# Capabilities to succeed in the digital age

**Supply Chains in Practice Networking Event**
**11th June 2018**

WMG
THE UNIVERSITY OF WARWICK

# Join the discussion…

#SCinPractice

@WMGSupplyChain

@wmgwarwick

@JanGodsell

Connect to wifi network - Warwick Guest

# 2 perspectives…

- Capabilities to support
  - Technology adoption, Dr. Sha Abubakar, WMG
  - SME growth, Zakiah Suhaimi, WMG

- Case studies
  - Low cost digitisation at AVPE, Mark Summers, AVPE
  - R&D programme for the digital age, Kostas Efthymiou, Meggitt

# Capabilities to support technology adoption

Dr. Sha Abubakar, WMG

# “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?

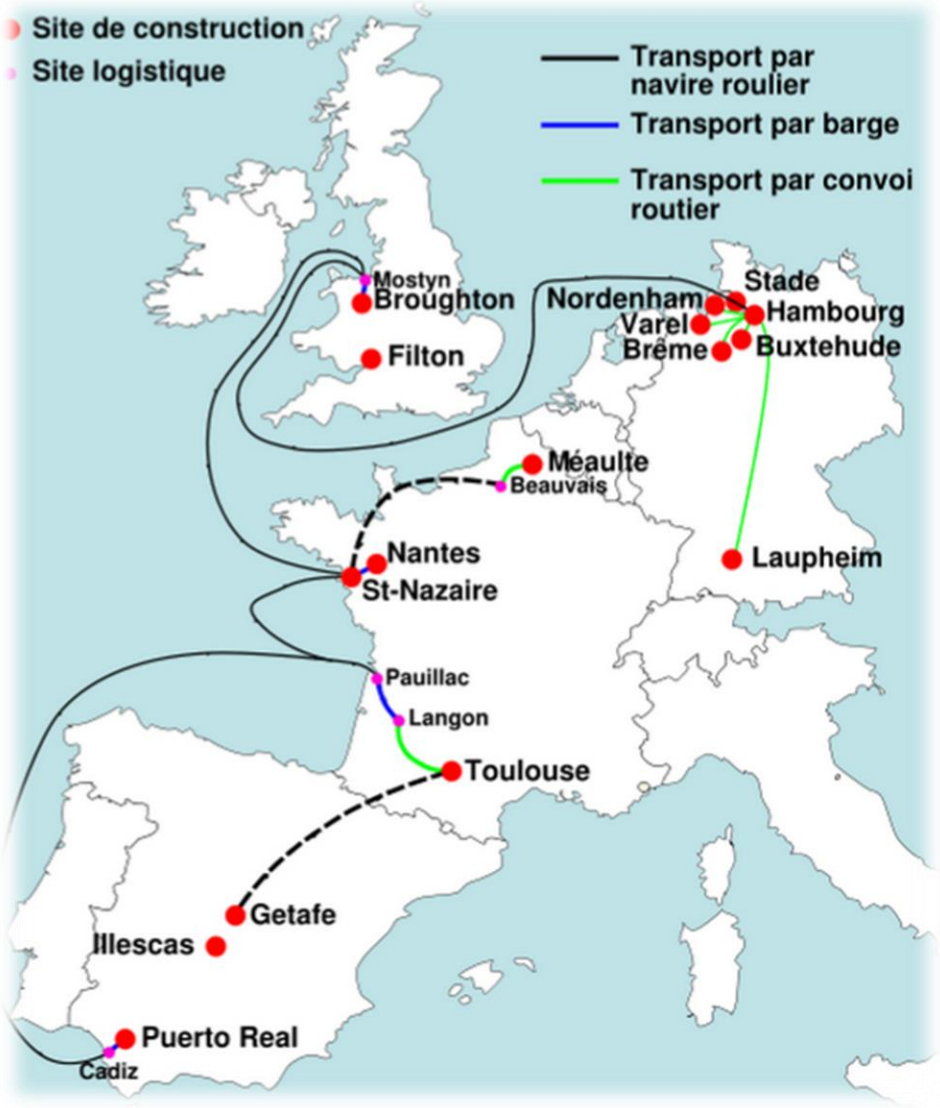
£31.1 billion

| | |
|---|---|
| £27 billion | exports earnings |
| 128,300 | direct jobs |
| 153,900 | indirect jobs |

(AGP, 2016)

# 3 key challenges..

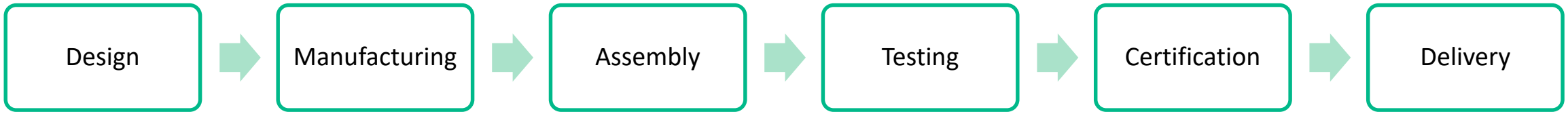
- Technology – regulatory and industry certification requirements
- Funding – long development cycle
- Market – new entrants from emerging economies



