BS'20 & ViNOrg'20

Smart Additive Manufacturing: the path to digital chain

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Research Structure

1. Digital Manufacturing

2. Smart Manufacturing & Smart Additive Manufacturing

3. Smart Additive Manufacturing & Smart Factories

4. Smart Additive Manufacturing & Digital Value Chain

1. DIGITAL MANUFACTURING

2. SMART MANUFACTURING & SMART AM

2.1 SMART MANUFACTURING

- Internet-connected machinery to monitor the production process
- Automating operations and use data analytics to improve manufacturing performance
- Deployments involve embedding sensors

2. SMART MANUFACTURING & SMART AM

2.1 SMART MANUFACTURING | TECHNOLOGIES

- Internet of Things
- Artificial intelligence/machine learning
- Drones and driverless vehicles
- Blockchain
- Edge computing
- Predictive analytics
- Digital twins

2. SMART MANUFACTURING & SMART AM

2.1 SMART MANUFACTURING | BENEFITS

- Improved efficiency
- Increased productivity
- Long-term cost savings
- long-term competitiveness by optimizing labor, energy, and material

2. SMART MANUFACTURING & SMART AM

2.1 SMART MANUFACTURING | SIX PILLARS

1. Manufacturing technology and processes,
2. Materials,
3. Data,
4. Predictive engineering,
5. Sustainability and resource sharing
6. Networking.

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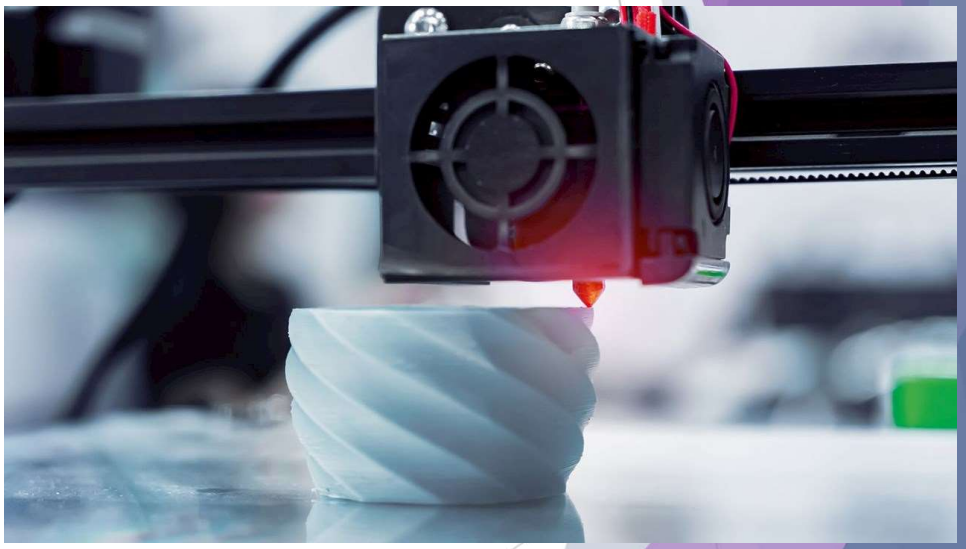
2. SMART MANUFACTURING & SMART AM

2.2 ADDITIVE MANUFACTURING

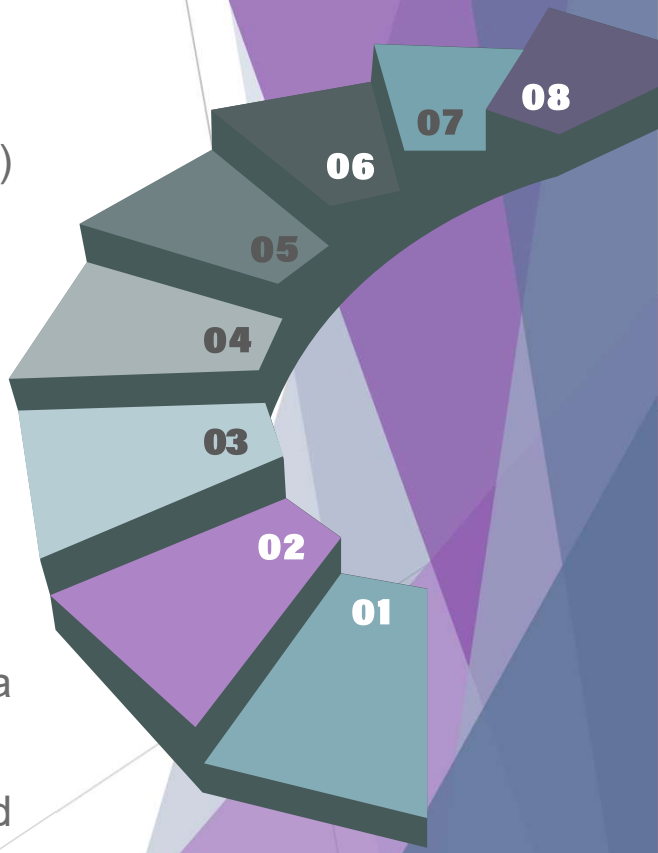
- Various structures and complex components.
- Charles Hull (1986) - Stereolithography(SLA) process
- Main Benefits: mass-customized production, prototyping, sustainable production, and minimized lead time and cost
- New Developments: bioprinting, four-dimensional (4D) printing, nano-scale, and metamaterials printing



