Why Additive Manufacturing?

Machining is a **subtractive** process, beginning with a solid piece of stock. The machinist must carefully remove material until the desired geometry is achieved. For **complex part geometries**, this is an **exhaustive**, **time consuming**, and **expensive process**. Some parts are even too complex to be machined.

Advantages of Additive Manufacturing

- Reduced lead times (product to market).
- Reduced costs (labour, inspection and assembly).
- Reduce part count.
- Improved quality.
- Variety of materials.
- Fast build times.
- Create impossible and complex shapes.
- Reduced Waste.
- Reduced rejection rate.

Cons
Unexpected pre- and post-processing requirements
High process cost
Lack of industry standards
Low speed, not suitable for mass production
Inconsistent Materials
Limited number of materials
High equipment cost for high-end manufacturing

Additive vs. Subtractive Manufacturing

The cavity here is too deep to machine

The undercut here cannot be performed without more than 3 axis machining

Difficulty in machining sharp internal features

Base cannot be machined since machine needs to hold

What is Additive Manufacturing ?

INTRODUCTION:

WHAT IS IT:

Additive Manufacturing by ASTM (American Society for Testing and Materials): “Process of joining materials to make objects from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing methodologies, such as traditional machining”

NAMING:

Rapid Prototyping: This term was used in the beginning of the professional use of the technology because the main application was the manufacturing of prototypes, mock ups and sample parts.

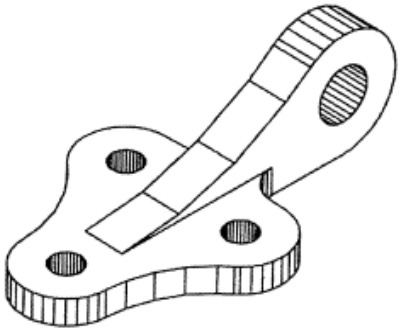
Todays most common terminologies are:

ADDITIVE MANUFACTURING (AM) or **3D PRINTING**

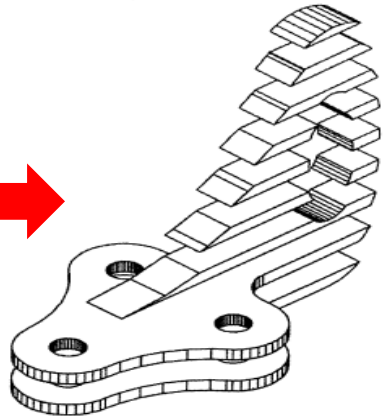
Principle of Additive Manufacturing

- AM process belong to the generative (or additive) production processes unlike subtractive or forming processes such as lathing, milling, grinding or coining etc. in which form is shaped by material removal or plastic deformation.
- In all commercial AM processes, the part is fabricated by deposition of layers contoured in a (x-y) plane two dimensionally.
- The third dimension (z) results from single layers being stacked up on top of each other, but not as a continuous z-coordinate. Therefore, the prototypes are very exact on the x-y plane but have stair-stepping effect in z-direction. If model is deposited with very fine layers, i.e., smaller z-stepping, model looks like original.
- AM can be classified into two fundamental process steps namely generation of mathematical layer information and generation of physical layer model.

