EPSRC Centre for Innovative Manufacturing in INDUSTRIAL SUSTAINABILITY

The future of manufacturing: a UK perspective

FAPESP

BRITISH COUNCIL

PRESENTED TO
LGP

PRESENTED BY
DCM

13/03/2015

UNIVERSITY OF CAMBRIDGE

Cranfield UNIVERSITY

EPSRC
Pioneering research and skills

Imperial College London

Loughborough University

EPSRC Centre for Innovative Manufacturing in INDUSTRIAL SUSTAINABILITY

Overview and Introduction

Overview

- Introduction
- Future of manufacturing: foresight
- Industrial sustainability research
- An agenda for industry?

13 years in Cambridge UGrad, PGrad, PDoc

Joined EPSRC Centre in 2011 at inception

Based at the IfM

Leading Configurations for sustainable industrial systems Grand Challenge and Cohort Development Porgramme

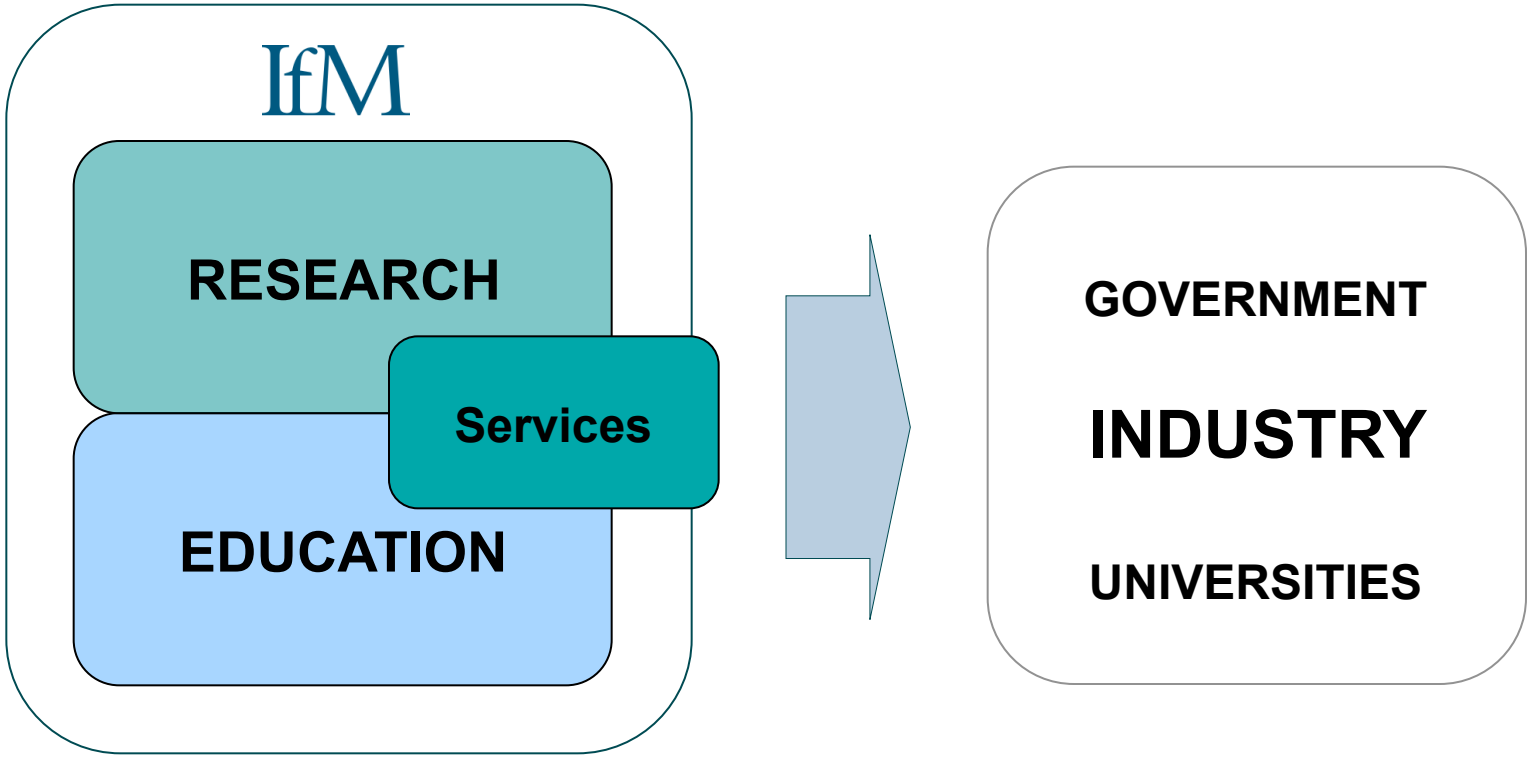
- David Morgan – lead researcher @ EPSRC Centre for Industrial Sustainability
- Manufacturing Engineering – MEng (2005)
- Novel Polymer Recycling Processes – PhD (2010)

The Institute for Manufacturing

Manufacturing

The full cycle from understanding markets and technologies through product and process design to operations, distribution and related services

Approach


IfM
RESEARCH
Services
EDUCATION
GOVERNMENT
INDUSTRY
UNIVERSITIES

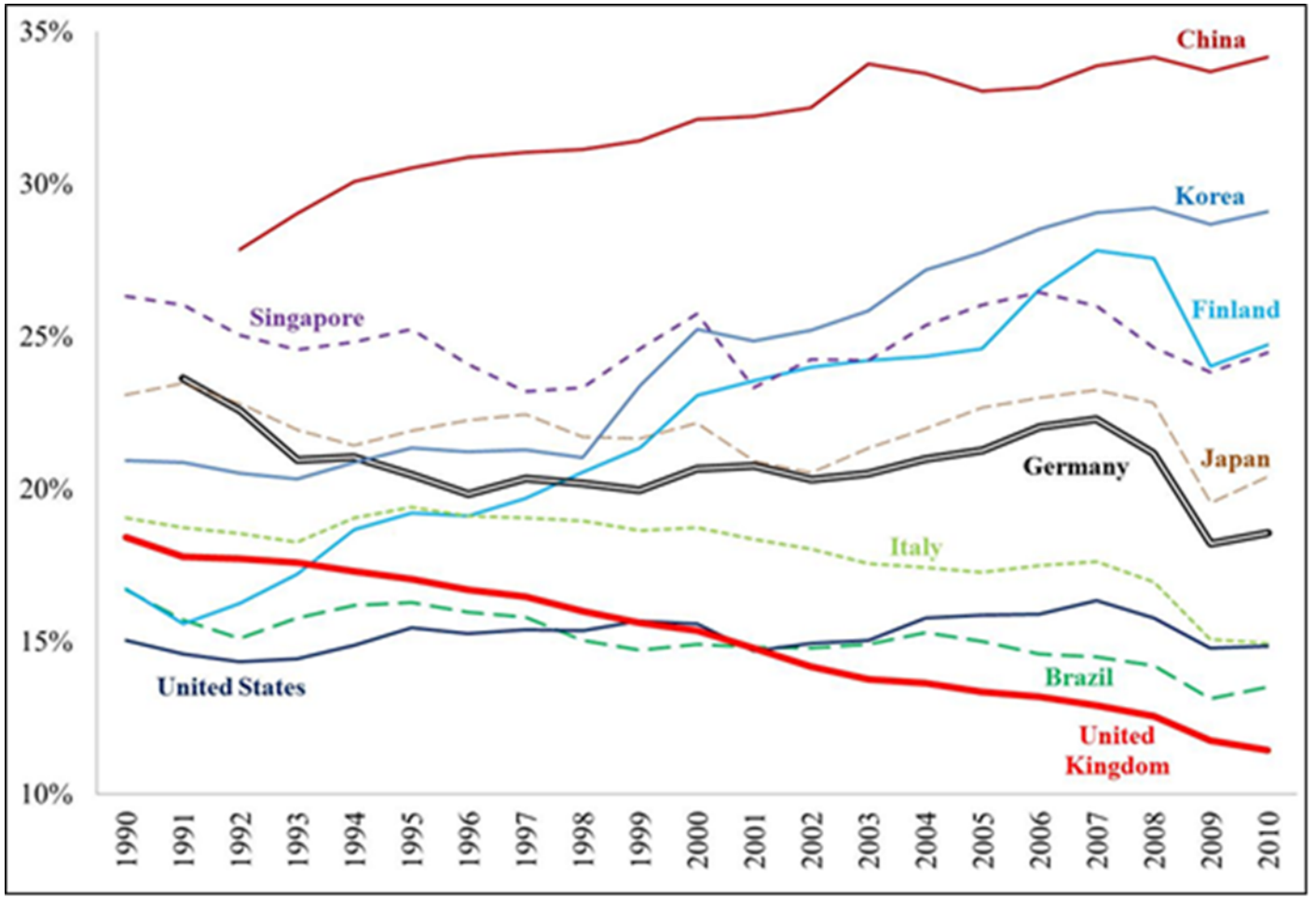
EPSRC Centre for Innovative Manufacturing in INDUSTRIAL SUSTAINABILITY

