

# **A Method of 3D Printing which is Consistent with Natural Direction in Shape**

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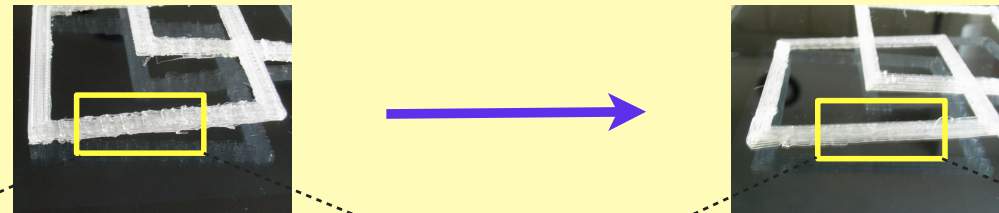
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# Problem to Solve

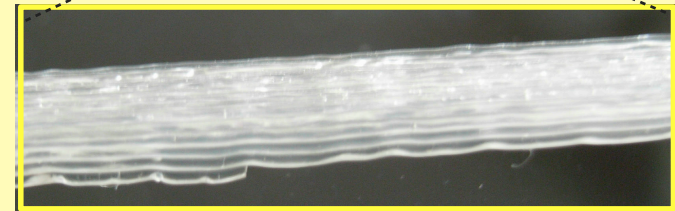
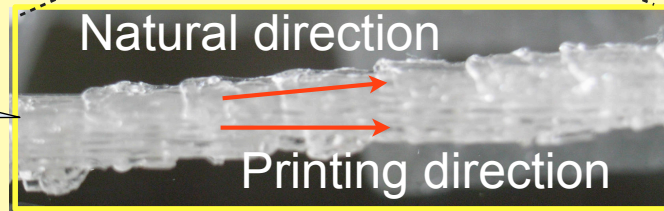
- An object to be printed, such as a collection of fibers, may have “natural direction” in shape.



- The printing direction of FDM 3D printers may contradict with the “natural direction”.



