Digital Manufacturing

A status update of the "Next Industrial Revolution"

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September 19, 2017

3D Printing is also called Additive Manufacturing

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Subtractive Manufacturing

Subtractive manufacturing processes works by removing material by cutting, grinding, milling and other methods.

Additive Manufacturing

Additive manufacturing works in the opposite way, by adding material layer by layer.

Both are forms of Digital Manufacturing and both are used in Advanced Manufacturing

4 Primary Technologies

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VAT PHOTOPOLYMERIZATION

MATERIAL EXTRUSION

LASER SINTERING

INKJET PRINTING

How is 3D printing used?

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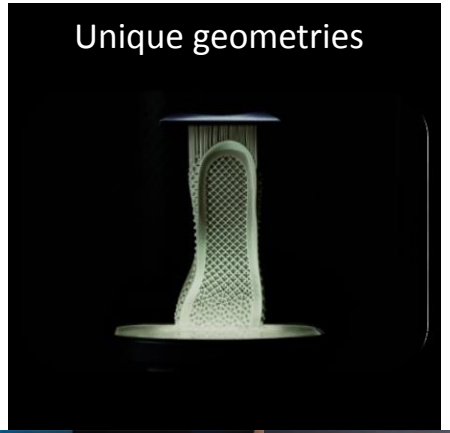
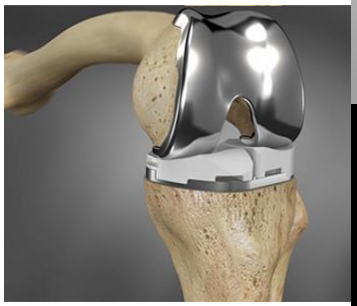
Prototyping

Short run production

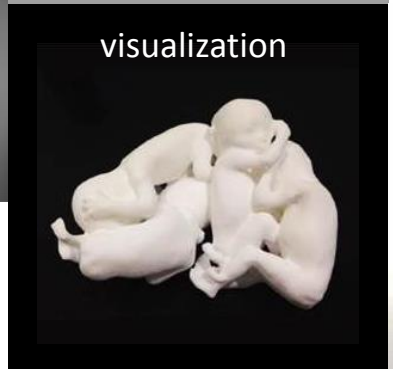
Weight saving strategy



Hyper customization



Surgical aids and implants



Fixtures
Manufacturing aids

3D Printing in Manufacturing

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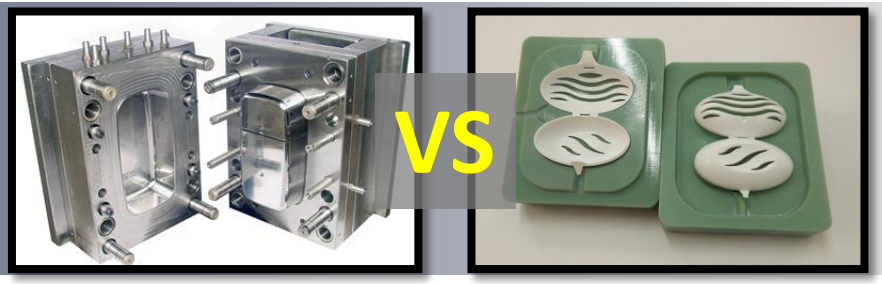
Short run injection molds

- $40,000 vs $400
- Limited yield
- Actual production material

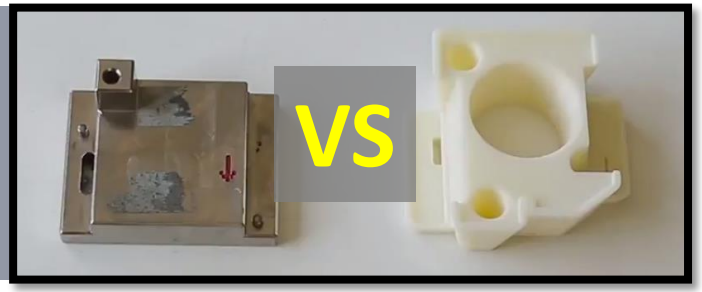


Complex Engineering

- 18 components vs 1 integrated part
- 25% weight reduction
- 20% fuel savings

Ricoh Replaces Metal Tooling with 3D Prints

- Ricoh custom fixture 98% cost savings
- Workstation customization addresses 6 key fundamentals of the Ricoh Way Production System



Healthcare applications are set to explode

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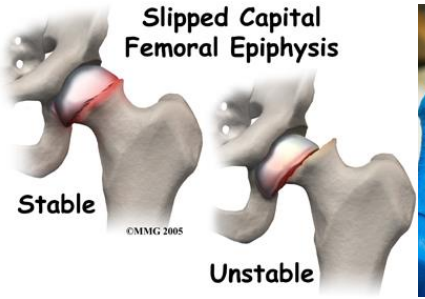
The $1.25B intra-oral scanning and braces company relies entirely on 3D Printing and Scanning.

