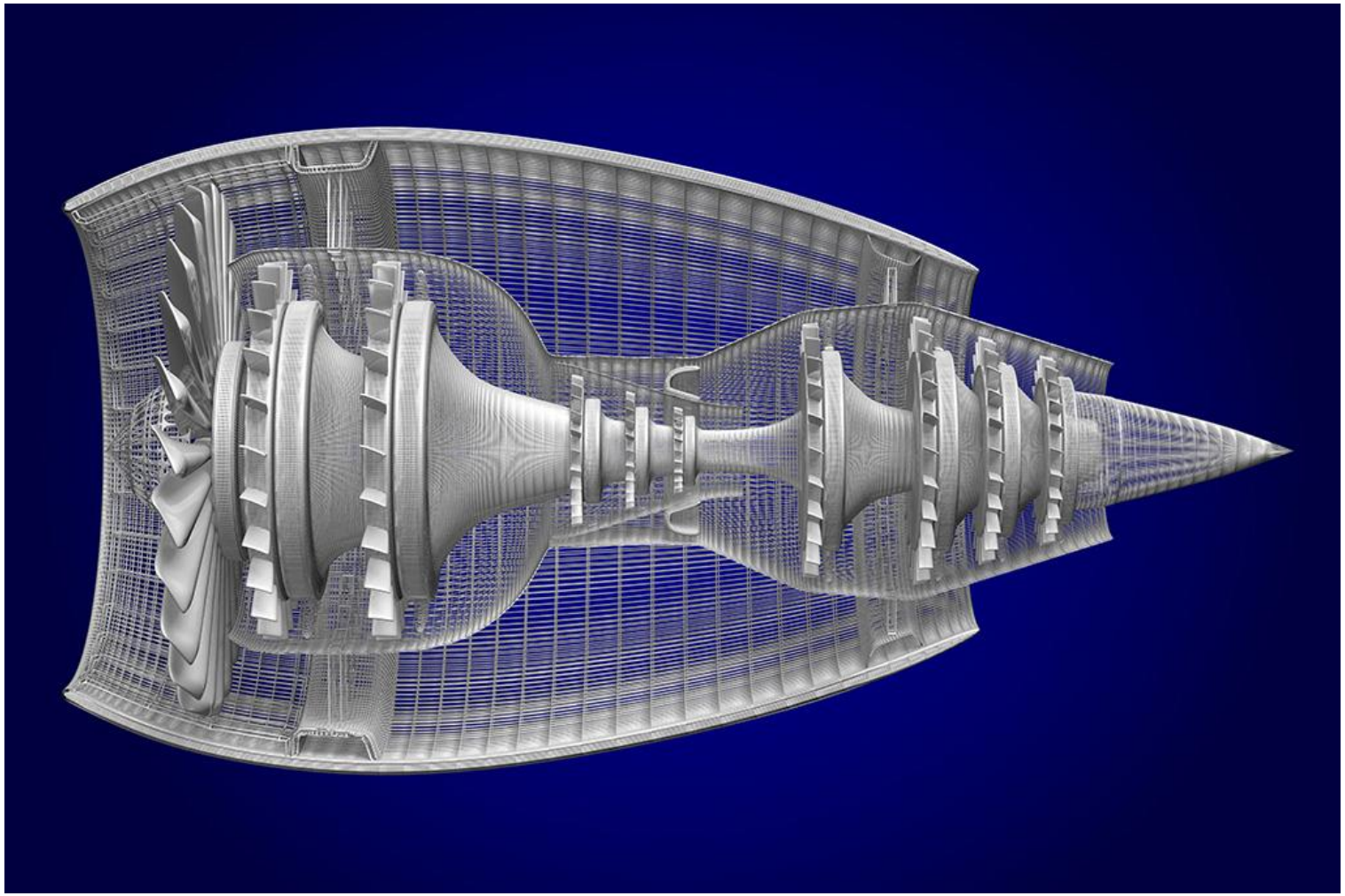
Unit-2

CAD Modelling for 3D Printing

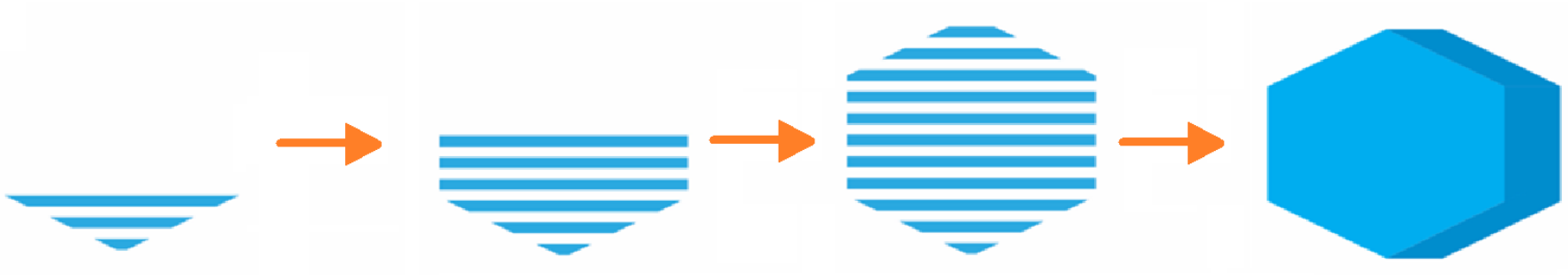


1. Introduction to 3D Printing

- **Definition**: 3D printing, also known as additive manufacturing, is the process of creating three-dimensional objects from a digital file by adding material layer by layer.
- **History**: Developed in the 1980s, 3D printing has evolved from simple prototypes to complex manufacturing processes used in various industries, including healthcare, automotive, and aerospace.
- **How It Works**: The process typically involves:
  - Creating a 3D model using CAD software.