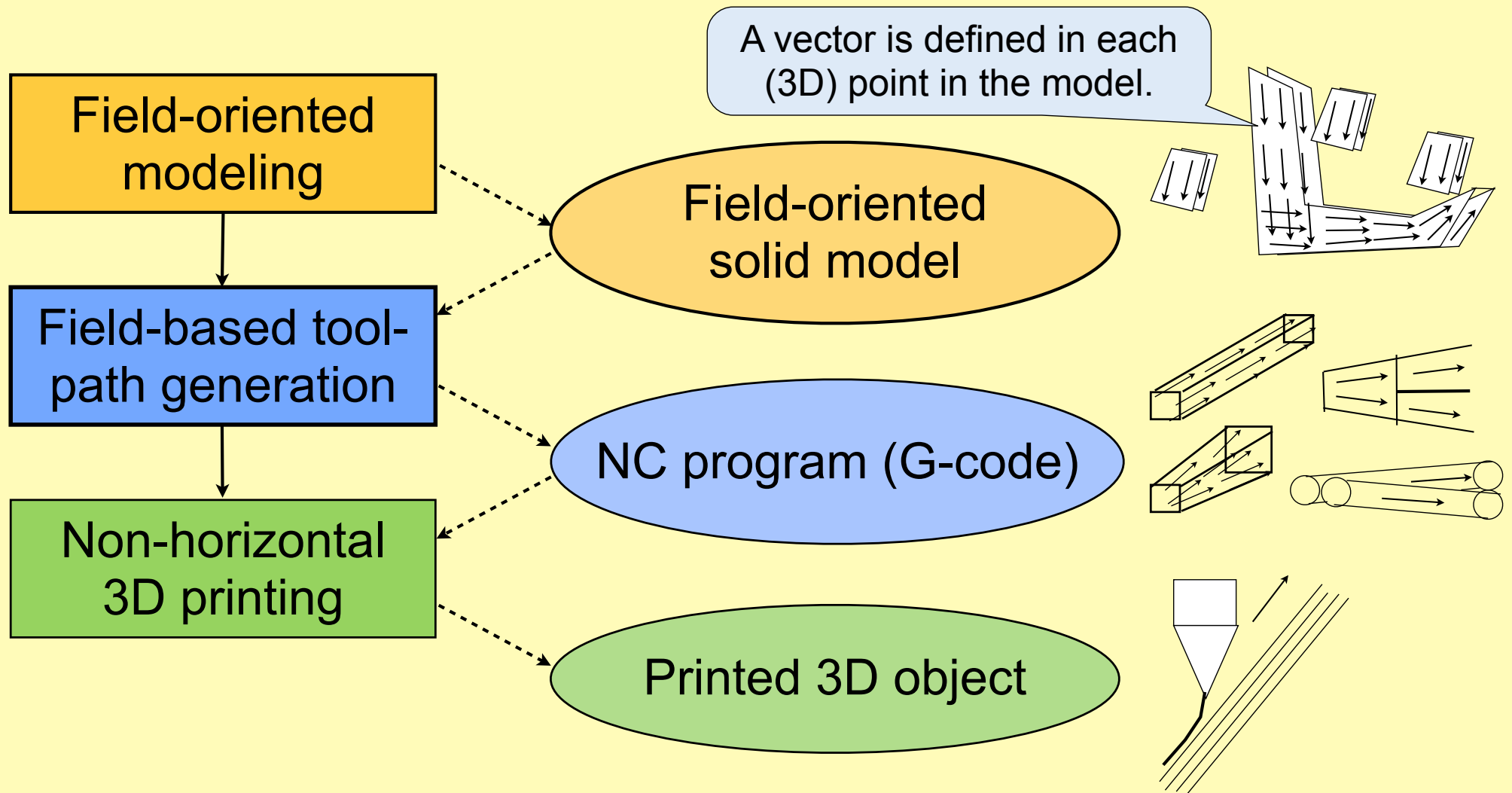
Staircase effect



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# “Field” Based Solution

- To model objects with “natural directions,” and to slice and to print objects in the “natural direction.”



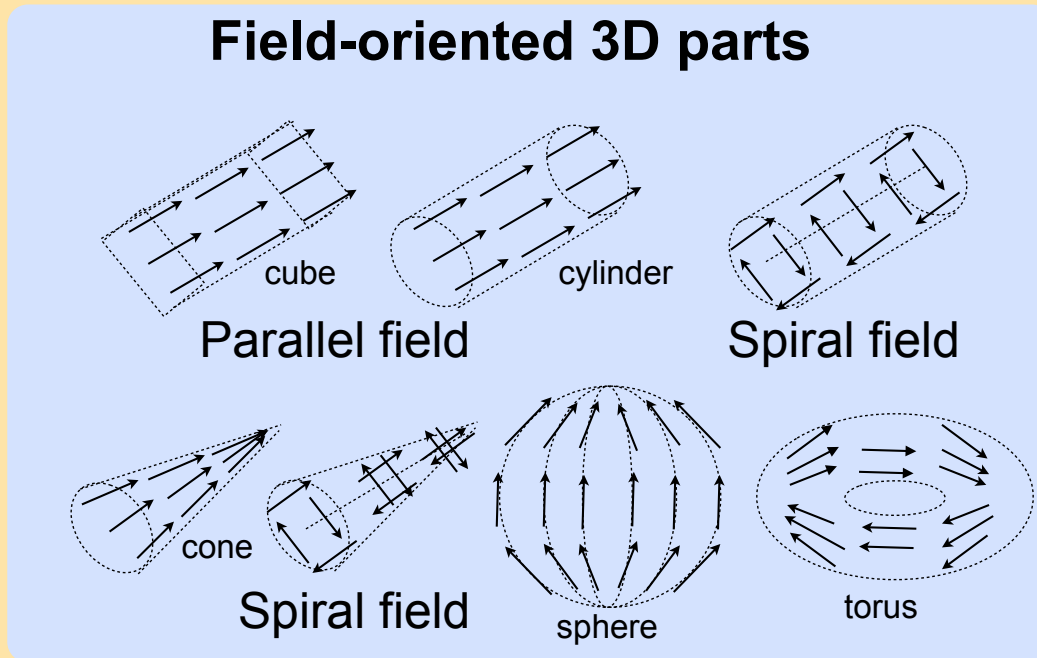
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# Modeling Methods