Medical 3D printing saves $2700 per surgery
Published in the Journal of Children's Ortopaedics, Rady Hospital's study reduced surgery time by 25% by using 3D Printed surgical aids, for a cost savings of $2700 per surgery and improved patient outcomes.



Why is 3D Printing Important ?

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We see additive manufacturing as the next chapter in the industrial revolution. This new Industrial Revolution will rethink manufacturing all over the globe.

The next industrial revolution

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1st Industrial Revolution

Age of Mechanization **1800**

- Factory made vs. home made
- Favored innovation

2nd Industrial Revolution

Age of Mass Production **1900**

- Factories operate 24/7
- Efficiency followed cheapest labor/materials

3rd Industrial Revolution

Age of Digital Manufacturing **2000**

- Distributed, direct digital production
- Favors localized production

The Third Industrial Revolution requires a new kind of decentralized, **Advanced Manufacturing** that favors capital investment and skilled labor.

Why 3D Printing is important?

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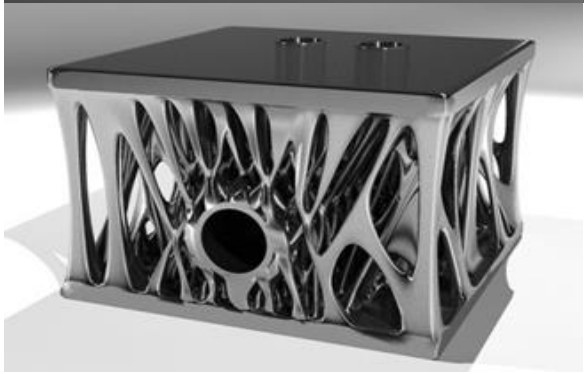
DESIGN



- Direct digital manufacturing: Design to production in one step
- Organic
- Complex
- Optimized

INDIVIDUAL

- Mass-customization
- Smarter design
- Enhanced performance, durability, economy

HYPER LOCAL

- Increase Domestic Manufacturing
- Decrease Supply Chain Costs/Waste
- Bespoke, on-demand production

Global AM Demand Outlook

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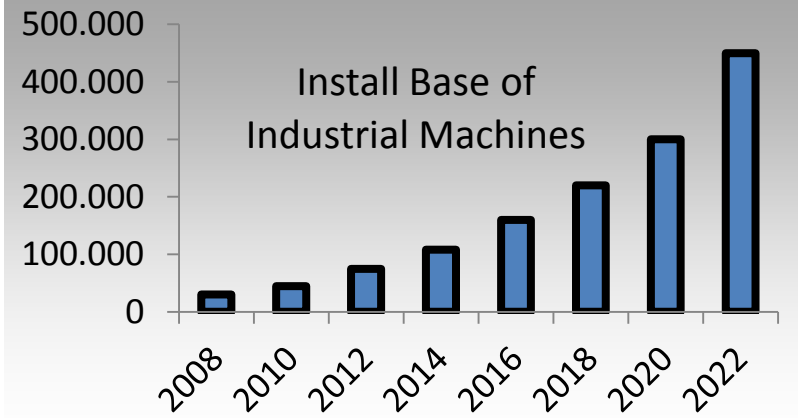
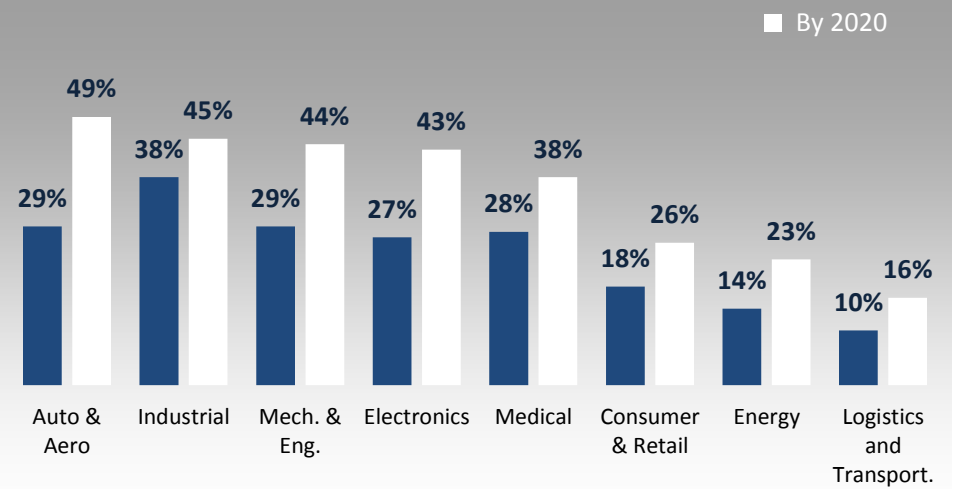
Adoption Timeline