# Additional challenge in supply chain management..

## *Manufacturing Process 1*

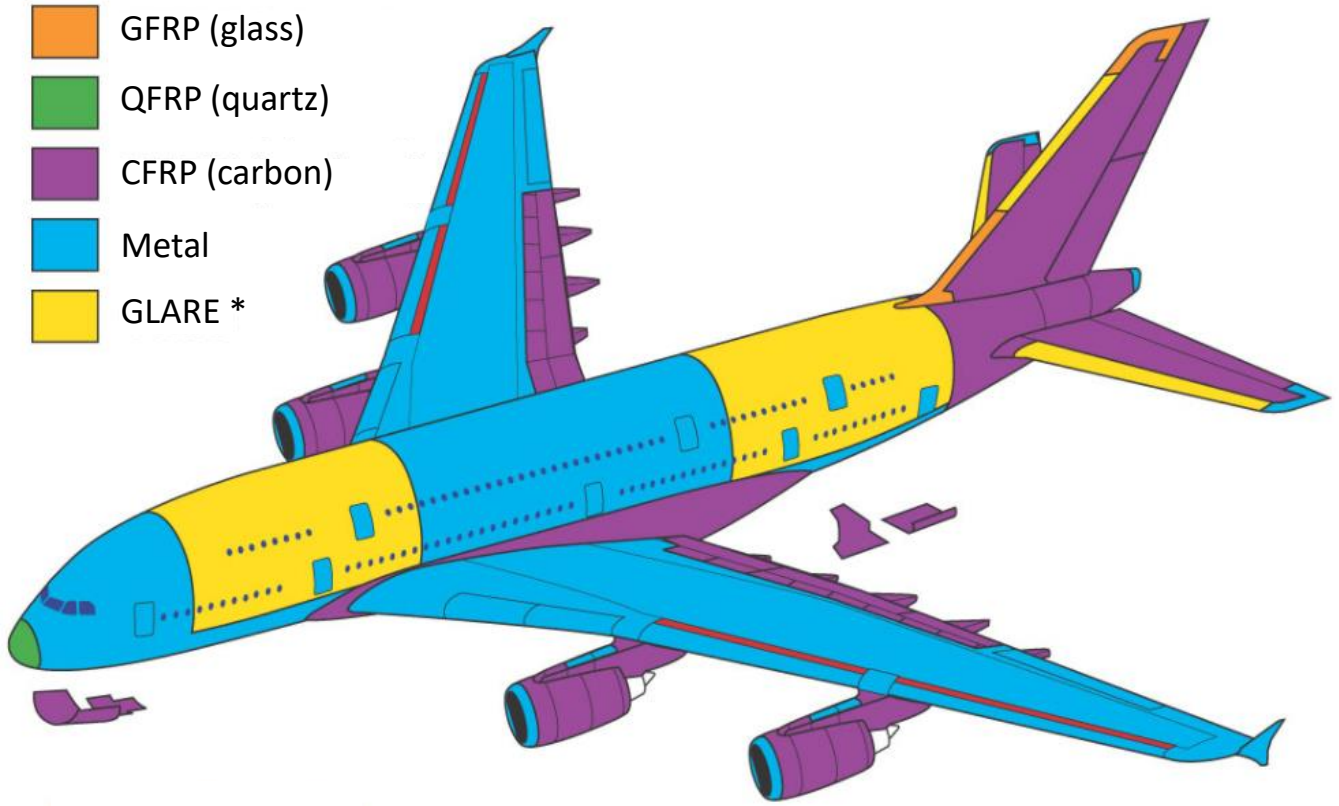
*Design to delivery*



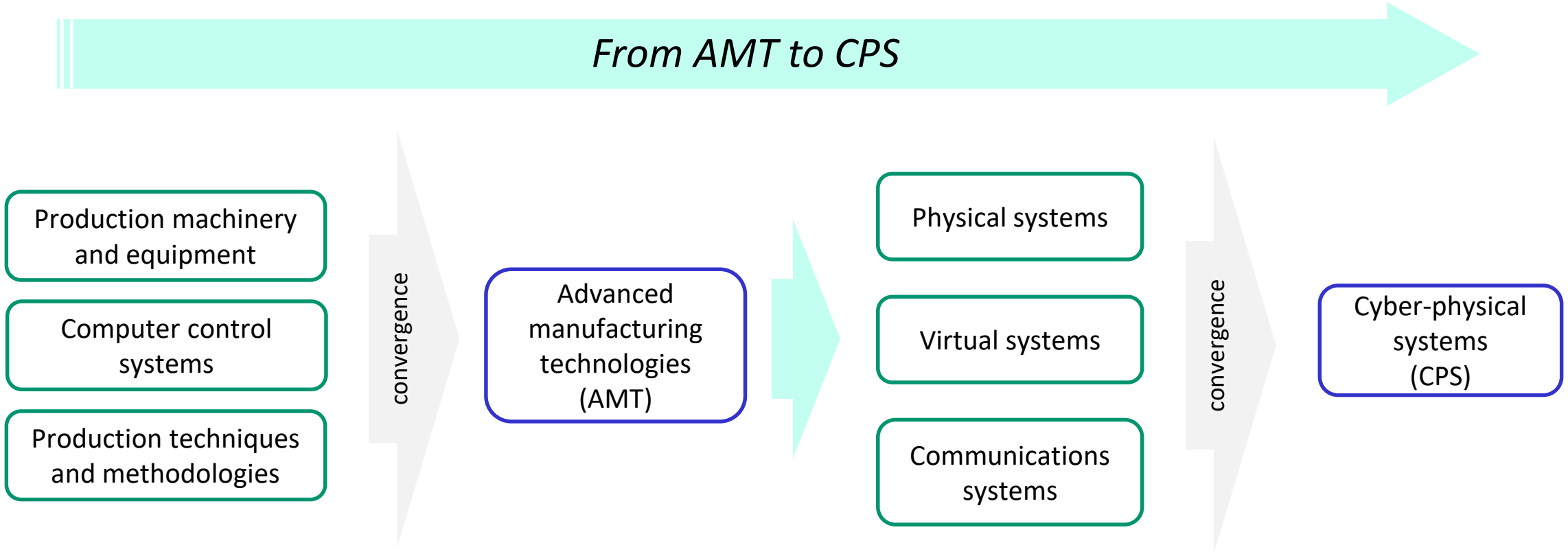

## *Manufacturing Process 2*

*In-service aircraft throughout its useful life*

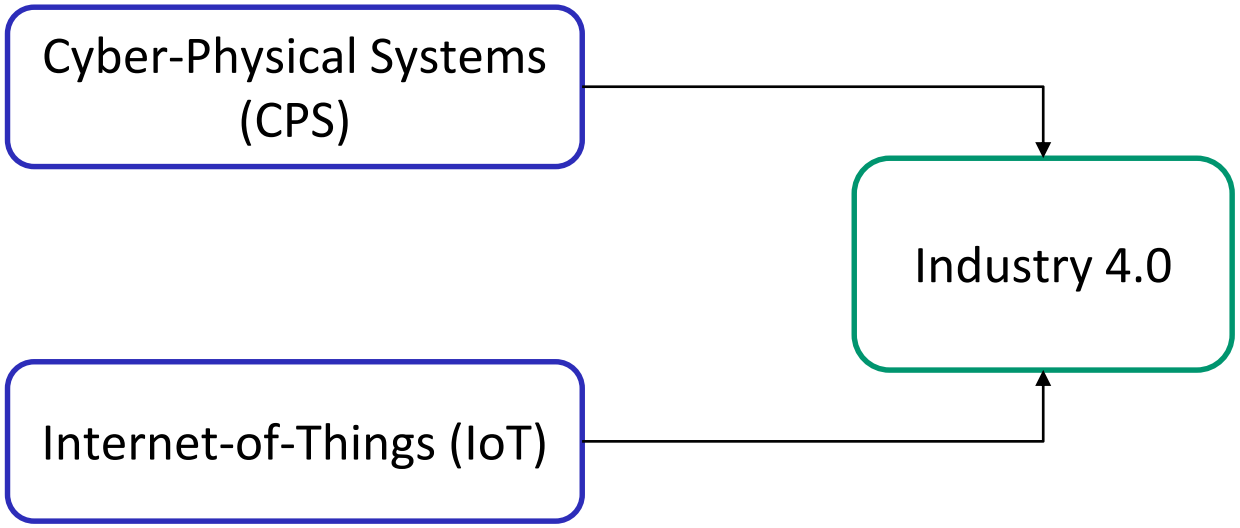
# Some advanced technologies in use in aerospace manufacturing..

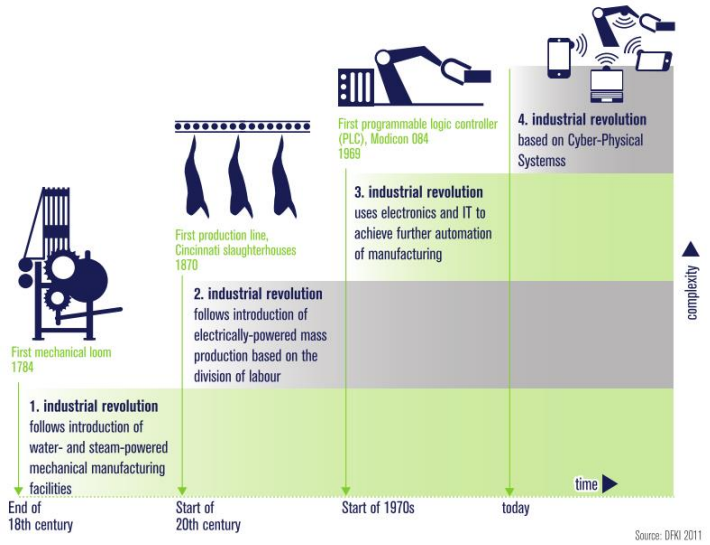


# A tale of evolution..



# 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?

| Cost | Quality |
| --- | --- |
| Unit cost of manufacturing | Quality of product conformance |

| Delivery | Flexibility |
| --- | --- |
| On-time delivery performance | Flexibility to change volume |