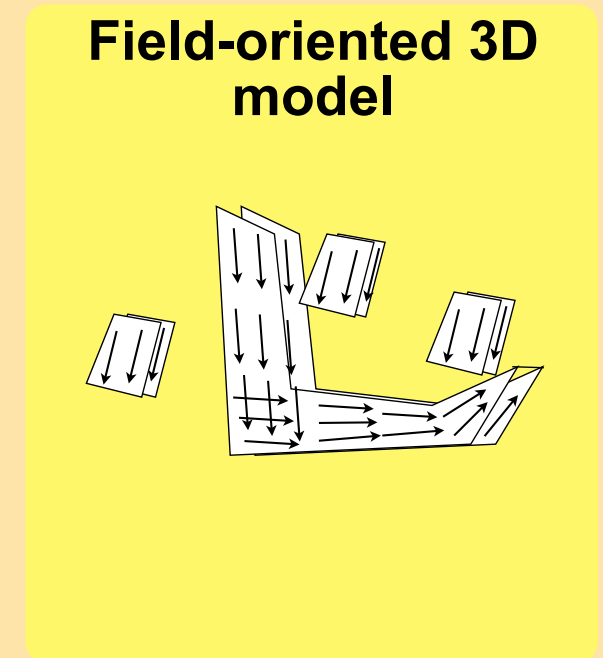
- **Two methods**
  - Field-oriented 3D CAD
  - Field-oriented 3D painting

# • Field-oriented 3D CAD

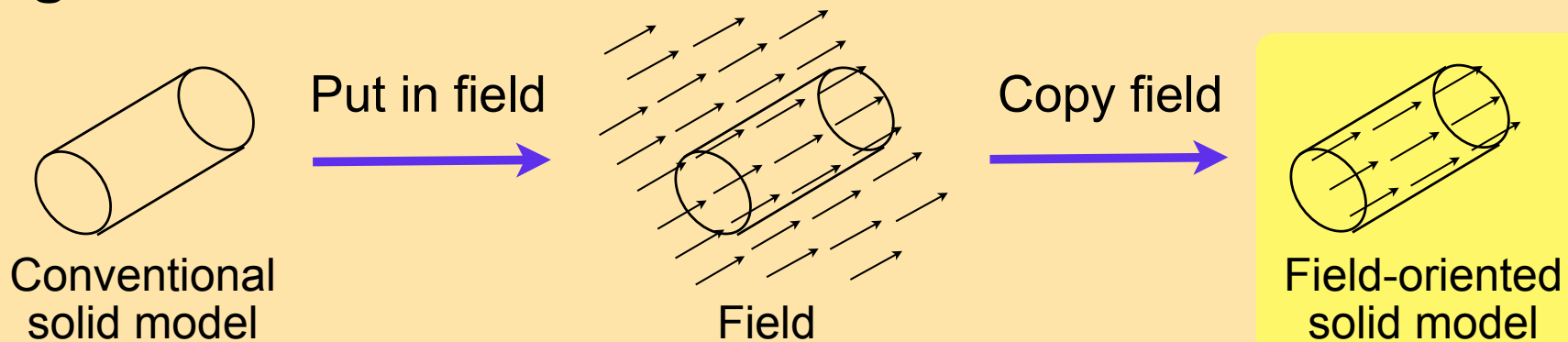
## –Parts combination



Combine  
  
 (union,  
 intersection,  
 difference,  
 etc.)



