Digital Manufacturing: Linking Advanced Materials and Software

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Summary

- CDO3: Digital Manufacturing
- Background: 3DP Printing and Additive Manufacturing
- New Production Economics of Additive Manufacturing
- Policy Implications
  - **America Makes** AM Roadmap

Reference Case: America Makes

- National Centers for Manufacturing Innovation. Primary goal of transitioning AM technology and know-how to **mainstream manufacturing**.
- Overall, the initiative is designed to develop regional platforms, or **“industrial commons**” which provide **more robust regional assets** that are common and shared by all member organizations.
- Emergent feature of Innovation system is the interaction of **Community Colleges and SMEs**

Digital Manufacturing: Questions

1. How are industries adopting and deploying new digital technologies?
2. What are the new platforms in manufacturing?
3. How are Canadian firms adopting and diffusing ICT ?
4. What policy initiatives are needed?

3DP and Additive Manufacturing

1. What type of firms are benefiting from government initiatives to advance additive manufacturing?
2. What segment of the value chain are current initiatives aimed at? Prototyping, design, manufacturing?
3. How do Canadian AM initiatives compare to ones abroad (e.g. in the US)?
4. What are some suggestions for future AM policy initiatives?

Field Research

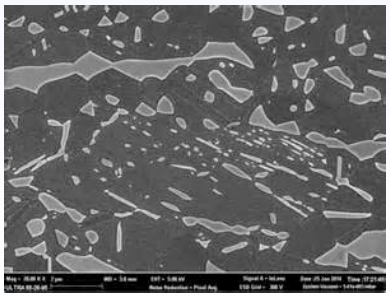
	Interviews
SMEs	20
Colleges	6
ReMAP	6

Introduction to AM

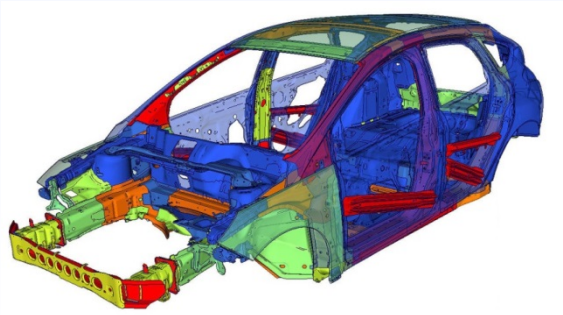
- Additive Manufacturing
  - The process of joining materials to make objects from 3D model data, usually layer upon layer. Traditional manufacturing uses subtractive methods, creating objects by material removal machining.
- 3D Printing
  - The fabrication of objects through the deposition of a material using a print head, nozzle or other printer technology

AM: Interface of Advanced Materials and Software

- Advanced Materials:
  - Not just specialized and price premium
  - Micro-behaviour of the materials determines macro-behaviour of the product

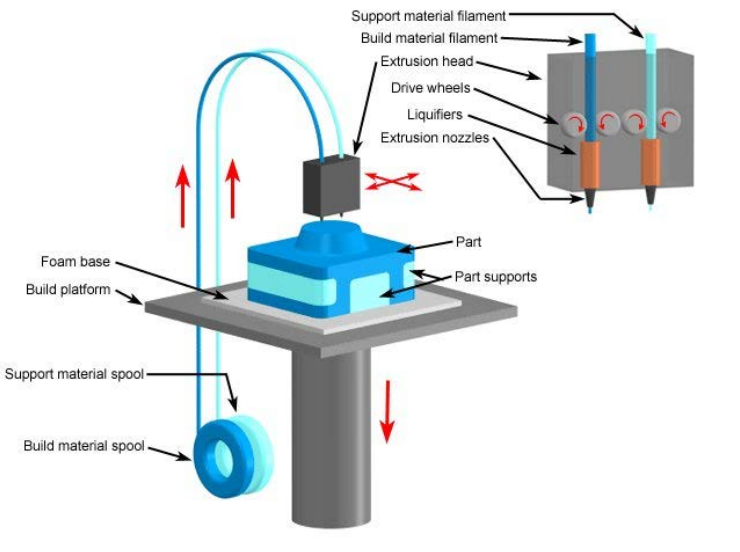


- Role of Software
  - Research, visualize and compose materials
  - Micro-structural manufacturing