2. SMART MANUFACTURING & SMART AM

2.2 ADDITIVE MANUFACTURING | PROCESS

1. Prepare the solid model through a Computer-aided Design (CAD) software or a scanning device.
2. Convert the CAD file into the STL file format
3. Transfer the STL file to the AM machine language (called G-Code)
4. Set the printing parameters on the 3D printer
5. Build the part layer by layer
6. Remove the part from the machine build plate.
7. Complete the extra post-processing step to clean the part and extra support material.
8. Obtain the final product using machining, grinding, painting, and assembly with other components.



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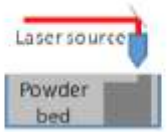
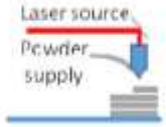
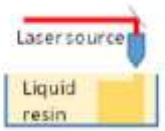
2. SMART MANUFACTURING & SMART AM

2.2 ADDITIVE MANUFACTURING | PROCESSES

Table 1 Additive manufacturing process categorization

Additive Manufacturing (AM) Processes												
Process	Laser Based AM Processes						Extrusion Thermal		Material Jetting		Material Adhesion		Electron Beam	
	Laser Melting				*Laser Polymerization*									
Process Schematic														
Name / Material	SLS		DMD		SLA		FDM		3DP		LOM		EBM	
	SLM		LENS		SGC		Robocasting		IJP		SFP			
	DMLS		SLC		LTP				MJM					
			LPD		BIS				BPM					
					HIS				Thermojet					
Bulk Material Type			Powder		Liquid		Solid							

Source: Additive manufacturing methods and modelling aproaches: a critical review, H. Bikas1 & P. Stavropoulos1,2 & G. Chryssolouris1

2. SMART MANUFACTURING & SMART AM

2.2 ADDITIVE MANUFACTURING | FREEDOMS

- Freedom of shape and design complexity.
- Freedom of scale.
- Freedom from highly skilled labor.
- Freedom from material constraints and changes.

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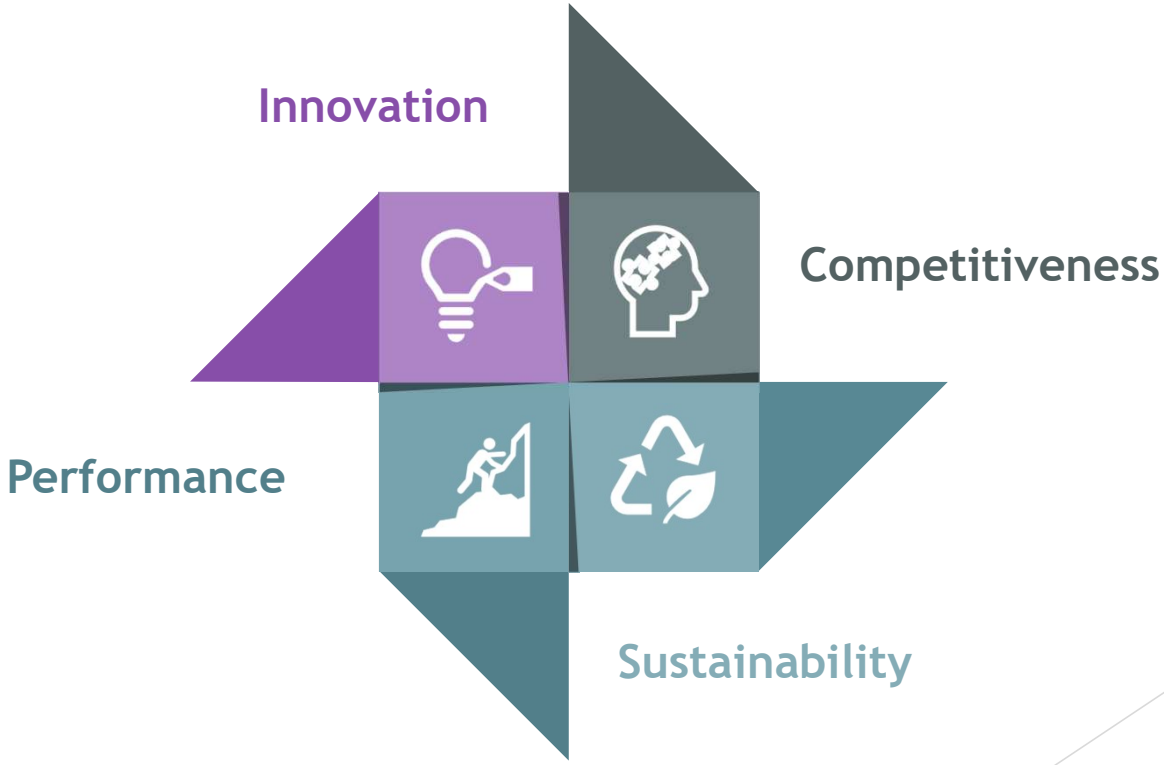
2. SMART MANUFACTURING & SMART AM