Future of manufacturing (UK)

UNIVERSITY OF CAMBRIDGE
Cranfield UNIVERSITY
EPSRC Pioneering research and skills
Imperial College London
Loughborough University

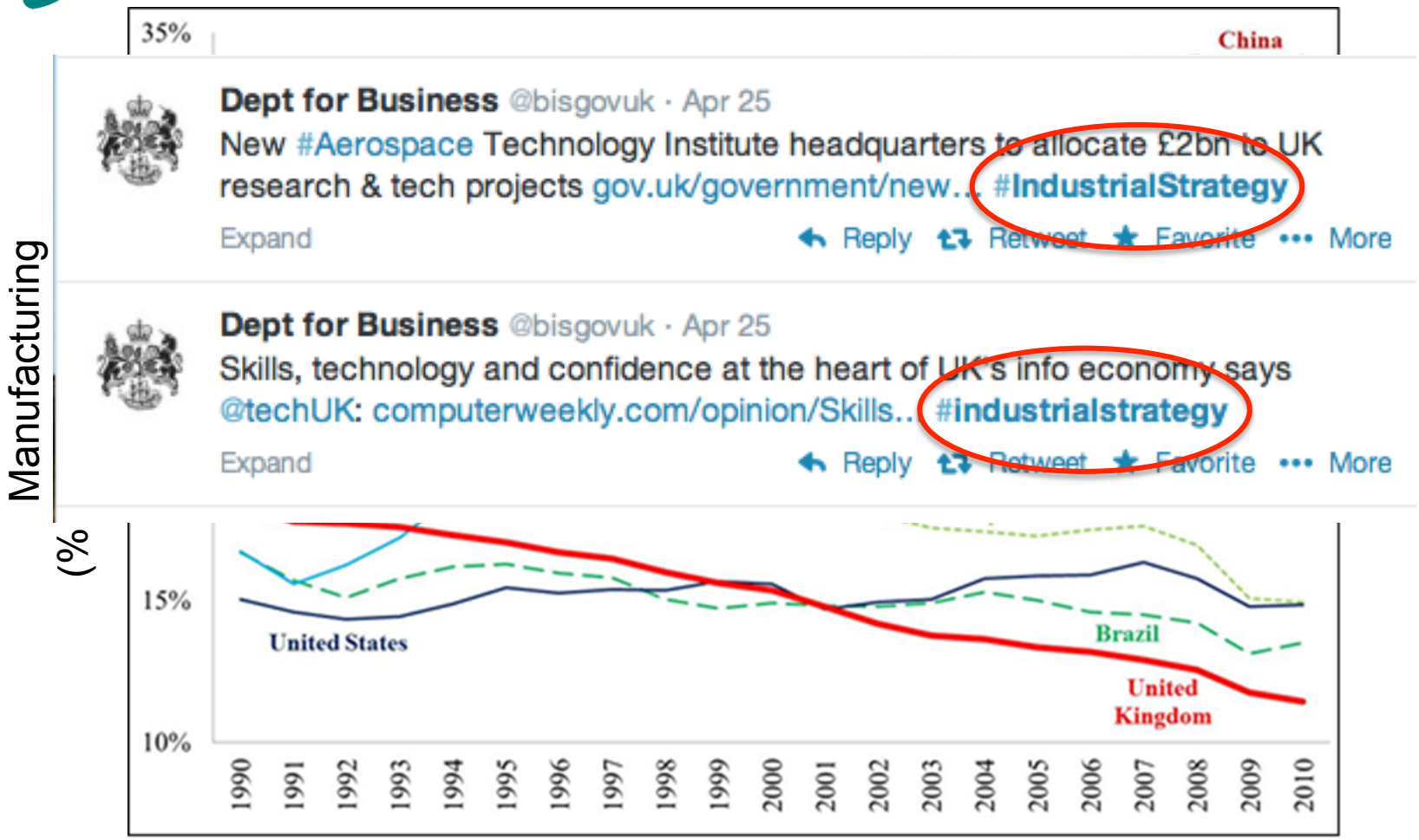
EPSRC Centre for Innovative Manufacturing in INDUSTRIAL SUSTAINABILITY

Economic change and uncertainty



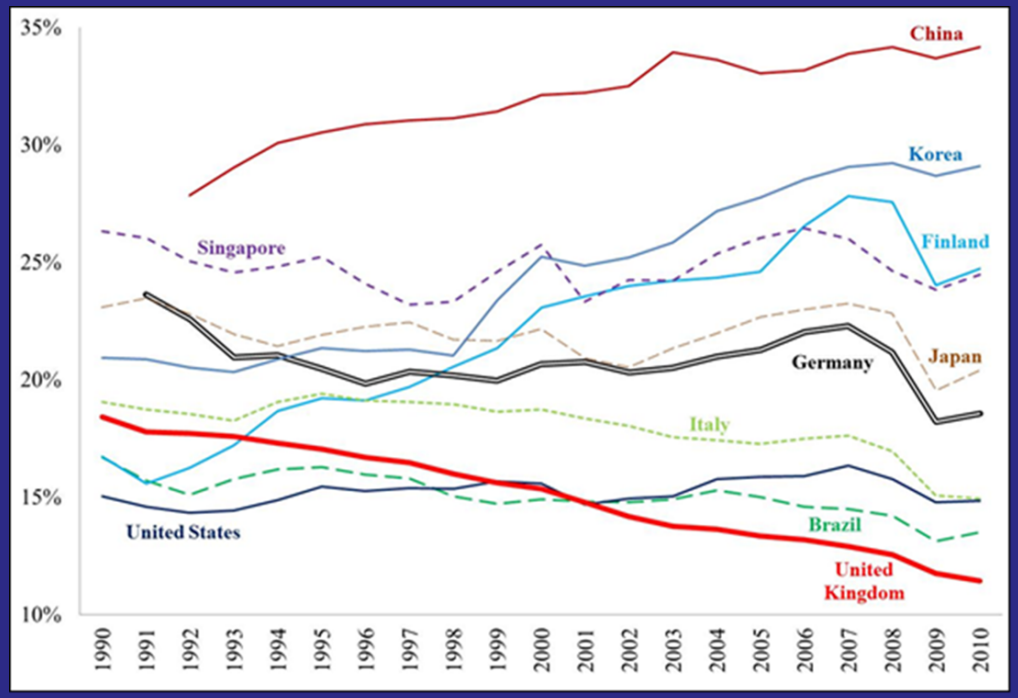
EPSRC Centre for Innovative Manufacturing in INDUSTRIAL SUSTAINABILITY

Economic change and uncertainty



Slides courtesy of Foresight

The Future of Manufacturing:
A new era of opportunity and challenge



Foresight Future of Manufacturing Project

Objective has been to investigate *changes and uncertainties* facing UK manufacturing activities, to 2050 where possible, to inform how the UK can create and capture *future value.*

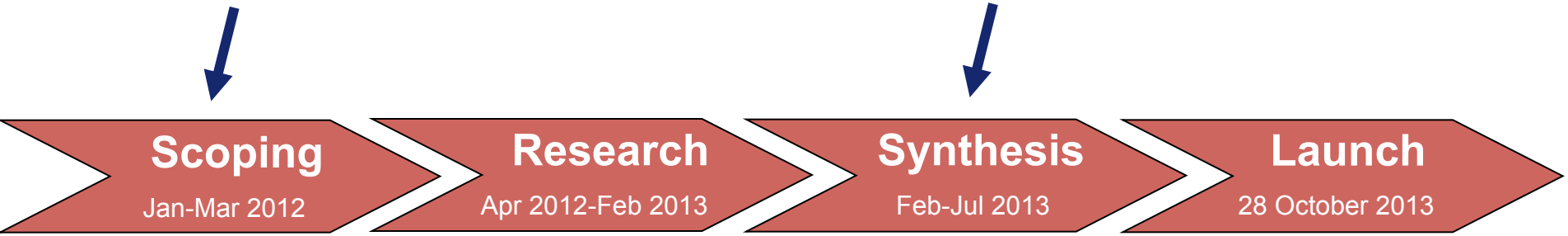
Vince Cable is the sponsoring minister. Findings available for BIS to use to inform development of future policy.