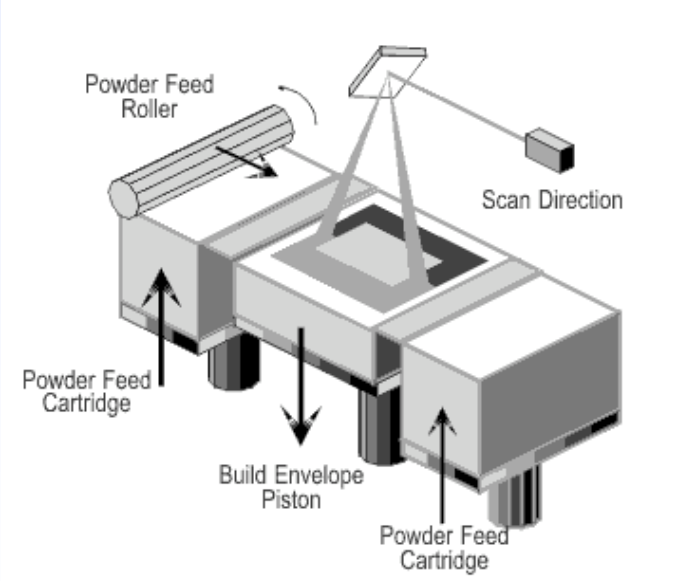


Types of Additive Manufacturing

- Polymer Spray Deposition



- Direct Metal Laser Sintering



Limits of AM

- 3D printing is not a “push button” technology
  - Post-processing needed to remove support structures,
  - Achieve certain properties that the AM process alone cannot achieve.
- Post-AM process uses conventional manufacturing processes. CNC.

Manufacturing Game Changer ?

- Traditional Economy-of-Scale Model is not relevant to 3DP/AM
  - Conventions for product selection and design for manufacturing and assembly (DFMA). NOT.
- AM Roadmap reference system
  - Production Volume: < 10k units
  - Customization
  - Complexity

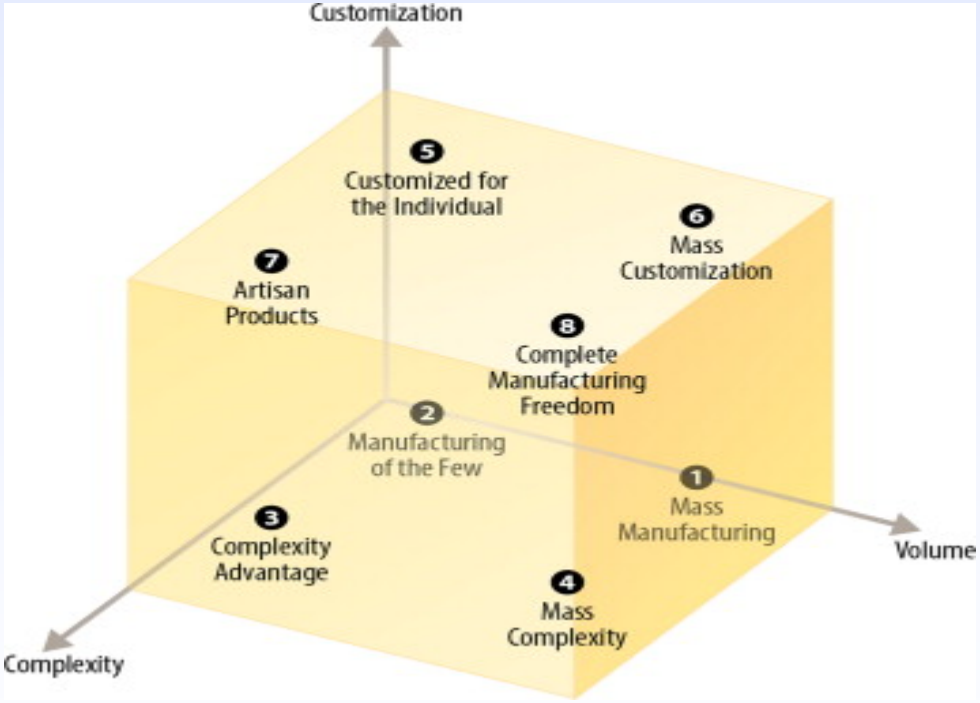
New Production Economics of AM

- Complexity. Features, the geometry and location of features.
  - The more complex the part, the more difficult it is to produce by traditional subtractive and formative means.
  - Tooling costs. Dies for Plastics Injection Molding. Stamping Dies for Automotive.
- AM: Complexity is Free

