me270hw1 3Dprinting

slides

questions

1 Select any and all processes that work by depositing powder layers and solidifying each layer with a laser.

Multi-Jet Printing (MJP)
Selective Laser Sintering (SLS)
Direct Metal Laser Sintering (DMLS)
Fused Deposition modeling (FDM)
Stereolithography (SLA)
Direct Metal Deposition (DMD)

Selective Laser Sintering (SLS)
Direct Metal Laser Sintering (DMLS)

1. **Direct Metal Laser Sintering (DMLS)**: 这是SLS的一个变种，专门用于金属粉末。DMLS工艺与SLS类似，也是通过激光逐层固化粉末材料，但使用的是金属粉末。这种工艺允许制造具有复杂几何形状的金属部件，具有很高的设计自由度和材料利用率。

- **Multi-Jet Printing (MJP)**: 这种工艺使用喷射技术来逐层构建模型，通常使用蜡或塑料粉末，不是通过激光固化
- **Fused Deposition modeling (FDM)**: 这种工艺通过熔融沉积来构建模型，使用热熔喷嘴将热塑性材料熔化并沉积在构建平台上，逐层构建模型。
- **Stereolithography (SLA)**: 这种工艺使用光敏树脂，通过紫外线激光逐层固化。SLA通常用于制作高精度的原型，特别是在牙科和珠宝行业。
- **Direct Metal Deposition (DMD)**: 这种工艺通过激光或电子束将金属粉末逐层沉积并固化，用于制造金属部件或修复现有部件，但它不是通过逐层沉积粉末并用激光固化每一层来工作的，而是通过直接沉积金属粉末来构建部件。

2 Select all the processes that do NOT require support structure material.

Selective Laser Sintering (SLS)
Multi-Jet Printing (MJP)
Fused Deposition modeling (FDM)
Stereolithography (SLA)
Direct Metal Laser Sintering (DMLS)

Selective Laser Sintering (SLS)
Direct Metal Laser Sintering (DMLS)

3 soluable support structures Which of the following have water soluble support structures:

Fused Deposition modeling (FDM)
Selective Laser Sintering (SLS)
Stereolithography (SLA)
Multi-Jet Printing (MJP)
Direct Metal Deposition (DMD)
Direct Metal Laser Sintering (DMLS)

Fused Deposition modeling (FDM)
Multi-Jet Printing (MJP)

4 3D Printing - isotropic Which of the following processes is the least isotropic (least smooth) in the vertical direction?

Stereolithography (SLA)
Selective Laser Sintering (SLS)
Fused Deposition modeling (FDM)
Multi-Jet Printing (MJP)
Direct Metal Deposition (DMD)
Direct Metal Laser Sintering (DMLS)