# Capabilities to match CPS technologies adoption..


Managerial capability

Technical capability

Learning capability

Integrating capability

Coordinating capability

# 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)…

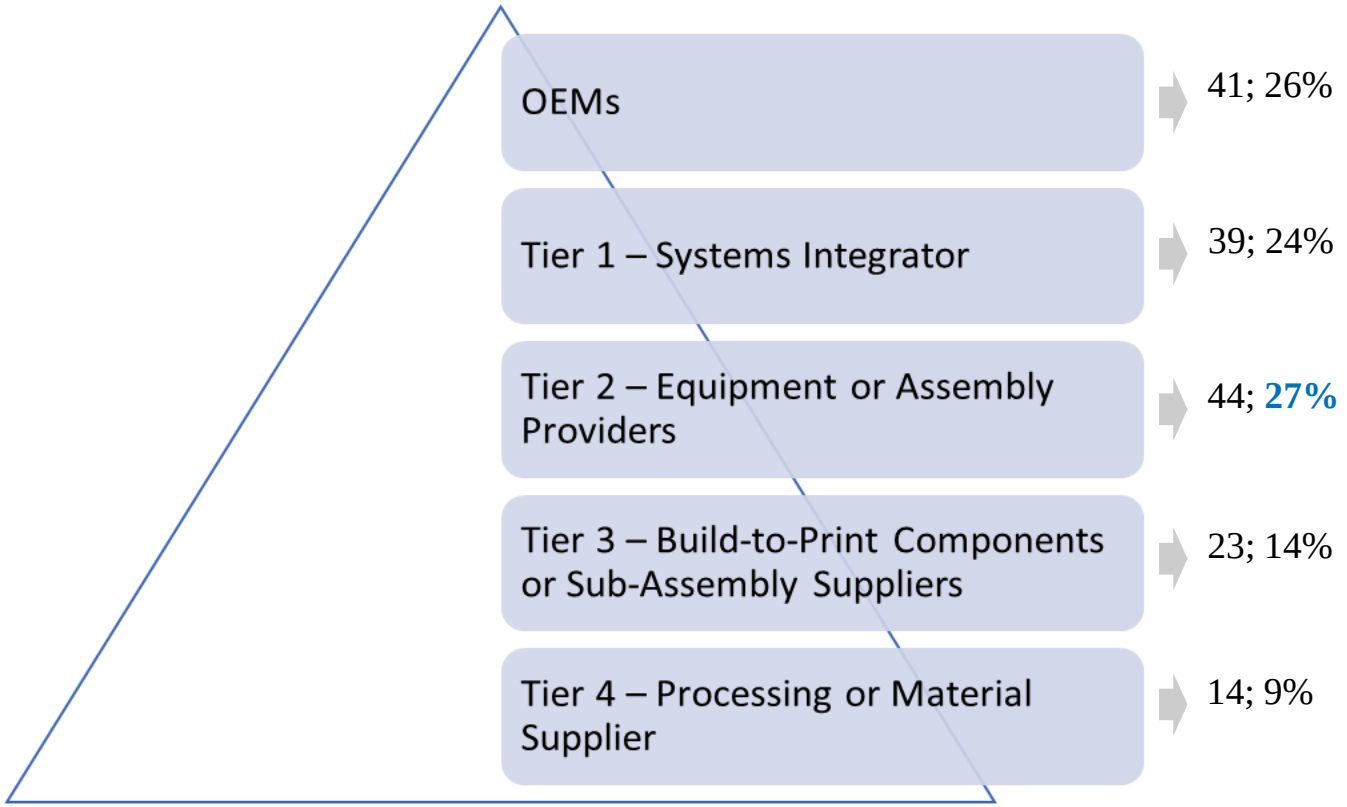
**Managerial**

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

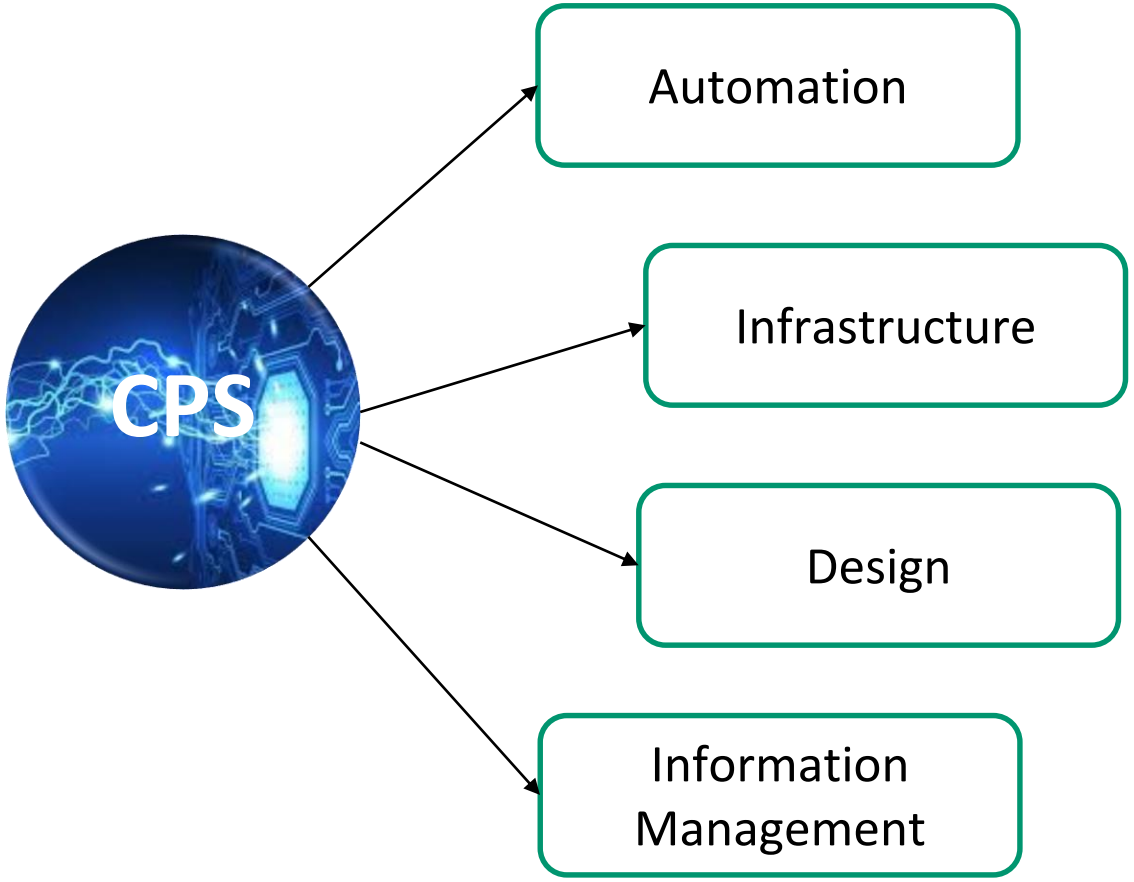
**Technical**

*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*

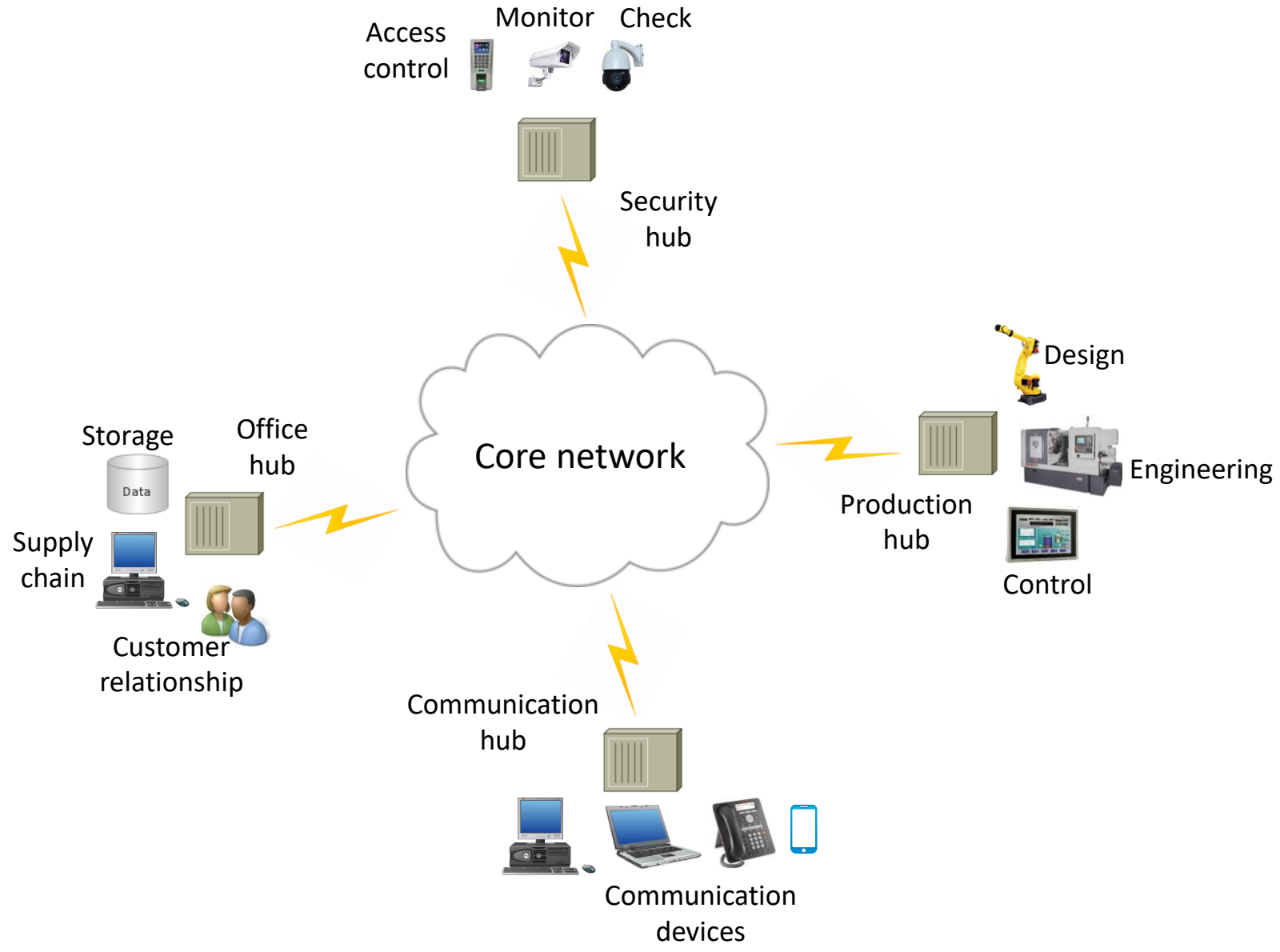
Reduce direct and indirect labour

Minimise rework and inspection

Improve manufacturing planning and control

# Infrastructure CPS..

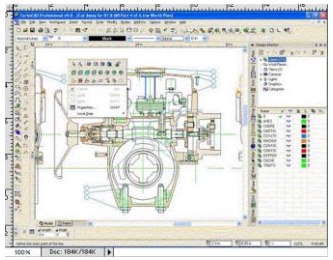
*Examples….*
*Office Automation,*
*Activity-Based Costing,*
*Intra-Company*
*Computer Networks,*
*Wireless*
*Communication*



# Design CPS..

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

CAD

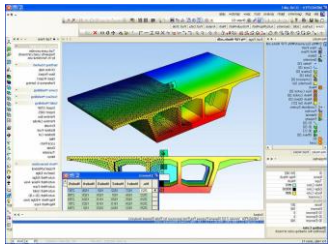


Reduce the need for prototypes

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*

*High capabilities*

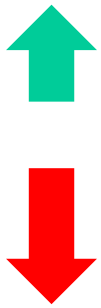
*adoption of Infrastructure CPS*

*marginal increase in operational performance*

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

# *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*

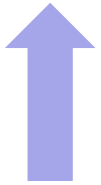
*marginal increase in operational performance*

*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…

*Capabilities*

| *CPS categories* | ***Low*** | ***High*** |
|---|---|---|
| **Information Management** | Highly recommended | Adopt with caution |
| **Design** | Not recommended | Adopt with caution |
| **Infrastructure** | Not recommended | Recommended |
| **Automation** | Highly recommended | |

*Improve operational performance through CPS adoption*

# Capabilities to support SME growth

Zakiah Suhaimi, WMG

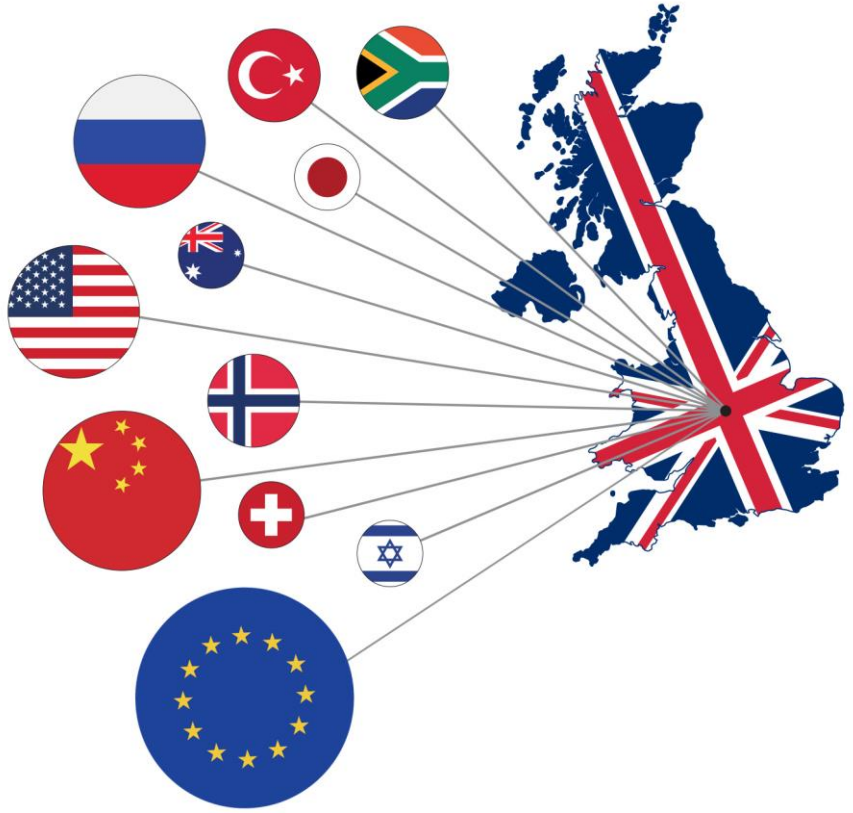
# Challenges to the UK are from advanced & emerging economies…