AM & Rapid Prototyping

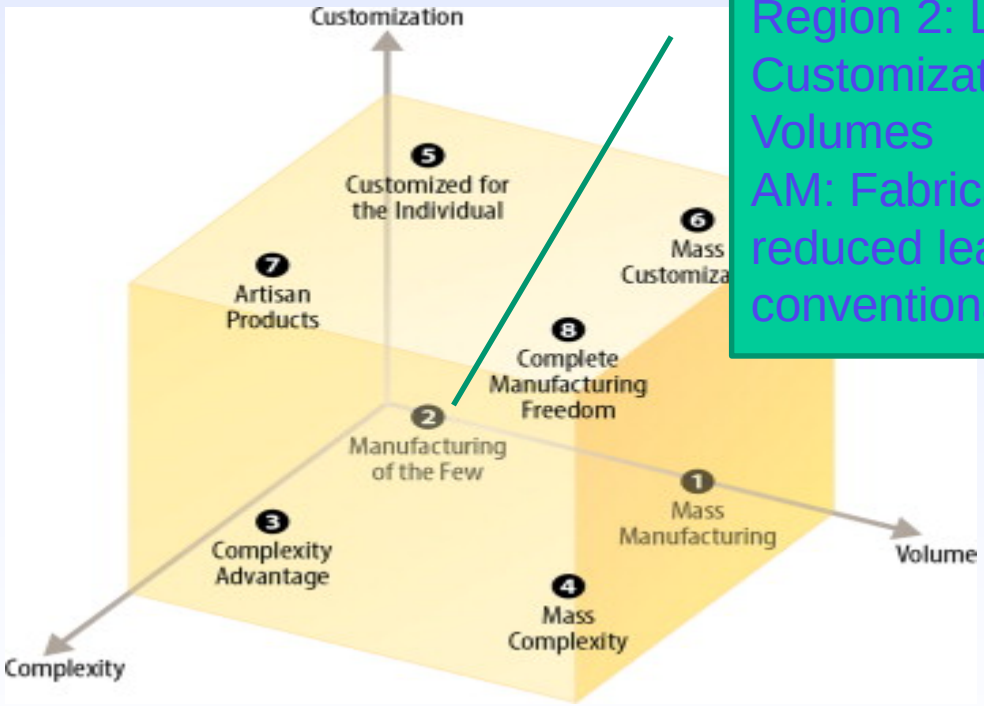
- Paradox: Lead times for tooling & fixturing longer than to make Product
  - Visual Prototyping: Support Design & Marketing
  - Functional Prototyping: Fully functioning mechanical systems. Reduced Time to Market and Eliminating Tooling & Fixturing. Guarantees final product functionality.

Additive Manufacturing Roadmap



(Conner 2014)

Additive Manufacturing Roadmap

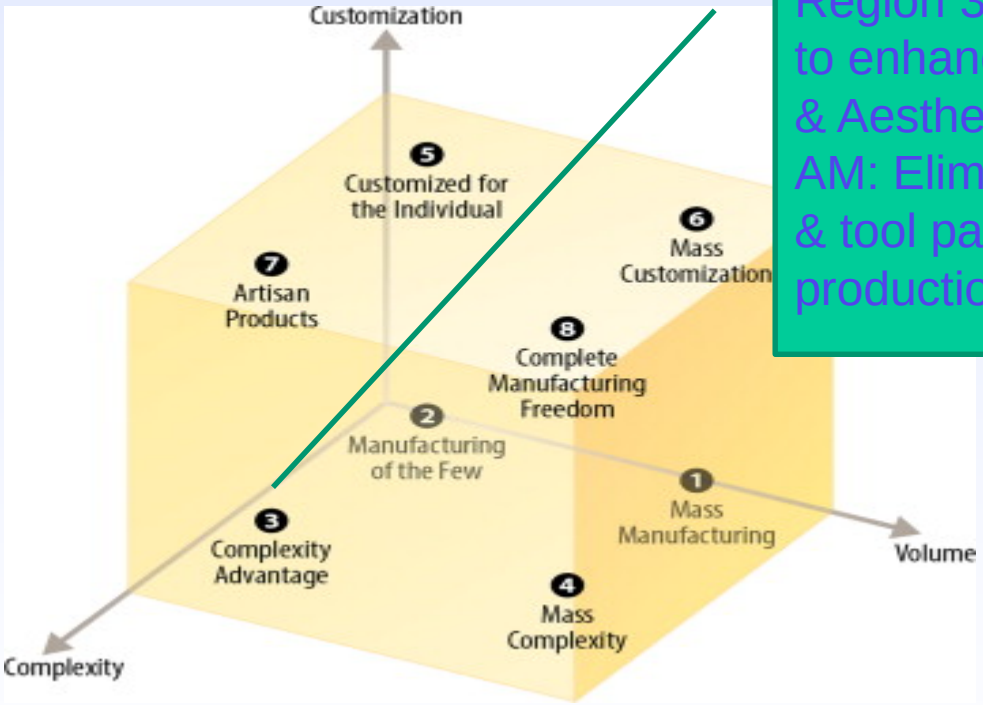


Region 2: Limited Complexity & Customization. Low Production Volumes
AM: Fabricate tooling and reduced lead times for conventional machining