## –Magnetization

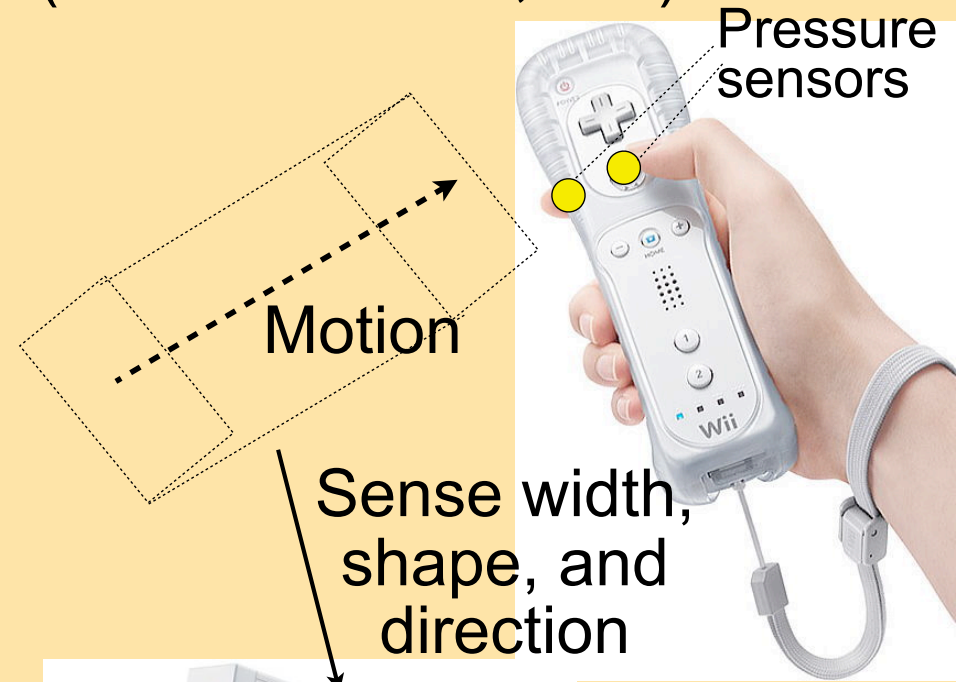
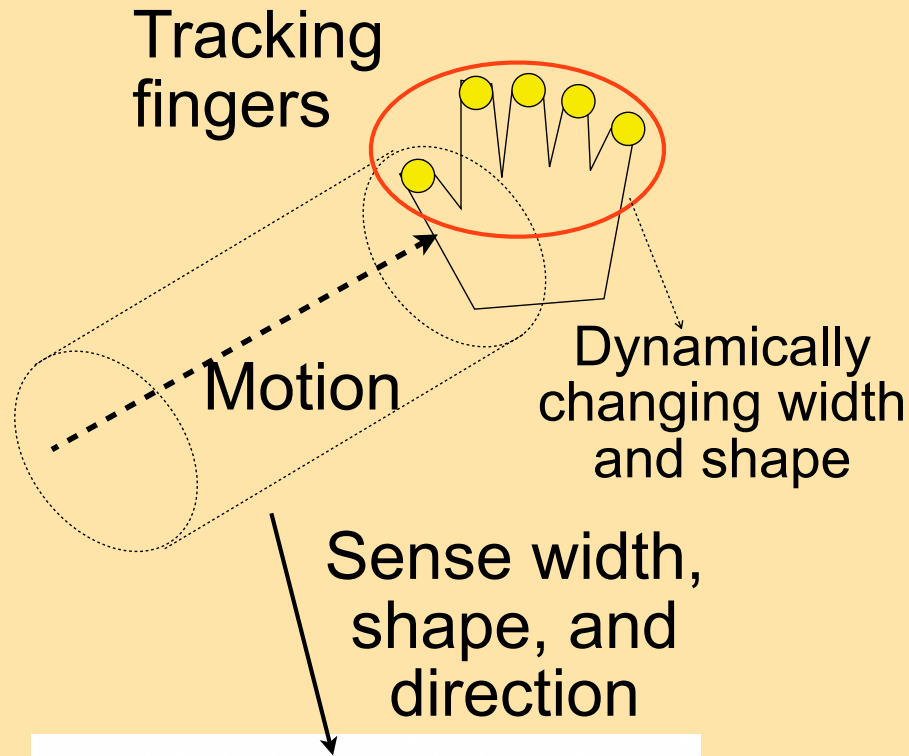




# • Field-oriented 3D painting

- By using human body tracking

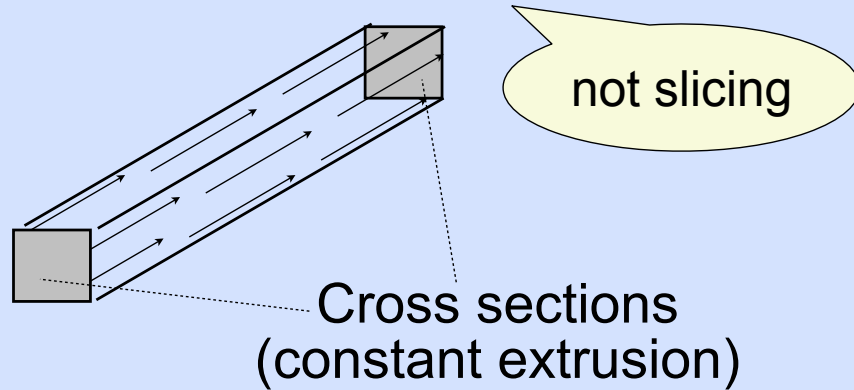
- By using sensors (accelerometers, etc.)