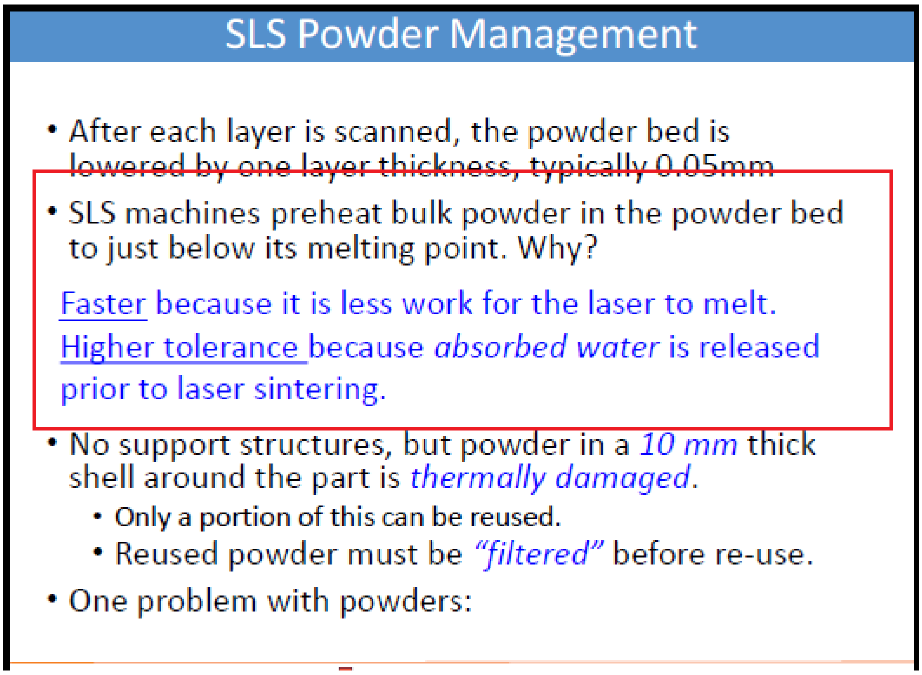
Fused Deposition modeling (FDM)
FDM技术通过逐层堆叠熔融材料（通常是塑料丝）来构建模型。每一层都是在前一层的基础上堆叠而成，这种层叠的方式导致了FDM打印件在垂直方向上的强度和表面质量不如水平方向。具体来说，FDM打印的模型在垂直方向上可能会显示出层与层之间的阶梯效应，这是因为每一层的边缘在冷却后变得坚硬，而新一层的熔融材料在固化前很难与前一层完全融合，导致表面不够平滑

5 SLS preheat Select all the correct reasons as to why SLS machines preheat the build area:

To reduce the build time
So that the process doesn't need to use support structures.
To "dry out" the build area.
To help the extrudate "bond" to the previous layer.
To help the droplets join with the previous layer.
To help the part cure faster.

To reduce the build time
To "dry out" the build area.

1. **To reduce the build time**：预热构建区域可以减少构建时间。通过预热粉末，激光的能量主要用于烧结而不是加热粉末，这样可以加快3D打印的速度。
2. **To "dry out" the build area**：预热有助于“烘干”构建区域。这个说法可能是指预热可以去除粉末中的湿气或其他挥发性物质，从而提高烧结效果和打印质量



6 Which are considered weaknesses of most 3D Printing methods:

@It is often time consuming and difficult to change the part design.
@Although increasing in number, there generally are few material choices.
@Not a cost effective method for volume production.
@Generally not a high tolerance method when compared to other manufacturing methods.
@Surfaces are generally not smooth and often require post-processing to improve surface finish.
@They often require a significant amount of training, knowledge, and skill to make parts.

@Although increasing in number, there generally are few material choices.
@Not a cost effective method for volume production.
@Generally not a high tolerance method when compared to other manufacturing methods.
@Surfaces are generally not smooth and often require post-processing to improve surface finish.

Advantages of 3D Printing

- Easy and quick to change part design and produce a new version.
- Limited skills or training needed to make parts
- Cost of producing one part, or a few unique parts, is relatively low.
- Some parts can be made already assembled.

Problems with 3D Printing

- *Part tolerance and/or surface smoothness*
  - Staircase appearance for a sloping part surface (due to slicing and layer thickness)
  - Shrinkage and distortion of RP parts
  - Part dimensions: *holes are smaller and posts bigger*
- Limited variety of materials in RP
  - Mechanical performance of the fabricated parts is limited by the materials
- Cost/removal of support material *(when needed)*
- Per part cost for large quantities is generally higher
- Part size is generally limited.