2 years: UK Roundtables, International Workshops, 37 commissioned evidence papers

How the research was done

- Lead Expert Group
- Industry High Level Stakeholder Group

- Drafting of chapters
- Engagement with BIS & HMT



- 37 commissioned evidence papers, 2000+pages
- 3 international workshops (USA, Germany, Japan)
- Engagement with industry
- UK roundtable events

Local contributions

Lead expert group

- Professor Steve Evans
- Professor Alan Hughes
- Professor Chris Lowe

Evidence papers

- Dr Elif Bascavusoglu-Moreau
- Professor Ha-Joon Chang
- Dr Antonio Andreoni
- Ming Leong Kuan
- Dr Ken Coutts
- Professor Simon Deakin
- Professor Michael Kelly

Evidence papers ctd

- Dr Finbarr Livesey
- Dr Eoin O'Sullivan
- Nicola Mitchell
- Dr. Mike Tennant (EPSRC Centre)

Report peer review

- Prof. Sir Mike Gregory
- Professor Robert Rowthorn

Workshops

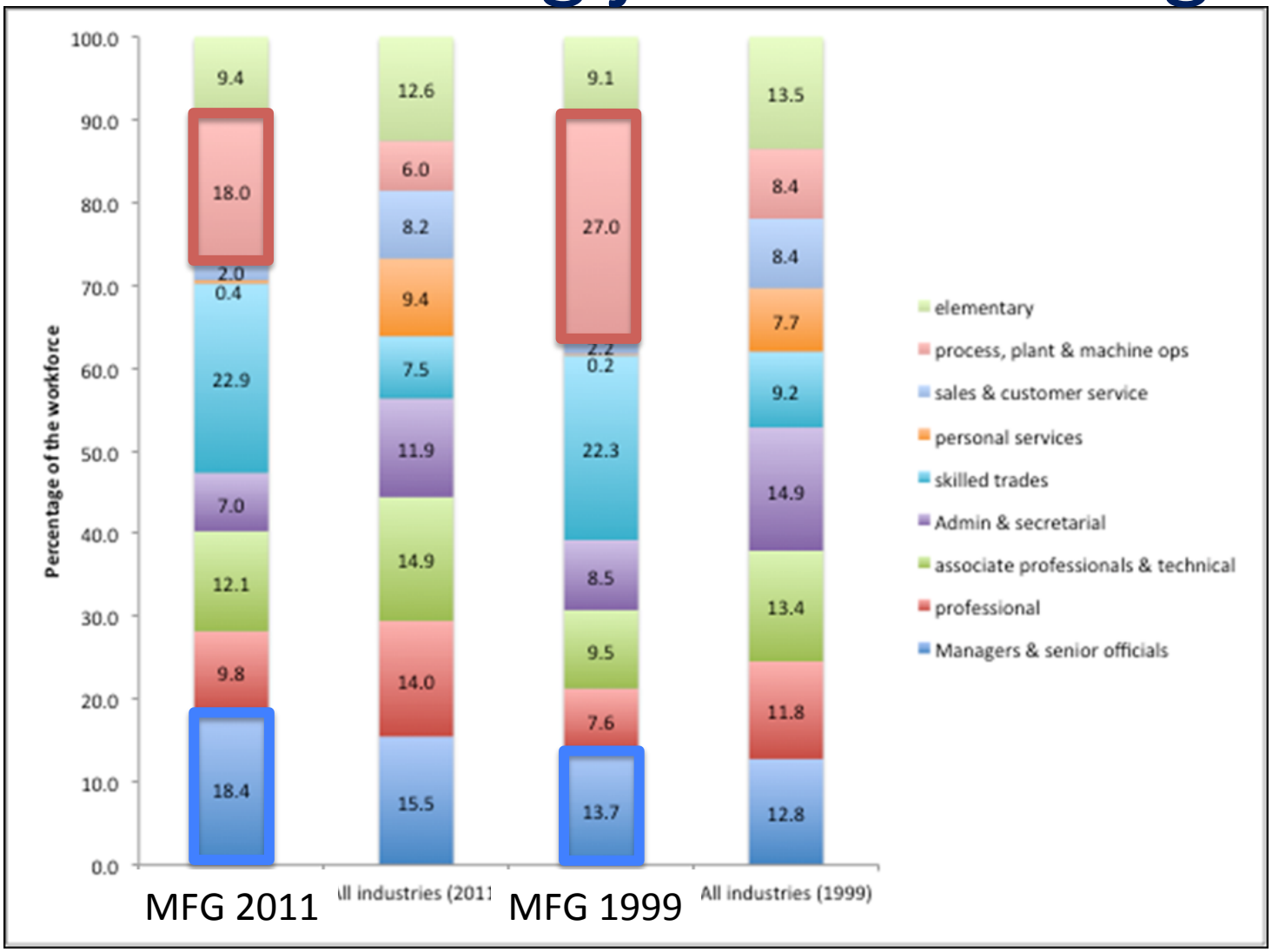
- Dr. Carlos López-Gómez
- Elliot More

Further evidence

- Professor Andy Neely

A range of indicators for value

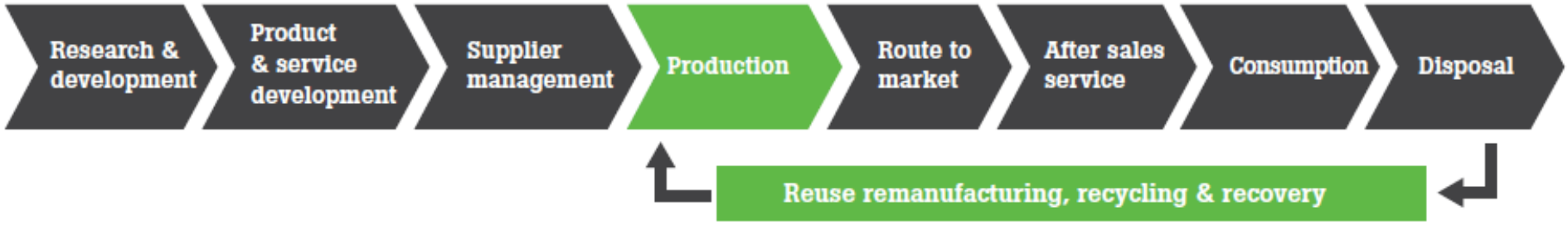
Manufacturing jobs are changing



1. More than making a product and selling it

- **Services with products** e.g. Rolls Royce
- Selling of **technological 'know how'** e.g. ARM
- **Remanufacturing** of products e.g. JCB / Caterpillar

Manufacturers will increasingly make use of a wider value chain to create revenue.




Massive Incremental Technology
Full integration of ICT
(involving digital modelling, simulation and automation) into manufacturing processes
Massive Incremental Technology
Sustainable technologies
reduce material and energy use
Massive Incremental Technology
Sensors integrated
into digital networks and products
By 2050 we will see a technological revolution in how products are designed, offered and used by customers.
New opportunities for value creation including true mass personalisation at low cost.
Massive Incremental Technology
New materials
currently in development penetrate the mass market
Radical Technology
Bio and medical technology,
including cell printing and production of in-vitro meat
Disruptive Technology
Currently unknown disruptive and innovative technologies
Radical Technology
Additive manufacturing
becomes mainstream, complementing or displacing existing processes

2. Faster, more responsive and closer to customers

- Mass **personalisation** of products on demand
- **Distributed**: big high-tech, modular, home, mobile
- Greater **design freedom**
- More **digital connections** along value chains

3. Exposed to new market opportunities

- Changes to **personal wealth** / **ageing** populations
- **BRICs** and the '**Next 11**'
- Continued **global 'fragmentation'** of the value chain
- Some '**onshoring**'