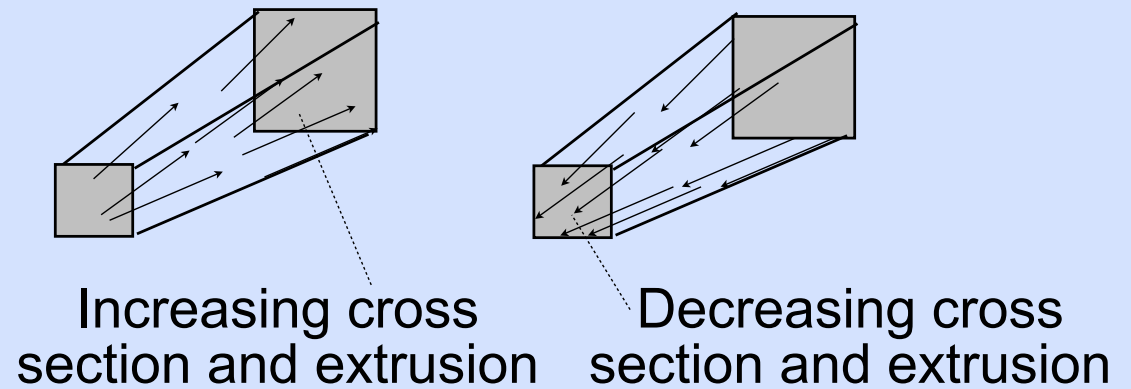
# 7 Tool-path Generation Methods

## • Basic field-based method

### - Parallel hashing

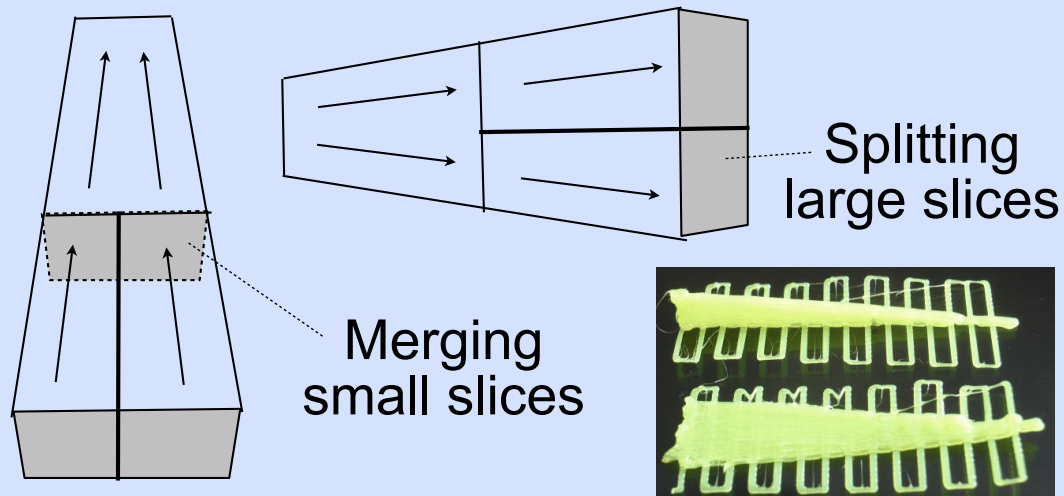


### - Widening / narrowing

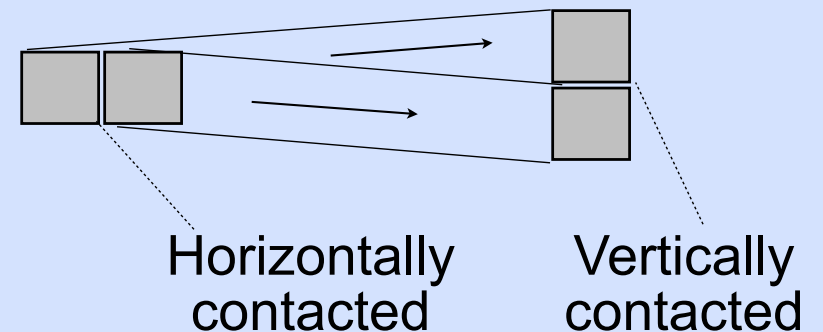


