

# Capabilities to support technology adoption

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# “Exploring the adoption of CPS technologies in UK aerospace manufacturing”

- ▶ Aerospace industry has high reliance on technology advancements
  - Constant focus on speed and fuel-efficiency
- ▶ In the era of Industry 4.0, technology adoption is inevitable
  - Technologies with increasing complexities and interconnectivity
  - Different sets of capabilities required
- ▶ Why aerospace manufacturing in the UK?

£31.1 billion

£27 billion exports earnings

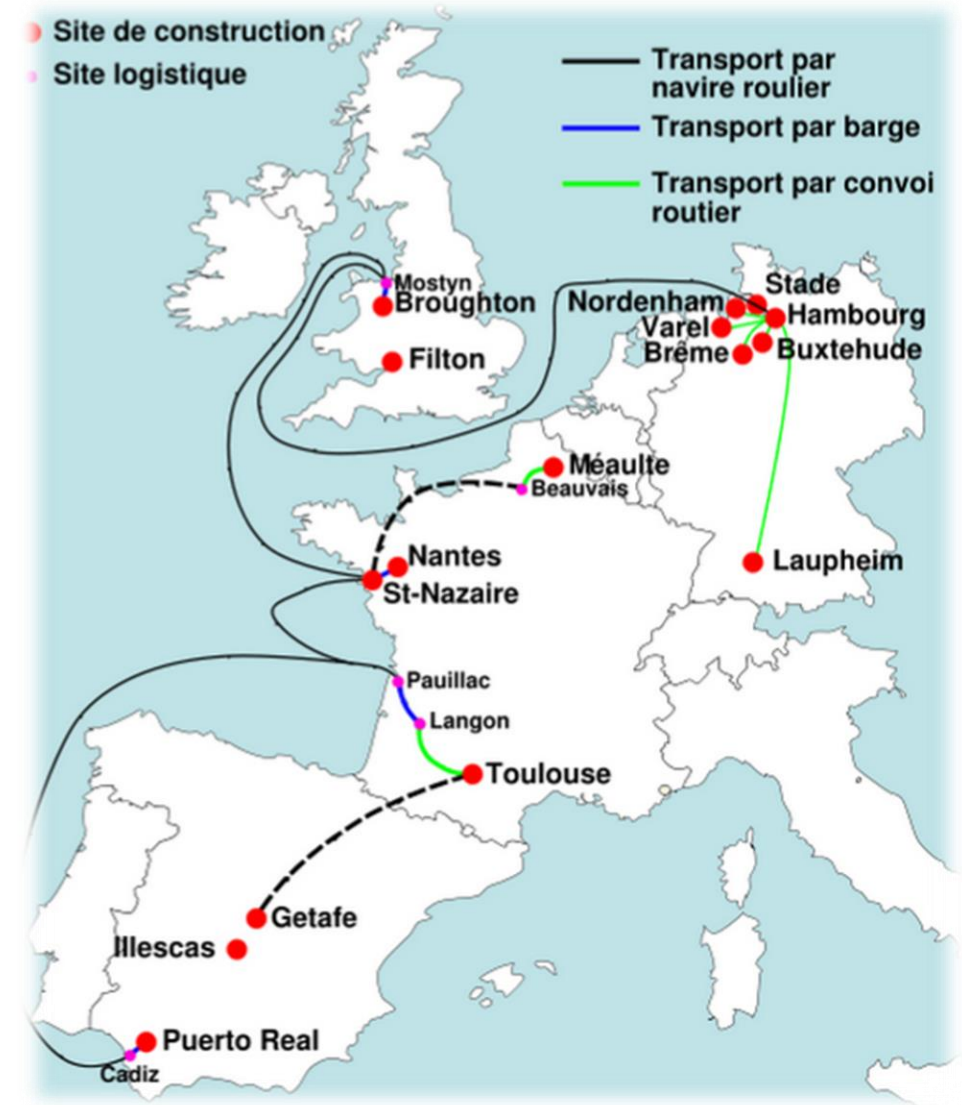
128,300 direct jobs

153,900 indirect jobs

(AGP, 2016)

# 3 key challenges..

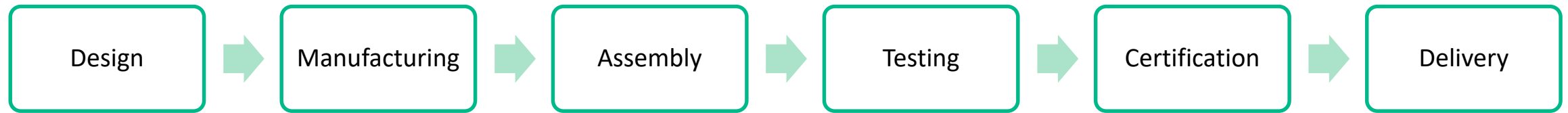
- ▶ Technology – regulatory and industry certification requirements
- ▶ Funding – long development cycle
- ▶ Market – new entrants from emerging economies



