HOW THIS WILL TRANSFORM OUR INDUSTRY?
Additive manufacturing is defined as the process of joining materials to make objects from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing (ASTM F2792).
Subtractive vs Additive Manufacturing
Core Technologies Transformation

**Subtractive Manufacturing**
- Tooling
- Jig & Fixtures
- Design & Manufacturing Software
- Subtractive Manufacturing
- Material in block form
- Waste (material chip)
- Product

**Additive Manufacturing**
- Design & Manufacturing Software
- Mechatronics
- Material Processing
- Additive Manufacturing
- Material in Powder, Pellets, Liquid, Filament form
- No or Less Waste (typically as support structure)
- Product

Waste (material chip)
How Additive Manufacturing can disrupt traditional supply chain?

• AM revolutionize product design as it is possible to produce parts with much more complex geometry.
• AM shorten product time to market through rapid prototyping and testing.
• AM eliminate cost for tooling, jig and fixture, dies which result in flat part cost/quantity.
• Three factor above open door to Mass Customization!

The breakeven point for high-pressure die-casting and selective laser sintering, a powder bed fusion AM technique.
Source: Costs and Cost Effectiveness of Additive Manufacturing, National Institute of Standards and Technology (2014) <http://dx.doi.org/10.6028/NIST.SP.1176/>
Industries that will benefit from AM Technology

- **Medical**
  - 3D Printed Cranioplasty
  - Prosthetic Arm

- **Aerospace**
  - Turbine Blades
  - Composite Tooling

- **Automotive**
  - Engine Manifolds
  - Car Interior

- **Building - Construction**
  - Pre-fab building
  - In-situ fabrication
Case Study: Concrete 3D Printing

CNC Design manufactures Concrete printers for Construction in Preform, Onsite and Architectural sectors.

VSF Configuration:
- One or Two beam
- 3 or 5 axis concrete printing and robot reinforcement placement.
- Maximum print rate 4000 Kg/Hr.
- Printing surface speed 6-40 m/min
- Printable Module size 9m x 5m x 3.2m
Additive Manufacturing Evolution
Why it takes so long to take off?

Product Design
Prototyping and Customization

Production
Scaling in Volume, Size and Availability

1986
AM Invented (SLA)

2004
Component Manufacture

2008
User Generated Art

2014
Selective Laser Sintering Patent Expires

1989
AM Rapid Prototype (FDM)

2007
RepRap Movement

2009
FDM Patents Expires

Future

Main Applications 1986 - 2011:
- Product Design
- Product Part Production
- Rapid Prototyping
- Concept Modeling

Catalyst for Mass Production Adoption:
- GE plans to mass-produce 25,000 LEAP engine nozzles with AM – already have $22B in commitments
- Parts will drive production and operational cost savings
- First test to see if AM can revolutionize production

Main Applications 2014 - Future:
- End Product Production
- Mass Production
- Democratized Consumer 3D Printing

Revenue for AM products and services worldwide. The market has grown by 5.5 times over the past eight years. (US$ m)

Source: Wolters Report 2018
Facts: In 2019 ASEAN countries spend $3.8 billion for Additive Manufacturing Technology, which only cover 5-7% of total Asia market.

Source: IDC, thyssenkrupp analysis
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