

# 3D Printing for Industry Today: Fact or Fiction?

March 2015

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# Part 1: Challenge

Part 2: Approach

Part 3: Examples

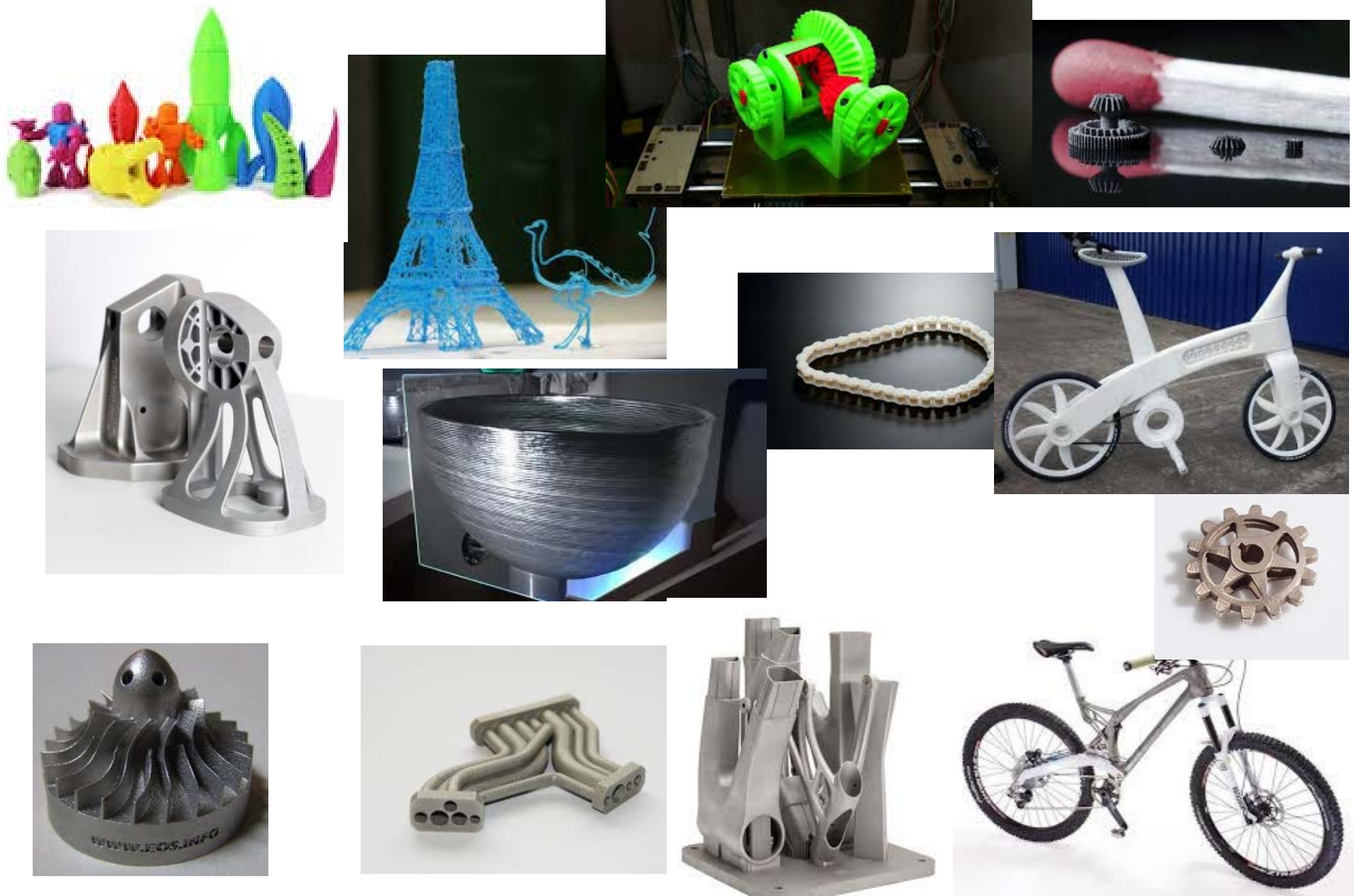
Part 4: Conclusions

## Main question

Can we use 3D printing to produce industrial scale products, today?

