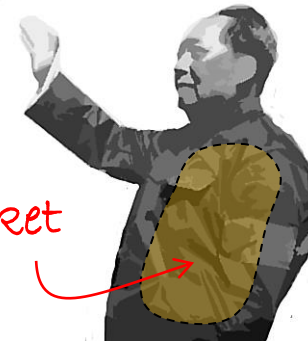
- Support extended overhanging geometry



- Give hollow shapes drainage holes

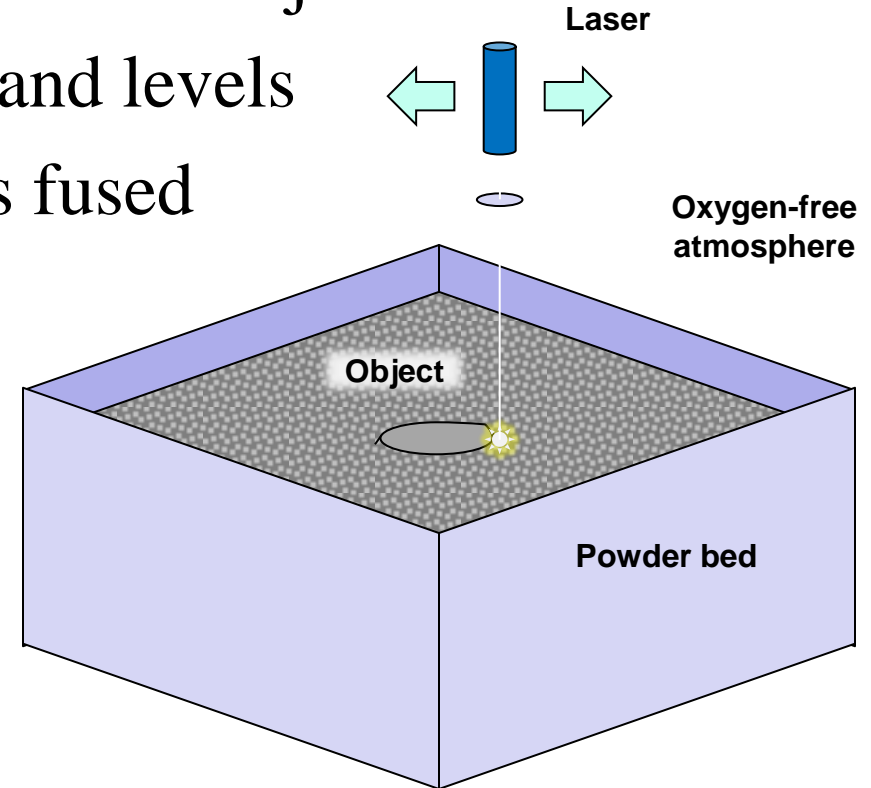


Fluid pocket



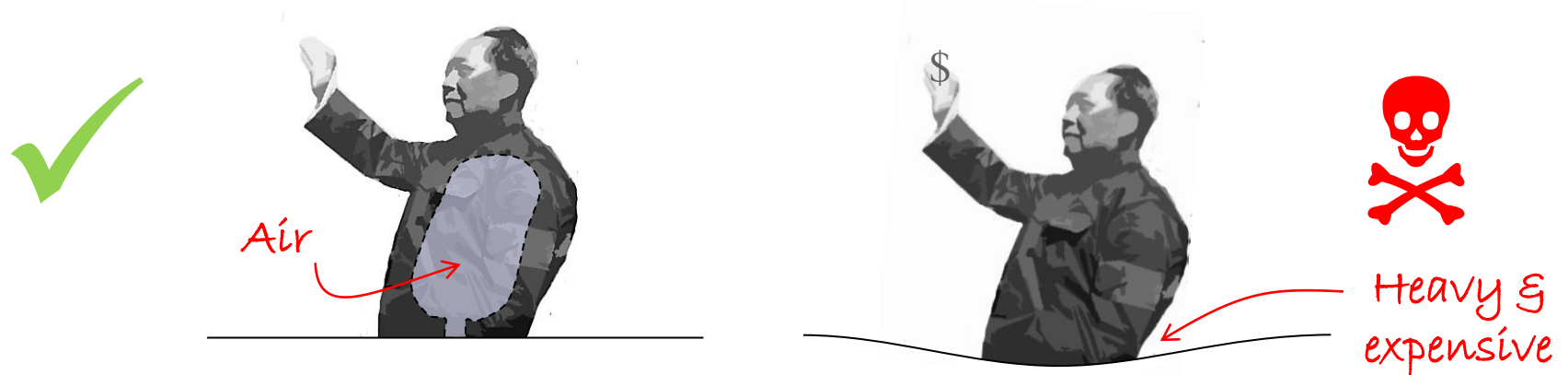
# Selective Laser Sintering

- Gantry laser fuses powdered plastic together
  - Unfused powder supports the object
  - Build platform lowers and levels powder as each layer is fused
  - Excellent for complex overhanging shapes