**Advanced Economies**

- Knowledge, skills, science, R&D

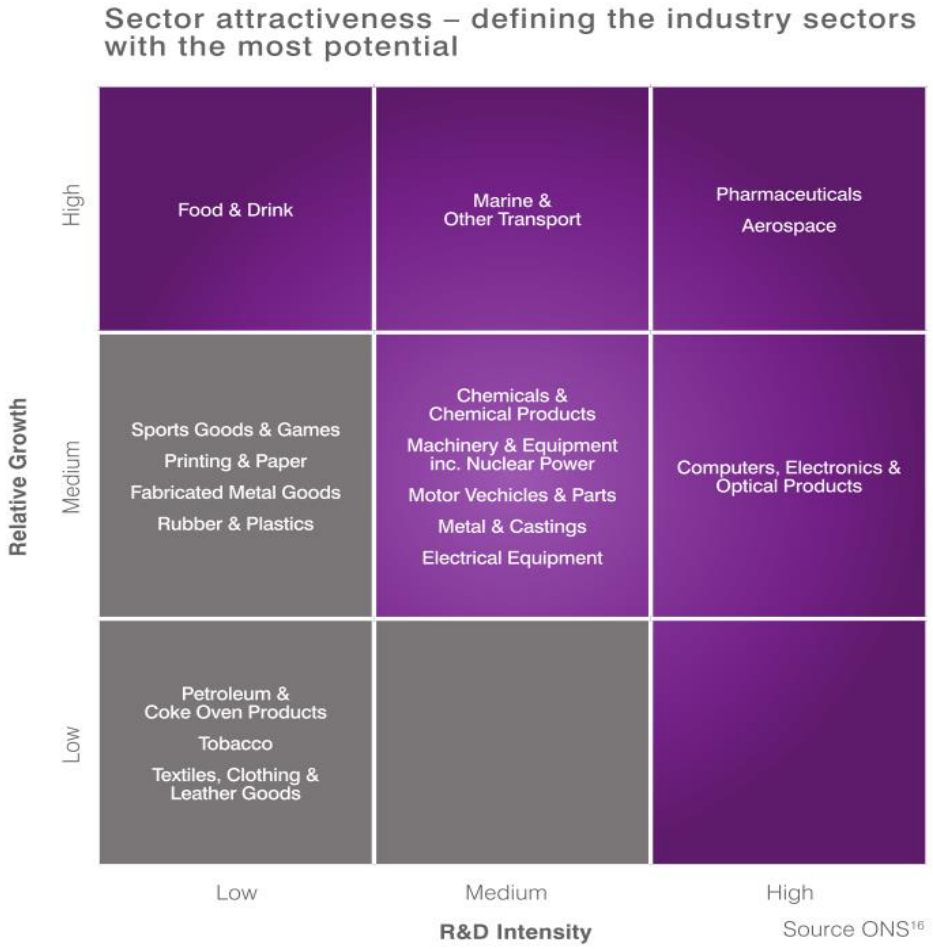
**Emerging Economies**

- Low cost labour
- Towards high value products.



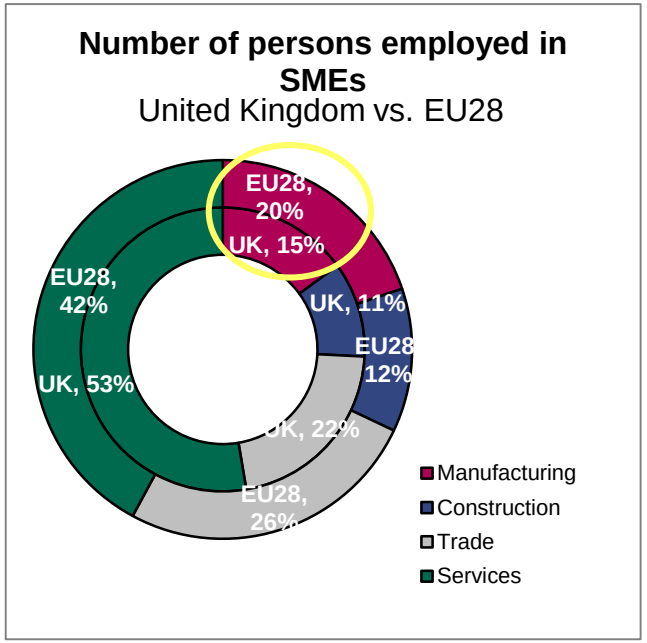
# UK response is to focus on High Value Manufacturing…

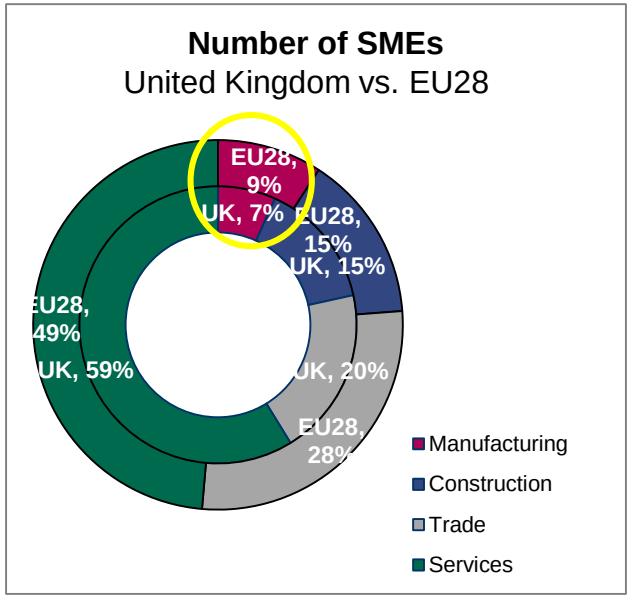
‘The application of leading-edge technical knowledge and expertise to the creation of products, production processes, and associated services which have strong potential to bring sustainable growth and high economic value to the UK’

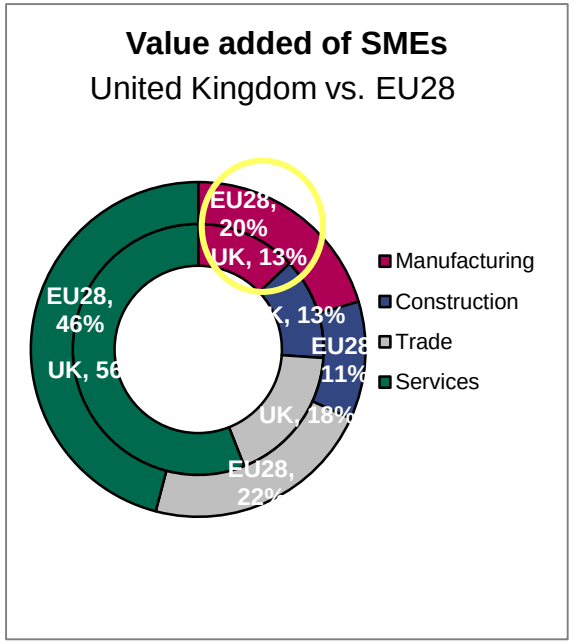



Technology Strategy Board 2012

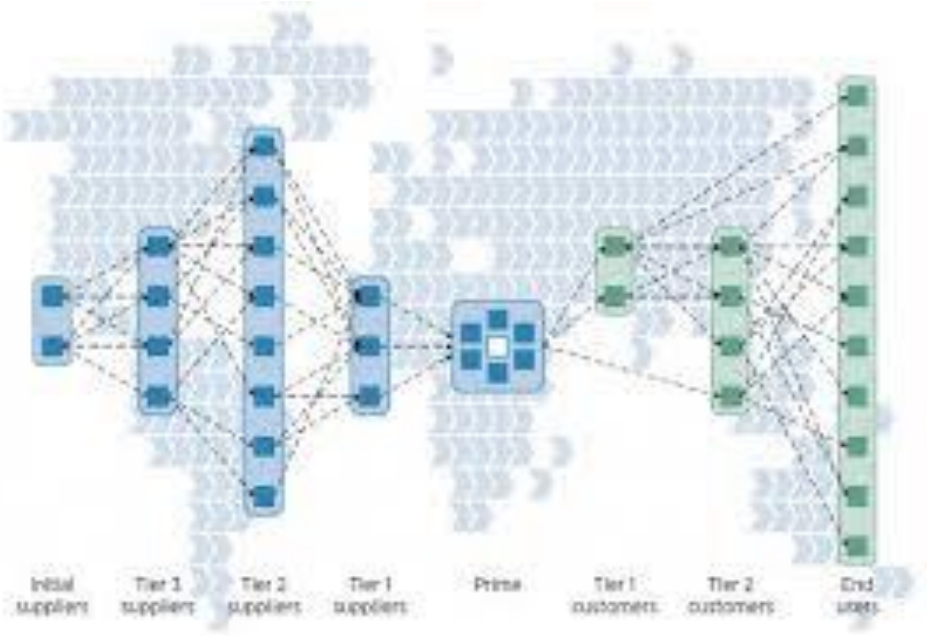
# UK Manufacturing SMEs are lagging their EU28 counterparts across a number of key measures…