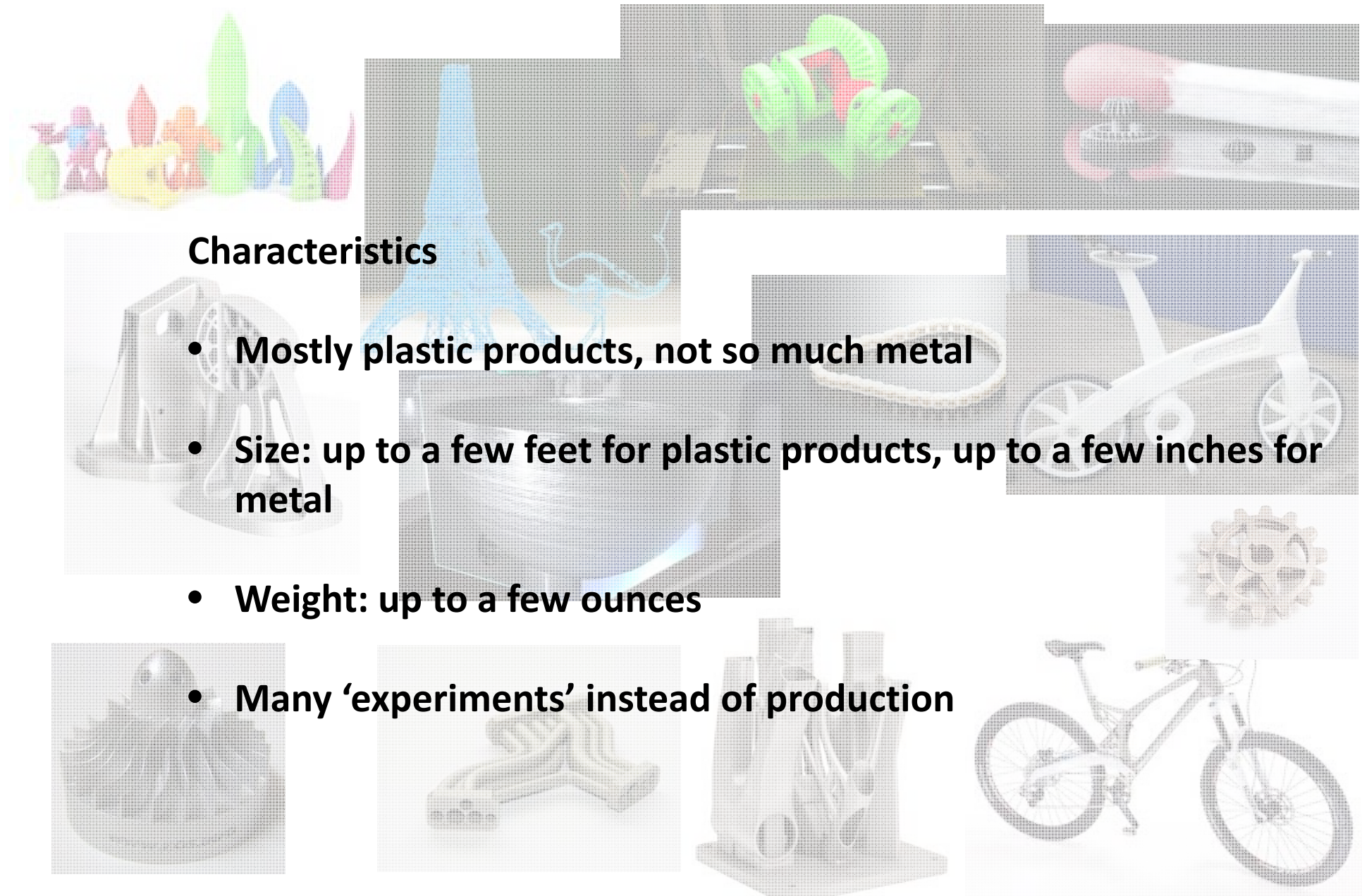
- Large
- Heavy
- (Mostly) metal
- Compliance with standards

# Common products produced with 3D printing



*Pictures from the internet, courtesy of Renishaw, EOS and others*

# Common products produced with 3D printing

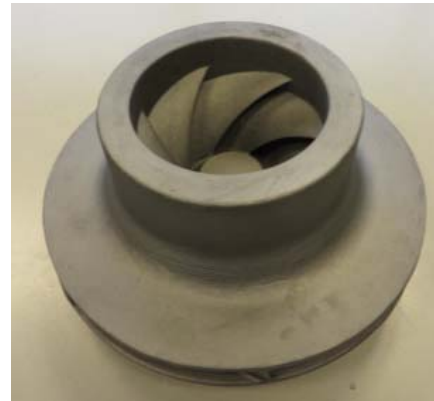


## Characteristics

- **Mostly plastic products, not so much metal**
- **Size: up to a few feet for plastic products, up to a few inches for metal**
- **Weight: up to a few ounces**
- **Many 'experiments' instead of production**