Example: lower unit cost with laser sintering than injection molding

(Conner 2014)

Additive Manufacturing Roadmap

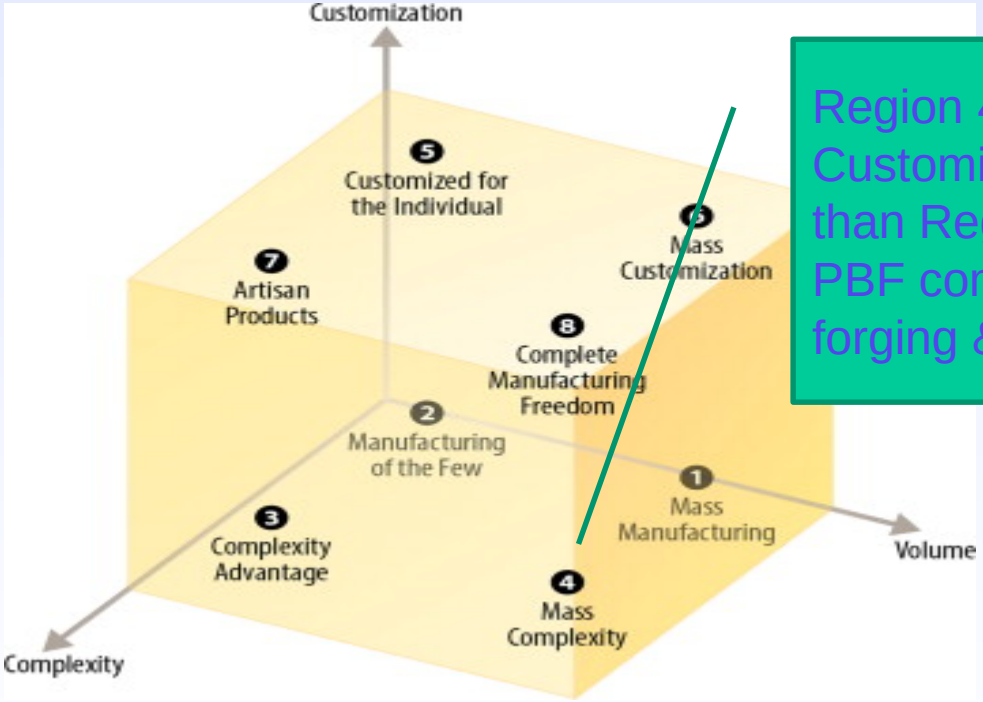


Region 3: Increased complexity to enhance product functionality & Aesthetics
AM: Eliminates machining steps & tool paths thru layer by layer production. Complexity is free.

Example: GE LEAP engine fuel nozzle.
Machining 20 titanium parts in 1 AM step.

(Conner 2014)

Additive Manufacturing Roadmap



Region 4 Complex but not Customized. Greater volume than Region 3.
PBF complex parts, eliminate forging & coating steps

Example: 400,000 hip replacements surgeries. Metal acetabular cap. Off the shelf product SML