## • Several techniques

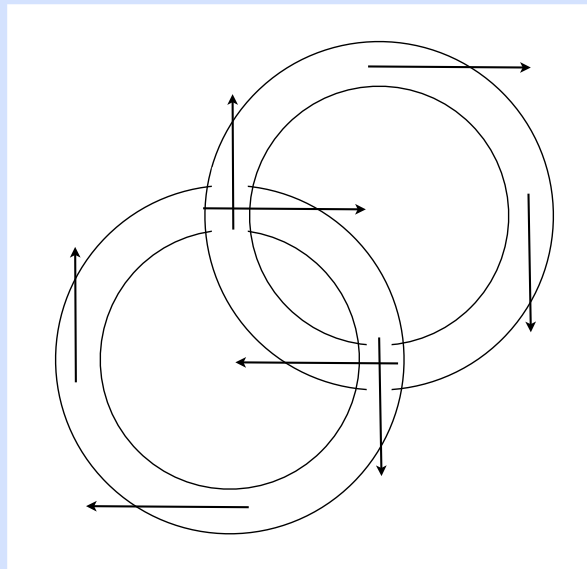
### - Splitting / merging



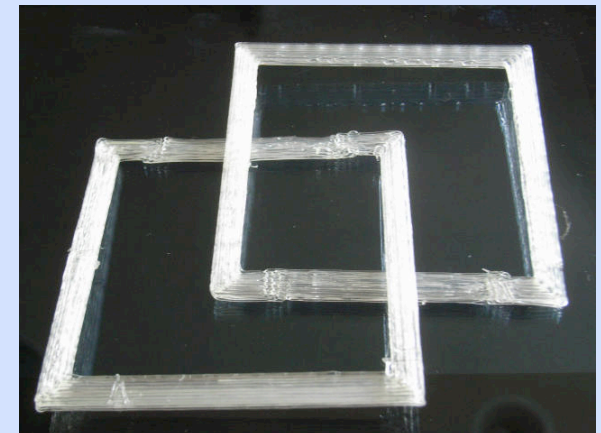
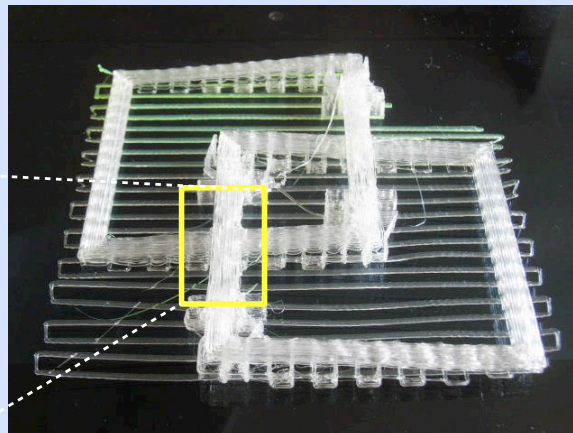
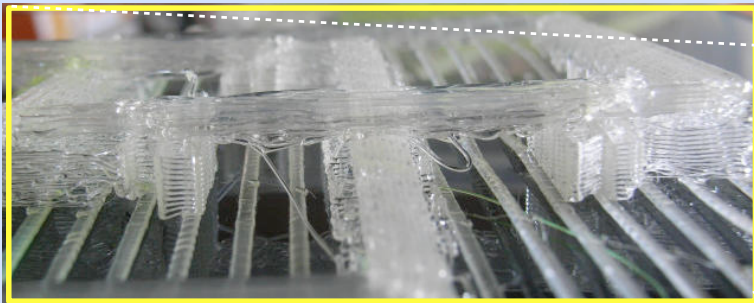
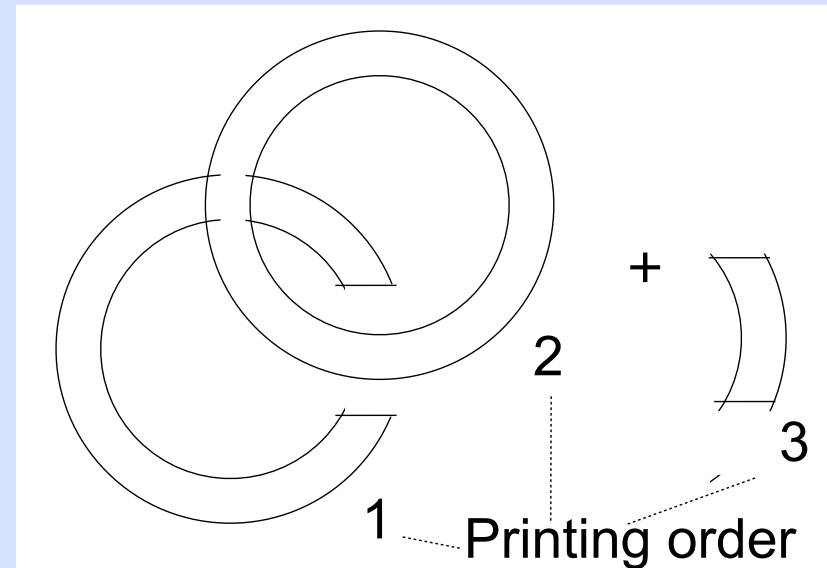
### - Twisting



