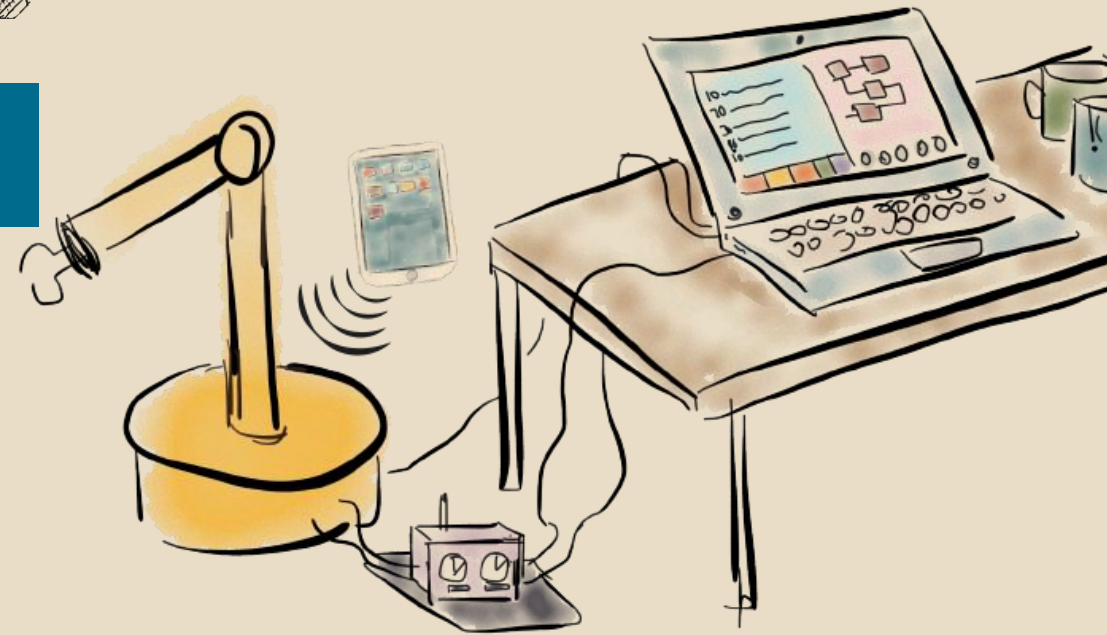


DIGITAL MANUFACTURING ON A SHOESTRING

Research Workshop

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Institute for Manufacturing
University of Cambridge

December 2019



Workshop Aims

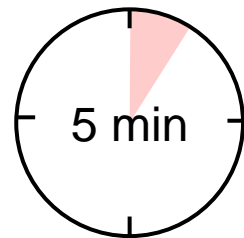
- Reflect on business priorities
- Identify potential digital solutions
- Build awareness of digital solutions
- *What might a digital solution look like in your business?*

- Building the Shoestring data set
 - SME priorities
 - Priority digital solutions

Exercise

- On your cover sheet:

What current challenge in your business would you like to address with a digital solution this year?



EPSRC Digital Manufacturing on a Shoestring Requirements Workshop

Step 1: About You

The following fields in step 1 are all **optional**. Fill in some, all, or none. This information will help us understand the collected data better. All collected data will be anonymised before use and kept secure.

Company Name: _____

Industrial Sector: _____

Size of Work Force?

Annual Revenue

0-9 employees

less than £100,000

10-49 employees

£100,000 to £1 million

50-100 employees

£1 to £10 million

100-249 employees

£10 to £45 million

Step 2: Keep in Touch

If you'd like to be informed of the results of this study, let us know:

Your Name: _____

Your Email Address: _____

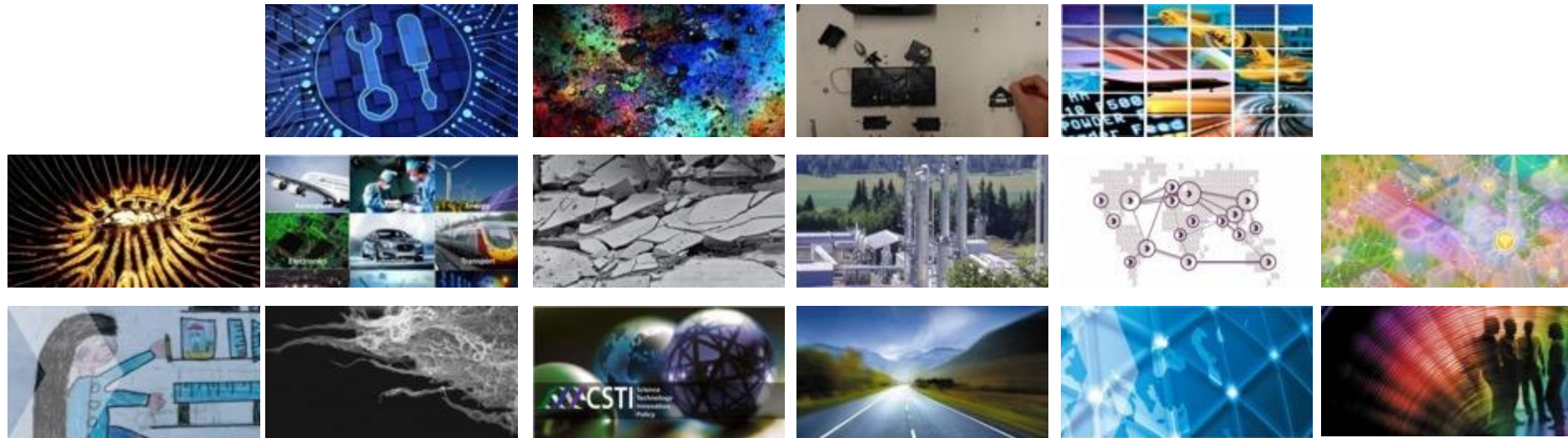
Tick here if you'd also like to subscribe to the Shoestring project newsletter:

Step 3: First Thoughts

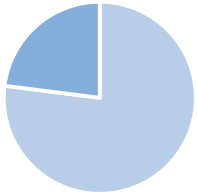
What digital solutions do you plan to implement in your business this year, and what benefits are you hoping to see as a result?

The Institute for Manufacturing and its four core themes

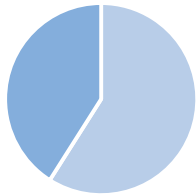
Digital Healthcare Skills SMEs



The digital challenge for SMEs



“77% of companies consider missing digital skills as the key hurdle to their Digital Transformation.”



“59% of companies cite high investment and operating costs as another major obstacle.”

[Saam et al. (2016)]

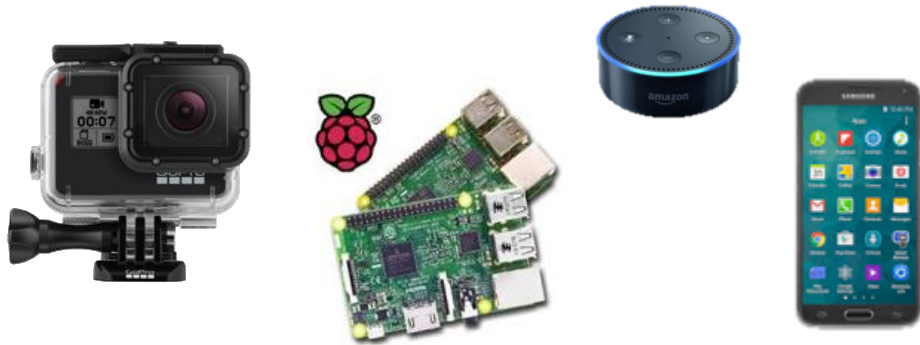


Digitalisation is perceived as *inaccessible* by many companies.

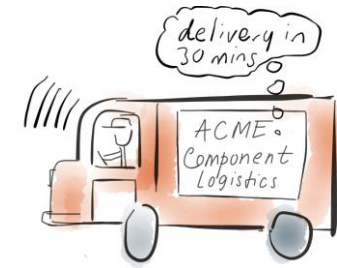
expensive

complex

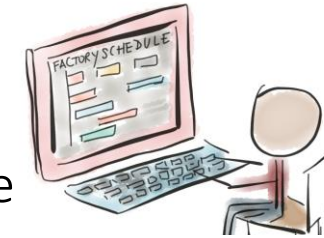
Shoestring = Low Cost Off-The-Shelf-Automation for SMEs