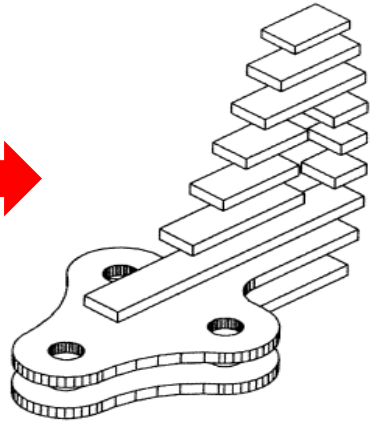
Principle of Additive Manufacturing



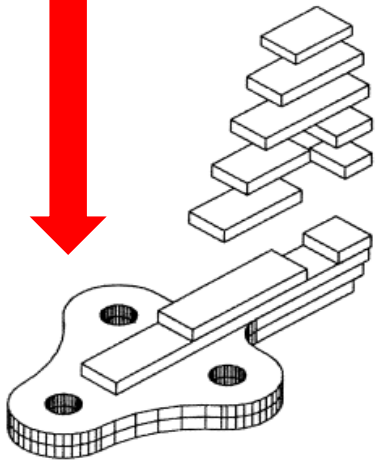
CAD MODEL



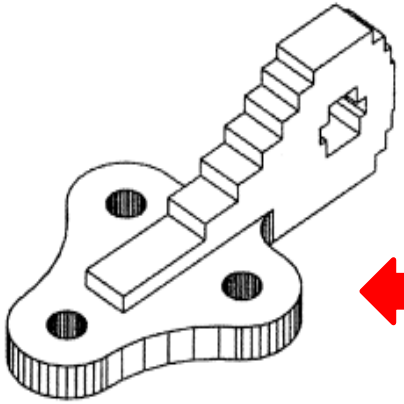
SLICING THE MODEL



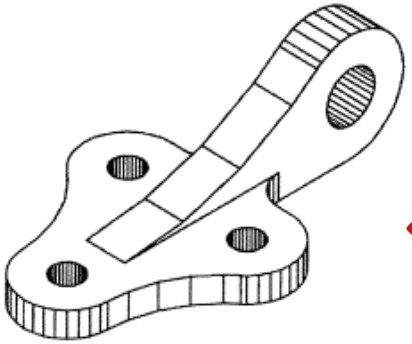
SQUARING EDGES OF MODEL



STACKING AND PASTING LAYERS

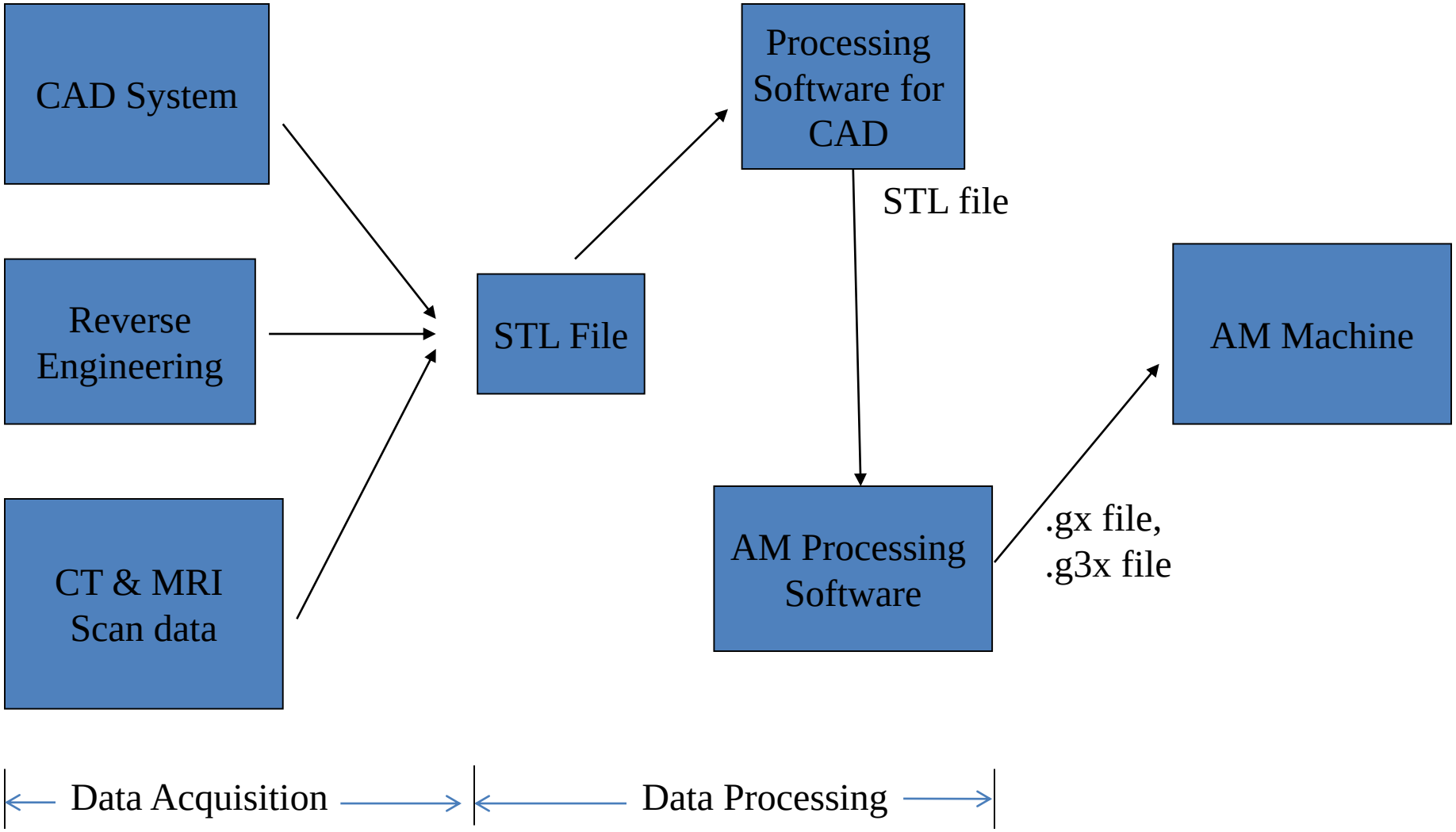


PHYSICAL PROTOTYPE



FINISHED PHYSICAL PROTOTYPE

Additive Manufacturing Process



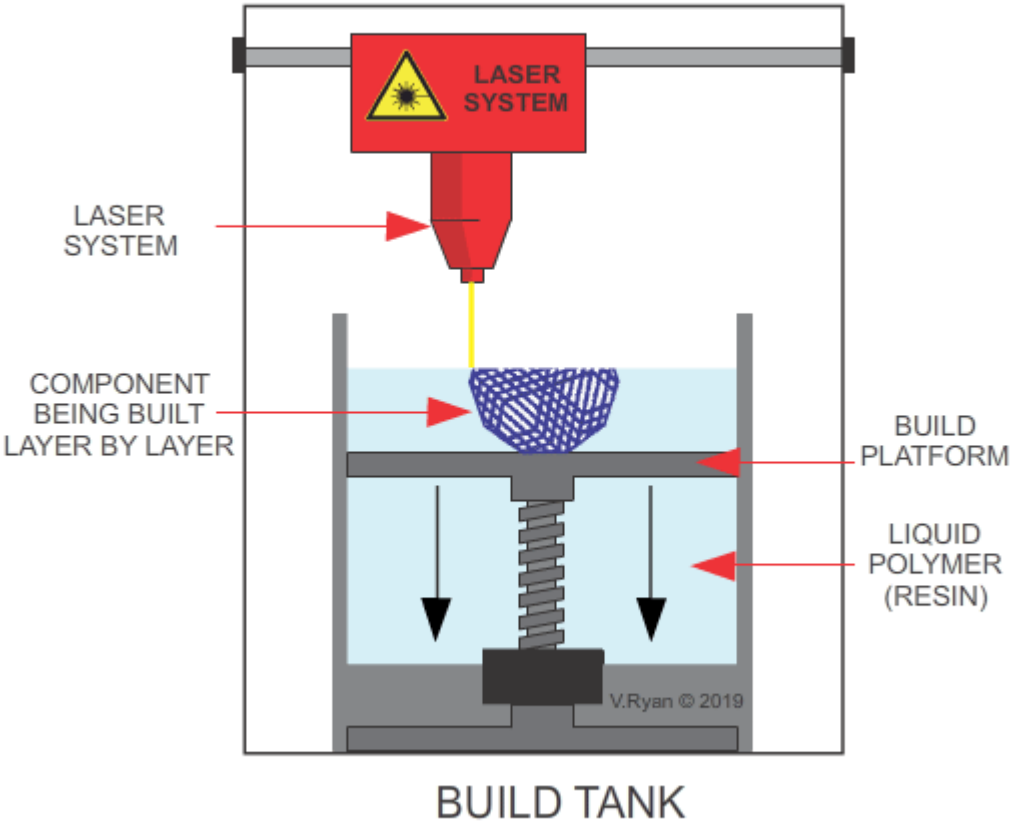
Common AM Processes

Since the presentation of first commercial application in 1988, a large number of processes have been developed. Now a days commonly used AM processes includes

- Stereolithography ,
- Powder Bed Fusion,
- Material Jetting ,
- Binder Jetting
- Material Extrusion
- Sheet Lamination
- Directed Energy Deposition

Stereolithography (SL)

- **Stereolithography** also known as **vat photopolymerisation**
- 3D Prints parts in a layer by layer fashion using photochemical processes by which light causes chemical monomers and oligomers to cross-link together to form polymers
- Those polymers then make up the body of a three-dimensional solid



Powder Bed Fusion (PBF)

- A layer, typically 0.1mm thick of material is spread over the build platform.
- A laser fuses the first layer or first cross section of the model.
- A new layer of powder is spread across the previous layer using a roller.
- Further layers or cross sections are fused and added.
- The process repeats until the entire model is created. Loose, unfused powder is remains in position but is removed during post processing.

Types

- Selective Laser Sintering (SLS)
- Selective Laser Melting (SLM)
- Direct Metal Laser Sintering (DMLS)
- Electron Beam Melting (EBM)