CASE STUDY - 3D PRINTING

Assembly Collet

CNC Machining vs. 3D Printing (FFF)

Version 01

Growth Garage

MITSUBISHI CHEMICAL ADVANCED MATERIALS

Assembly Collet

CNC Machining vs 3D Printing (FFF)

Objective

Relative production cost comparison between **CNC Machining** and **3D Printing** (FFF, Fused Filament Fabrication) of an **assembly collet**.

Both CNC Machining as well as 3D Printing can be used for **functional prototyping** and **small series production**. In this case study, the production of 1 and 5 sets of pieces are taken into account.

Application Description

This part is used as an assembly aid when joining (2) pieces of pipe together in the field. It is a non-standard part that only requires a few sets to be produced every year. Due to the low volume, injection molding is not practical nor cost efficient and so it is traditionally machined out of a large rod of nylon. Although the design is not complex, it requires a significant amount of material to be machined away which results in a large amount of waste material.

Source: Assembly collet example produced at MCAM

Assembly Collet– Input Parameters

CNC Machining vs 3D Printing (FFF)

CNC Machining

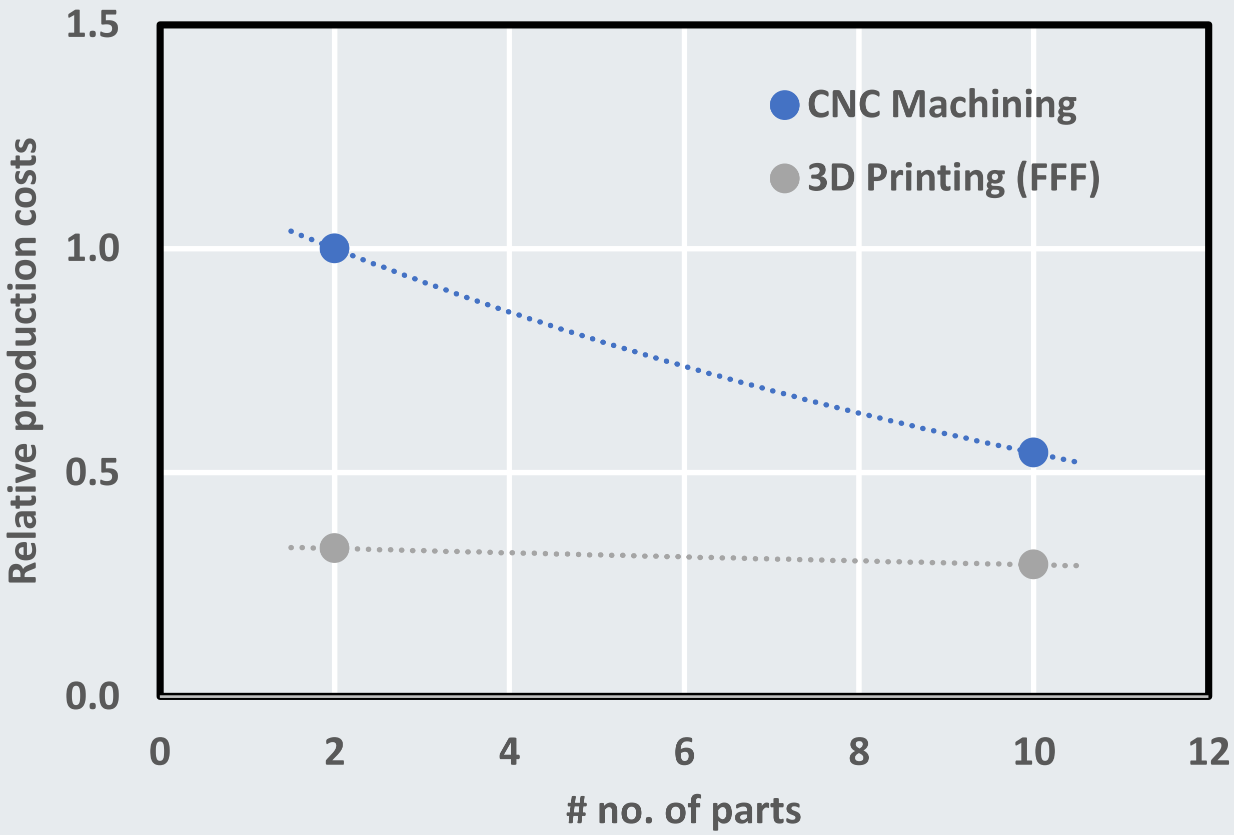
- **Material**
  - Nylon (polyamide)
- **Approx. part dimensions**
  - 10”x 5”x 2” (254mm x 127mm x 51mm)
- **Required material for (2) parts**
  - 21.6 lbs. (9.8 kg)
- **Tolerance**
  - ±0.005” (±0.127 mm)
- **Surface finish**
  - √125 RMS
- **Approx. fabrication time**
  - 12.5 hours with fixture build (5.5 hours CNC time)

3D Printing (FFF)

- **Material**
  - Nylon (polyamide)
- **Approx. part dimensions**
  - 10”x 5”x 2” (254mm x 127mm x 51mm)
- **Required material for (2) parts**
  - 2.72 lbs. (1.23kg). 87% reduction vs CNC Machining.
- **Tolerance**
  - ±0.010” Z-Direction (±0.25 mm) / ±0.040” XY-Direction (±1 mm)
- **Surface finish**
  - Varies depending on location, fairly rough in Z-direction
- **Approx. print time**
  - 4.25 hours

Assembly Collet – cost comparison

CNC Machining vs 3D Printing (FFF)



In this example, 3D printing of prototypes or small series production is **significantly lower in costs**.