With suppliers



In the office

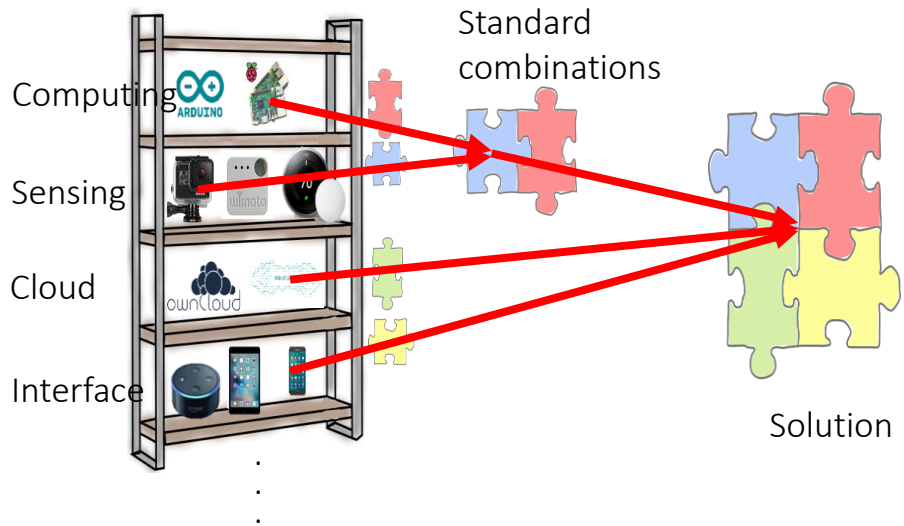


On the shop floor



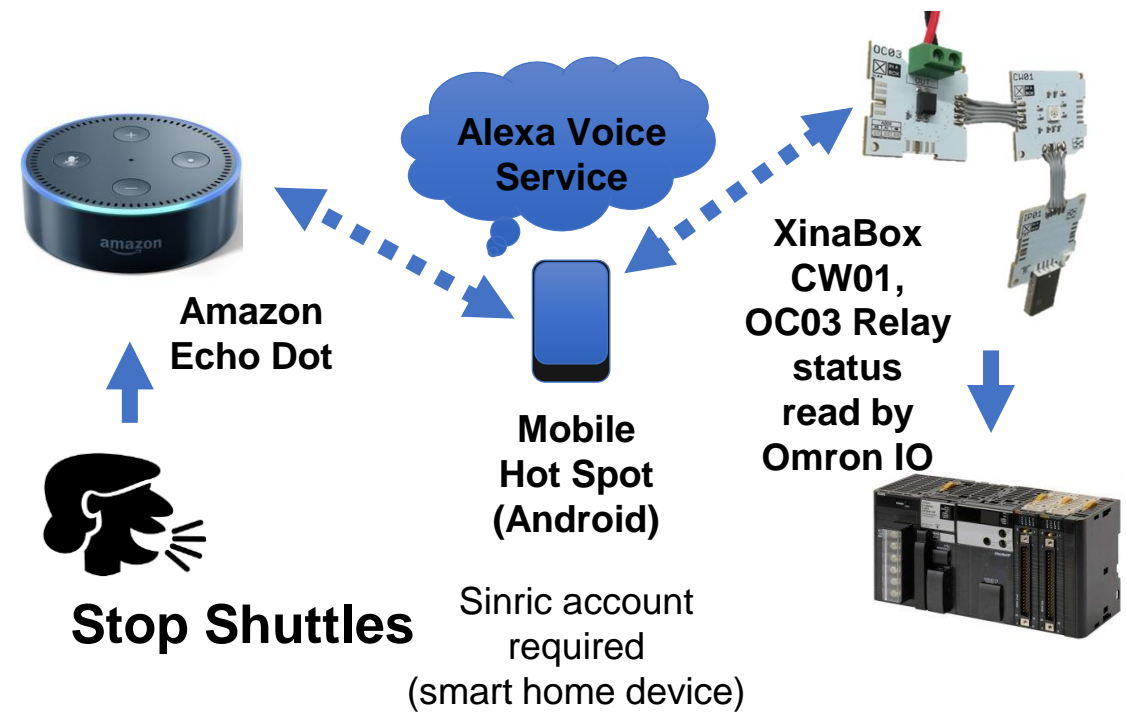
Shoestring Vision:
Increase digital capabilities throughout the company using low-cost, easily accessible “off-the-shelf” components.