# SLS dos and don'ts

- Don't make objects solid unless necessary



- Leave vents to shake out trapped powder



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# SLS dos and don'ts

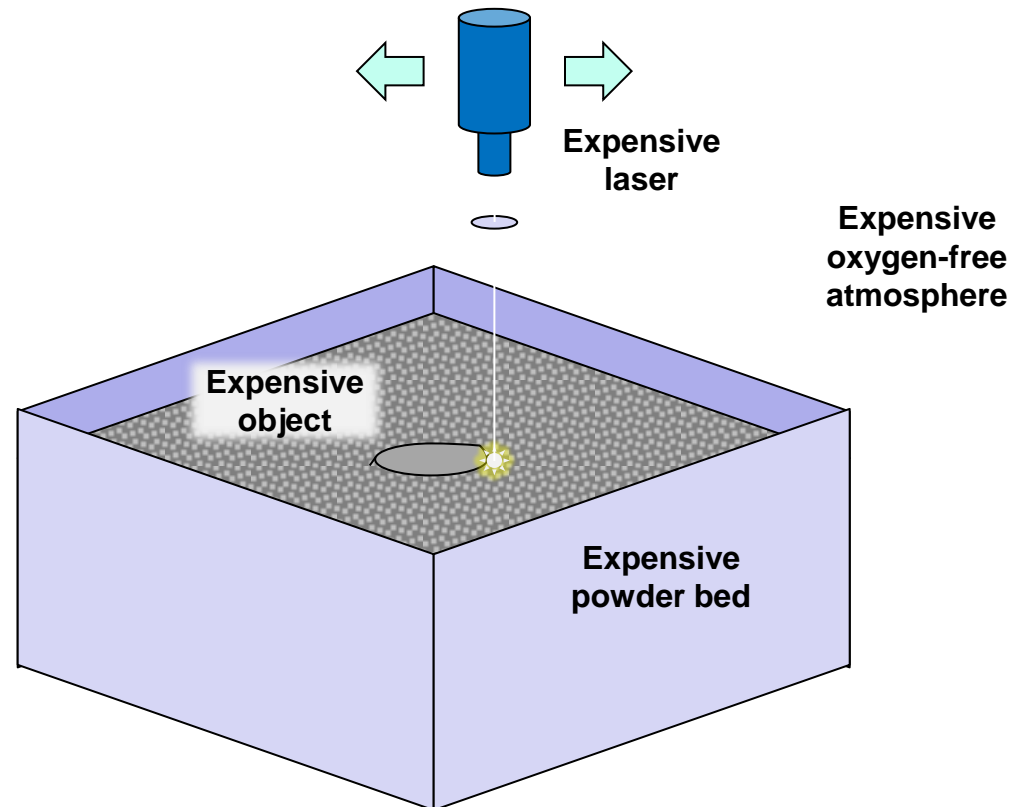
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- SLS requires an oxygen-free atmosphere
  - Must be purged every time a run is commenced
  - This gets expensive fast!
  - Best done in large batches, but a batch can fill the *entire* build volume of the powder bed



# Sintered Powder Metallurgy

- Just like SLS, except you can't afford it





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# Gratuitous project tips!

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- IT'S A TRAP!
  - That +1 for onboard processing isn't worth it
- So what do you need all that weight for?
  - Smaller is probably better
- 3D printing is hard to waterproof
  - To say nothing of electronics!
- Don't rely on super mechanical precision
  - Friction in your bearings will break your heart

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# Gratuitous project tips!

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- Find someone's codebase and use it
  - Some other poor schmuck, somewhere, has probably already solved your problem
  - There is no shame in open source
- Simple simple simple
  - Robust robust robust
  - Test test test

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# Paul's Laws

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- I. Prototypes are expensive. Experiments are expensive. Experimental prototypes are very expensive.
- II. It takes at least three prototypes.

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# Shameless plug

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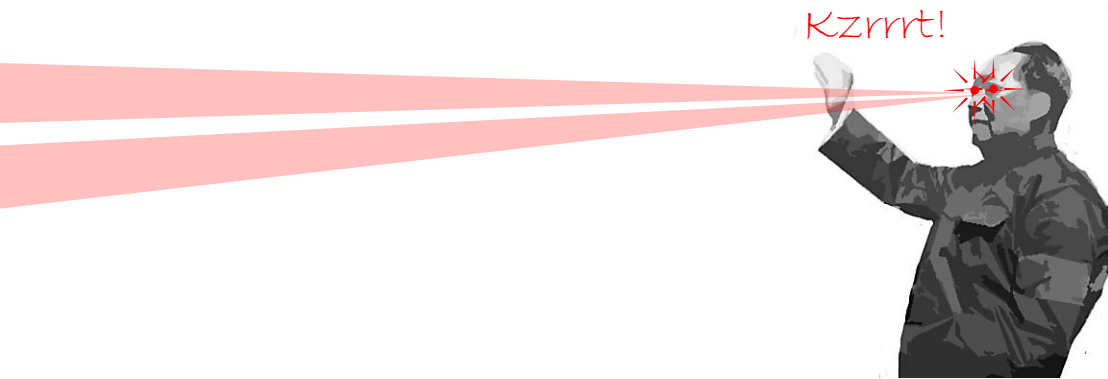
If you feel any of the mechatronics teaching ECR faculty are doing an outstanding job, please consider nominating them

Nominations close Friday 12<sup>th</sup> April!

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# Questions?

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# Tune-in next time for...

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## Image Processing on Microcontrollers

*or*

“Libraries and Interfaces, Oh Joy!”

Fun fact: You still can't 3D print love.