- **Method for making unprintable objects printable**
  - Objects which cannot be printed may become printable by dividing them and by changing printing order.



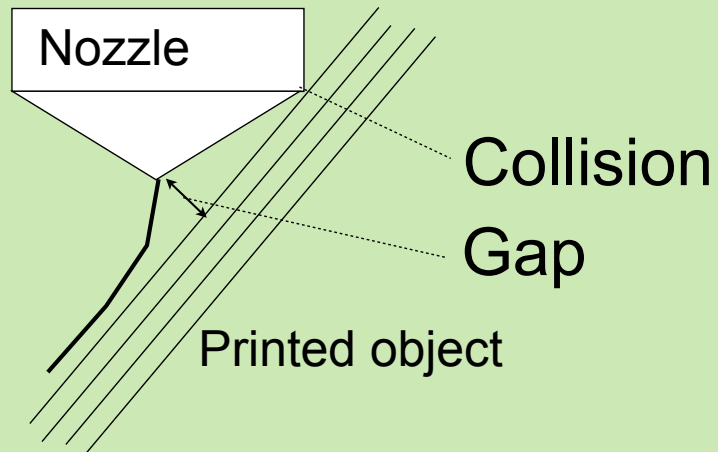
Divide  
→





# Printing Techniques

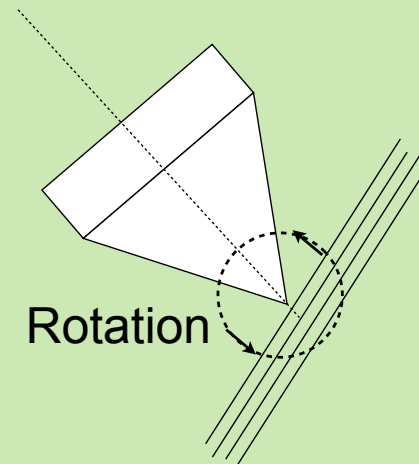
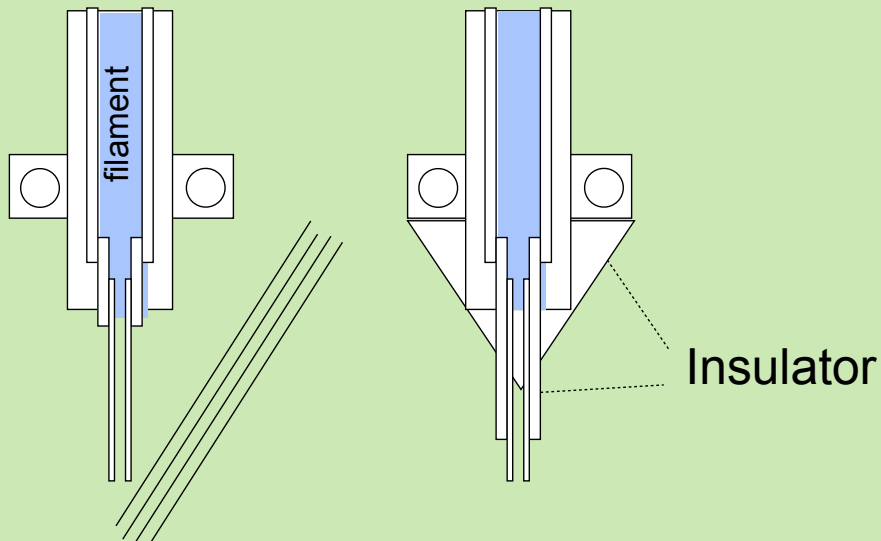
## • Problem in steep printing