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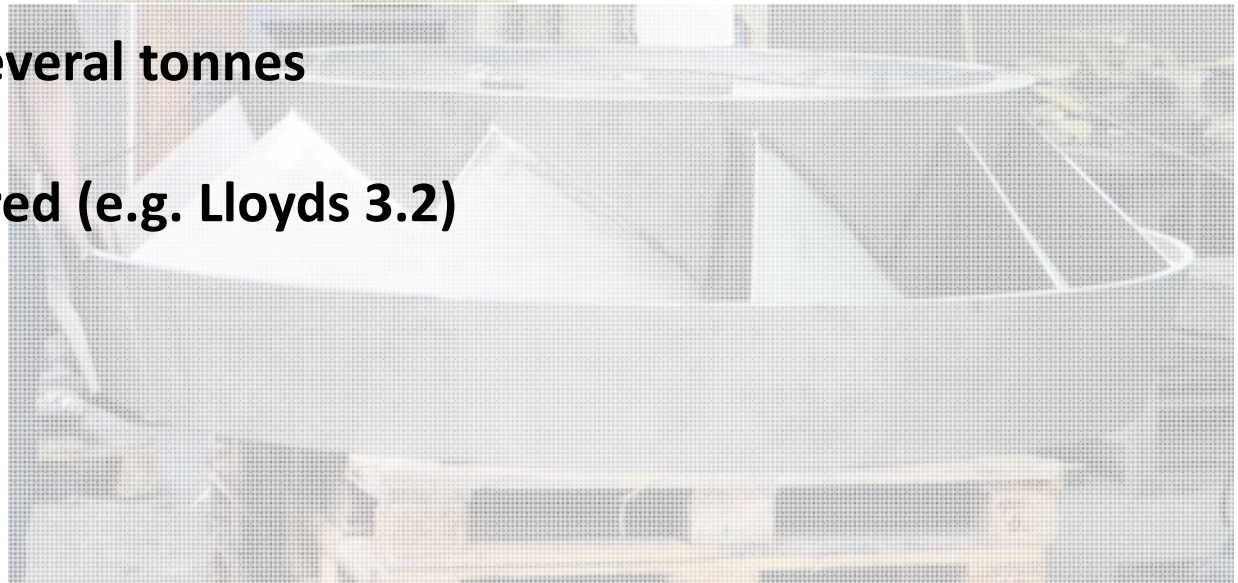
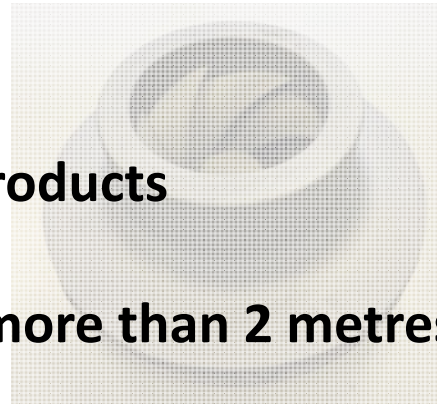
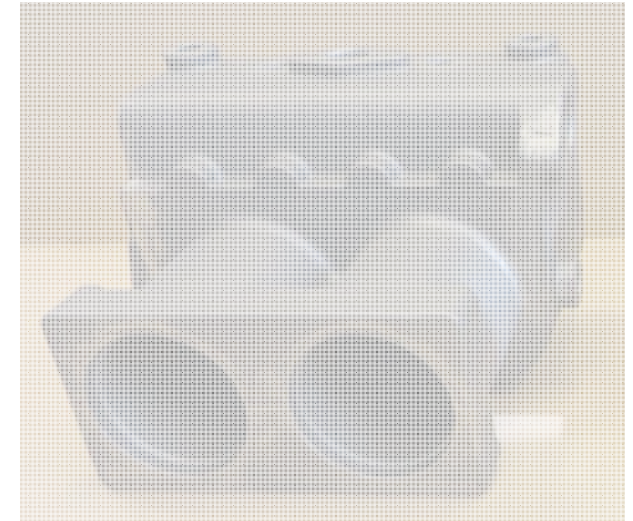
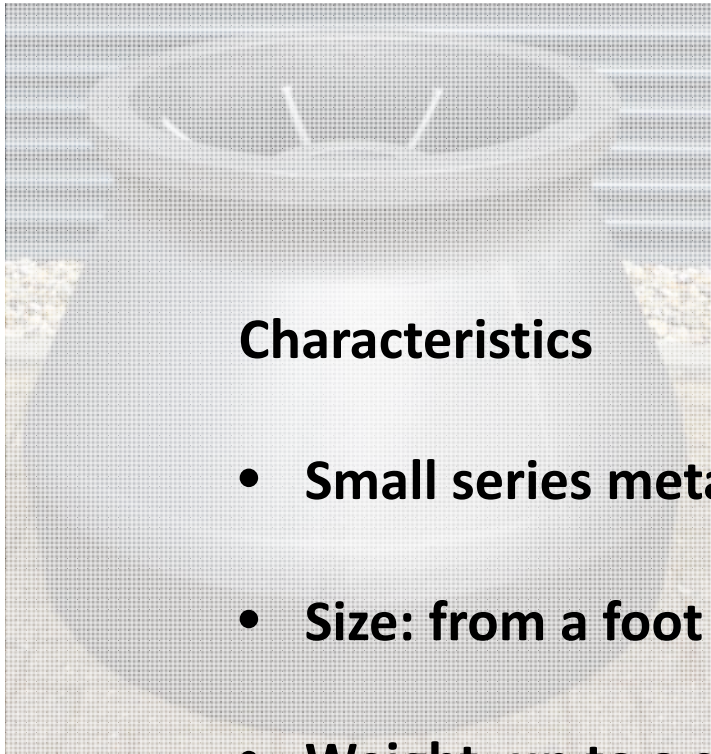
# Can we use 3D printing to produce these products?