  - Converting the model into a format suitable for printing.
  - Slicing the model into layers.
  - Printing the object layer by layer.

What is 3D Printing?

➡ Structuring a three-dimensional object in its physical configuration from its digital form.



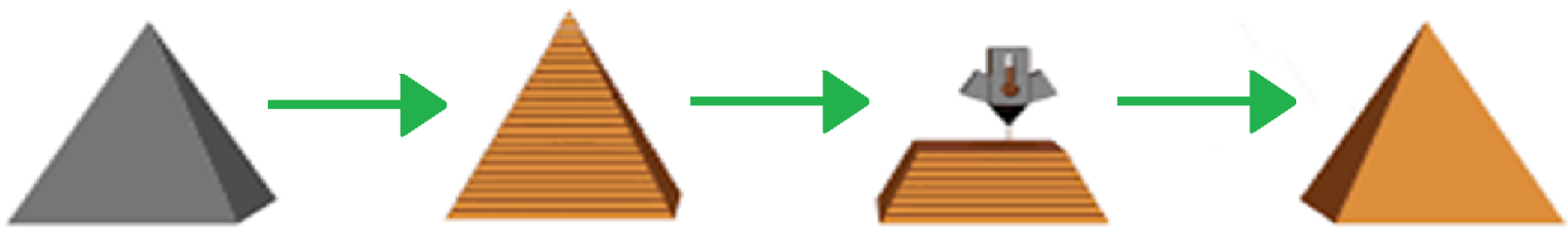
3D printing and additive manufacturing

3D CAD FILE
.STL file format

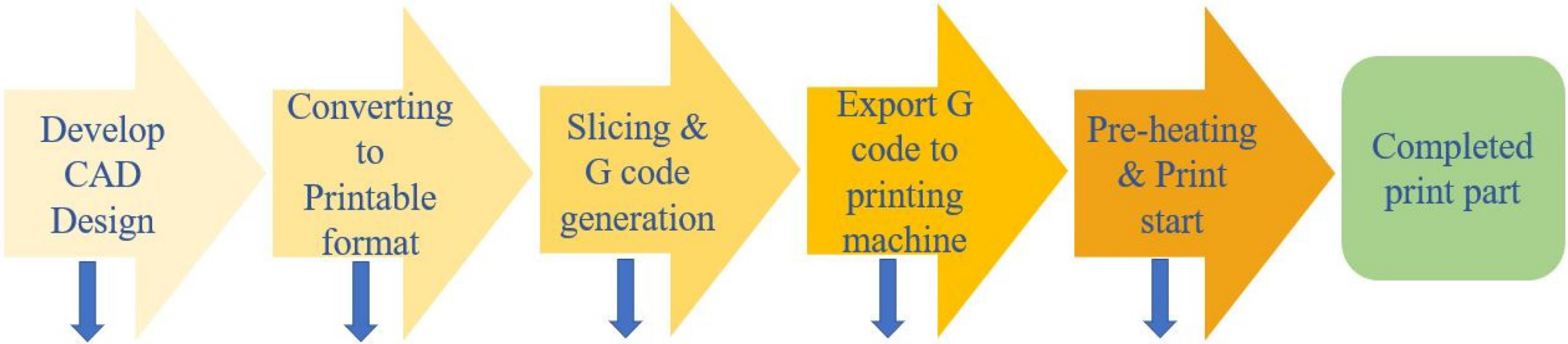
CAM - SLICIGN
.GCODE file format

3D Printing

FINAL - PHYSICAL OBJECT



Process of 3D Printing



- SolidWorks
- Rhino 3D
- Mol 3D
- 3DS Max
- Fusion 360
- 3D Slash
- SketchUP
- Wings 3D