2.2 ADDITIVE MANUFACTURING



2. SMART MANUFACTURING & SMART AM

2.2 ADDITIVE MANUFACTURING | SOME CONCLUSIONS

- Time to market, flexibility, personalization and responsiveness
- Producing pieces with complex, creative and exclusive designs
- The cost, speed and massification of production are aspects still to be improved
- Although still in an early stage of research, 4D printing has the potential to transform various industries, from construction to fashion, and also in the health area.
- 4D printing will help create new categories of equipment, such as so-called soft robotics that do not require electrical components

2. SMART MANUFACTURING & SMART AM

2.3 SMART ADDITIVE MANUFACTURING

AM can be a vital component of industry4.0 or smart manufacturing due to:

a. its high capability as a non-traditional manufacturing approach for mass customization.

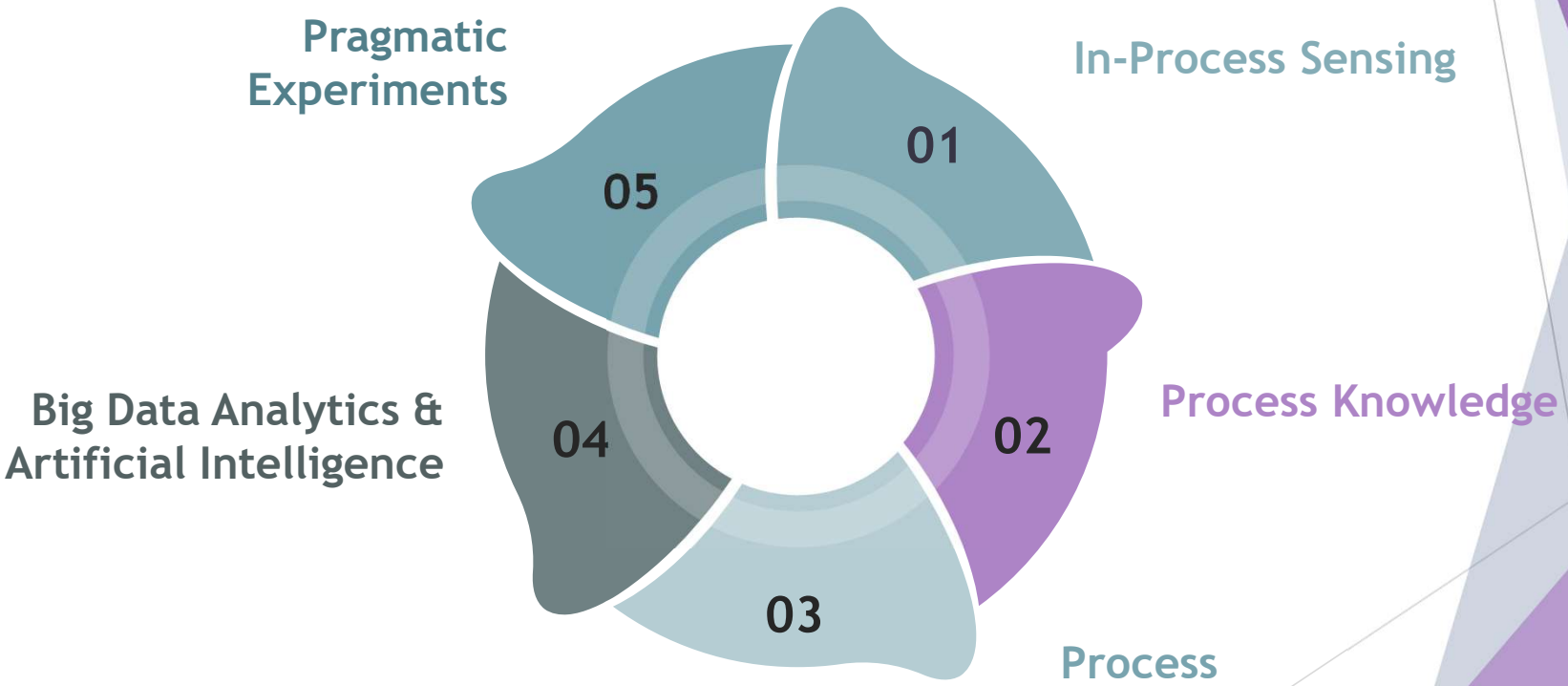
b. Its numerous benefits, such as time and material saving, rapid prototyping, high efficiency, and decentralized production methods

c. the AM processes are computer-controlled and it is possible to control an unlimited number of machines from a computer at once