# Additional challenge in supply chain management..

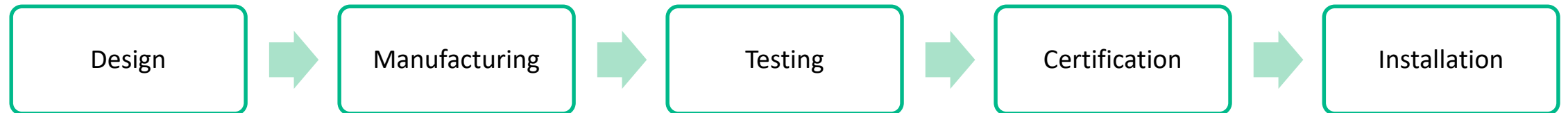
## *Manufacturing Process 1*

*Design to delivery*

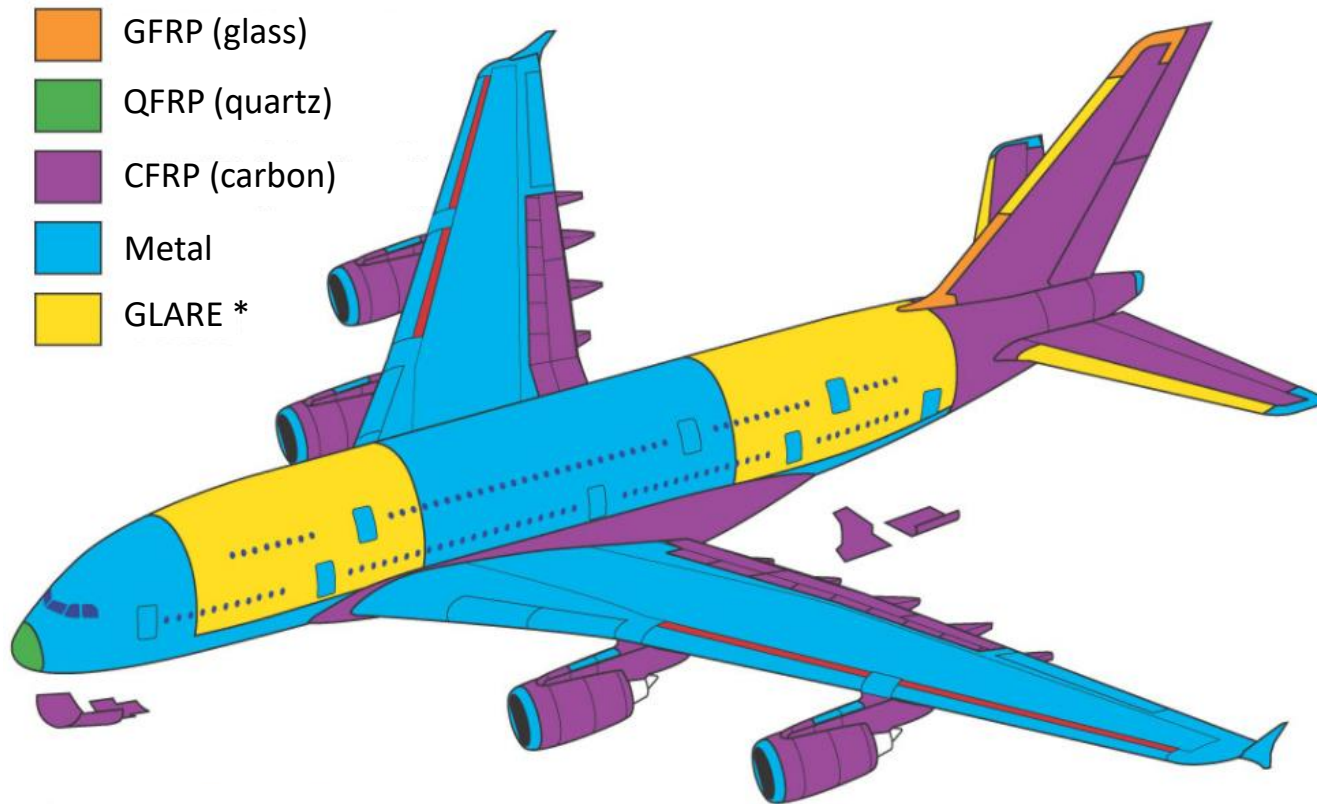


## *Manufacturing Process 2*

*In-service