4. Increasingly dependent on highly skilled workers

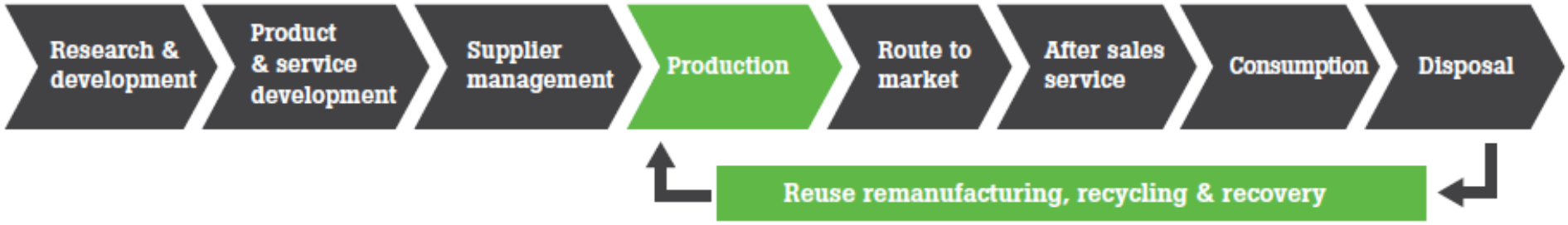
- **Strong demand** for manufacturing workers
- A need to accommodate more **older workers**
- Importance of **STEM** qualifications
- Blending of technical & commercial **'hybrid' skills**
- Potential for **human enhancement**

5. More sustainable

- Growing / urban populations **raise resource demand**
- **Climate change** and global supply chain vulnerability
- Volatility in **price & availability of commodities**
- Reuse, **remanufacturing**, recycling: circular economy

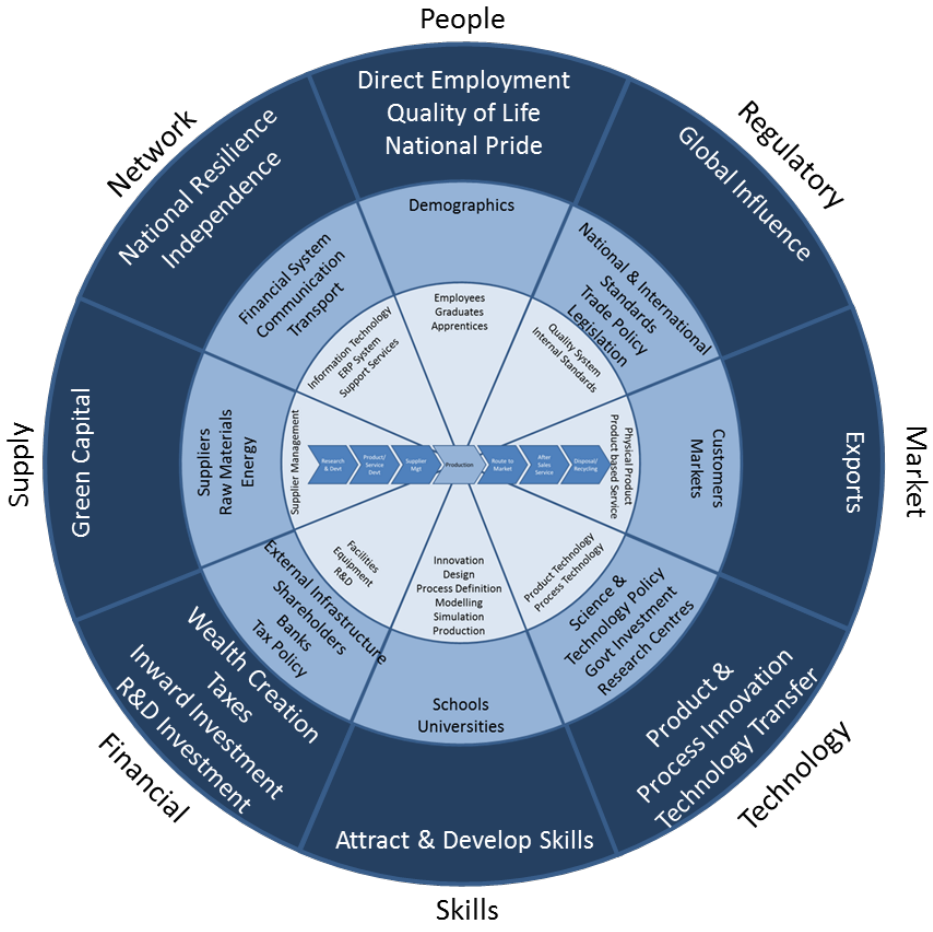
5 key findings

- **More than making a product and selling it**
  Services with products, selling know-how
- **Faster, more responsive and closer to customers**
- **Exposed to new market opportunities**
- **Increasingly dependent on highly skilled workers**
- **More sustainable**



Understanding Value

Manufacturing will be a complex, value creating system. Emphasis not on production or services but on flexing business models and offerings to create value.



EPSRC Centre
for Innovative
Manufacturing in
INDUSTRIAL
SUSTAINABILITY

Industrial sustainability

UNIVERSITY OF CAMBRIDGE
Cranfield UNIVERSITY
EPSRC
Pioneering research and skills
Imperial College London
Loughborough University

EPSRC Centre for Innovative Manufacturing in INDUSTRIAL SUSTAINABILITY

Global systems are under pressure

ENVIRONMENT

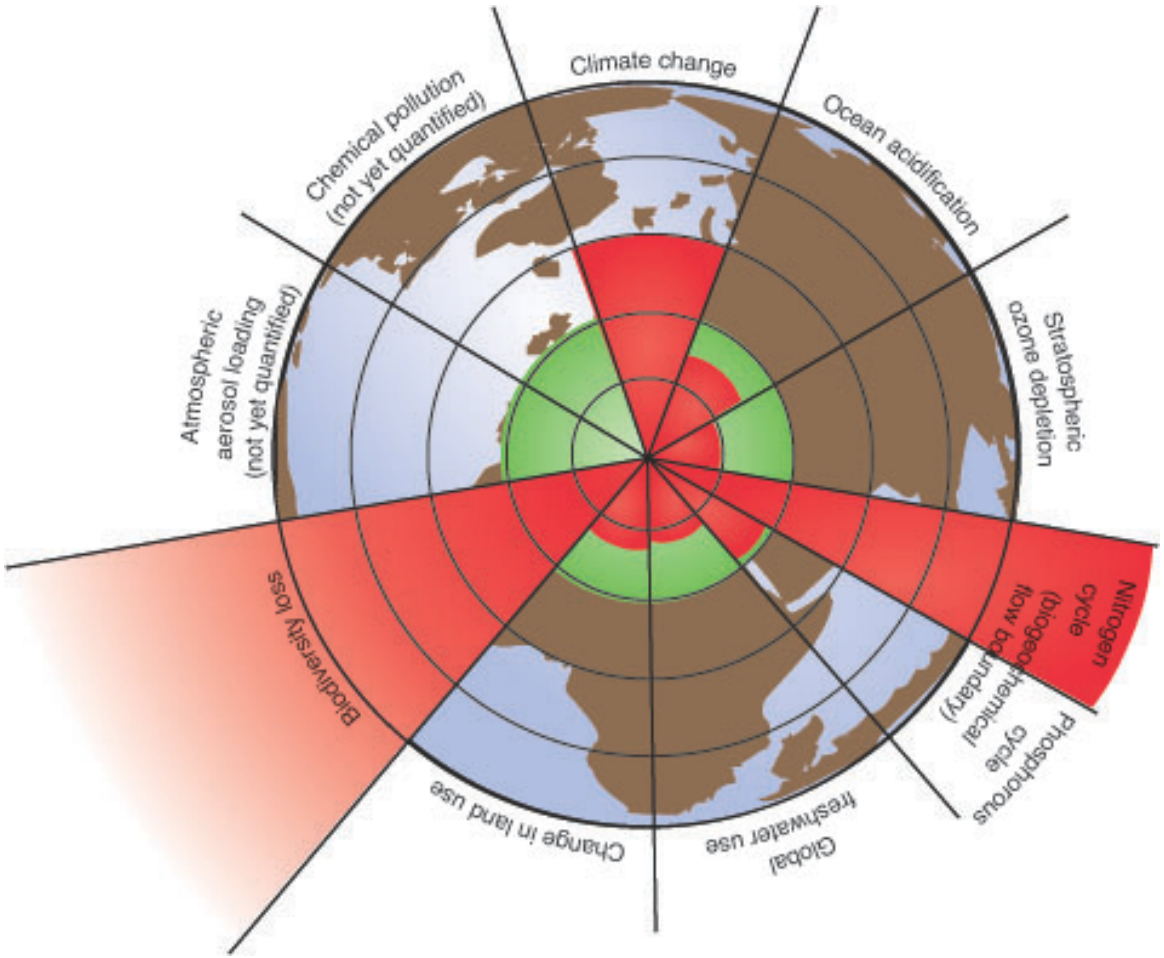
Attempts to define safe operating limits of key planetary systems.