# Can we use 3D printing to produce these products?

## Characteristics

- **Small series metal products**
- **Size: from a foot to more than 2 metres**
- **Weight: up to a several tonnes**
- **Certificates required (e.g. Lloyds 3.2)**



# Challenges for industrial scale 3D printing

Size	<p>The vast majority of 3D printers produce objects smaller than a foot</p> <p>Larger printers produce up to a few feet in plastic, or a few inches in metal</p>
Weight	<p>3D printers generally produce products up to a few ounces, not several tonnes</p>
Speed	<p>Larger products often take several days to print</p>
Material	<p>Most 3D printers produce plastic</p> <p>Metal printers tend to be small and create tensions in the material</p>
Cost	<p>Plastic prints : generally &gt; €1,000 per kg.</p> <p>Metal prints: generally &gt; €10,000 per kg.</p>
Certificates	<p>Difficult/expensive to obtain, if possible at all</p>
Technology not ready	<p>We need ALL of the challenges addressed today, not just a few elements with a promise for the future</p>



*There are many stories full of expectations about 3D printing.*

*We cannot produce products with expectations,  
we need technology that works.*

Part 1: Challenge

**Part 2: Approach**

Part 3: Examples

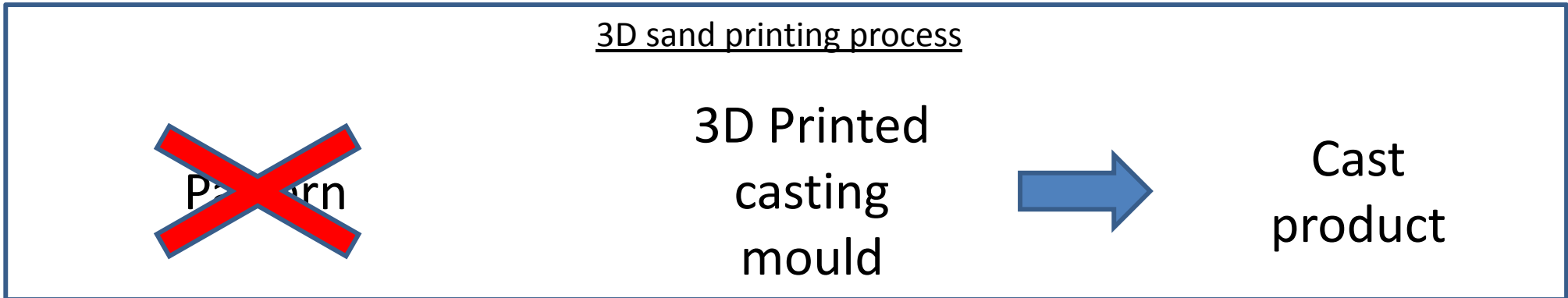
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# Our approach: 3D sand printing