# SME contribution is usually at lower tiers of HVM supply chains…

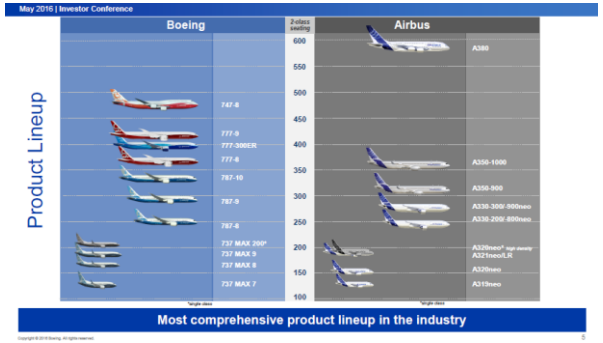




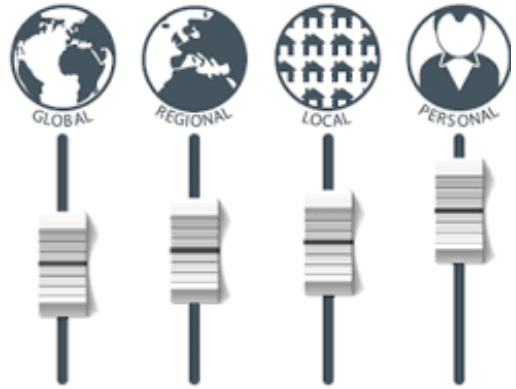
**Problem: How to increase SME participation in HVM supply chains?**

# Increased participation across 3 dimensions through…

- New products
- Increased geographic reach
- Increased diversification of business



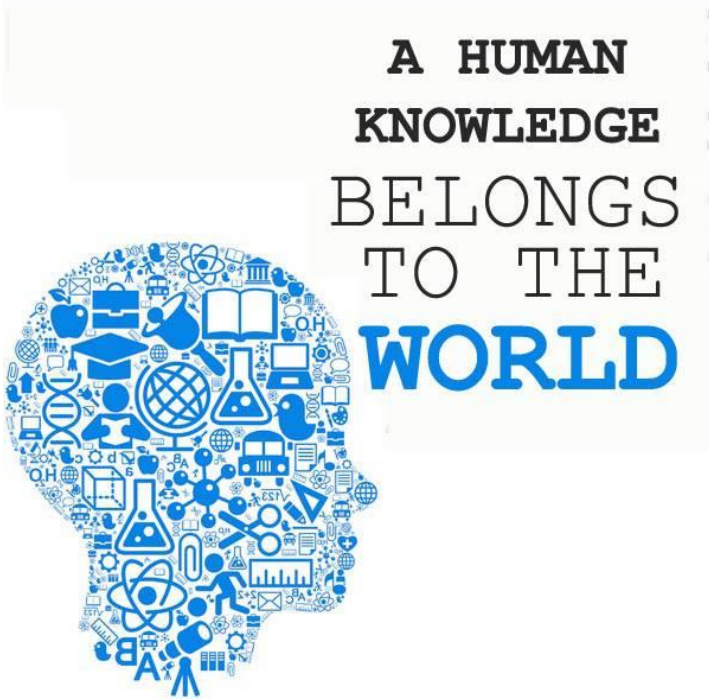




# To increase participation SMEs need to successfully ‘interact’ with their customers…

# Human interaction capability

Ability of an SME to **develop, combine** & **exchange** knowledge, skills & expertise with larger customers




Leonard-Barton 1992; Johnsen & Ford 2006; Ngugi et al. 2010

# Technological interaction capability

Ability of an SME to **open up** to technological innovation, **combine** existing technologies & **collaborate** on new technological configurations with larger customers.

Leonard-Barton 1992; Johnsen & Ford 2006; Ngugi et al. 2010

# Managerial systems interaction capability

Ability of an SME to **plan** & **collaborate** effectively with larger customers at a strategic level

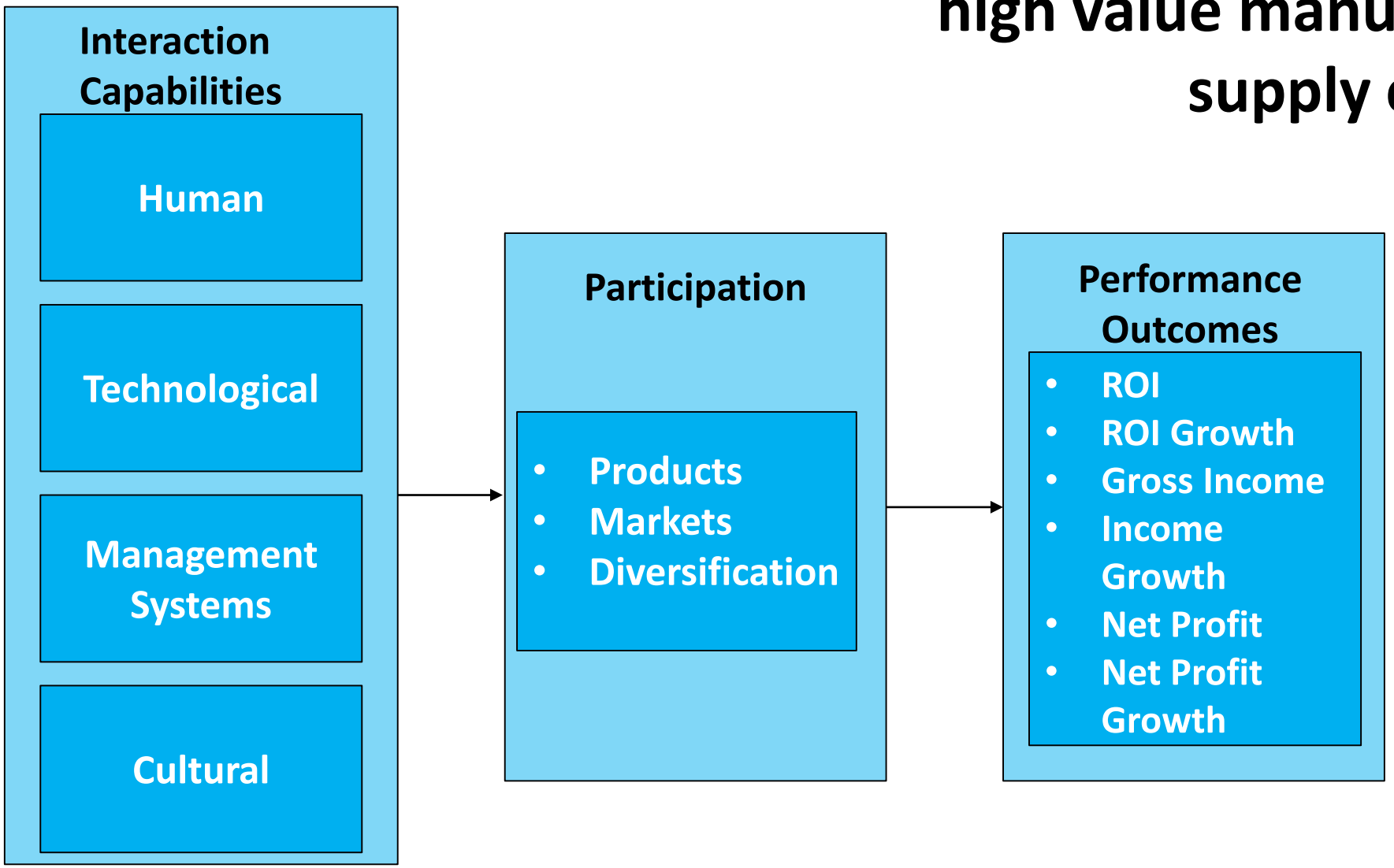

Leonard-Barton 1992; Johnsen & Ford 2006; Ngugi et al. 2010

# Cultural interaction capability

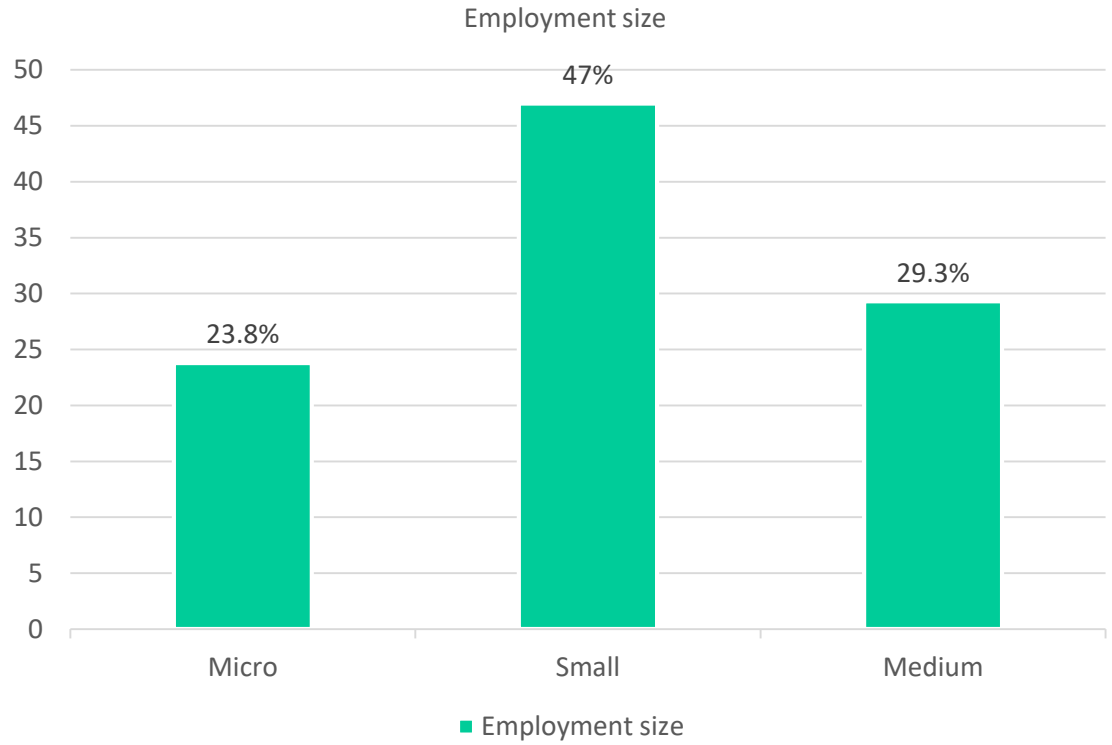
Ability of an SME to **learn** and be **tolerant** of larger customers' culture and values.