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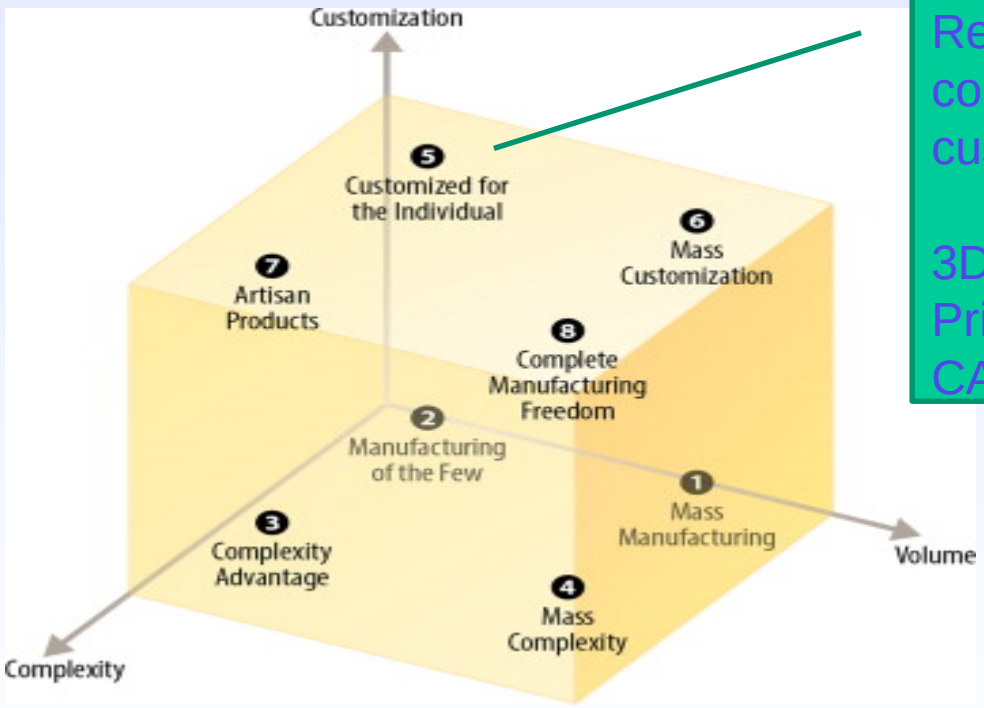
Additive Manufacturing Roadmap



Region 5. Low volume & complexity, high customization.

3DP: Most Desktop Printers. Standard CADCAM software

Examples: Personalized keychains, sports trophies. Also customized prosthetics & implants. Repair parts.

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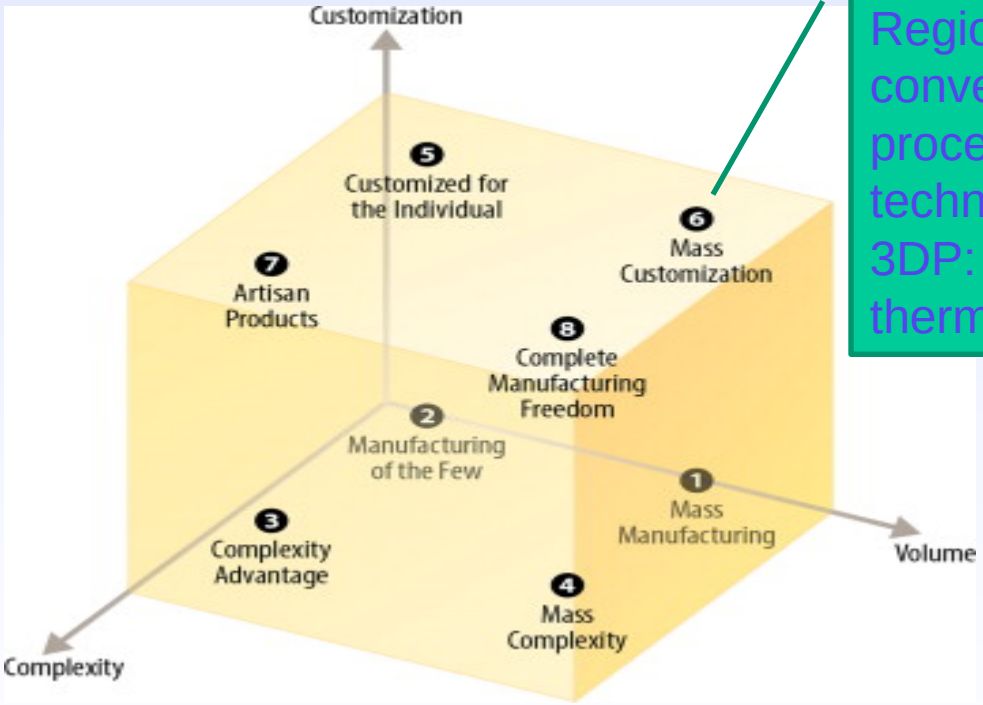
Additive Manufacturing Roadmap



Region 6. Challenging for conventional manufacturing processes. Combined technology processes. 3DP: mold making for thermoplastics

Example: Mass customization of plastic braces. Nike customized track & field spikes.

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Summary of Findings

- Moving AM into Mainstream Manufacturing has technical and business barriers
- Canada has a loosely coupled system without Central Focus
- Present policy will not likely see significant increase in Manufacturing Capacity
- There is a misalignment of Actors: Colleges, Universities, SMEs, Large Firms & Public Labs