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# Digital technology in food and drink manufacturing – The UK experience

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Smart agri-food supply chain of the future  
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## Introduction and Content



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- Digital food and drink manufacturing
- Ultrasonic and optical process analytical technologies
- Machine learning, predictive analytics, multi-sensor data fusion
- Sustainability, safety and productivity
- Appropriate technologies for SME's

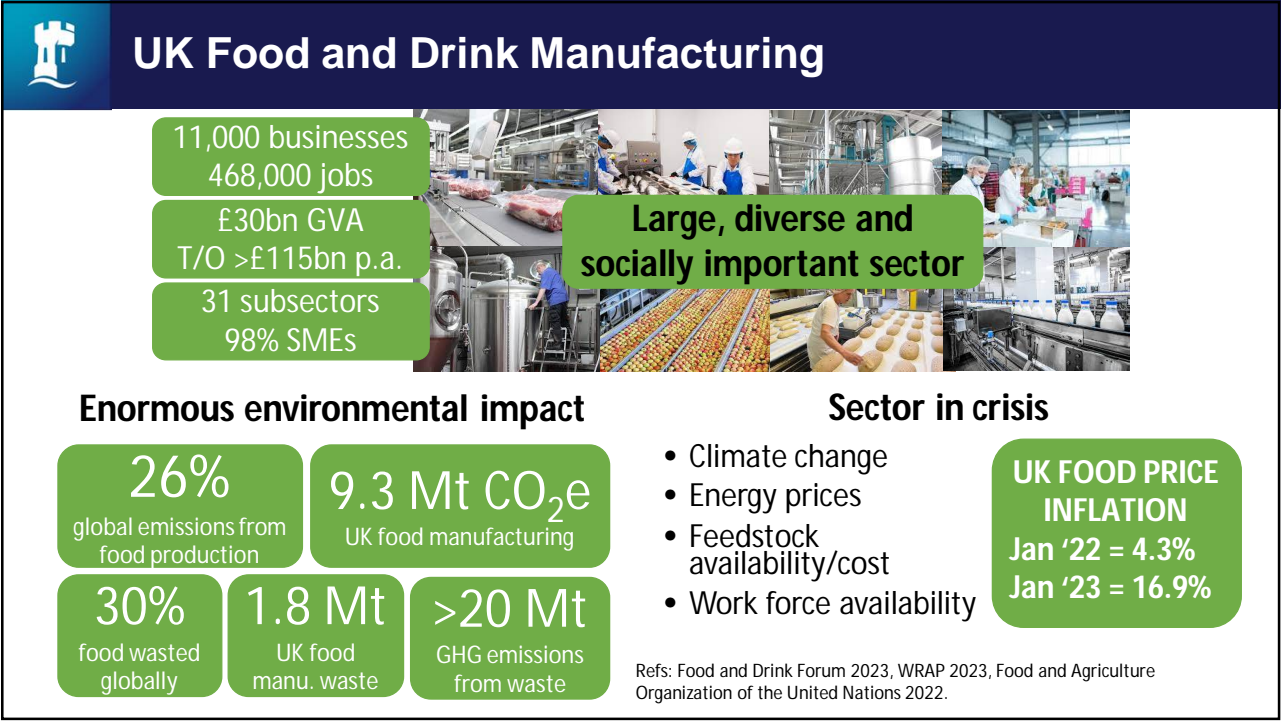
   

### Presentation Topics

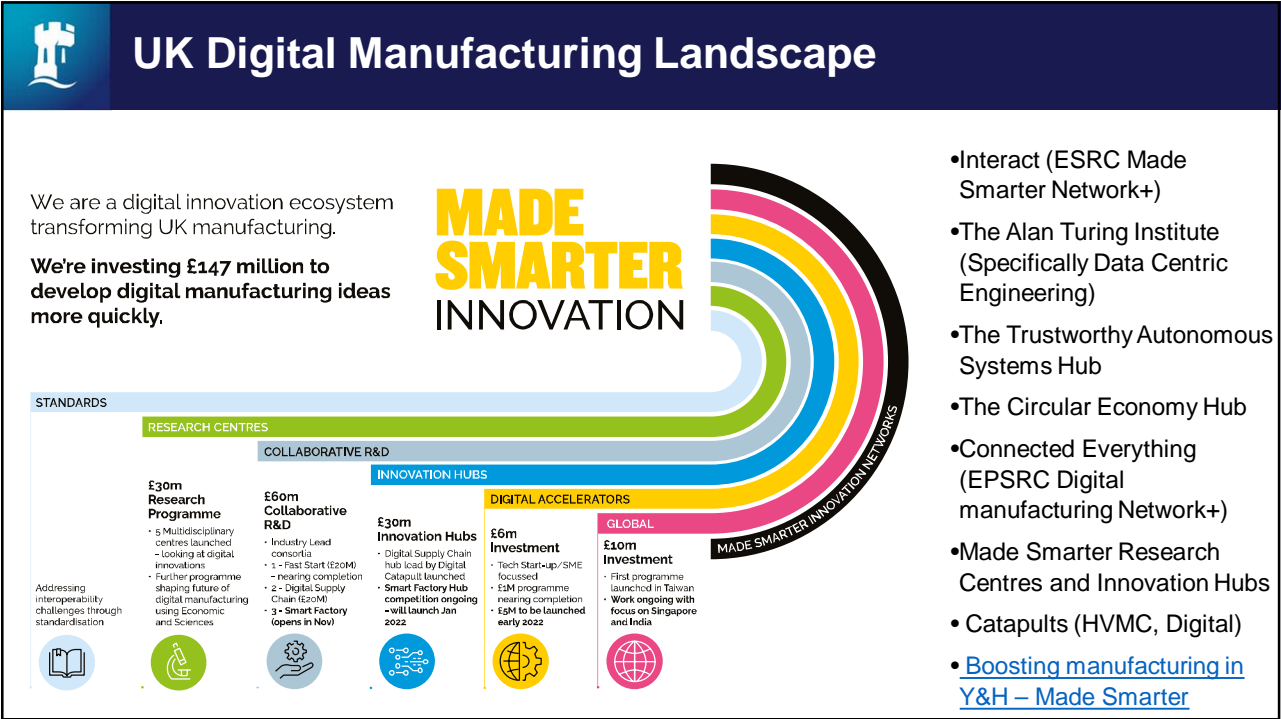
- Digital food and drink manufacturing in the UK
- Sensors and Machine learning to monitor materials and processes
- Case studies
- Summary and how to get involved

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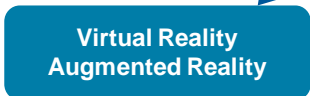




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Enabling IDT's for Food and Drink Manufacturing









Artificial Intelligence,  
Machine Learning &  
Data Analytics

DATA

Robotics and  
Automation


Industrial Internet of  
Things



**What about the Food and Drink sector?**

- High volume, low value products sector (different investment models and time frame)
- Many SMEs in sector
- Legacy equipment
- Highly variable biological materials (hygiene and food safety)
- Many manual operations


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Human In the Loop

Successfully combing sensor measurements with machine learning requires a diverse range of expertise.


Materials




Process



Sensor



Data




+

+

+

Important to have champions and engagement from factory floor to boardroom


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# HumanS In the Loop

Food materials and processes are complex so technology needs our help!


## Airport Security



## Self-driving Cars



## Cricket



All use a variety of different technologies and human interventions with processes which are constantly assessed to enable improvements.