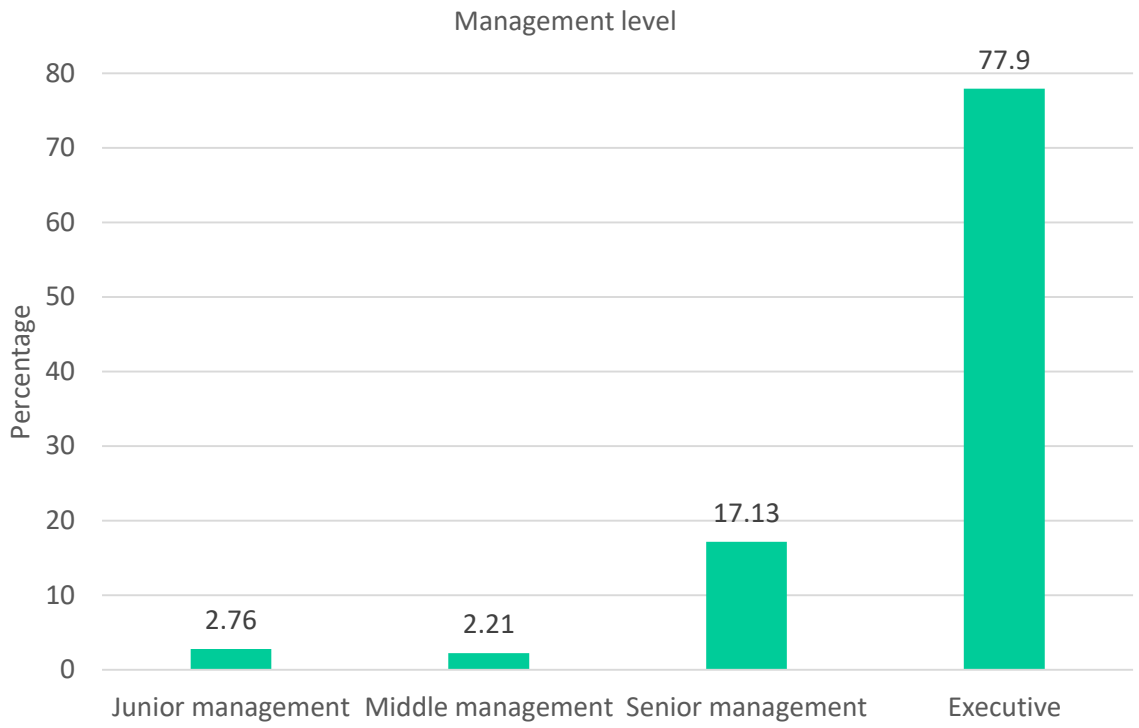
Leonard-Barton 1992; Johnsen & Ford 2006; Ngugi et al. 2010

# How do interaction capabilities affect the participation of SME in high value manufacturing (HVM) supply chains?

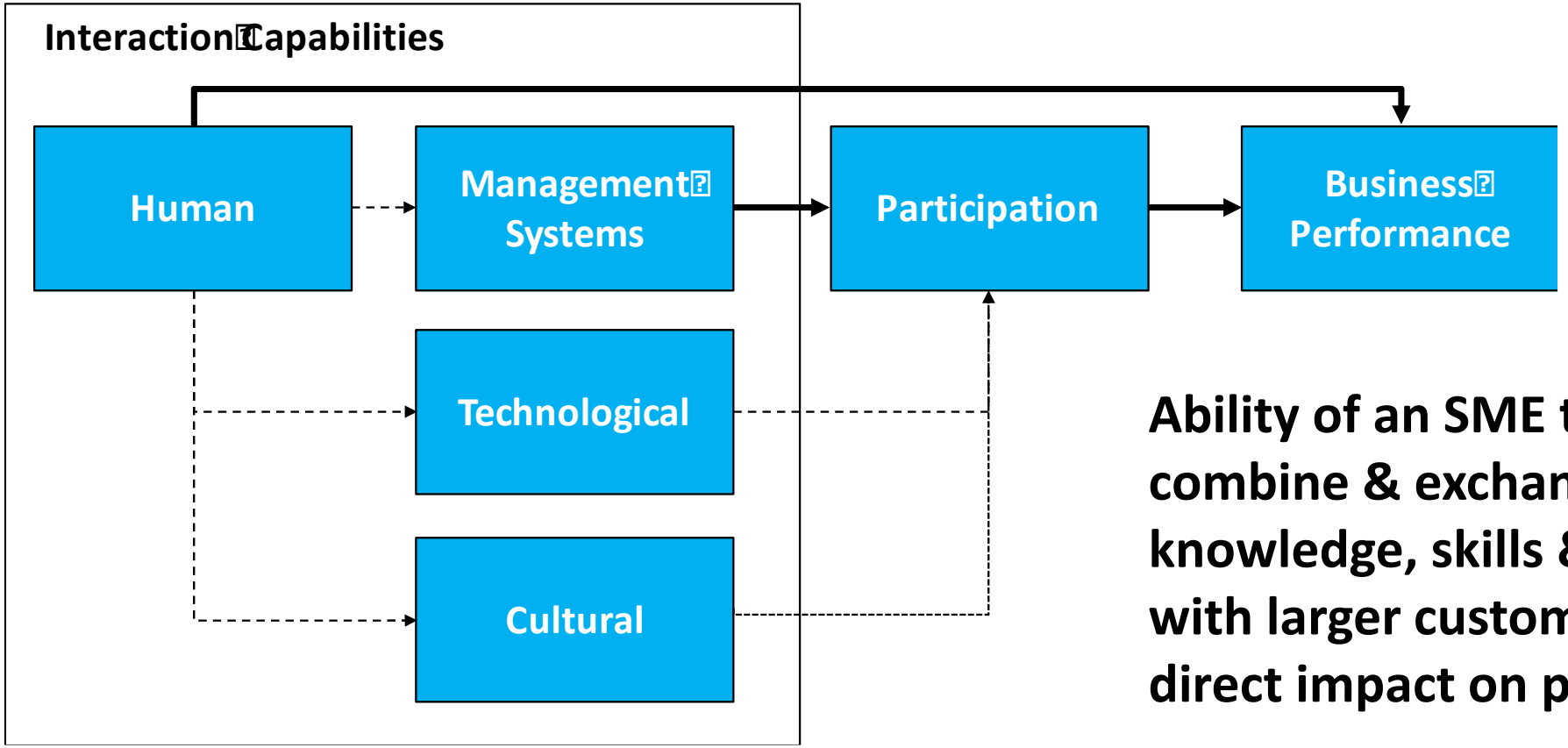


# 181 UK HVM SME's took part in the study…



# SME's ability to strategically plan and collaborate was key to increasing participation and performance…




**Ability of an SME to develop, combine & exchange knowledge, skills & expertise with larger customers had a direct impact on performance.**

# 2 practical insights…

1. Develop the capabilities to combine & exchange knowledge, skills & expertise with larger customers
    - Direct positive impact on business performance
    - Supports the development of other interaction capabilities

2. Invest in the capabilities requires to strategically plan and collaborate with your customers
    - Help to grow your business
    - In turn will have a positive impact on business performance

# Low cost digitisation at AVPE

Mark Summers, AVPE

# IFM Presentation
# Adoption of Technology an SME Perspective
# 11th June 2018

**Mark Summers**
**Managing Director**

# ADOPTION OF TECHNOLOGY AN SME PERSPECTIVE

1. Company Overview
2. Competitiveness
3. Overall Equipment Effectiveness (OEE)
4. Machine Monitoring Overview
5. Machine Monitoring Data
6. Machine Monitoring In Practice
7. Machine Monitoring Business Benefits
8. Questions

AVPE
PRECISION ENGINEERED COMPONENTS

# INTRODUCTION TO AVPE

- Established in 1997 and operating from a 2,300 sq.m facility in Bristol Avon Valley Precision Engineering ('AVPE') is a privately owned business operating in the Aerospace & Defence sectors.
- AVPE manufactures precision machine components for both Production and Maintenance, Repair & Operations ('MRO') with rapid response "Fast Shop" capability.
- The business supplies directly into Prime & Tier 1 partners.
- AVPE is committed to investing in the latest machining technology with the company positioned to dedicate capacity for partner programs.
- AVPE has available spare footprint within it's facilities and is supported by shareholders who can make swift capital investment decisions should customer needs dictate.
- AVPE currently employs 54 Staff and aims to have at least 10% of it's workforce as apprentices or trainees.
- AVPE is involved in development funded projects to understand how Additive Layer Technology (ALM) may influence it's business in the future.