## Traditional casting process



## 3D sand printing process



## Direct 3D printing



# 3D sand printing process characteristics

Size	<p>Up to the size of a phone booth (1800 x 1000 x 700 mm) in a single print</p> <p>Stack mould parts 'like Lego' to make larger parts of several metres in each direction</p>
Weight	Products up to several tonnes
Speed	Up to the size of a phone booth (1800 x 1000 x 700 mm) in 24 hours
Material	<p>Sand moulds for practically all types of metals: cast iron, steel, aluminium, bronze, brass</p> <p>Recently added: (fibre reinforced) concrete</p> <p>Working on: plastics, carbon fibre, rubber, etc.</p>
Cost	< €100 per kg. product
Certificates	The casting process enables material certificates: Lloyd's 3.2 and others
Technology readiness	Technology is in production use today

# 3D sand printing process



Part 1: Challenge

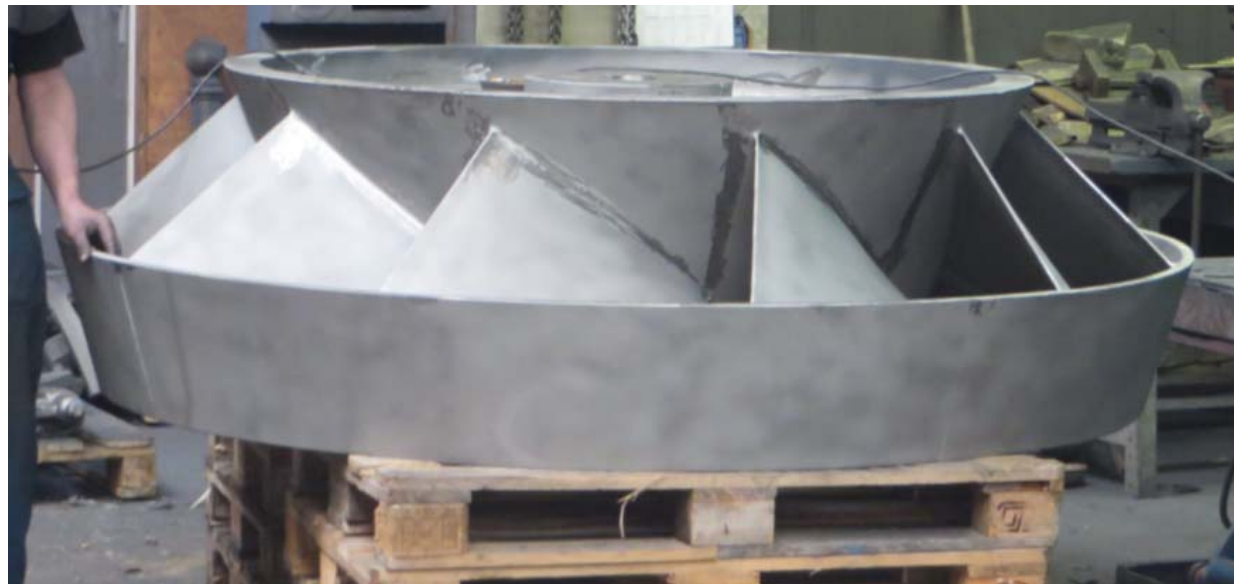
Part 2: Approach

**Part 3: Examples**

Part 4: Conclusions

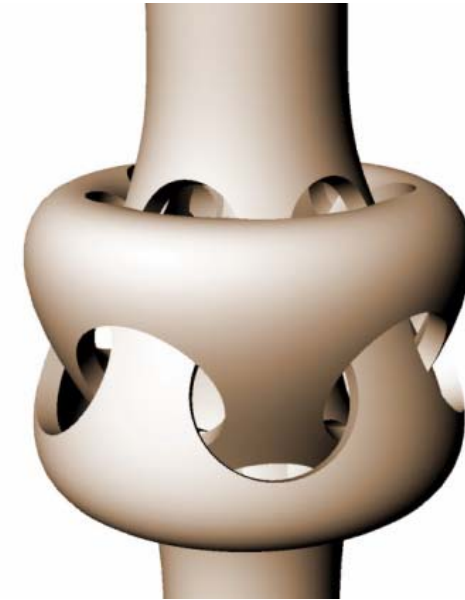
## Examples : large products

- Size: over 2 metres diameter
- Weight: over 2 tonnes
- Lead time: 3 to 6 weeks
- Series size: 1 resp. 3
  