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# Case Study 1: Fermentation

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# Sustainable Fermented Products



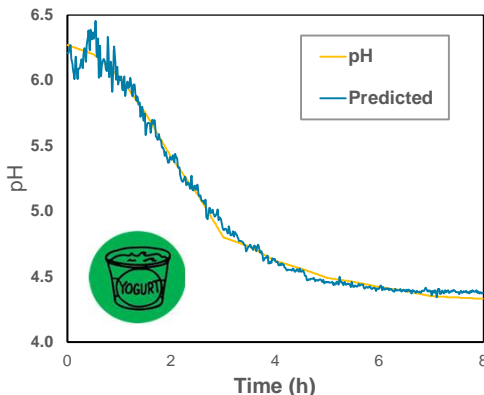
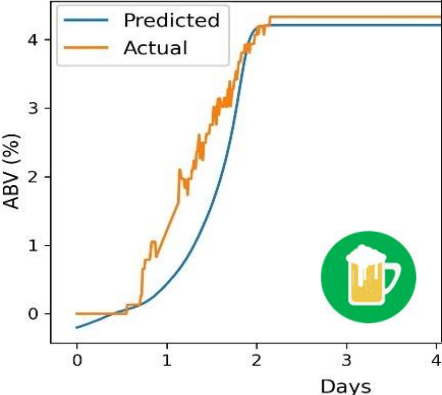

Inline ultrasonic measurements and machine learning to optimise fermentation processes



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# Sustainable Fermented Products




- Data collected from lab and industry partners
- Convolution + Long Short-Term Memory Neural Networks with waveform and process features
- Transfer and Federated Learning

**2021** Convolutional Feature Extraction for Process Monitoring using Ultrasonic Sensors. *Computers and Chemical Engineering*, 107508.

**2021** Domain Adaptation and Federated Learning for Ultrasonic Monitoring of Beer Fermentation. *Fermentation*, 7(4), 253.


**2022** Machine learning and domain adaptation to monitor yoghurt fermentation using ultrasonic measurements. *Food Control* (Under review)

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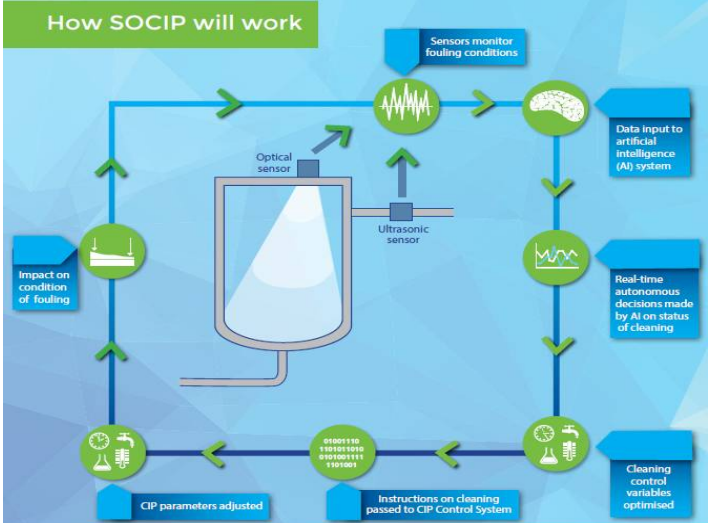
# Case Study 2: Self-Optimising Clean-in-Place


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## Self-Optimising Clean-In-Place

### How SOCIP will work









35% of water in beer production is spent on cleaning (Pettigrew et al 2015)




30% of energy in dairy processing is spent on cleaning (Eide et al 2003)