Towards Low Cost Digital Solutions



Toolbox of low cost off-the-shelf components

Example: Voice controlled PLC based assembly



The ShoeString approach

1. Digital requirement assessment

What are the digital solution needs of a small manufacturer?

2. Solutions development

How can available technologies, algorithms and software be combined into accessible solutions?

3. Prototyping / Pilot testing

...of the developed technologies and methods in partner SMEs

4. Incremental integration

Implementing and integrating solutions in an incremental manner

5. Engagement / Dissemination

Application of the approach in a wide array of companies & labs



Digital Requirements Assessment



Aims:

- Key order winning area and business constraints identified
- Digital needs in terms of specific solutions identified

Outputs:

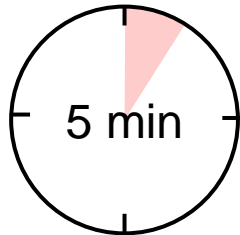
- Understanding of classes of digital solutions
- Priority areas for digital developments in your business
- Specific digital solutions

Workshop structure

1

• With A Neighbour:

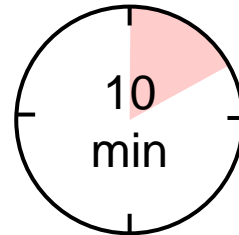
- What are your main priorities for Order Winning
- What is the main business constraint your company faces



2

• Group Exercise:

- Identify specific digital solution needs aligned with your
 - Order winning priority
 - Business constraint priority



3

• Summary / Wrap Up

- Priority areas across the group
- Popular solution needs
 - Must have
 - Nice to have

Order winners / Business Constraints

- **Priorities:**

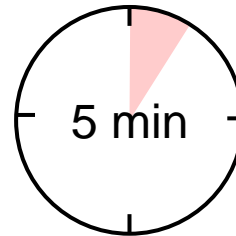
What is the most important order winner / business constraint for your business?

Chose:

1 x Order winner

1 x Business constraint

Discuss with a neighbour



Step 4: Rank the Order Winners

For each of these five order winners for your business, rank them from 1 to 5, with 1 being your highest priority and 5 being your least. Write the rank in the blue boxes.

<p>Price</p> <p>We want to compete and win business on price. The cheapest provider in the marketplace will get the orders.</p> <input type="text"/>	<p>Quality</p> <p>Our ability to provide reliable, fit-for-purpose products and services will be key to our success in the marketplace.</p> <input type="text"/>
<p>Unique Value</p> <p>We need to compete on the uniqueness of our offering: developing our product and improving our service, in order to stay ahead of the competition.</p> <input type="text"/>	<p>Delivery</p> <p>Customers expect the product when they ask for it. It must be available as soon as possible or on the date promised, even if customers change their minds.</p> <input type="text"/>
<p>Ethics</p> <p>Our customers and other stakeholders are concerned about the performance of our humanitarian, social, environmental, and regulatory obligations.</p> <input type="text"/>	<input type="text"/>

Step 5: Rank the Business Constraints

For each of these five constraints on your business, rank them from 1 to 5, with 1 being your greatest constraint and 5 being your least. Write the rank in the red boxes.

<p>People and Information</p> <p>A key priority for us will be to maximise the effectiveness and flexibility of our staff and our support systems. E.g., software processes, decision-making, etc.</p> <input type="text"/>	<p>Plant and Equipment</p> <p>A key constraint will be our structural assets. We need to reduce bottlenecks and maximise the effectiveness of our equipment, factory space, etc. to produce more value.</p> <input type="text"/>
<p>Supply Chain</p> <p>A key constraint will be the supply chain of goods and services into our company. A priority will be to optimise the capacity, quality and delivery performance of our suppliers.</p> <input type="text"/>	<p>Demand</p> <p>A key priority for us will be to find more customers for our product or service. We could accommodate increased volumes without difficulty, but the demand is lacking.</p> <input type="text"/>
<p>Cash</p> <p>A key barrier to achieving growth will be a lack of cash to invest in value-generating activity. It will be critical that cash is released from inventory and other sources.</p> <input type="text"/>	<input type="text"/>