- Reasons for 3D printing:
  - Lead time reduction
  - Save pattern cost

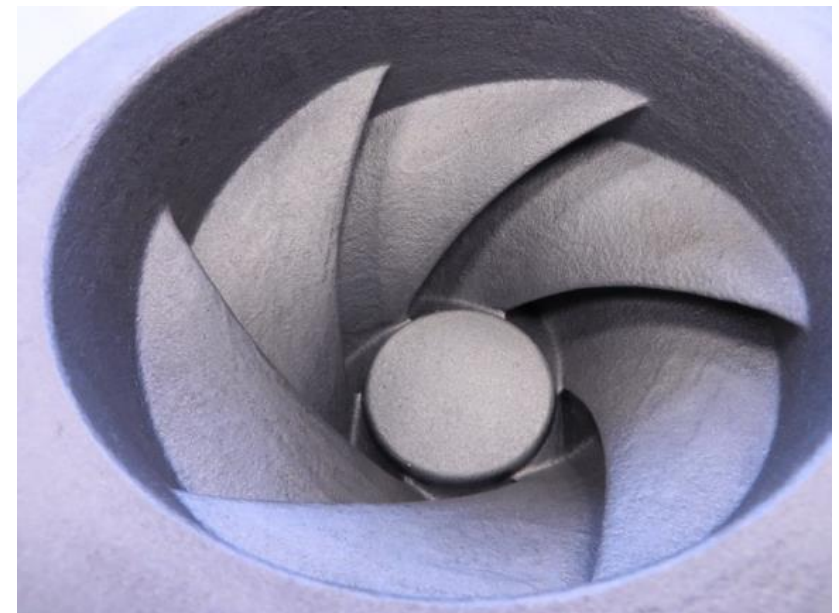


# Examples : 'impossible' products

- Size: 50 centimetres high
- Weight: 5 kg.
- Lead time: 4 weeks
- Series size: 1
  
- Reasons for 3D printing:
  - The only possible production method

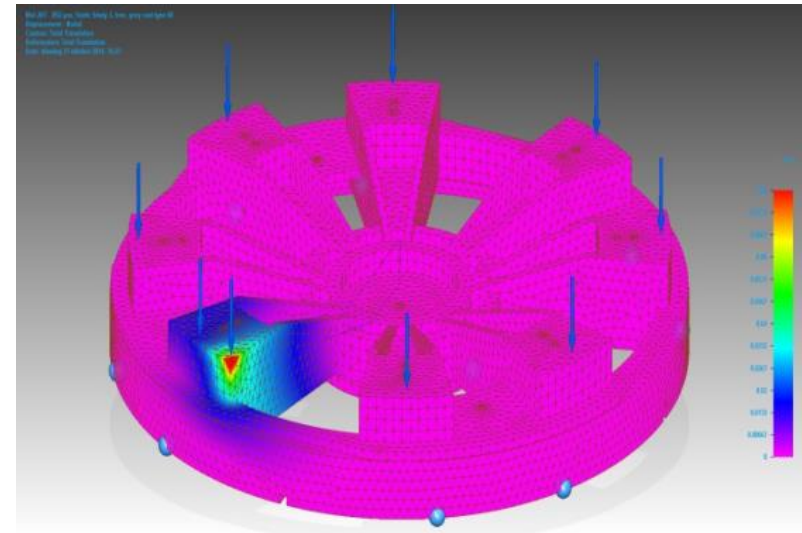
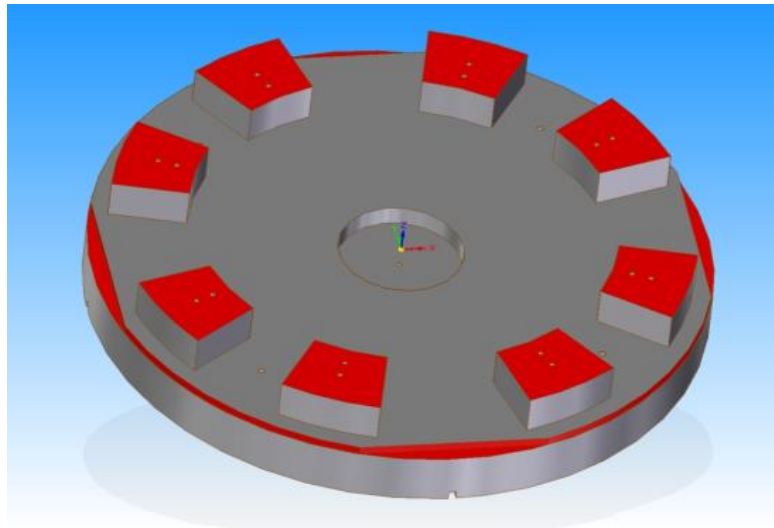