Key systems are

- *Interconnected*
- *Non linear*

Some safe limits have been reached and breached – although uncertainty is high.

(credit: Azote Images/ Stockholm Resilience Centre)



UNIVERSITY OF CAMBRIDGE · Cranfield UNIVERSITY · EPSRC Pioneering research and skills · Imperial College London · Loughborough University

EPSRC Centre for Innovative Manufacturing in INDUSTRIAL SUSTAINABILITY

Mega-Forces

BEYOND CLIMATE CHANGE

Expect the Unexpected: Building business value in a changing world, KPMG 2012

Sustainability and Manufacturing, Evidence Paper 35, Foresight

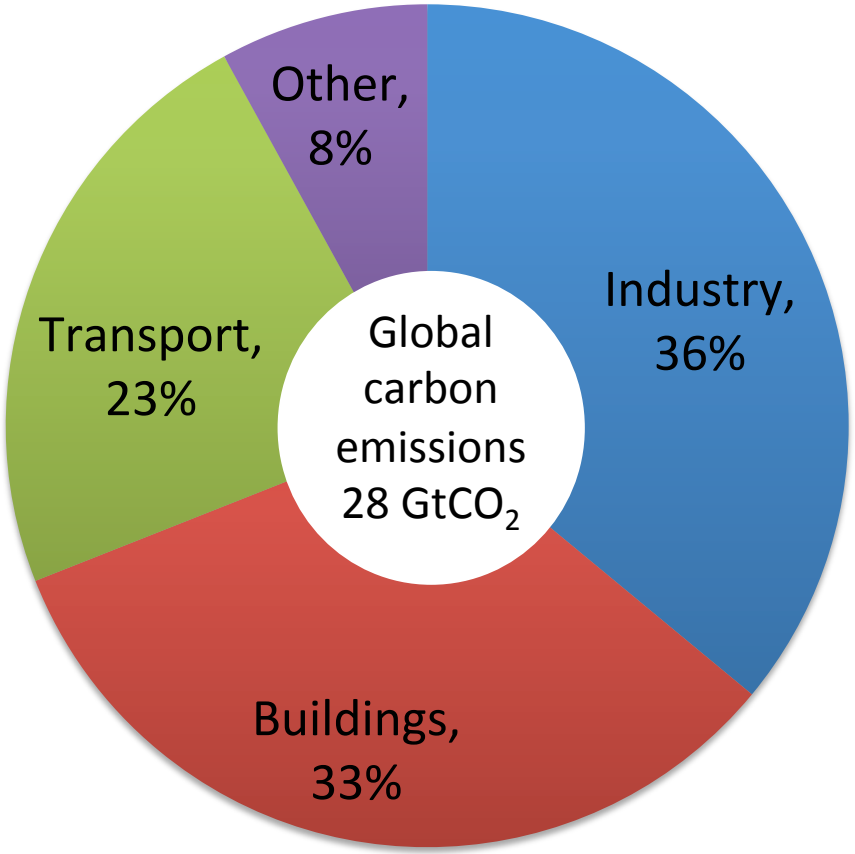
Tennant (2013)

- Climate change, food security, water scarcity, population growth, energy and fuel, material and resource scarcity, ecosystem decline, urbanisation *(KPMG report 2012)*

> *'…it is critical to understand that the drivers are **irreducibly inter-related**. They influence each other in **complex, unpredictable ways** and cannot be disentangled to elucidate determinate cause-and-effect relationships. This has implications in that industry will have to conceive of business propositions and technologies that **satisfy multiple constraints simultaneously**. '*
>
> *Tennant, 2013*

EPSRC Centre for Innovative Manufacturing in INDUSTRIAL SUSTAINABILITY

Impacts - Global carbon emissions (process & energy)



Allwood et al. (2010) Options for achieving a 50% cut in industrial carbon emisisons. Environ. Sci. Technol. 2010, 44, 1888–1894

EPSRC Centre for Innovative Manufacturing in INDUSTRIAL SUSTAINABILITY

What are we trying to sustain?

"you can be profitable without being resilient, but you cannot be resilient without being profitable"

Industrial Collaborator

EPSRC Centre for Innovative Manufacturing in INDUSTRIAL SUSTAINABILITY

Visible and affecting pollution

HANGZHOU - 2013

Hangzhou, Summer 2013

Hangzhou, Winter 2013

Courtesy of Miying Yang

EPSRC Centre for Innovative Manufacturing in INDUSTRIAL SUSTAINABILITY

The Urgent Challenge:

THE BENEFITS OF INDUSTRIALISATION WITHOUT THE BAD BITS

- To quadruple output,
- To emit 80% less GHGs,
- To halve resource use

All by 2050

- The challenge requires new approaches and new understanding that we term ***Industrial Sustainability,*** which leads to nothing less than a new industrial revolution

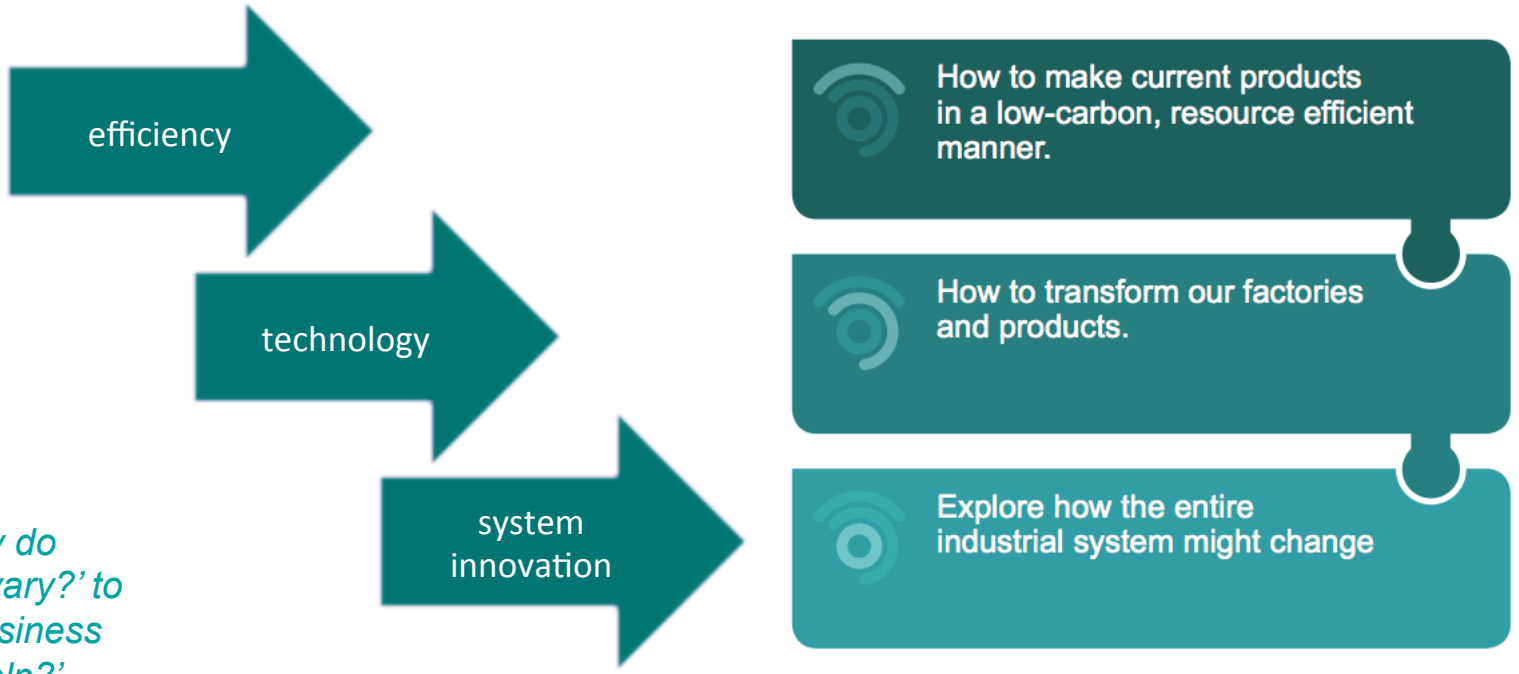
The national centre for industrial sustainability in the UK.