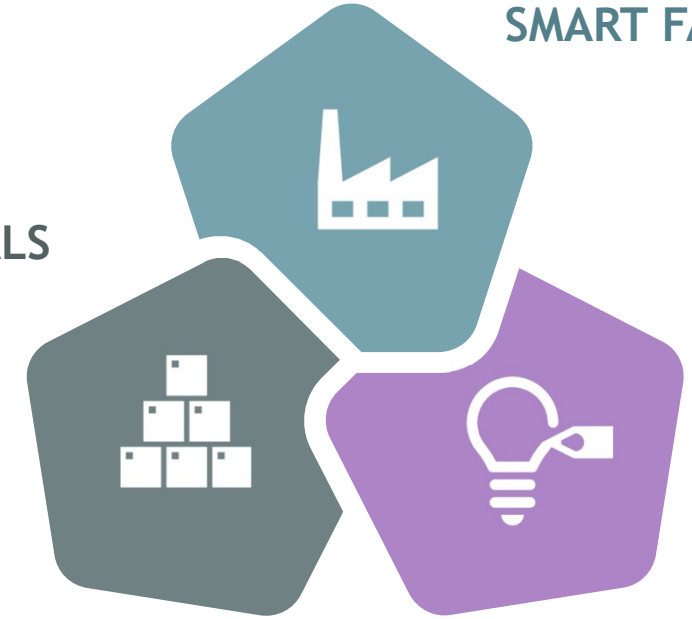
d. In addition to that digitization helps in continuous monitoring of feedstock monitoring, supply evaluation, and availability of machines for a fabrication process.

2. SMART MANUFACTURING & SMART AM

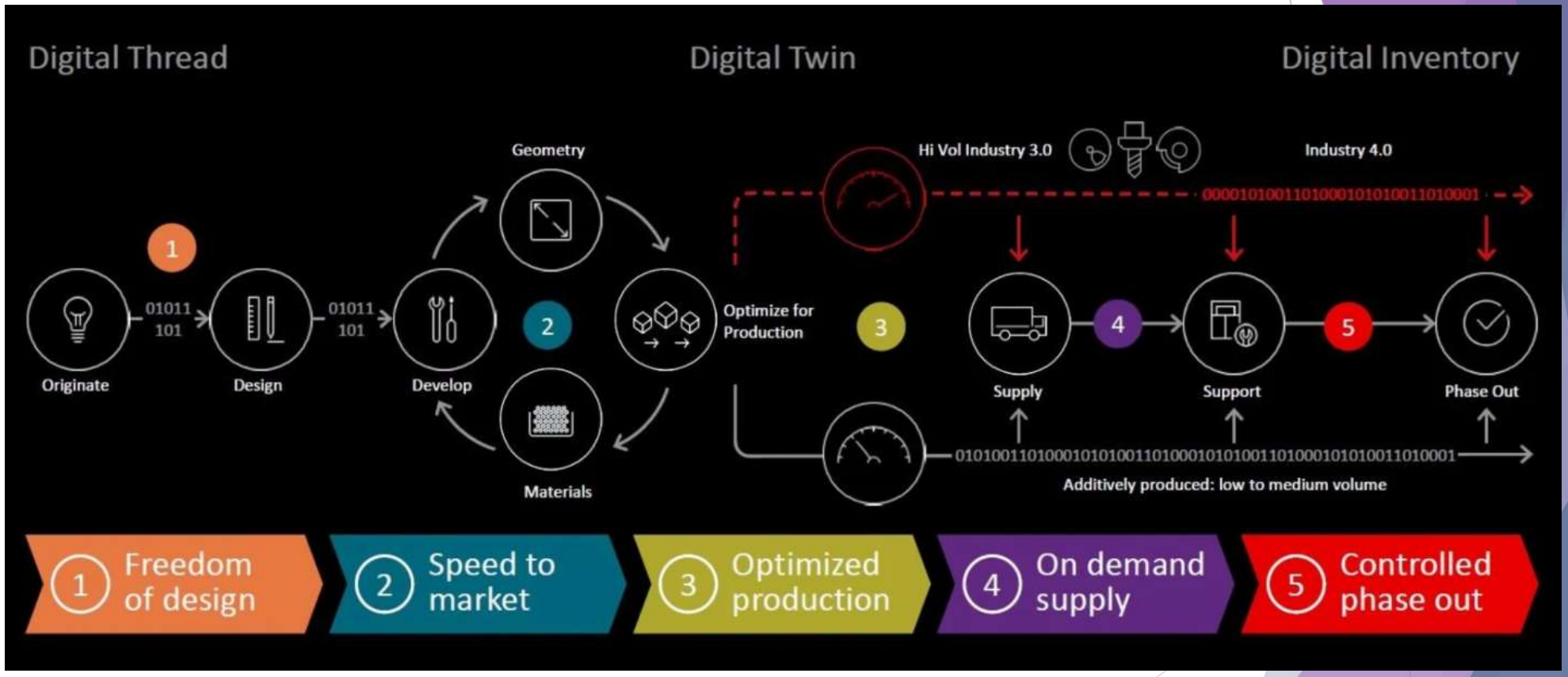
2.3 SMART ADDITIVE MANUFACTURING | FIVE FUNDAMENTAL ASPECTS