aircraft throughout its useful life*

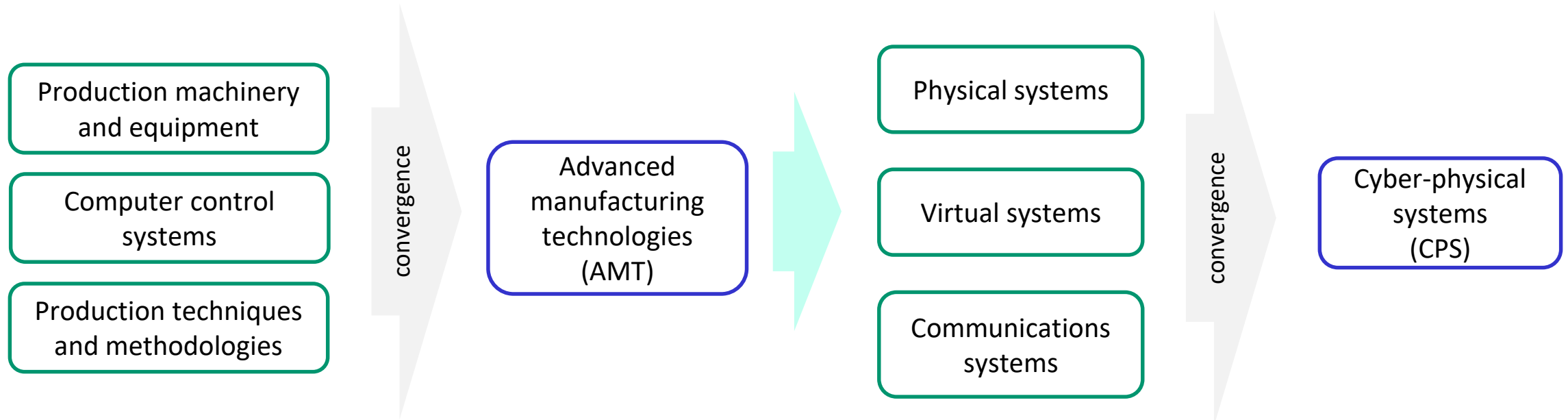


# Some advanced technologies in use in aerospace manufacturing..

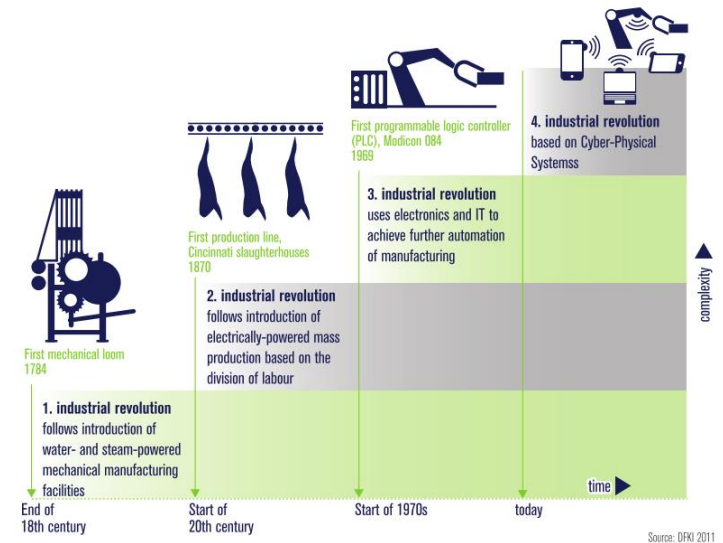
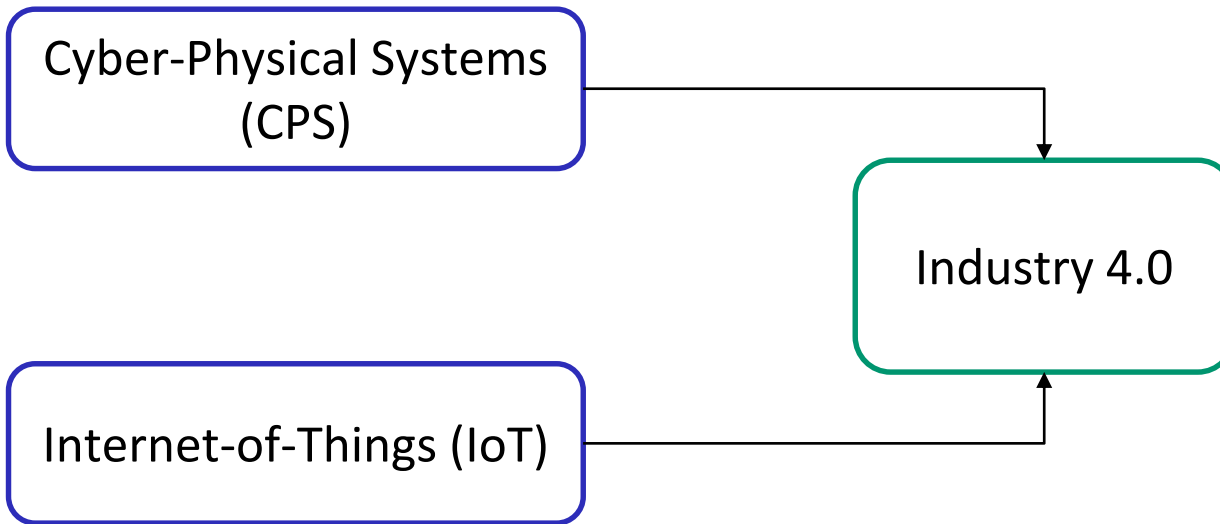