Adoption by Industry



Machine sales are being driven by successful adoption into wider range of industries

Benefits of AM adoption

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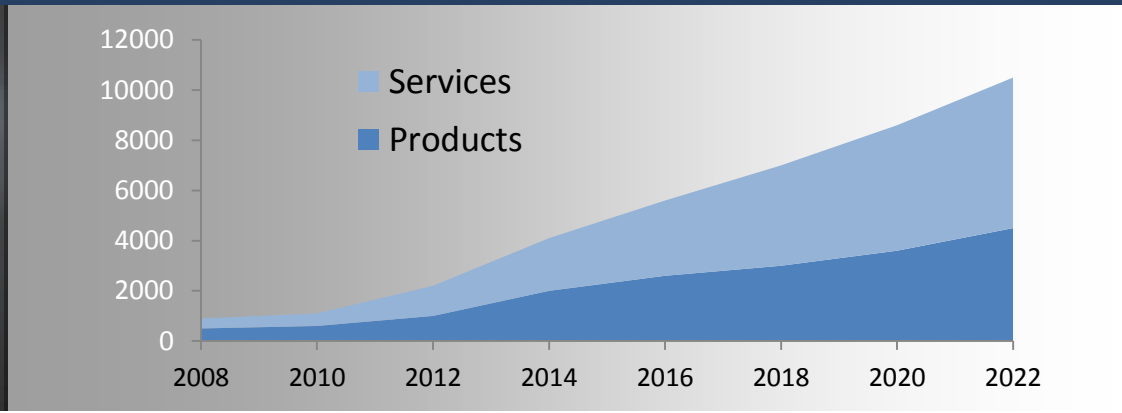
Measurable benefits of AM use leads to services growth due to barriers to adoption



- 10x time savings in product development
- 88% cost savings on custom fixtures/jigs
- 20% efficiency gain on complex engineering
- Physical planning tool for improved outcomes
- Opens new markets with new products
- Quick production of low demand product

Barriers to Adoption

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The adoption of AM faces challenges that traditional manufacturing has already overcome:

Will the product meet industry standards ?

Will the quality be accepted by the customer ?

Will insurance cover new risk exposure?

Barriers to Adoption

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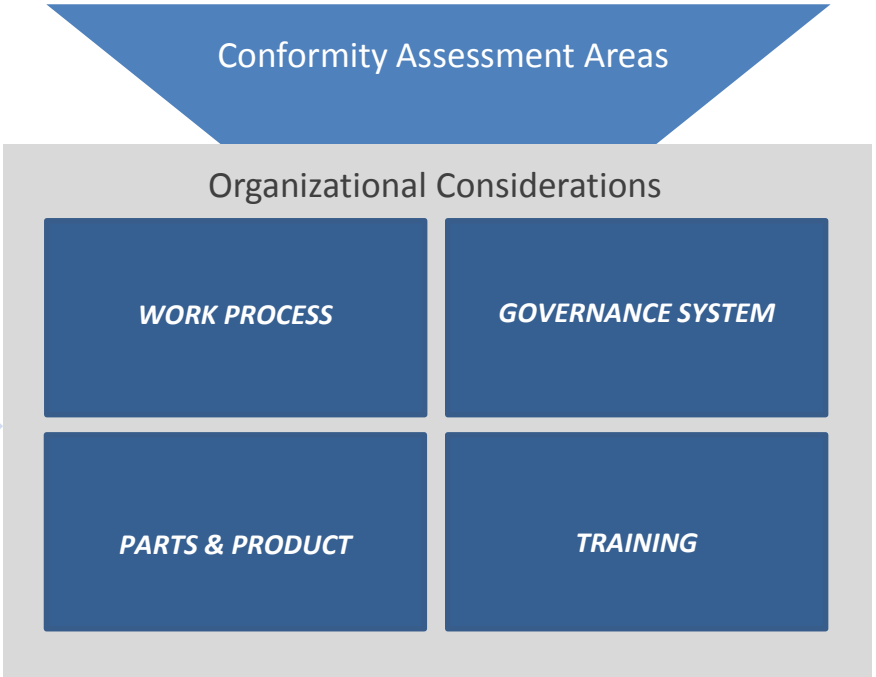
Conformity Assessment is the demonstration that the technical requirements of production are fulfilled