3. SMART ADDITIVE MANUFACTURING & SMART FACTORIES



4. SMART ADDITIVE MANUFACTURING & DIGITAL VALUE CHAIN



Source: Smarter Manufacturing: Additive Manufacturing and the Digital Value Chain > ENGINEERING.com

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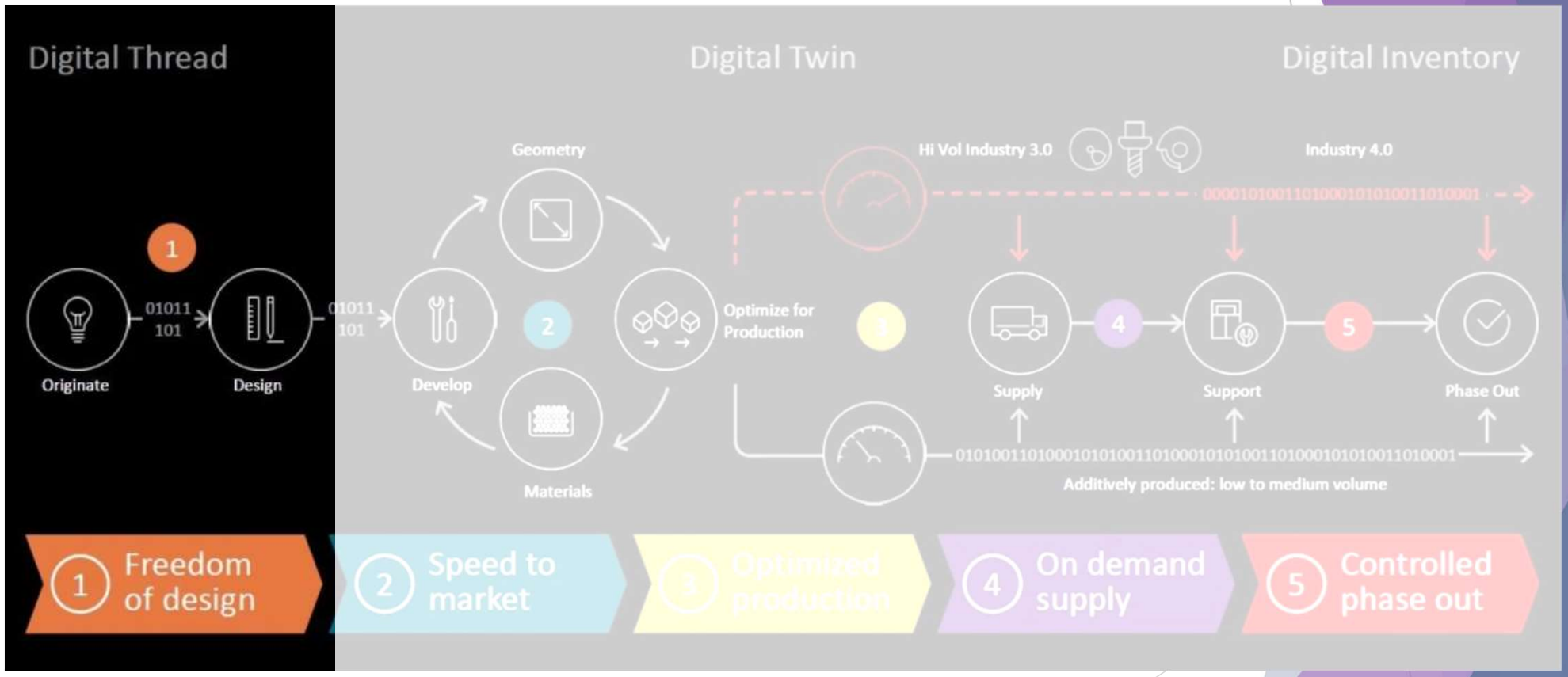