# A tale of evolution..

*From AMT to CPS*

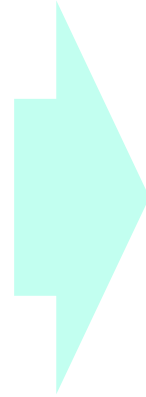


# One of 2 key components of Industry 4.0..



# Some theoretical context..

***4 initial categories of CPS***



Design

CAD, CAM, CAE, CAPP

Manufacturing

Industrial robots, RTPCS, FMS, CNC, AMHS, ECS, AutoID, KBS, DSS, MRP, MRPII, ERP, 3DP

Administrative

OA, ABC, data analytics

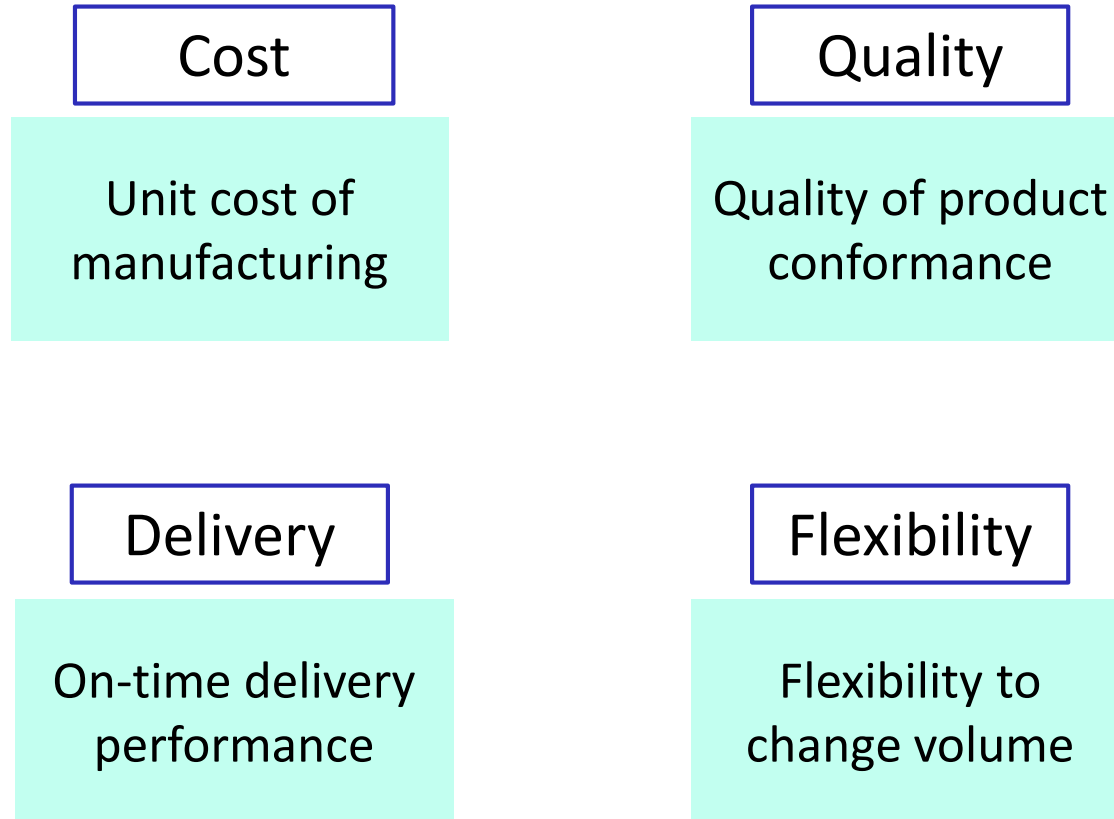
Connectivity

Intra-company computer network, wireless communication, cloud computing

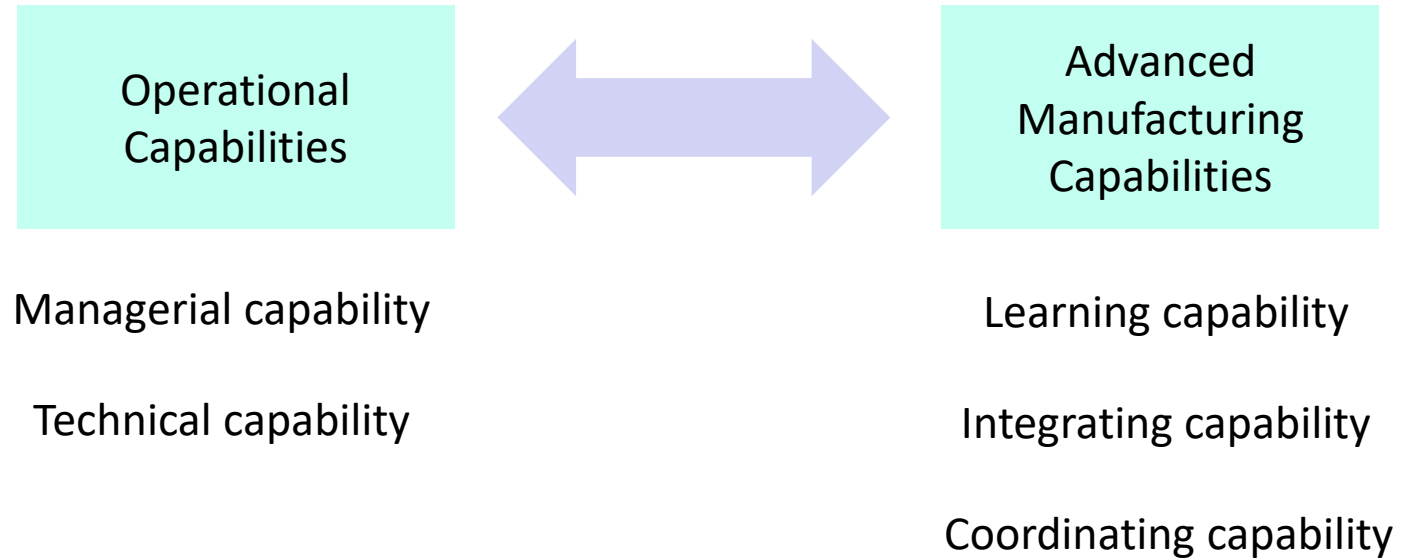




# What do we mean by operational performance?



# Capabilities to match CPS technologies adoption..



# Describing Advanced Manufacturing Capabilities (AMC)...



## Learning

*The ability to acquire, assimilate, transform, and exploit knowledge.*



## Integrating

*The ability to combine individual knowledge by contributing, representing, and interrelating individual input to the entire business unit.*



## Coordinating

*The ability to orchestrate and deploy tasks, resources, and activities.*



# Describing Operational Capabilities (OC)...



## Managerial

*The ability to administer operational activities by monitoring and reporting progress, designing incentives, and managing conflicts*