Barriers to Adoption

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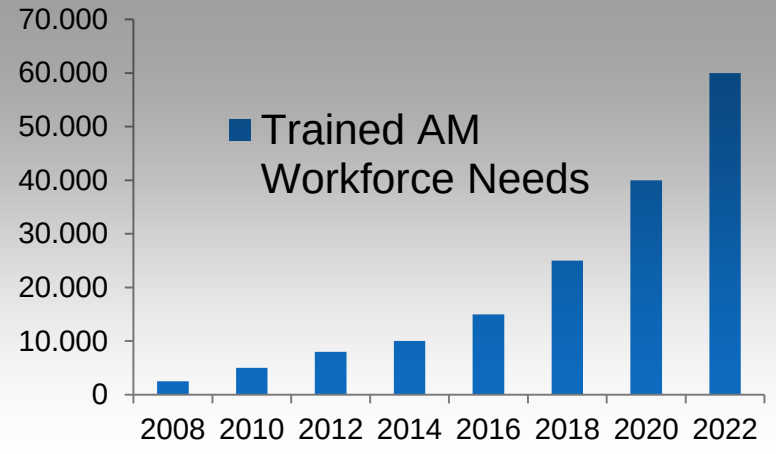
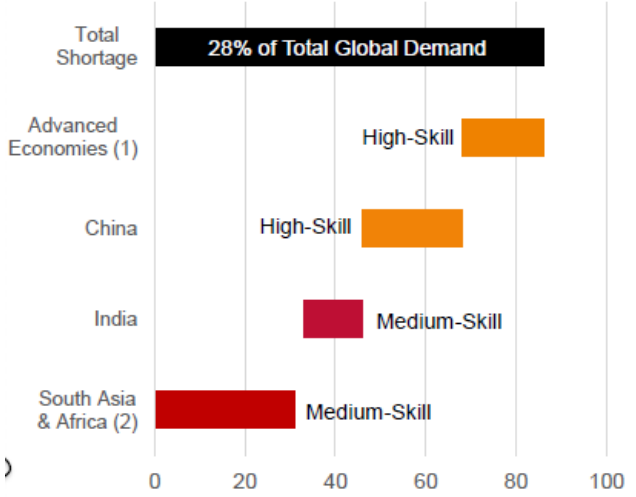
Successful AM growth requires a properly trained workforce



However the global workforce is not prepared to meet these needs

Manufacturing Skilled Labor Shortage is a Global Problem

2020 Forecasted Global High & Medium-Skill Labor Balance (million workers)



NOTES:
(1) 25 countries that have GDP per capita greater than $20,000 at 2005 purchasing power parity levels in 2010
(2) 11 countries from South Asia & sub-Saharan Africa, with GDP per capita less than $3,000 at 2005 PPP levels in 2010

Barriers to Adoption

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Existing training infrastructure Unequipped

Engineering Design

- Unique design guidelines for components & assemblies
- Interactions between AM & conventionally manufactured parts
- Additional design specification requirements
- Management of interoperability between CAE systems
- New advanced tools

Additive Manufacturing Processes

- Multiple technologies with different behaviors
- Unique environmental, software, consolidation, build volume, mechatronic, support & other factors affecting part performance precision

Additive Manufacturing Materials

- Different behaviors between AM & conventional materials
- Unique environmental, physical, chemical & other factors affecting part performance precision
- Unique interactions among design, materials & process factors

Post Processing

- Multiple post-processing techniques for finished parts
- Unique effects of techniques on part-performance

Call to Action : What Educators need to do:

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Access

Engage

Integrate

Enhance

Innovate

Excite

RICOH's Approach

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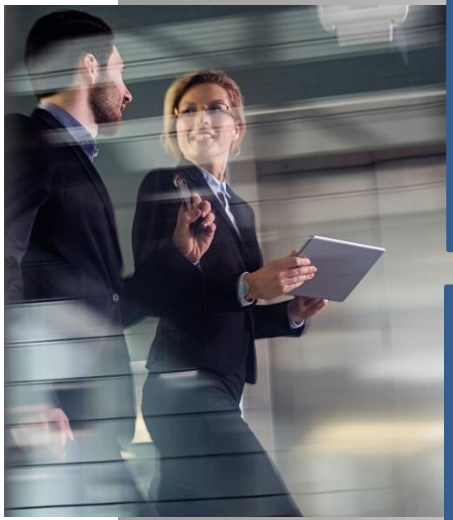

Consultative Services

for the growth of Advanced Manufacturing

Managed Services

for Additive and Digital Manufacturing

Production Services

that support and enhance a services-based approach

Distributed Manufacturing

position Ricoh as the global leader in enabling the emergence of the new manufacturing model

Thank you!

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