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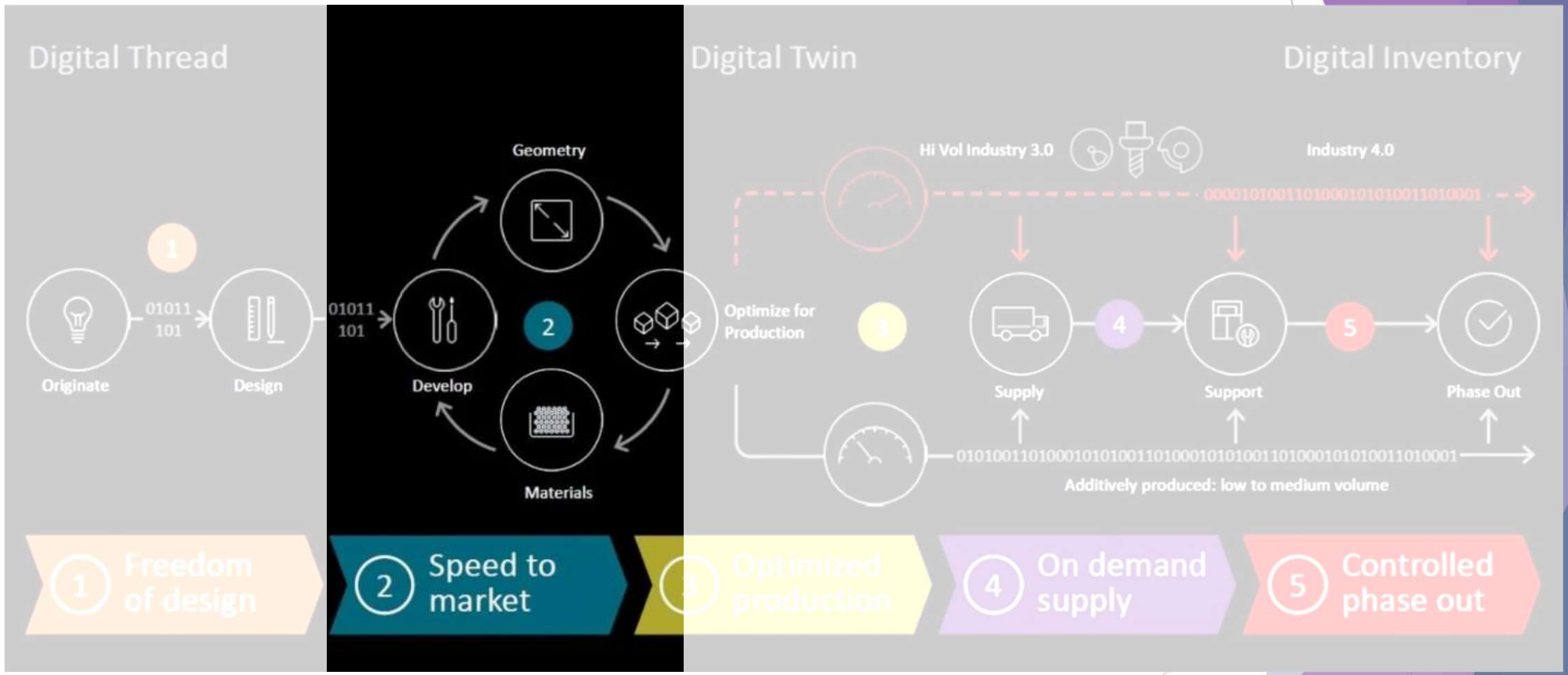