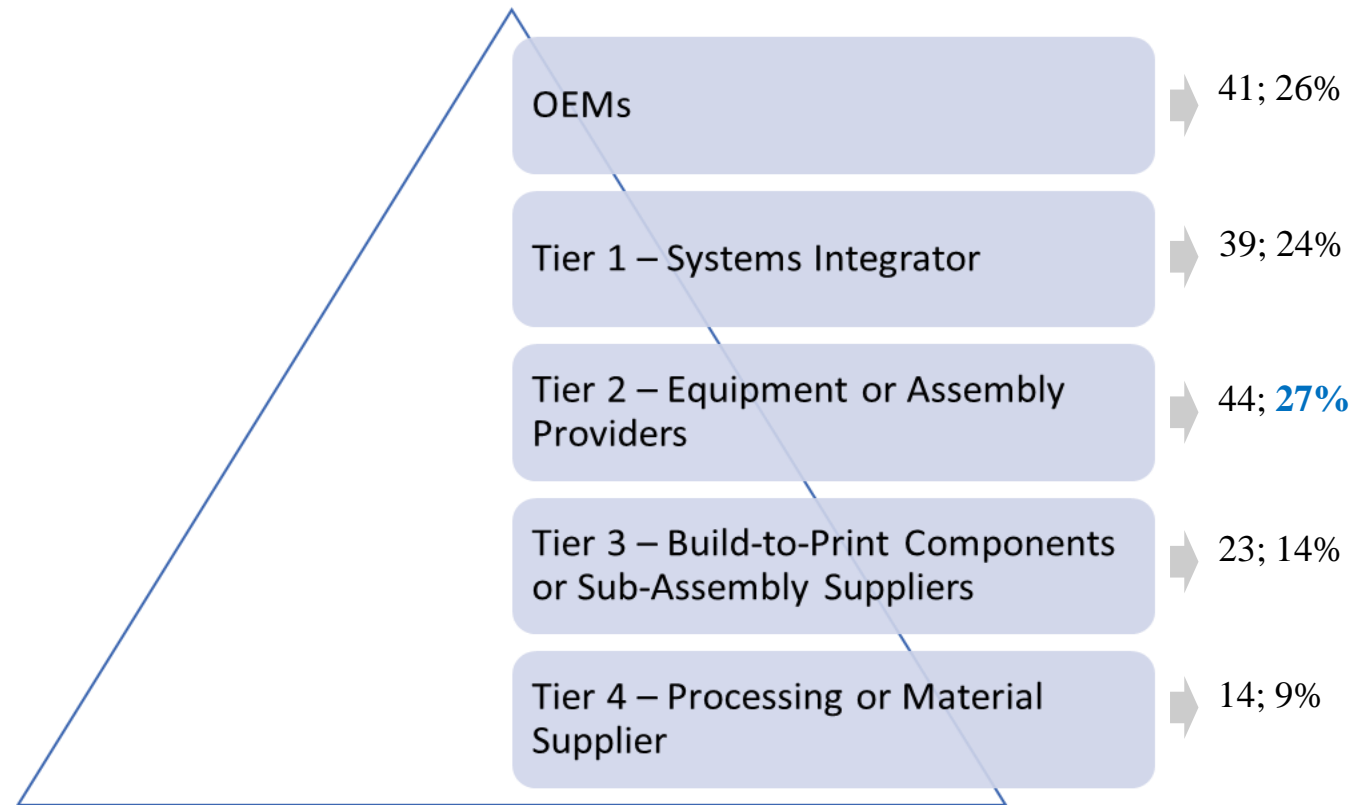


## Technical

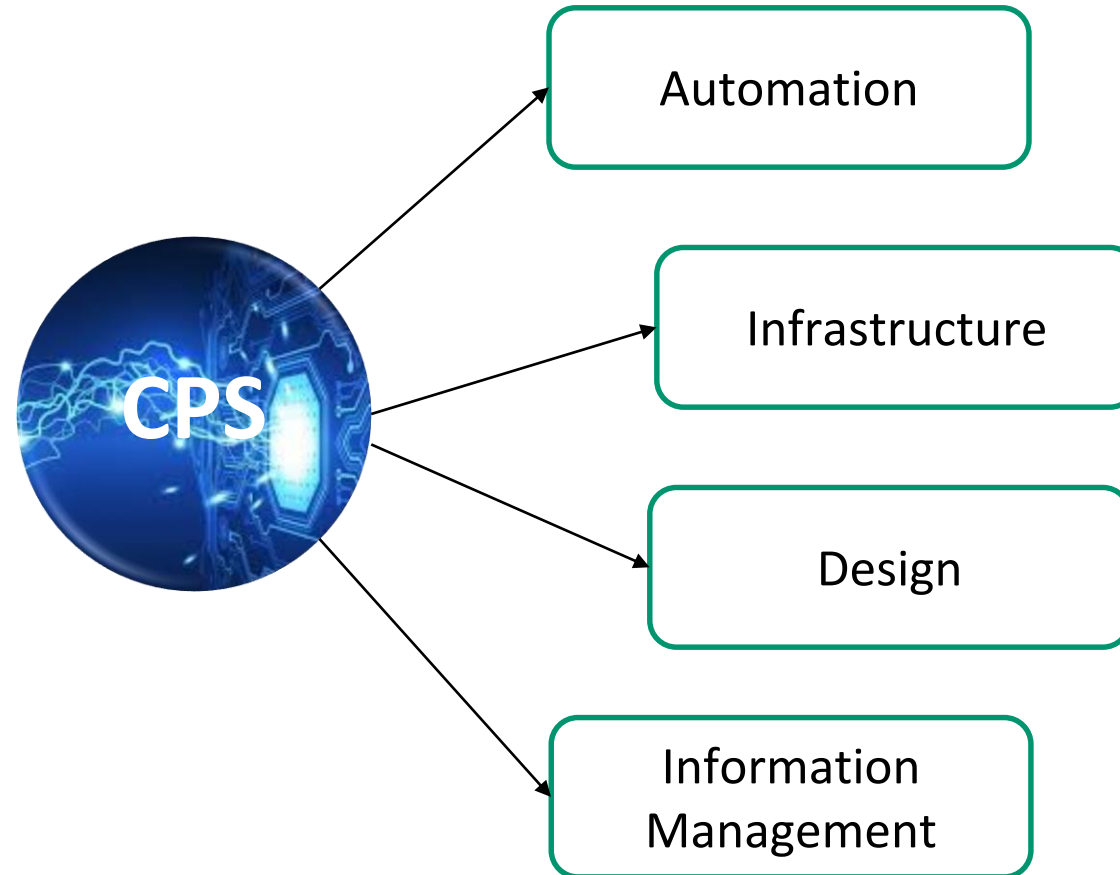
*The ability to deploy manufacturing technologies and accumulate technical knowledge in the process*