AVPE
PRECISION ENGINEERED COMPONENTS

# COMPETITIVENESS WHAT IS IT?

“Possession of a strong desire to be more successful than others”

“The quality of being as good as or better than others of a comparable nature”

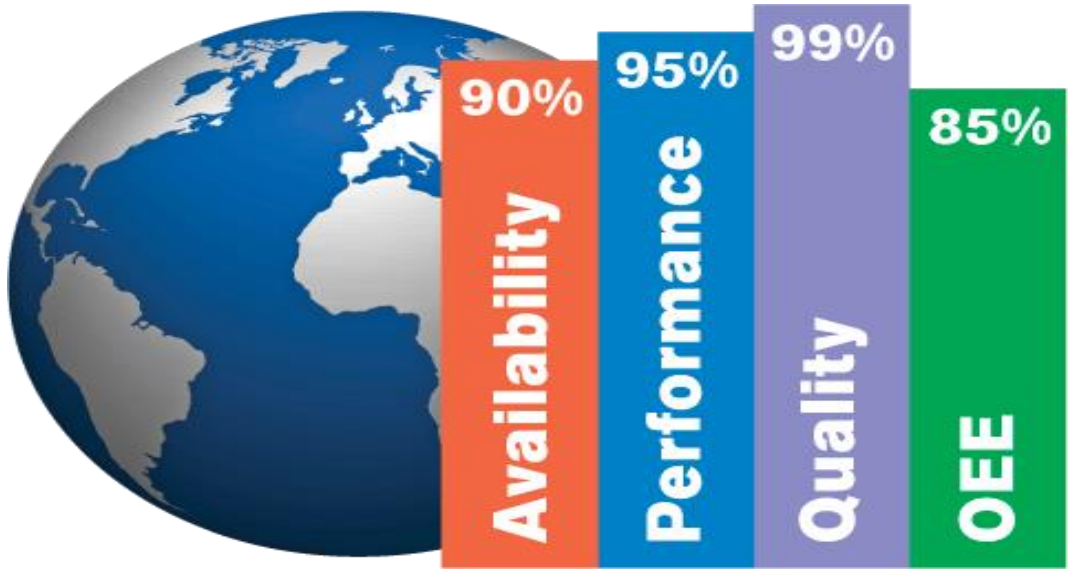
**Interestingly no mention of price and cost.**

# OVERALL EQUIPMENT EFFECTIVENESS (OEE)

**“Develop a Common Understanding”**

**- Measure and Monitor**

**- Recalibrate as Required**




AVPE
PRECISION ENGINEERED COMPONENTS

# MACHINE MONITORING

## Key Questions

- When is the machine stopped?
- Why is the machine stopped?
- When it is running and what are it’s run speeds?
- Can I calculate OEE with little or no manual intervention?

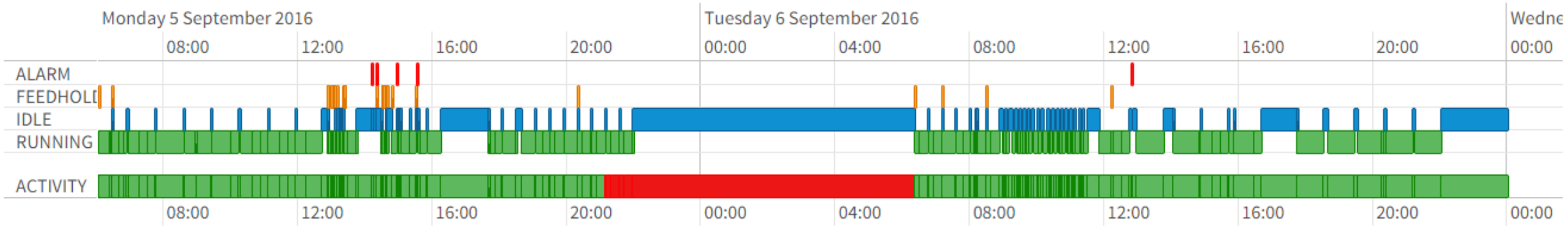
CNC Connect

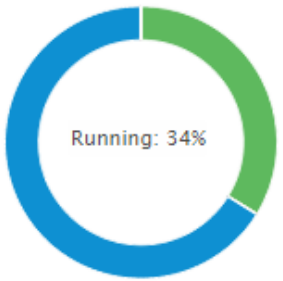
DNM400-1

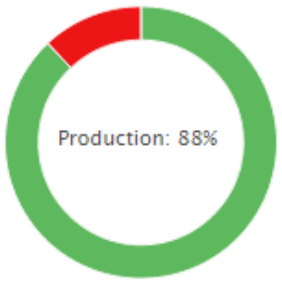
AVP

| STATUS | PROGRAM | ACTIVITY | OEE |
|---|---|---|---|
| RUNNING | 2325 | PRODUCTION | 37% A: 100% P: 37% Q: 100% |

7 DAY | 3 DAY | TODAY




Sun 0 | Mon 54 | Tue 67

| | ACTIVITY | OEE | CYCLES |
|---|---|---|---|
| **WEEKEND** StartTime - 00:00 | | 0% | 1 |
| **WEEKEND OT** StartTime - 06:00 | | 0% | 1 |
| **WEEKEND** | | | |

| | |
|---|---|
| 22:01 Tue 06 | **Idle for more than 10 minutes** Machine Idle in Production |
| 22:00 Tue 06 | **NIGHT Shift started** |
| 16:38 Tue 06 | **Idle for more than 10 minutes** Machine Idle in Production |
| 14:00 Tue 06 | **LATE Shift started** |
| 13:44 Tue 06 | **Idle for more than 10 minutes** Machine Idle in Production |
| 12:49 Tue 06 | Status changed to Idle during Production |
| 11:28 Tue 06 | **Idle for more than 10 minutes** Machine Idle in Production |
| 06:00 Tue 06 | **Idle for more than 10 minutes** Machine Idle in Production |
| 06:00 Tue 06 | **EARLY Shift started** |

Number of Records : 7

07:30
07/09/2016

# MACHINE MONITORING IN PRACTICE

- **Relatively Cheap c. £200 per machine centre**
- **Can be monitored remotely**
- **Provides a base point for challenge**
- **Realigns your expectations on what is achievable**
- **Helps support a culture of continuous improvement**

# MACHINE MONITORING BUSINESS BENEFITS

More realistic capacity planning

Accountability driven down to operator level

Repeatability of results

Gain job knowledge quickly and easily

Interpret facts not supposition

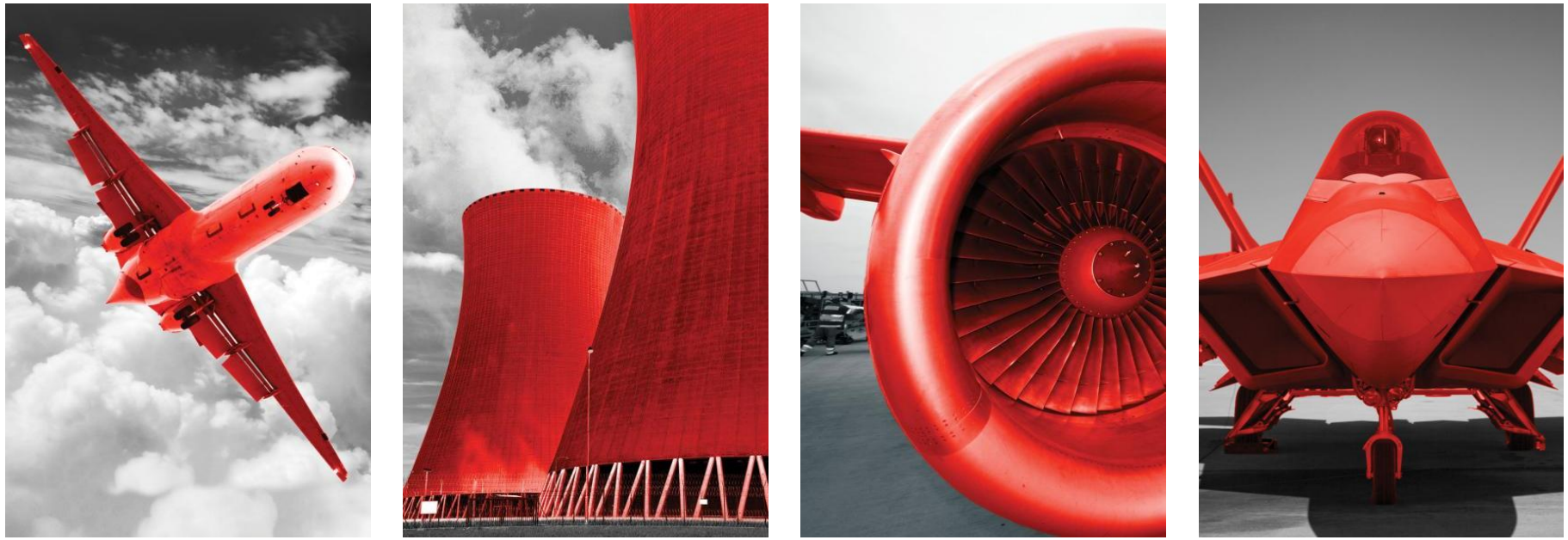
Nowhere to hide!