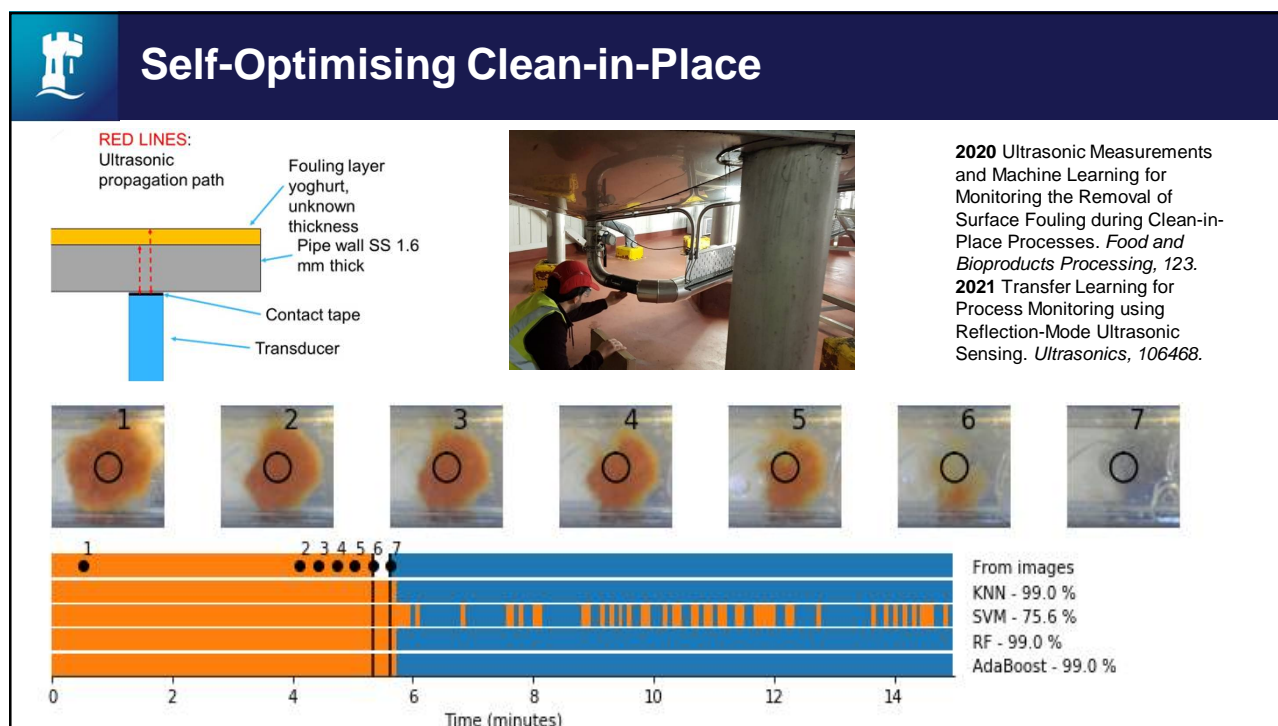








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## How to Get Digital!

- Just try something!
  - What data/information do you need to make better decisions?
  - What technologies could have the biggest impact on your business?
- Get in touch
  - Happy to provide advice
  - We want to monitor your processes!
- Networks
  - Made Smarter: [UK Digital Manufacturing advice & innovation – Made Smarter](#)
  - Connected Everything: [Connected Everything II: Accelerating Digital Manufacturing Research Collaboration and Innovation](#)

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## Summary

- The deployment of Industrial Digital technologies such as sensors and AI is expected to rise within food and drink manufacturing due to the safety, sustainability and productivity benefits they deliver and the potential for large data collection
- Understanding the limitations as well as the benefits of any technology is key
- HumanS in the loop is essential for all critical decision making processes and we should focus on digital technologies augmenting human workers
- To accelerate the adoption of innovative technologies there is the need for more controlled factory trials (expensive and time consuming) to provide clear evidence of the benefits

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## Acknowledgements and References

Funding: Innovate UK, EPSRC (Internet of Food Things Network+ and Connected Everything Network+)

Fermentation Monitoring: Alex Bowler (UoN), Josep Escrig (UoN), Rob Witt (Totally Brewed)

CIP Monitoring: Josep Escrig, Alex Bowler (UoN), Elliot Woolley (LU), Alessandro Simone (SU)

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Bowler, A.; Escrig, J.; Pound, M.; Watson, N. Predicting Alcohol Concentration during Beer Fermentation Using Ultrasonic Measurements and Machine Learning. *Fermentation* 2021, 7, 34. <https://doi.org/10.3390/>

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J. Escrig, E. Woolley, S. Rangappa, A. Simeone, and N. J. Watson, "Clean-in-place monitoring of different food fouling materials using ultrasonic measurements," *Food Control*, vol. 104, pp. 358–366, Oct. 2019.

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