# 161 UK aerospace manufacturers participated in the study..



# Revised categories of CPS technologies emerged...



*Merging of physical, virtual, and communication technologies remains..*

# Automation CPS..

*Examples.... Automated Material Handling System, Flexible Manufacturing System, 3D Printing, Industrial Robots, Data Analytics, Cloud Computing*



Reduce direct and indirect labour

Minimise rework and inspection

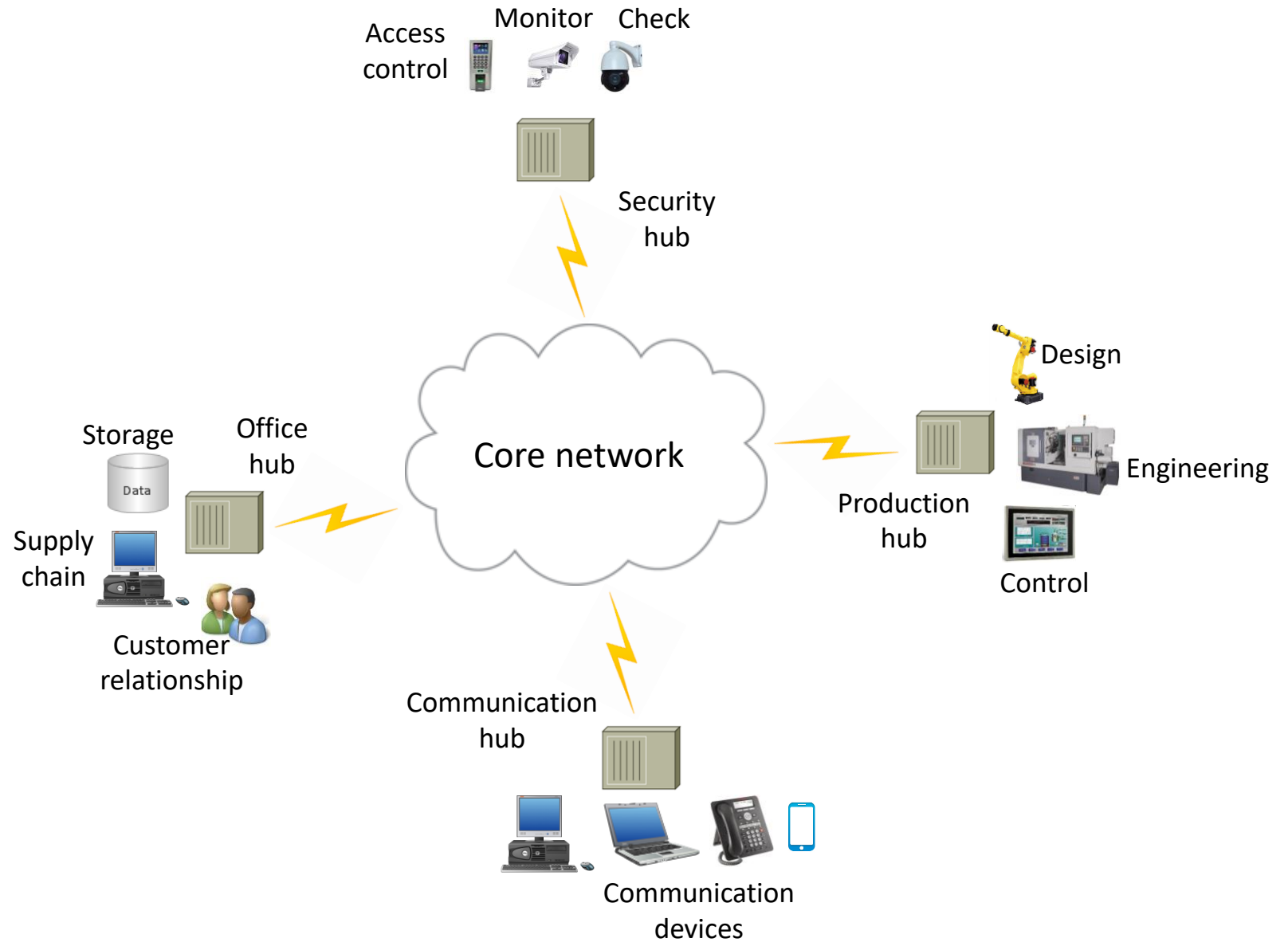


Improve manufacturing planning and control



# Infrastructure CPS..

*Examples....  
Office Automation,  
Activity-Based Costing,  
Intra-Company  
Computer Networks,  
Wireless  
Communication*

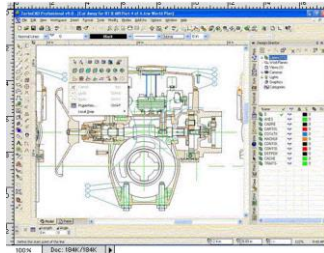




# Design CPS..

*Examples... Computer-aided Design (CAD), Computer-aided Manufacturing (CAM), Computer-aided Engineering (CAE)*

CAD



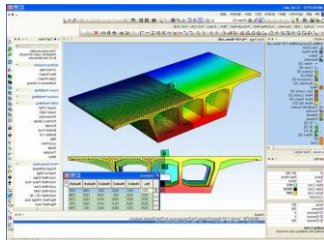
Reduce the need for prototypes

CAM



Enable rigorous design testing

CAE



Allow early detection of product failures



# Information Management CPS..

*Examples.... Enterprise Resource Planning (ERP), Material Requirements Planning (MRP), and Manufacturing Resource Planning (MRPII)*

MRP

ability to view a master production schedule, supported by bill of material files that identify specific materials needed to produce each finished item

MRPII

integrated in the manufacturing process with MRP, enabling firms to adjust production and inventory systems to address volume and delivery timing changes

ERP

provide information about all the functions within a firm through a single system



# ***Infrastructure CPS adoption at low capabilities results in decreased operational performance...***

*Low capabilities*



*adoption of Infrastructure CPS*



*operational performance*