Exercise: Digital solution priorities

UNIVERSITY OF NOTTINGHAM
UNIVERSITY OF CAMBRIDGE

Order Winners: Quality

Automated delivery of workpieces and tools to operators:	
Automated optimization of process parameters:	
Automated visual inspection of shape / finish of goods:	
Automated weight check and packaging:	●
Control procedure for equipment maintenance:	
Digital faults monitoring (tracking of re-works and complaints):	
Digital job cards:	●
Digital library of typical errors / faults and rectification instructions:	
Digitally assisted goods quality:	
Digitalised photos and ...:	
Integrated inform...:	
...ance:	
...ontext oriented displ...ion for operators:	
Process monitoring (vibration / energy / temperature etc.):	●
Weather based scheduling:	

Example:

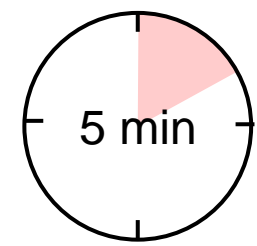
UNIVERSITY OF NOTTINGHAM
UNIVERSITY OF CAMBRIDGE

Business Constraints: People and Information

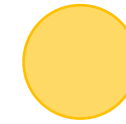
Automated bottleneck identification in operations:	●
Automated generation of CNC code:	
Automated job scheduling to human and machine resources:	
Automated minimisation of tooling:	
Automated optimisation of process parameters:	
Automated tracking and assignment of tools to operations:	
Capacity monitoring of human and machine resources:	
Control process to manage line side feeds / counters:	●
Digital cost modelling of disruptions and changes:	
Digital job cards:	
Digital library of typical errors / faults and rectification instructions:	
Digital management architecture (ERP and MES):	
Digital worker order management system:	
Digital worker shift management system:	
Digitised work instructions, photos and assembly procedures:	
Display of production schedule around the shop floor:	
Problem and context oriented display of information for operators:	
Process monitoring (vibration / energy / temperature, etc.):	
Real time tracking of internal jobs (location, status):	
Simulation of tools and processes for virtual process planning:	●

For your priority order winner:
Mark the 3 most attractive solutions on the sheets with 1 green dot each

For your priority business constraint:
Mark the 3 most attractive solutions on the sheets with 1 green dot each



Exercise: Digital solution priorities



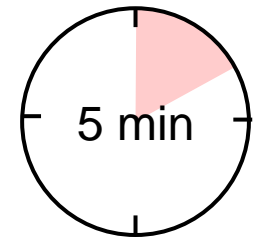
=

Useful:

“This sounds useful, but is not a priority”

Starting with your priority order winner:
Mark up to 7 other interesting solutions with a yellow dot

Starting with your priority constraint:
Mark up to 7 other interesting solutions with a yellow dot



Example

UNIVERSITY OF NOTTINGHAM
UNIVERSITY OF CAMBRIDGE

Order Winners: Quality

Automated delivery of workpieces and tools to operators:	
Automated optimization of process parameters:	●
Automated visual inspection of shape / finish of goods:	
Automated weight check and packaging:	●
Control procedure for equipment maintenance:	
Digital faults monitoring (tracking of re-works and complaints):	●
Digital job cards:	●
Digital library of typical errors / faults and rectification instructions:	
Digitally assisted goods quality:	●
Digitalised photos and ...:	
Integrated inform...:	●
...ance:	
...ntext oriented displ...ion for operators:	
Process monitoring (vibration / energy / temperature etc.):	●
Weather based scheduling:	

Example:

UNIVERSITY OF NOTTINGHAM
UNIVERSITY OF CAMBRIDGE

Business Constraints: People and Information

Automated bottleneck identification in operations:	●
Automated generation of CNC code:	
Automated job scheduling to human and machine resources:	●
Automated minimisation of tooling:	●
Automated optimisation of process parameters:	
Automated tracking and assignment of tools to operations:	
Capacity monitoring of human and machine resources:	●
Control process to manage line side feeds / counters:	●
Digital cost modelling of disruptions and changes:	●
Digital job cards:	
Digital library of typical errors / faults and rectification instructions:	
Digital management architecture (ERP and MES):	
Digital worker order management system:	●
Digital worker shift management system:	
Digitised work instructions, photos and assembly procedures:	
Display of production schedule around the shop floor:	
Problem and context oriented display of information for operators:	●
Process monitoring (vibration / energy / temperature, etc.):	
Real time tracking of internal jobs (location, status):	
Simulation of tools and processes for virtual process planning:	●