- STL
- OBJ
- AMF
- 3MF

- Cura
- CraftWare
- Slic3r
- KISSlicer
- 123D Catch

- G Code- Generic name for a control language understandable by printer

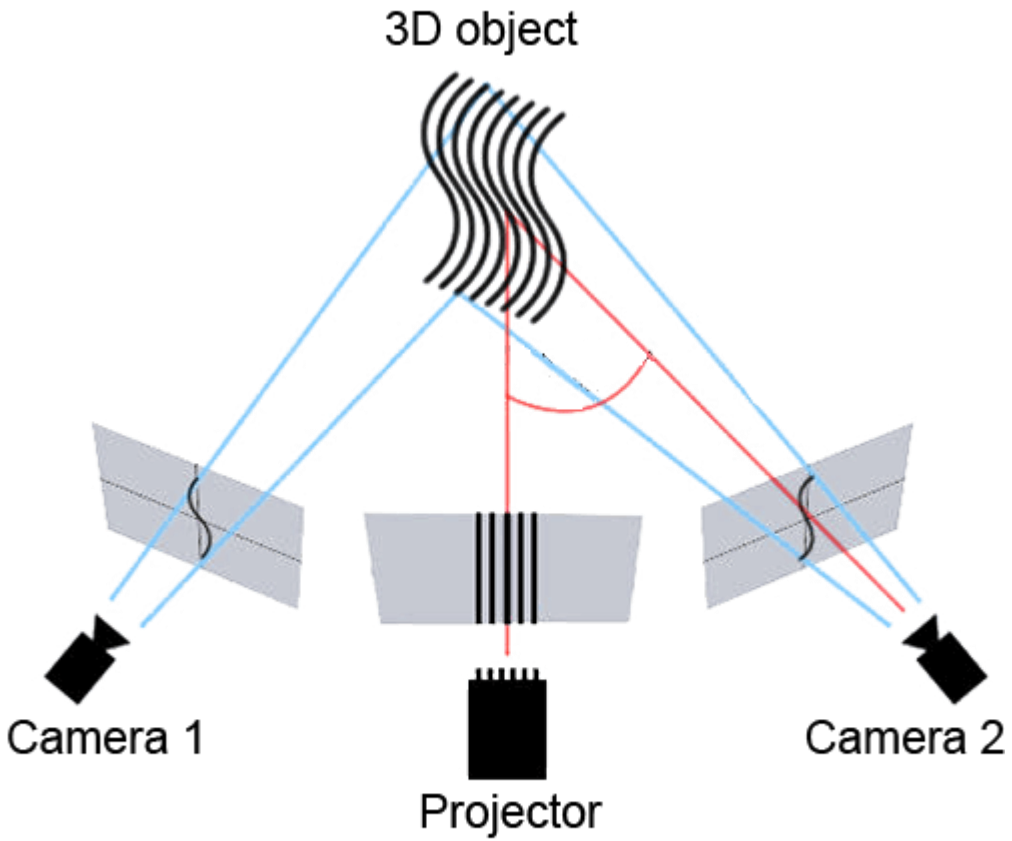
Nozzle temperatures

- PLA- 180^0 - 230^0
- ABS- 210^0 - 250^0
- PETG- 220^0 - 250^0
- Nylon- 240^0 - 260^0

2. 3D Scanning and Digitization

•**3D Scanning**: A method used to capture the physical dimensions of an object. It creates a digital model by recording the shape and surface details.

- **Types of Scanners**: Laser scanners, structured light scanners, and photogrammetry.