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*High capabilities*



*adoption of Infrastructure CPS*



*marginal increase in operational performance*

*Examples....*

*Office Automation, Activity-Based Costing, Intra-Company  
Computer Networks, Wireless Communication*

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# ***Design CPS adoption at low capabilities leads to significant reduction in operational performance...***

*Low capabilities*



*adoption of Design CPS*



*operational performance*

*High capabilities*



*adoption of Design CPS*



*marginal increase in operational performance*

*Examples.... Computer-aided Design (CAD), Computer-aided Manufacturing (CAM), Computer-aided Engineering (CAE)*



***Information Management CPS adoption at low capabilities increases operational performance tremendously!***

*Low capabilities*



*adoption of Information Management CPS*



*operational performance*



*High capabilities*



*adoption of Information Management CPS*



*marginal increase in operational performance*

*Examples.... Enterprise Resource Planning (ERP), Material Requirements Planning (MRP), and Manufacturing Resource Planning (MRPII)*



**Automation CPS adoption increases operational performance significantly *regardless* of levels of capabilities...**

*Low capabilities*



*adoption of Automation CPS*



*operational performance*

*High capabilities*



# Some suggestions...

		<i>Capabilities</i>	
		<i>Low</i>	<i>High</i>
<i>CPS categories</i>	<b>Information Management</b>	Highly recommended	Adopt with caution
	<b>Design</b>	Not recommended	Adopt with caution
	<b>Infrastructure</b>	Not recommended	Recommended
	<b>Automation</b>	Highly recommended	

*Improve operational performance through CPS adoption*