UNIVERSITY OF CAMBRIDGE

EPSRC Centre for Innovative Manufacturing in INDUSTRIAL SUSTAINABILITY

Research Themes

WHAT ARE TODAY'S KEY CHALLENGES?



From 'why do factories vary?' to ''which business models help?'

UNIVERSITY OF CAMBRIDGE

UNIVERSITY OF CAMBRIDGE · Cranfield UNIVERSITY · EPSRC Pioneering research and skills · Imperial College London · Loughborough University

EPSRC Centre for Innovative Manufacturing in INDUSTRIAL SUSTAINABILITY

Who do we work with?

Members

Project Partners

Associated British Foods plc

COLLABORATORS

- CLAAS
- ELCON Solution Oy
- FIDIA S.p.A.
- Luxottica
- Airbus
- Digital Green
- Vera Solutions
- Frontier Markets
- Indian Institute of Management in Ahmedabad
- Villgro Innovations Foundation
- Acumen Fund
- Venture Studio
- ASICS
- Cambridge Programme for Sustainability Leadership (CPSL)
- Angelantoni (Archemedes Solar)
- Stanley-DeWalt Italia
- Campari
- Colacem
- CSC
- Cucchinelli
- Dupont
- ILVA
- Loccioni
- Umbra Group
- Veragon
- AB Sugar
- Boots
- Kyocera
- Xeros
- Lavery Pennell
- 2degrees
- VTT Technical Research Centre of Finland
- Politecnico di Milano
- University of Stavanger
- RWTH Aachen University
- DIN, The German Institute for Standardization
- University of Genova

EPSRC Centre
for Innovative
Manufacturing in
INDUSTRIAL
SUSTAINABILITY

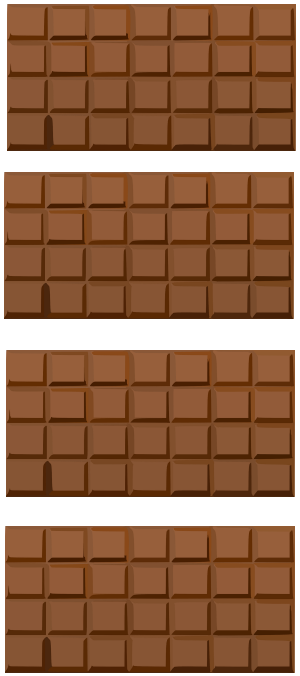
Research: Efficiency

EPSRC Centre for Innovative Manufacturing in INDUSTRIAL SUSTAINABILITY

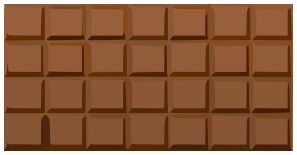
Energy needed to make chocolate bars

WHY DO FACTORIES VARY?

Factory A



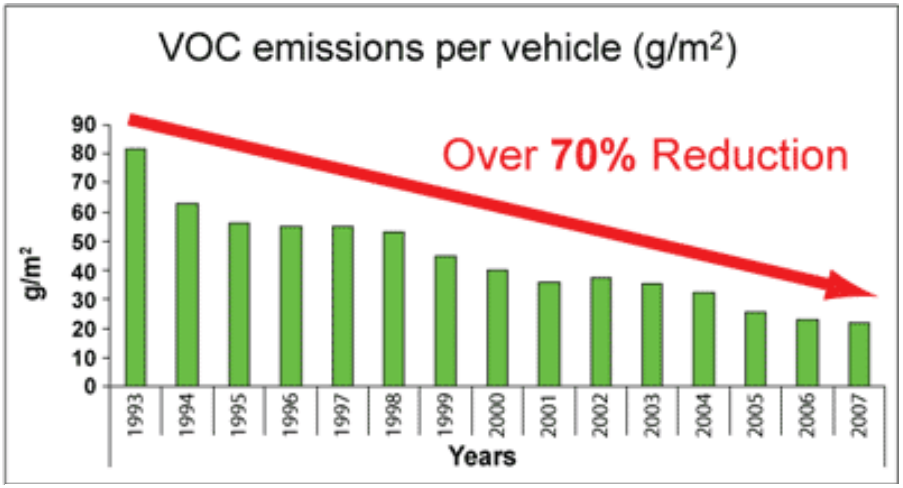
Factory B

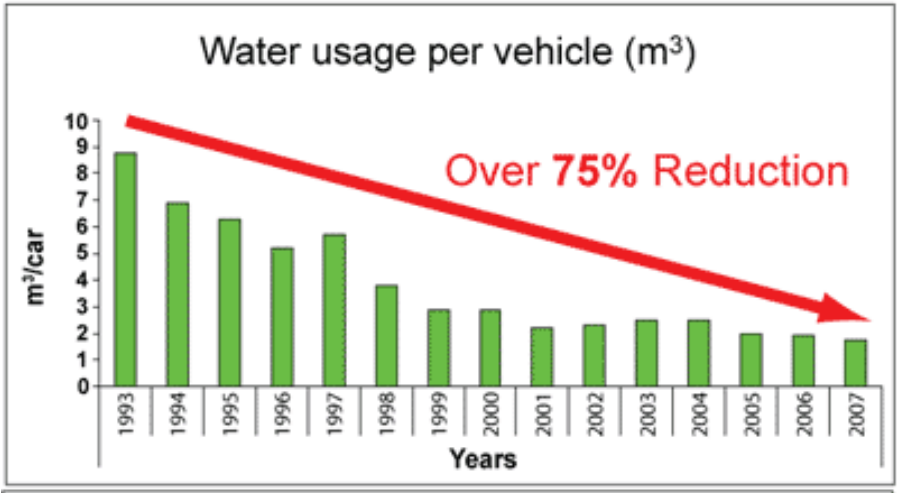


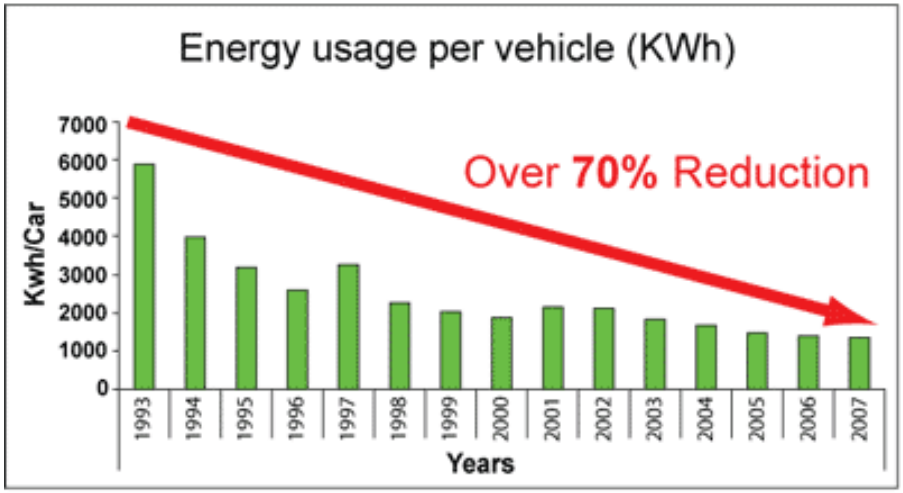
EPSRC Centre for Innovative Manufacturing in INDUSTRIAL SUSTAINABILITY