To chose the right production technology, other requirements such as **surface finish**, **dimensional accuracy**, **part size**, **production time** and **production waste** need to be taken into account. Some of these requirements can be overcome utilizing post processing techniques.

To facilitate smooth scaling of your product, you could consider hybrid production technologies, such as 3D printing of the tool for injection molding: **SPRINT** (Soluble Printed Injection Tolling). This technology requires relative low investment upfront and will result in very reproducible scaling when shifting to hardened steel tooling (high investment) when volumes are increasing.

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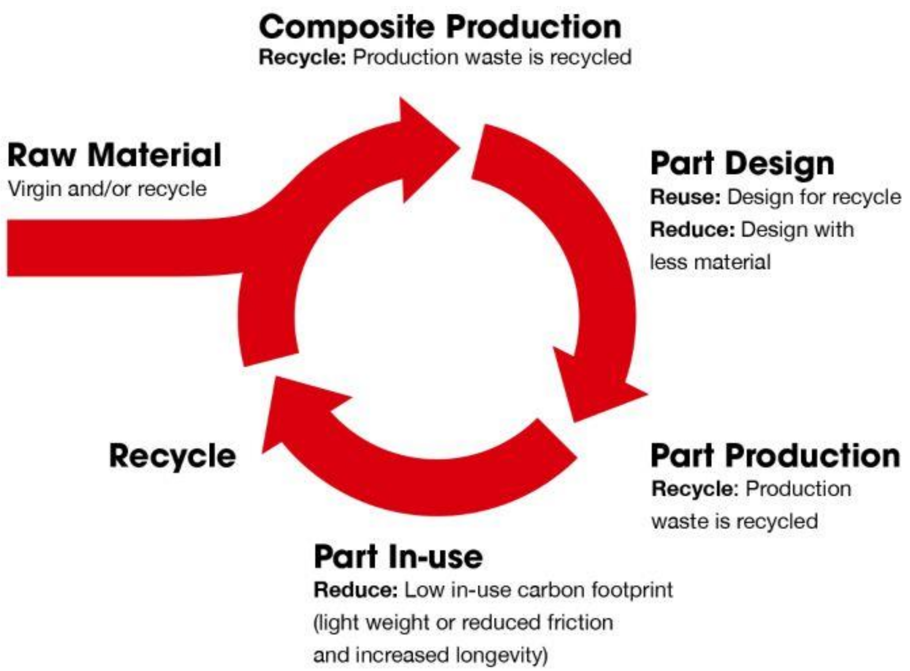
Carbon footprint reduction – CO_2 emission savings

CNC Machining vs 3D Printing (FFF)

A reduction of the carbon footprint of your product can be achieved:

Reduce | **Reuse** | **Recycle**



- The selection of the **material**, **design** and **production technology** are inextricable bound up and significantly influence the carbon footprint of your product.
- CNC machining; excess material from the plate, rod or near net shape needs to be recycled to avoid landfill and reduce the carbon footprint.
- In this example, 3D Printing (FFF) of the assembly collet resulted in an astonishing **87%** reduction of material usage.

Scaling matrix

# of parts	Manufacturing technology	Design freedom	Volume (# parts)	Upfront investment (tool)	Speed	Size part	Engineering plastic materials	
1 – 10	Functional prototyping and small series	Very High	Low	Very low	< 1wk	Small – Medium	All, KyronMAX®	3D printing (FDM or FFF) of a visual/functional part
1 – 10	Functional prototyping and small series	Very High	Low	Very low	< 2wks	Small – Medium	All, KyronMAX®	SPRINT (Soluble Printed Injection Tooling) is based on AddiFab's Freeform Injection Molding technology. It provides the flexibility of 3D printing (of the mold) with injection molding quality. It enables the production of small series parts that are 100% functional and can be scaled at low risk to high volume injection molding. Max size of the printed mold 96x54x150mm. Up to 4 molds can be combined to expand the build envelope.
1 – 100	Machining (CNC)	Moderate	Low	Low	2wks	Small – Very large	Limited by degree of fillers or very soft materials	Customization of plates, rods or near net shapes.
10 – 1000	Near net injection molding + Machining (CNC)	Moderate	Low – Medium	Medium	2wks	Small – Very large	Limited by degree of fillers or very soft materials	Cost effective way of production by combining injection molding of near net shapes (NNS) in combination with machining for adding features and creating very tight tolerances
100 – 10,000	Injection molding – Machined aluminum tool	Low – Moderate	Low – Medium	Medium	4-6 weeks	Medium	All, KyronMAX®	Conventional injection molding.
100 – 250,000	Injection molding – 3D printed metal insert in mother tool	Moderate	Medium – High	Medium	<6wks	Low Medium	All, KyronMAX®	Injection molding with a 3D printed metal insert. Max size is approx. 250*250*250 mm.
>10,000– 1 Million	Injection molding - Hardened Steel tool	High	High	High	10 – 24wks	Very large	All, KyronMAX®	Complete hardened tool with moving parts.

THANK YOU

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