## • Two solutions

- Needle-shaped nozzle

- Five-axis print-head



# Implementation Status

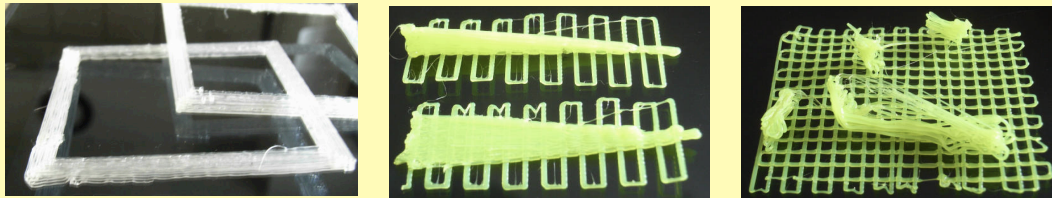
- **Field-oriented modeling**

- Kinect-based modeler is being designed.



- **Field-based slicing**

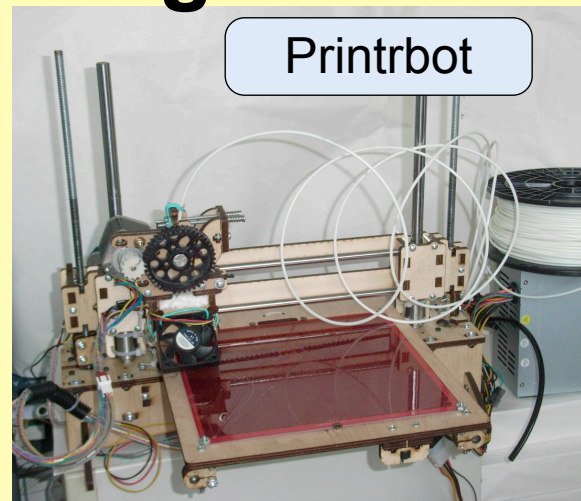
- Slicing algorithms are being tested.



Rostock MAX can move quickly along z-axis.

- **Non-horizontal 3D printing**

- Printing methods are being tested using Rostock MAX (and printrbot) 3D printers.



# Applications

- Art: 3D calligraphy
  - Solid 3D calligraphy



- Directed 3D calligraphy  
3D printing based



Iron based



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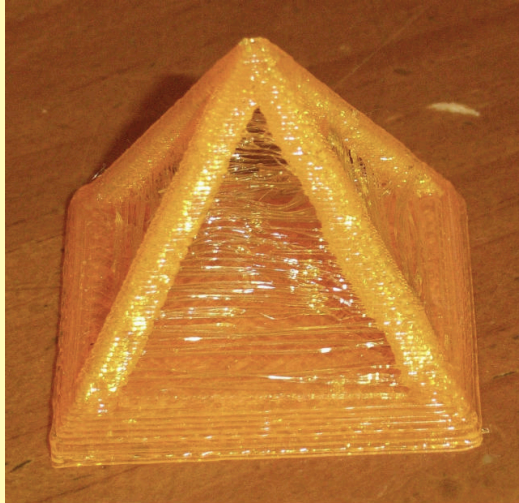
Shishu



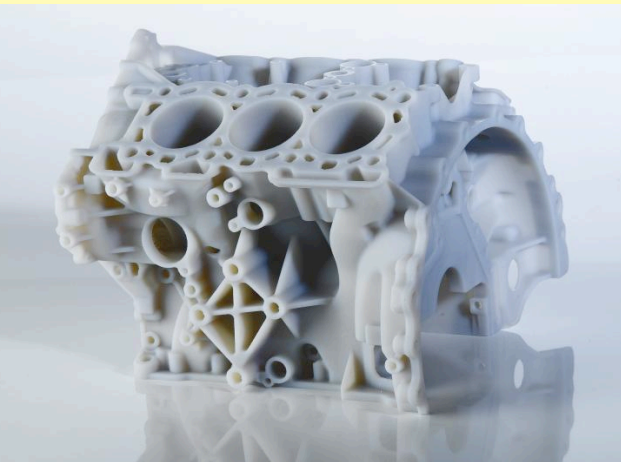


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•Hobby



•Industry



# Concluding Remarks

- Natural direction of 3D objects can be expressed by FDM 3D printing using field-oriented/based modeling, slicing, and printing methods.
- The developments of field-oriented/based algorithms and applications are in early stages.