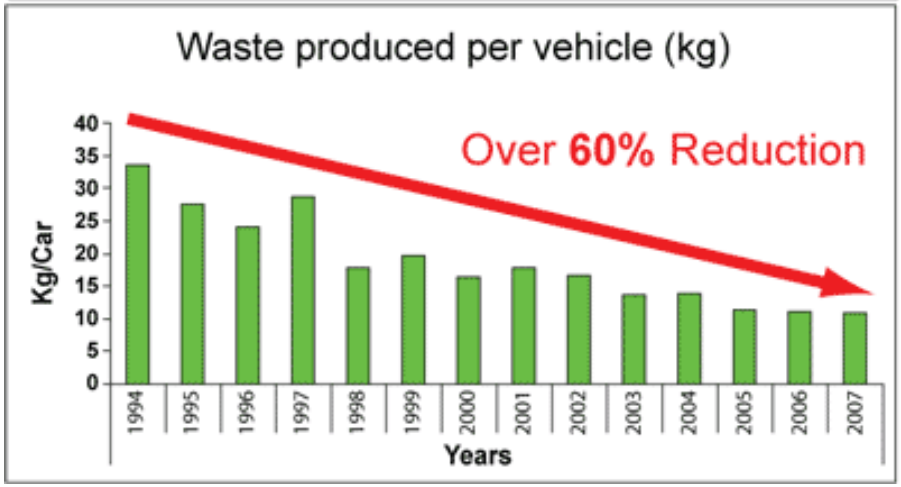
Toyota Manufacturing Europe

MORE EFFICIENT PRODUCTION









Courtesy of Steve Hope.
Toyota Motor Europe

UNIVERSITY OF CAMBRIDGE
Cranfield UNIVERSITY
EPSRC Pioneering research and skills
Imperial College London
Loughborough University

EPSRC Centre for Innovative Manufacturing in INDUSTRIAL SUSTAINABILITY

Environmental performance variation

GRAND CHALLENGE RESEARCH PROJECT

Grand challenge questions

How far can the best companies go?

What is the size of the prize?

What techniques help people deliver efficiency?

How do we spread those techniques?

PhD & Industry Projects

- Eco-efficient changeovers
- Efficiency practices and their application
- Maturity of management systems and how performance can be advanced
- Factory modelling & decision making tools
- Building eco-efficiency into supplier relationships

Outputs

- Integrated tool kits, techniques and games to help manufacturers engage and improve their environmental performance

EPSRC Centre
for Innovative
Manufacturing in
INDUSTRIAL
SUSTAINABILITY

Business models

UNIVERSITY OF CAMBRIDGE
Cranfield UNIVERSITY
EPSRC
Pioneering research and skills
Imperial College London
Loughborough University

Key Partners	Key Activities	Value Proposition	Customer Relationships	Customer Segments
	Key Resources		Channels	
Cost Structure		Revenue Streams		

Osterwalder and Pigneur

UNIVERSITY OF CAMBRIDGE

Cranfield UNIVERSITY

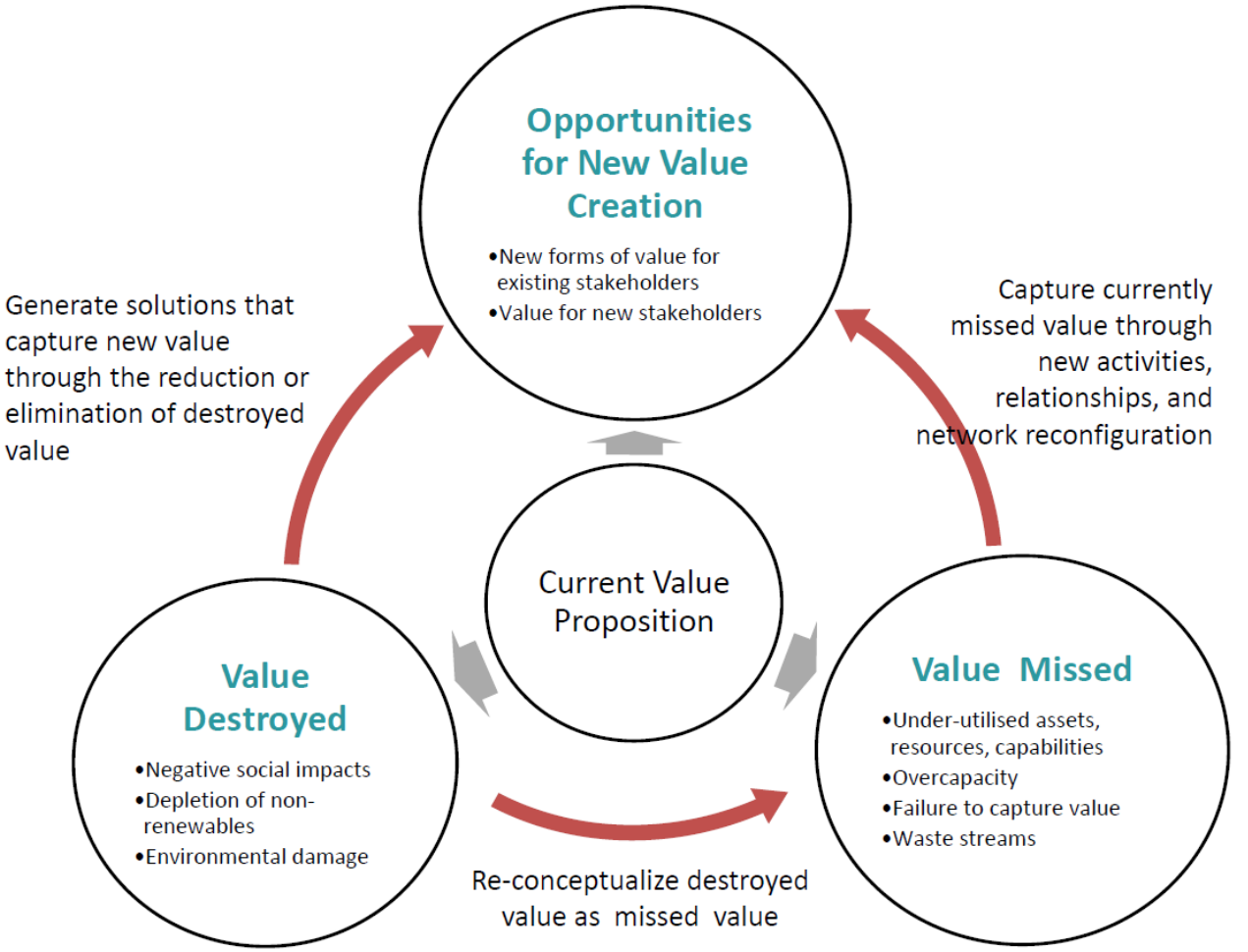
EPSRC Pioneering research and skills

Imperial College London

Loughborough University

EPSRC Centre for Innovative Manufacturing in INDUSTRIAL SUSTAINABILITY

Business model research: Value rationale



Develop frameworks and underpinning ideas from studying the literature, and working with / studying multiple industry case studies.

Embedding ideas in tools and techniques which can then be used by other companies