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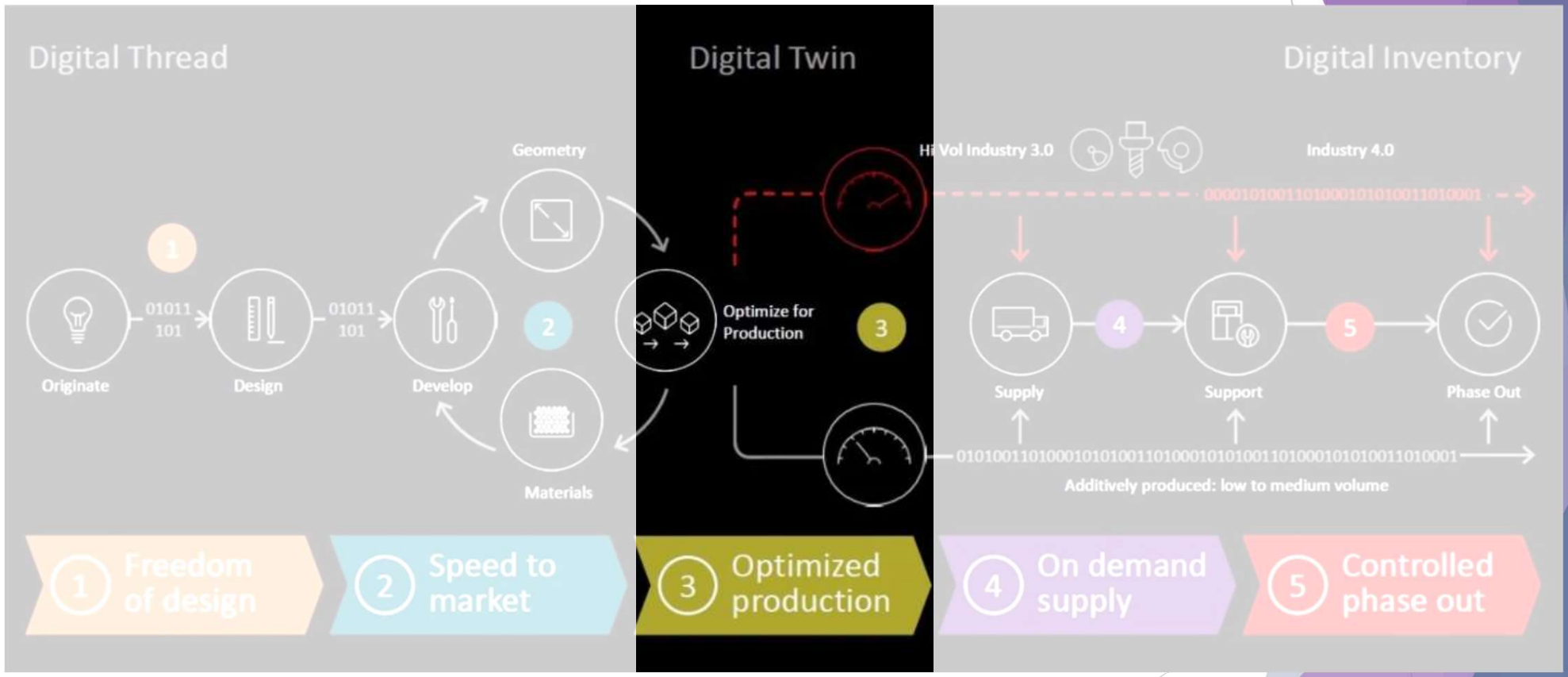

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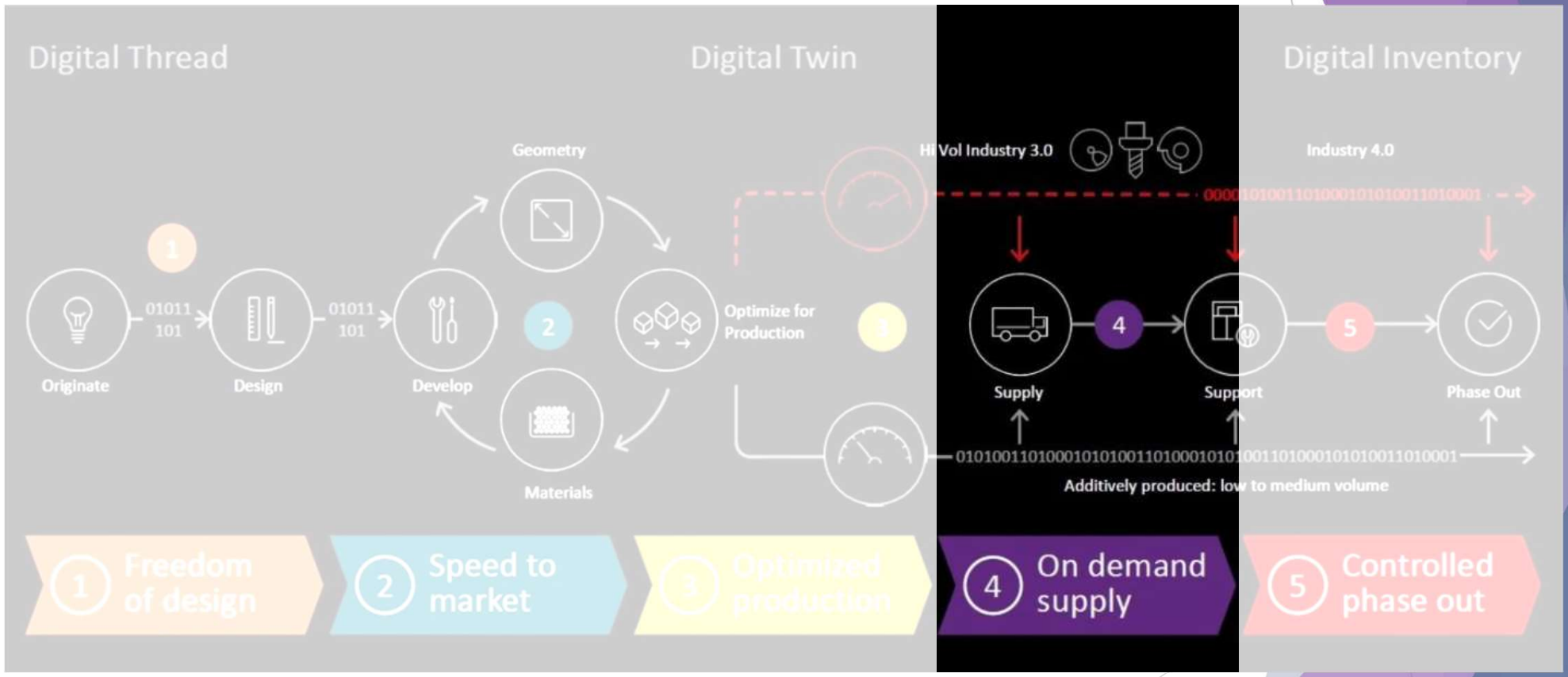