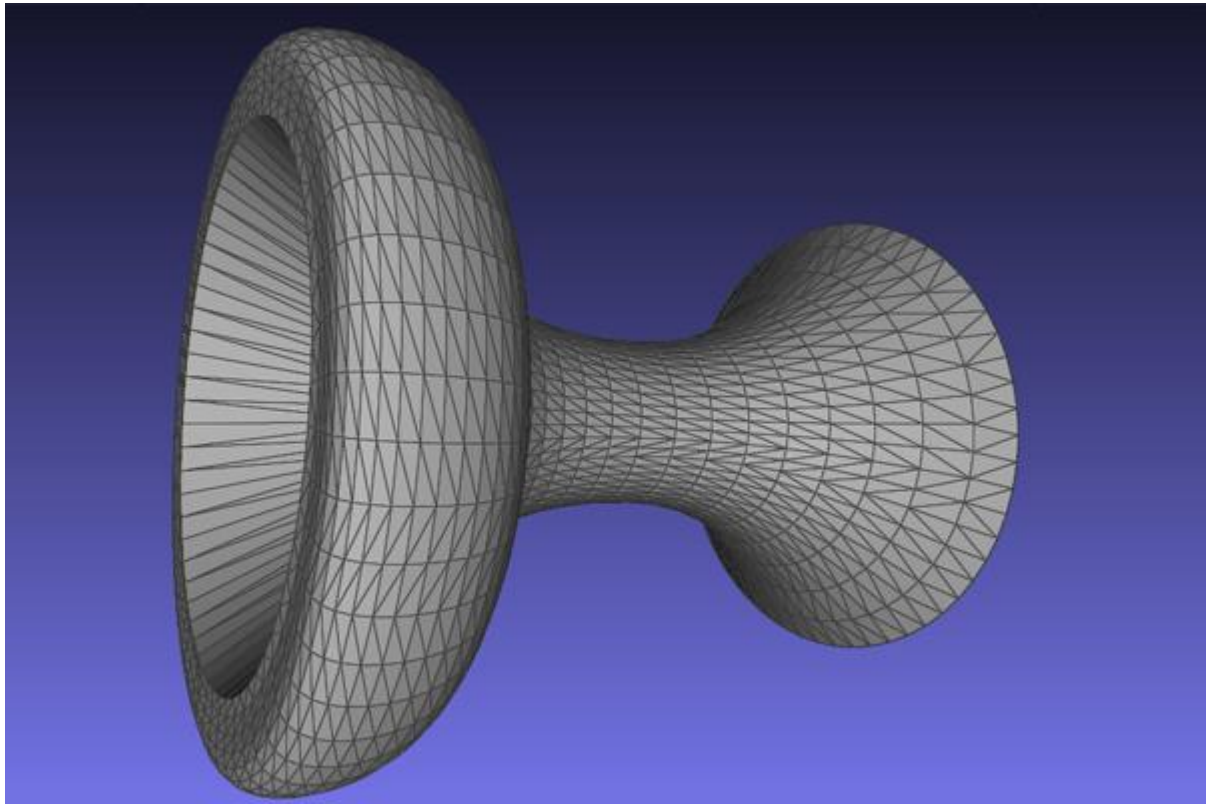
•**Digitization**: The process of converting physical objects into digital data. This can involve:

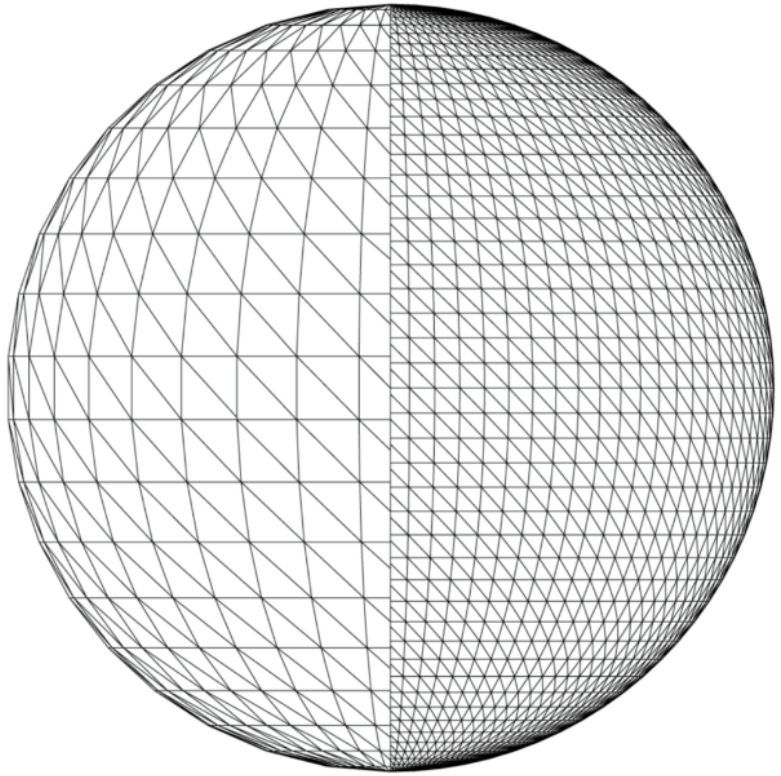
- Scanning an object to create a 3D model.
- Using software to refine the model for printing.