AVPE
PRECISION ENGINEERED COMPONENTS

# QUESTIONS

# R&D programme for the digital age

Kostas Efthymiou, Meggitt



# Digital manufacturing

## M4 Meggitt Modular Modifiable Manufacturing

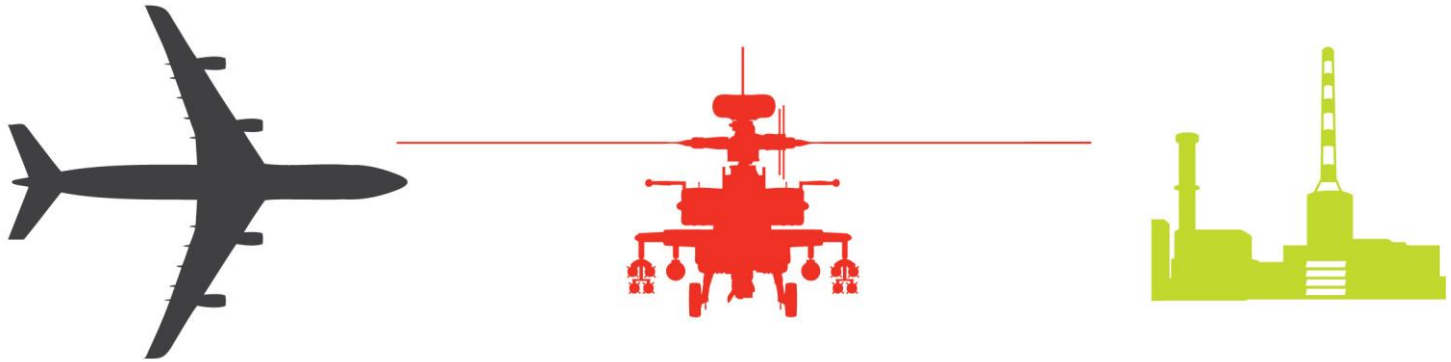
June 11th, 2018 – SCiP, WMG Coventry

MEGGITT

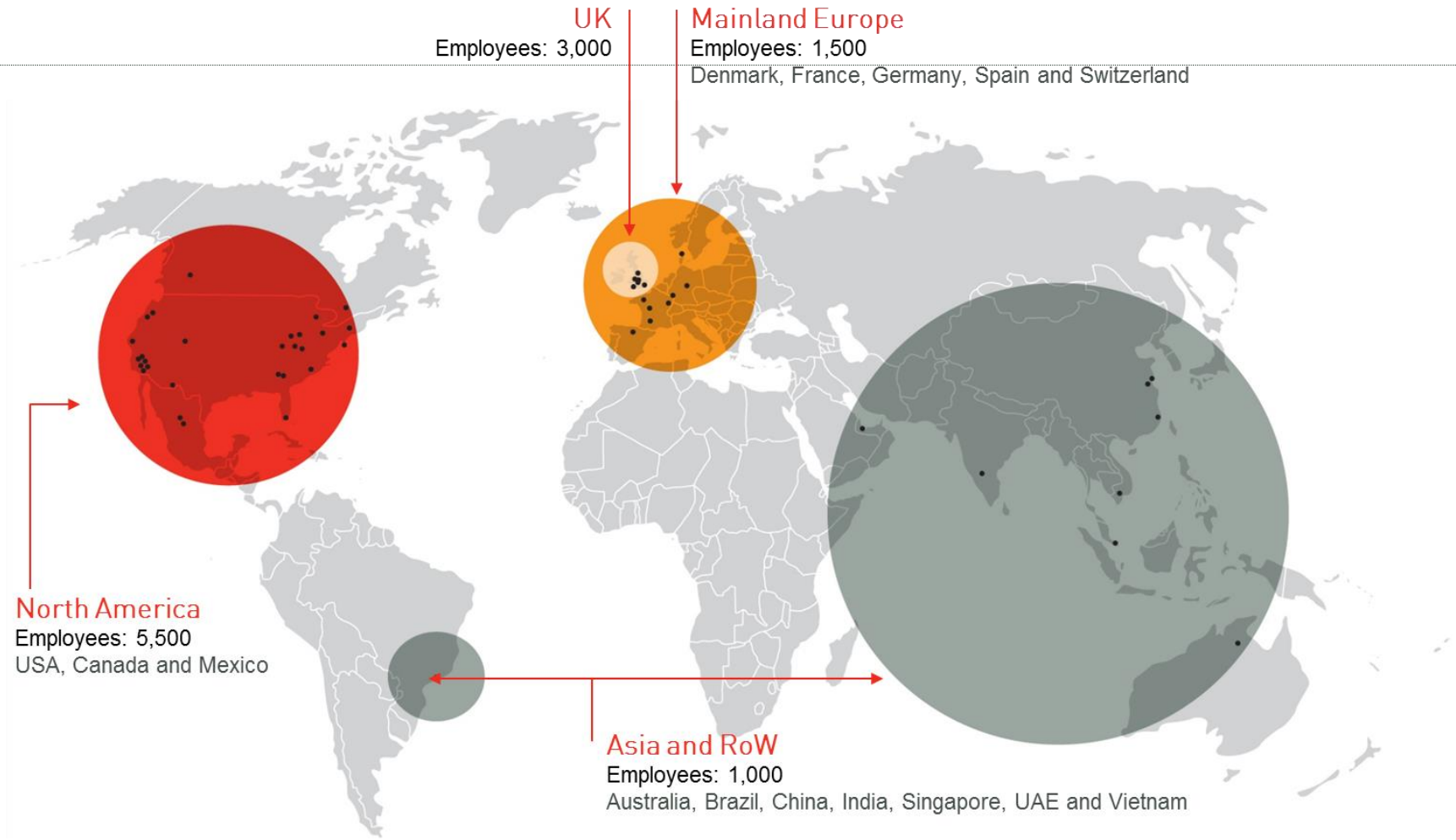
# Leading technology positions

## Meggitt divisions

| Aircraft Braking Systems | Control Systems | Polymers & Composites | Sensing Systems | Equipment Group |
|---|---|---|---|---|
| » Wheels<br>» Brakes<br>» Brake control<br>» Landing gear control<br>» Nose wheel steering<br>» Landing systems monitoring | » Safety systems<br>» Thermal management<br>» Flow and motion control<br>» Industrial controls | » Sealing solutions<br>» Fuel containment and systems<br>» Complex composite structures<br>» Ice protection<br>» Engine components<br>» Radomes | » Condition monitoring systems<br>» High performance sensors<br>» Power management<br>» Flight displays | » Threat simulation<br>» Combat support<br>» Speciality components |



# Global Footprint



# M4 Vision

## Flexibility, Visibility, Optimisation

A **modular** and **modifiable** factory having **flexible** production lines

with **interconnected** and **monitored assets** that is part of a

wider manufacturing **network** of Meggitt **factories**.

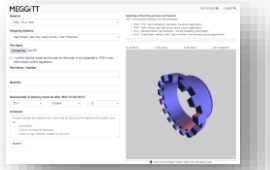
# M4 Lab

## Architecture

Simulation & Optimisation

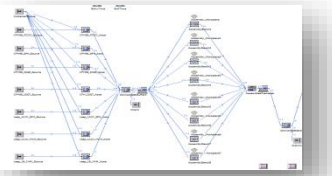
Digital Picking Instructions

Digital Twin & Working Instructions

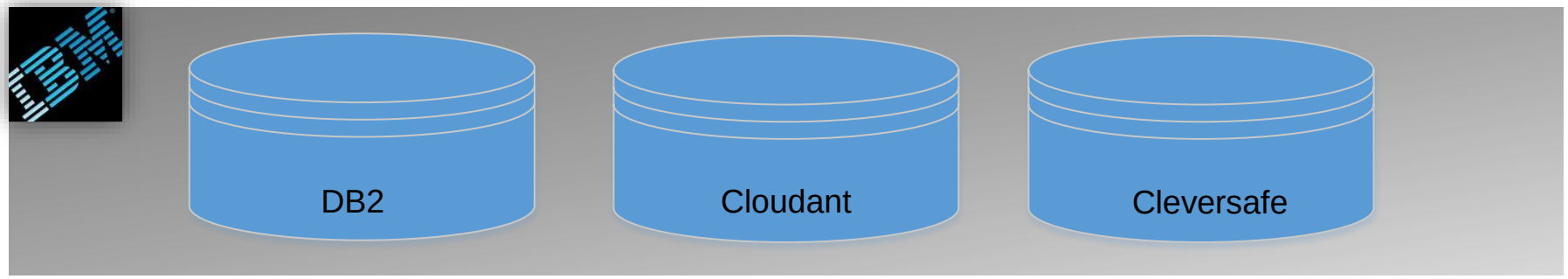


Network Service Interface

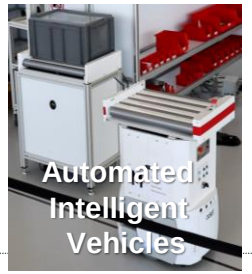
Product / Factory /SPC Analytics



Simulation Analysis







# M4 Lab

## Video

# M4 People

- Human factor is essential in our plans
  - Not about screens/displays and UIs
  - Making a system from which we can learn, share and improve

- Making a start
  - Building a team with the right skills
  - Involve the users (early)
  - Demonstration lab
  - Remove the mystery – explain and trial
  - Problem solving/workshops – make it useful
  - Improve based on feedback
  - Introduce technologies to the shop-floor

# M4 Next Steps

# M4 Thank You

- Start of a long but valuable journey
- Thank you to
  - ATI and BEIS
  - IBM
  - Catapults – AMRC and The MTC
  - Cranfield University
  - And mostly, Meggitt production staff





MEGGITT

# Q&A

WMG
THE UNIVERSITY OF WARWICK

# Keep in touch…

**Next SCIP networking event: Skills readiness for the digital age**

**Tuesday 3rd July, 08:00 (for 08:30)**

www.warwick.ac.uk/wmgresearch/scip

www.mychainreaction.co.uk

@JanGodsell

@WMGSupplyChain

#SCinPractice

#HowThingsGet2U

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