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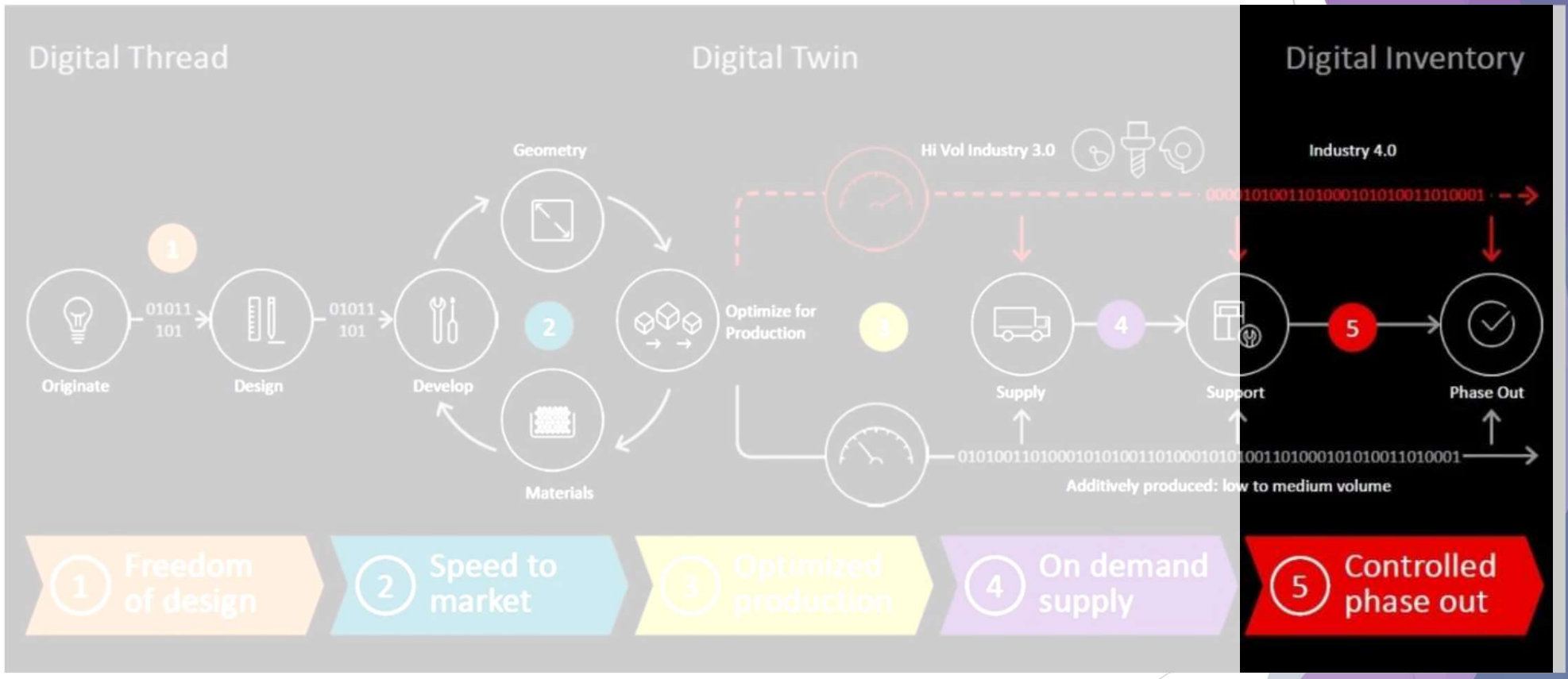

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5. SOME CONCLUSIONS

- When considering the value that AM could add to your manufacturing business, look beyond the four walls of the manufacturing department. The technology enables a new way of thinking about the entire product lifecycle, from design to spare parts.

- additive manufacturing and the digital thread represents a better way to make better parts, and is an excellent example of how 3D printing technology is maturing, becoming an effective part of the manufacturing landscape.

- Today, additive manufacturing has removed manufacturability constraints, changing the way manufacturers think about product lifecycle and ultimately bringing these better, more effective parts to market.

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THANKS FOR YOUR ATTENTION

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