3. AM Software: Data Formats

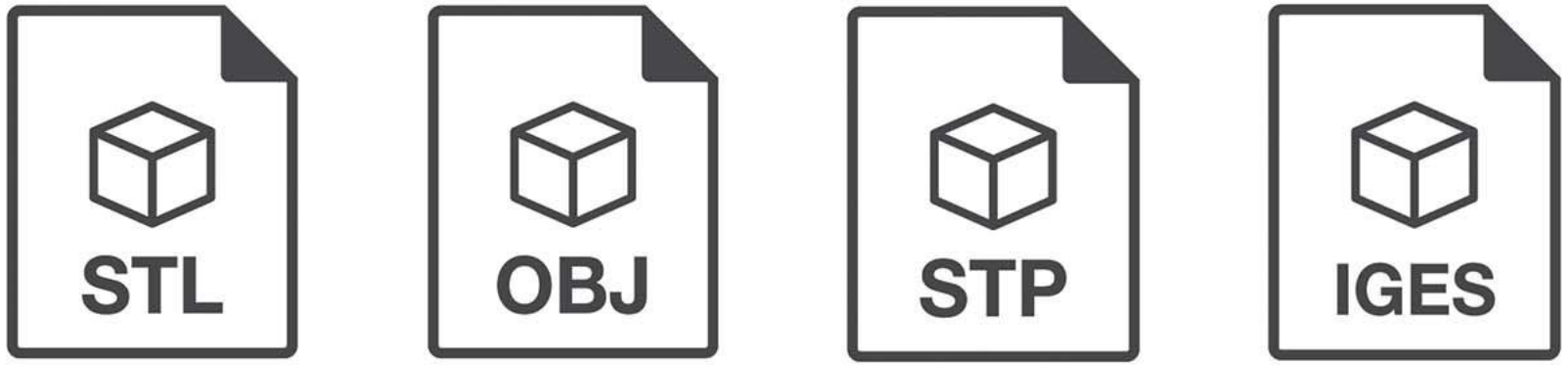
•**Common Data Formats**:

- **STL (Stereolithography)**: The most widely used format for 3D printing. Represents the surface geometry of a 3D object using triangles.
- **OBJ**: Includes color and texture information, suitable for more complex models.
- **AMF (Additive Manufacturing File Format)**: A newer format that supports advanced features like colors and multiple materials.





- **Advantages and Limitations of STL**:
  - **Advantages**:
    - Widely supported across different 3D printers.
    - Simple and efficient for geometric representation.
  - **Limitations**:
    - No support for color or texture.
    - Can result in large file sizes for complex models.
    - Does not support curved surfaces accurately.