Bocken, Short, Rana, Evans et al

EPSRC Centre for Innovative Manufacturing in INDUSTRIAL SUSTAINABILITY

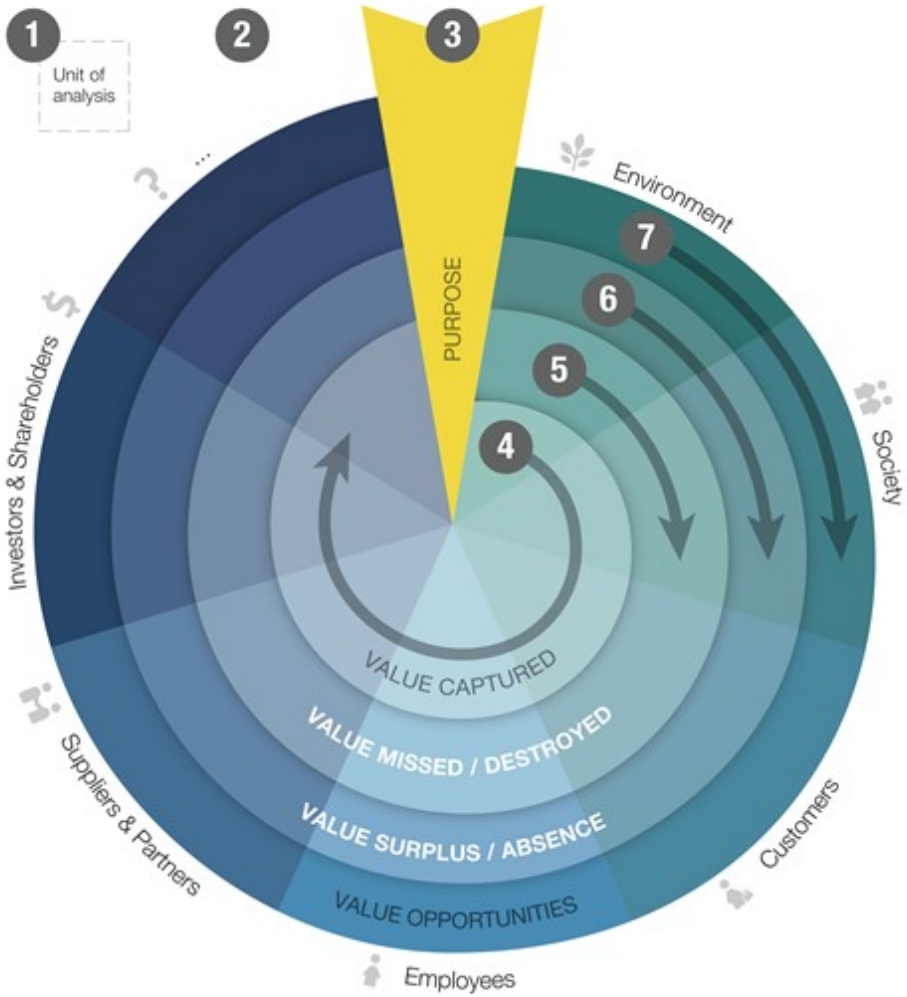
Business Model: Value mapping tool

***Use and test at 40+ workshops**:*

- *Firm level - start-ups, SMEs, MNCs*
- *Industry events*
- *Multiple stakeholders – Riversimple custodian workshop (1), Finnish Furniture Industry (3)*
- *Teaching material – Cambridge and Genoa (4)*

Used with other tools – business model canvas, roadmapping tool

Input towards PhD work



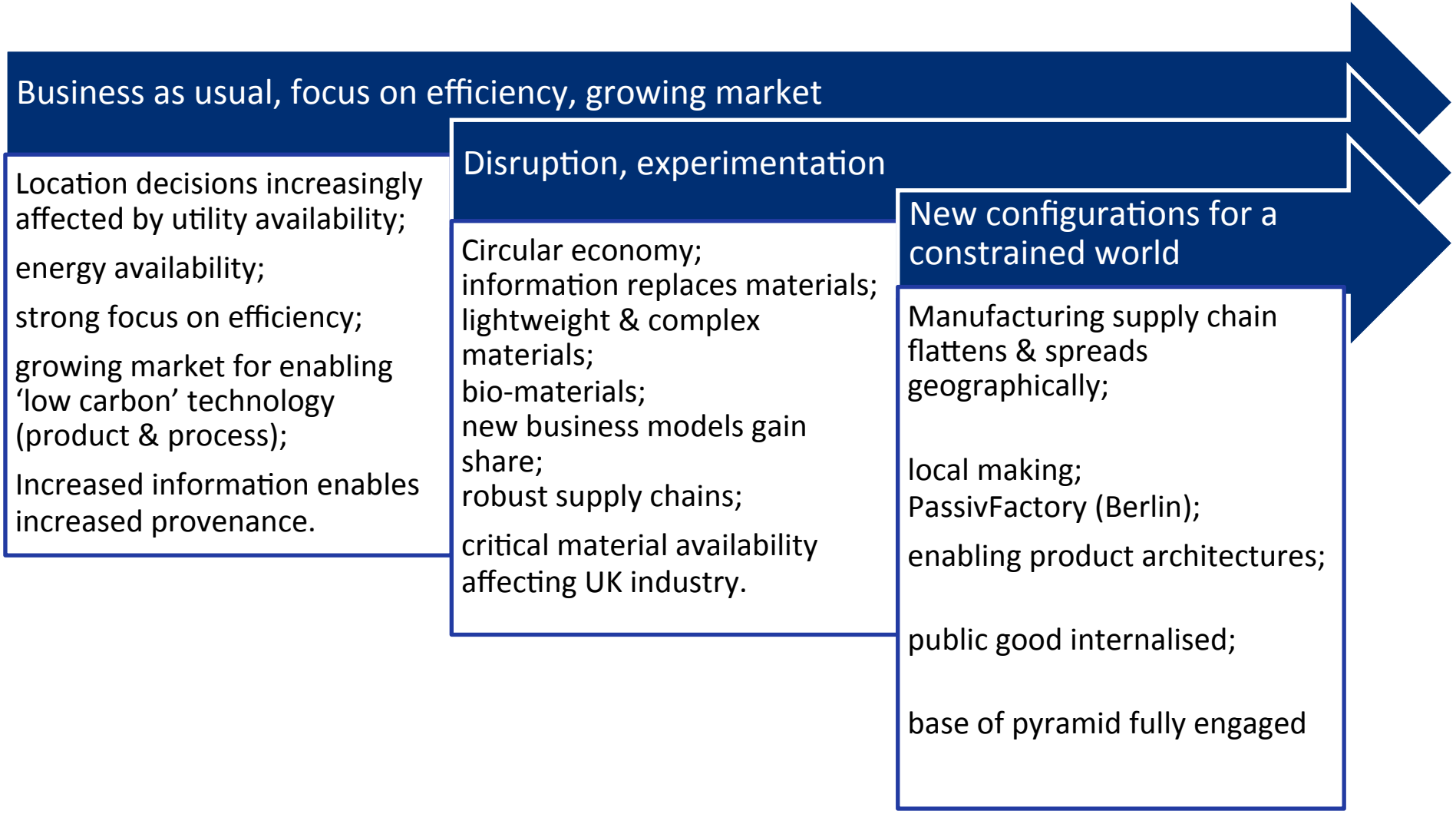
UNIVERSITY OF CAMBRIDGE · Cranfield UNIVERSITY · EPSRC Pioneering research and skills · Imperial College London · Loughborough University

EPSRC Centre
for Innovative
Manufacturing in
INDUSTRIAL
SUSTAINABILITY

System innovation

UNIVERSITY OF CAMBRIDGE
Cranfield UNIVERSITY
EPSRC
Pioneering research and skills
Imperial College London
Loughborough University

Sustainability



EPSRC Centre for Innovative Manufacturing in INDUSTRIAL SUSTAINABILITY

Systems research

- Design language for industrial systems
- Scenarios for systems change
- System mapping and capability analysis for sustainability transformations
- The role of the individual in radical, sustainability oriented innovation
- Sense making in circular modularity

How to companies engage with and plan for the future?

- Themes: Experimentation, systems thinking

EPSRC Centre for Innovative Manufacturing in INDUSTRIAL SUSTAINABILITY

Business model and supply chain innovation

MARKS AND SPENCERS CLOTHING

- REDRESS
  - 2 year project investigating opportunities to increase volume and value of textile recovery
  - Ambition

Oxfam

WE CAN'T AFFORD NOT TO SHWOP

LAUNCH OF REDRESS PROJECT WITH M&S

REDRESS is a collaborative project between M&S and Cambridge and funded by the TSB competition 'Supply Chain Innovation Towards A Circular Economy'. This is a 2-year project to drive garment recovery and retained value through business model and supply chain innovation. This project seeks to accelerate M&S Plan A commitments around reducing waste. The focus for this project will be to reduce the environmental impact of raw materials in M&S' clothing supply chain. The team will apply circular economy thinking to drive greater garment recovery and retained value. The outcomes of the project can be applied to textile and other industries.

The first REDRESS workshop took place on 2-3 October and was attended by a group of enthusiastic forward-looking thinkers from academia, business and other organisations. The group generated a wide range sustainable business model ideas for the project. The next challenge is to pick out the best ideas for the business pilots. To find out more about this project, contact lead researcher Dr Nancy Bocken (nmpb2@cam.ac.uk).

2012 Results

- 4 million items

- Approx 1700 tonnes

- Fibre value of £5 million

- What next?

UNIVERSITY OF CAMBRIDGE · Cranfield UNIVERSITY · EPSRC Pioneering research and skills · Imperial College London · Loughborough University

EPSRC Centre for Innovative Manufacturing in INDUSTRIAL SUSTAINABILITY

Tentative conclusions from UK experience

- Seek opportunities in efficiency aggressively, buy time, knowledge and credit for wider change. Seek the whole picture.
- Learning to experiment effectively and quickly to do things in seriously different ways.
- New ways of doing business can be found which are better for all.

EPSRC Centre for Innovative Manufacturing in INDUSTRIAL SUSTAINABILITY

Discussion & questions

http://www.ifm.eng.cam.ac.uk/

http://www.industrialsustainability.org/

Hangzhou, Summer 2013

Hangzhou, Winter 2013

Courtesy of Miying Yang