- Size: 50 centimetres diameter
- Weight: 20 kg.
- Lead time: 3 to 6 weeks
- Series size: 1
  
- Reasons for 3D printing:
  - Lead time reduction
  - Save cost compared to traditional investment casting





# Examples: weight reduction



- Machine fixture:  $\varnothing$  1600 mm
- Series size: 1
- Original design: 1710 kg
- New design: 980 kg
- 43% material reduction through topology optimisation

- Agriculture frame: 500 mm
- Series size: 5
- Material reduction: 57%



# Examples : affordable one-off items

- Project: remanufacturing a 1908 engine
- Approach: 3D scanning and sand printing
- Weight: 10 kg.
- Lead time: 6 weeks
- Series size: 1
  
- Reasons for 3D printing:
  - Save pattern production
  - The only affordable production method

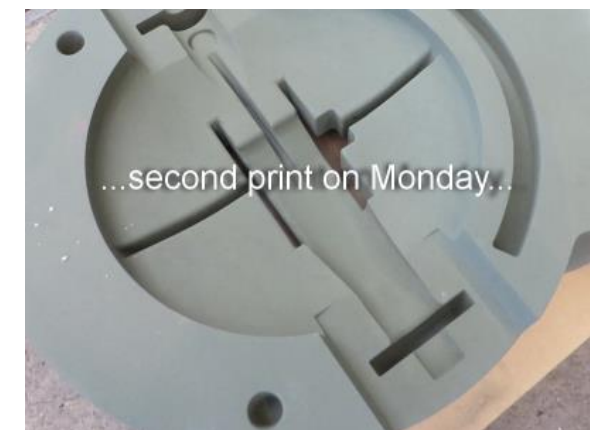


# Examples : rapid prototype



- Project: prototype valve
- Size: 800 mm.
- Weight: 20 kg.
- Lead time: two cycles in 1 week
- Series size: 1

- Reasons for 3D printing:
  - The fastest possible production method



## Examples : other materials

- Project: twisted H profile
- Material: concrete
- Size: 1600 mm. high
- Weight: 100 kg.
- Lead time: two weeks
- Series size: 1
  
- Reasons for 3D printing:
  - The only possible production method



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# Business opportunities for 3D sand printing

- **Short lead time** when a casting pattern is not available (e.g. for prototypes, repair jobs) – lead time can be reduced by 6 weeks or more
- **Prototypes and small series** when a casting pattern is not available – for series up to several hundred items (depending on product size and complexity), printing can be more cost effective than producing a pattern or core box
- **High complexity** (e.g. complex cores) – complex moulds are produced more cost effectively through printing than with a traditional pattern or core box
- **High quality/accuracy** – printed moulds have higher quality/accuracy than moulds that are hand-formed with a casting pattern
- **‘Impossible’ products** – mould printing provides access to a new and previously unthinkable universe of geometries with vertical walls, overhangs/undercuts and half-open honeycomb/mesh structures
- **Endless customisation** – 3D printing allows production of individually customised products, enabling for instance to size each product exactly to its application
- **Storage-free low-volume supply chain** – store digital files only and print a mould – anywhere in the world – when a product / spare part is needed

**Tactical opportunities**  
Better ways to solve traditional challenges

**Strategic opportunities**  
Transform the business model

# Looking forward

- 3D sand printing will remain a very capable method for industrial products
- Metal printers more capable
- Certification needs to be solved
- Printing with LED

## Further information



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