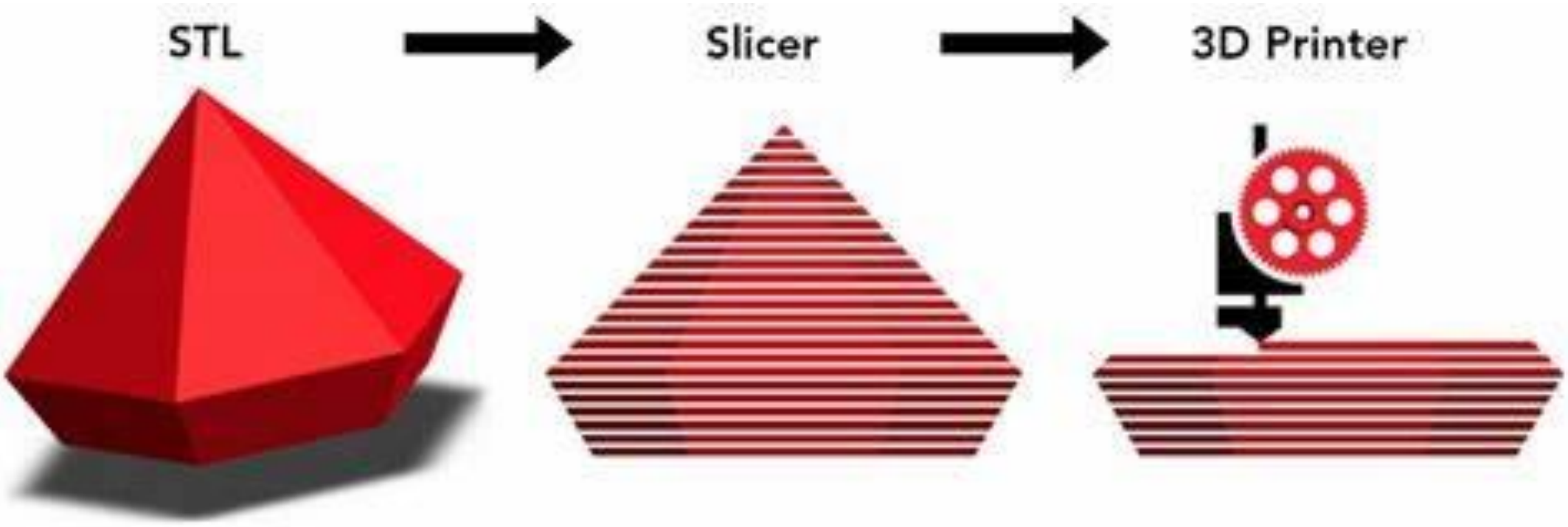


4. Creating an STL File

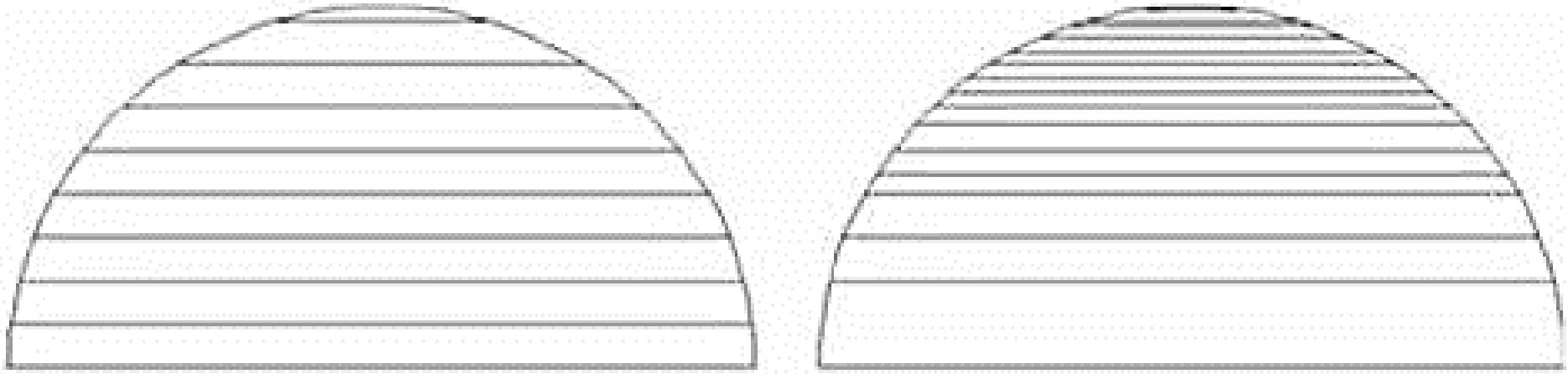
- **Steps to Create an STL File**:
  - **Model Creation**: Use CAD software (like AutoCAD, SolidWorks, or Tinkercad) to create the 3D model.
  - **Exporting**: Select the option to export or save the model as an STL file.
  - **Checking for Errors**: Use software to check the STL file for any errors, such as non-manifold edges or holes.
  - **Optimization**: Ensure the model is optimized for printing (size, scale, and complexity).

5. Slicing

•**What is Slicing?**: The process of dividing a 3D model into horizontal layers for printing. This step is crucial for translating a 3D model into instructions that a 3D printer can understand.