Workshop Wrap Up

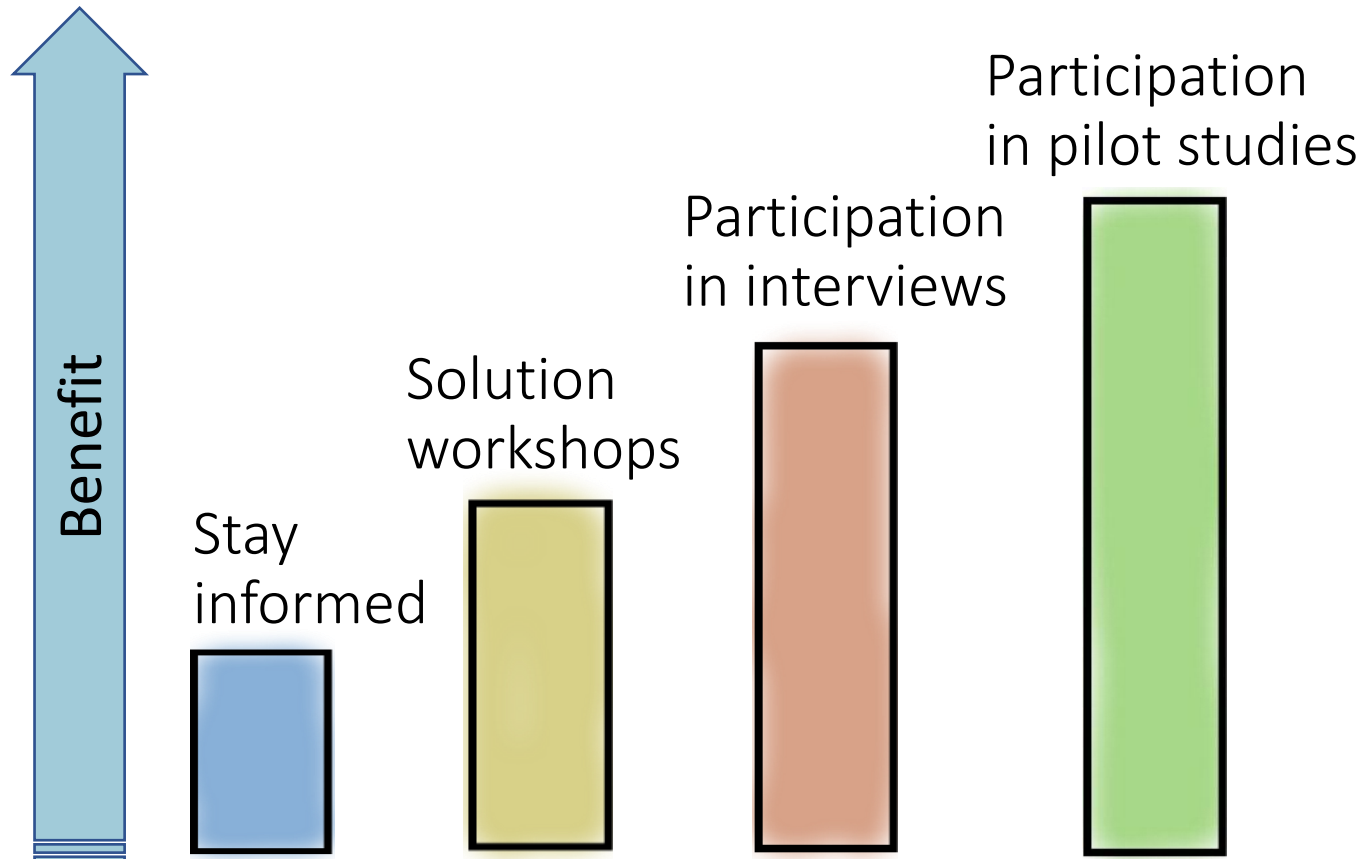
Priority Areas

- Order Winner
 - No1: Quality
 - No 2: Delivery
- Business Constraint
 - No 1: People and processes
 - No 2: Supply chain

Popular Specific Solution Needs

- Must Have
 - No 1: Digitised work instructions
 - No 2: Real time tracking
- Nice to Have
 - No 1: Automated bottleneck ID
 - No 2: Digitised work instructions
 - No 3: Condition monitoring

Being Involved in ShoeString:?