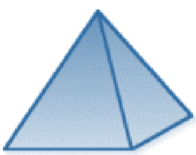
7 Elastomeric materials 弹性材料are available for:

(a) SLS
(b) DMD
(c) SLA
(d) DMLS
(e) FDM
(f) MJP

(f) MJP

8 Build time for a FDM pyramid with support structure

How long would it take to fabricate this hollow pyramid using FDM? The square base has a side length of 9 cm and the pyramid is 9 cm tall. The interior cavity is also a pyramid with a square base of 8 cm sides and a height of 8 cm. Assume the extrudate of ABS and support material both have a cross-section of 0.6 mm wide by 0.5 mm tall and is dispensed at a rate of 4 cm/sec. The stage takes 0.4 sec to move and it takes 8 sec to switch between materials. The support material has a volumetric fill ratio of 75 %. Volume of a pyramid = $\frac{s^2 h}{3}$.



Time = 303 minutes

fill ratio of support : 70%

$$T_i = \frac{A_i}{vd} + td$$

$$V_{outer} = \frac{s^2 \cdot h}{3} = \frac{8^2 \cdot 8}{3} = 170.667\ cm^3$$

$$V_{inside} = \frac{s^2 h}{3} \cdot 0.7 = 80.033\ cm^3$$

$$\text{real } V_{outer} = 170.667 - \frac{7^2 \cdot 7}{3} = 56.333\ cm^3$$

$$V_{total} = 136.367\ cm^3$$

$$t = \frac{V_{part}}{D \cdot t \cdot V} + n \cdot td$$

$$n = 8 / 0.04 = 200$$

one-material layers $= 1/0.04 = 25$ layer

Dual material layers $= 200 - 25 = 175$ layers

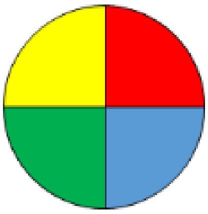
$$t = \frac{136.367}{0.09 \cdot 0.04 \cdot 4} + 175 \cdot 6 + (200) \cdot 0.7$$

$$= 177.666 \text{ min}$$

```
# 8
l1=8
h1=8
l2=7
h2=7
D=0.8/10 #mm->cm
tall=0.5/10 #mm->cm
V=4.5 #cm/sec
t1=0.8
t2=4
fill_ratio = 0.7



q=D*tall*V
v1=l1**2*h1/3-l2**2*h2/3 #cm**2
v2=l2**2*h2/3

T1=v1/q+h1/tall*t1
T2=fill_ratio*v2/q+h2/tall*t2
(T1+T2)/60
```

9 Build time for a 4 color ball by FDM

How long in minutes would it take to fabricate a 4 colored ball $6\ \mathrm{cm}$ in diameter using FDM? Assume a layer thickness of $0.4\ \mathrm{mm}$, a width of $0.9\ \mathrm{mm}$, and the extrudate being deposited at a rate of $3.5\ \mathrm{cm/sec}$. The stage movement time is 0.9 sec per layer, and it takes 8 sec to switch between any two materials. Assume the support structure has a volumetric fill ratio of 100%.



Time = 540 minutes

$D = 6cm$ $t = 0.5\ mm = 0.05\ cm$ $w = 0.9mm = 0.09cm$

$V = 3\ cm/sec$

Stage movement time

$t_m = 8sec$ /color

$V = \pi 3^3 + \frac{4}{3} \cdot \pi \cdot 3^3 \cdot \frac{1}{2}$

$= \pi 3^3 + \frac{2}{3}\pi \cdot 3^3$

$= 141.371\ cm^3$

3

3

6

cylinder

layers = $6 / 0.05 = 120$ layer

$T = \frac{141.371}{0.05 \cdot 0.09 \cdot 3} + 120 \cdot 0.5 + (8 \cdot 2) \cdot 60 + 8 \cdot 60$

$= 199.5$ min

```
# 9
tall=0.4/10
D=0.9/10
V=3.5
d= 6 #cm
t1=0.9
t2=8


# fill_ratio=1
q=D*tall*V
v1=4/3*(diameter/2)**3*np.pi
v2=((d/2)**3*np.pi-2/3*(d/2)**3*np.pi)


T1=v1/q+d/tall*(t1+t2)
T2=v2/q+(d/2)/tall*t2
T=T1+T2
print(T/60)
```