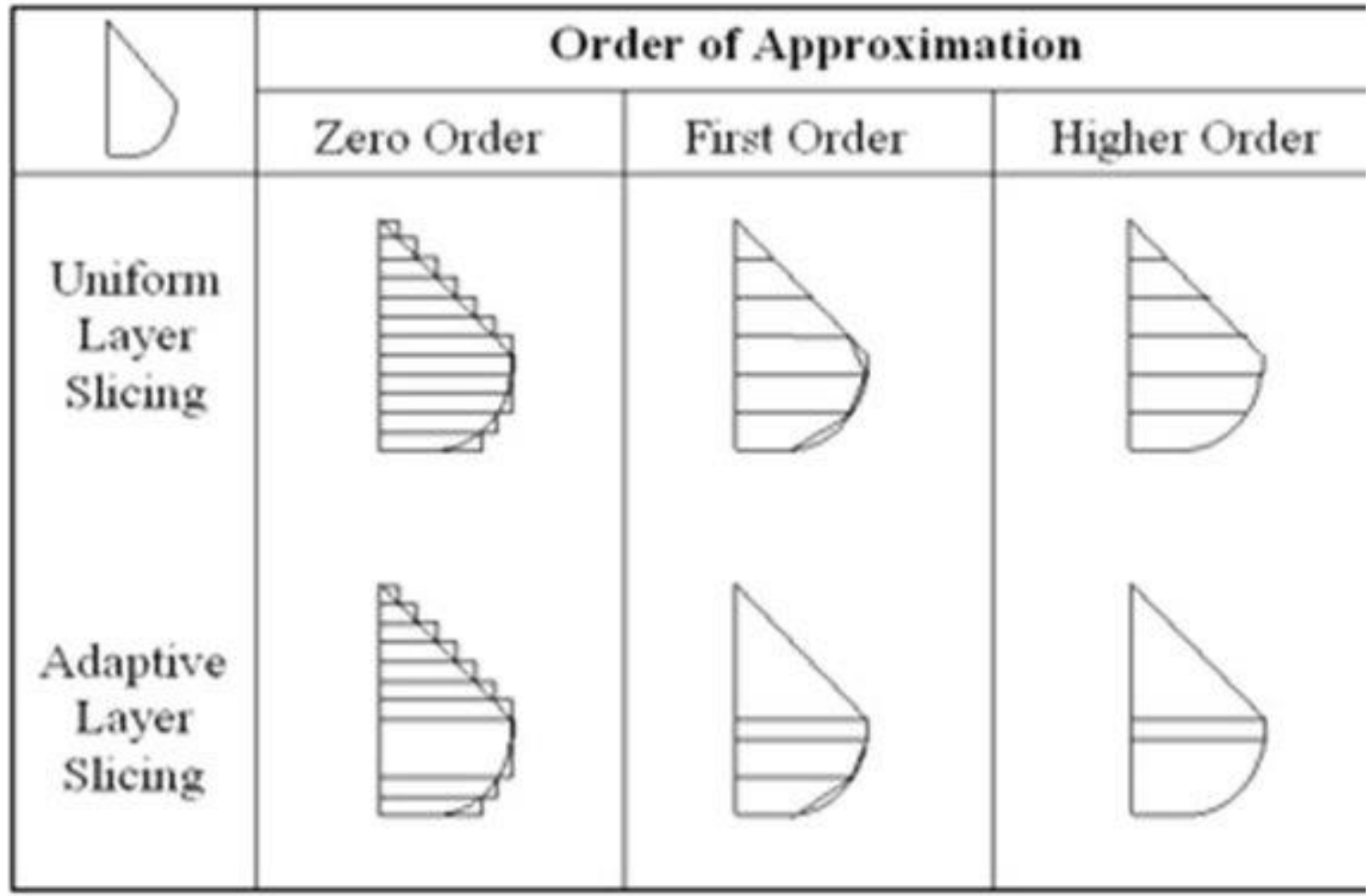


- **Slicing Techniques**:
  - **Uniform Flat Layer Slicing**: Each layer is of the same thickness, which is easy to calculate and implement but may not optimize material usage or printing time.
  - **Adaptive Slicing**: Varies layer thickness based on the model's geometry, allowing for faster printing of simple areas and more detail in complex regions