Contact details

Email us or pass on a business card and we will add you to a list to keep you updated.

E: contact@digitalshoestring.net
Website: digitalshoestring.net
Twitter: [@dmshoestring](https://twitter.com/dmshoestring)

Barriers to UK Manufacturing Digitalisation

What Is Preventing The UK From Fully Achieving The Vision?

The Made Smarter Review has identified three themes which are limiting the UK's ability to achieve its potential:

1. **Lack of effective leadership of industrial digitalisation in the UK.**
2. **Poor levels of adoption, particularly among SMEs.**
3. **Under-leveraged innovation assets to support start-ups/scale-ups.**

- The UK is behind other advanced nations in overall productivity (output per worker), which is in part due to **lower levels of adoption of digital and automation technology**. This is particularly acute among SMEs.
- One of the identified causes is an ineffective and confused landscape of business support, with **no clear route to access help** and ambiguity about what 'good' looks like.
- SMEs, in particular, perceive significant barriers to adoption, such as risks around cybersecurity, and a **lack of common standards allowing different technologies to connect**.
- Unlike other developed nations, the UK's tax system is not targeted enough to **incentivise the opportunity**.
- Businesses also face a **skills shortage**, particularly in digital engineering capabilities, and are hindered by a fragmented skills system and a lack of systematic engagement between education and industry.

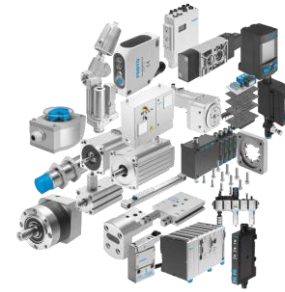
Shoestring Overview

Can low-cost, off-the-shelf devices be combined to address the manufacturing automation needs of SMEs?

- UK government needs to raise industrial productivity.
- The government and manufacturing organisations see information as key to improving their productivity and competitiveness.
- Digital transformation is the process of introducing the latest advancements in control, communication, AI etc. into the manufacturing company and processes.
- How can we ensure these developments are accessible to SMEs?

Commercial, Off-the-Shelf

To solve the cost hurdle, the Shoestring project will use commercial, often consumer-grade off-the-shelf products.



Low-Cost
Sensing

Low-Cost
Computing

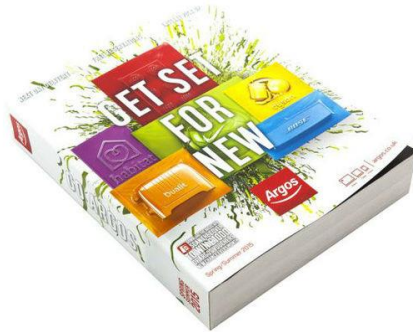
Low-Cost
Interfaces

Low-Cost
Actuation

Low-Cost
Intelligence

Catalogues and Toolboxes

To solve the complexity hurdle, Shoestring will take the approach of catalogues and toolboxes:



Catalogue of pre-prepared solutions to common problems

- Companies can quickly see what solutions exist.
- Rapid and easy deployment of solutions.
- De-risked as solutions are pre-tested and low cost.



Toolbox of components for customised solutions

- Combine pre-made compatible building blocks to make new solutions.
- Configuration not coding – deskilled implementation.
- Modification of catalogue entries or whole new solutions.

Project Plan



1. Digital Requirement Assessment

What are the digital needs of the small to medium manufacturer?



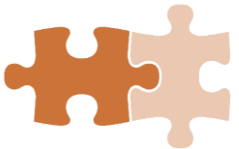
2. Solutions Development

How can we combine available technologies to create accessible solutions?



3. Prototyping and Pilots

Develop initial prototypes and deploy them at the universities and in manufacturing partners.



4. Incremental Integration

Continue to add to toolbox of solution elements as new challenges discovered.



5. Engagement and Dissemination

Get the results out there and into UK manufacturing companies.