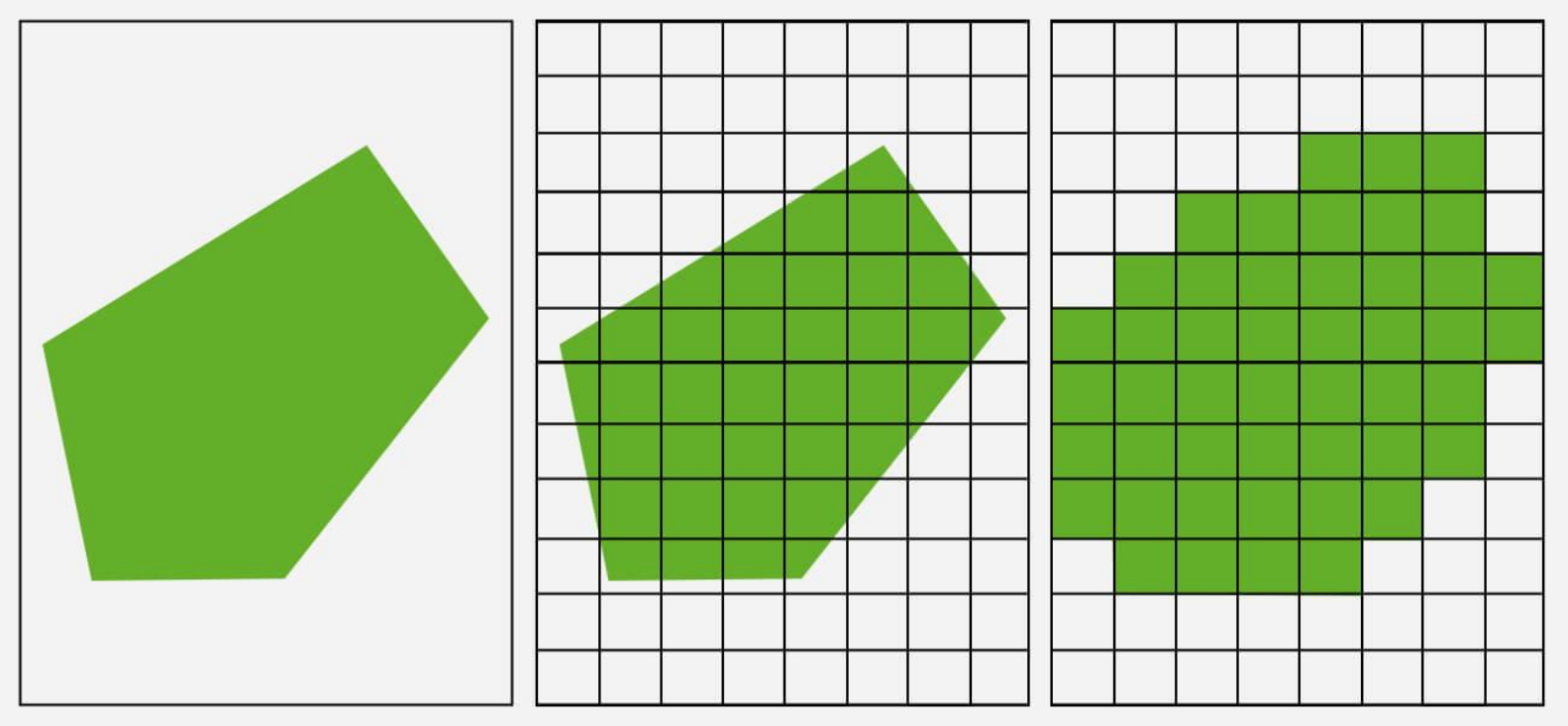
a

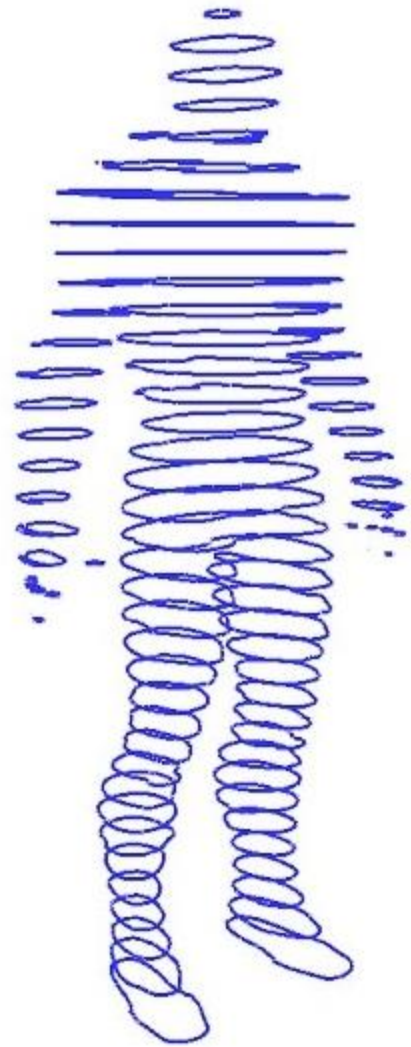
b


Order of Approximation
Zero Order
First Order
Higher Order
Uniform Layer Slicing
Adaptive Layer Slicing

6. Process-Path Generation

- **Rasterization**: Converting the 3D model into a 2D path that the printer can follow. This involves determining the movement of the print head or nozzle.
- **Part Orientation**: The angle and position at which the part is printed. Correct orientation can enhance strength and reduce the need for support structures.





•**Support Generation**: Structures added to support overhangs and complex geometries during printing. These can be removed after printing, but they need to be designed carefully to avoid damaging the printed part.