Future Supply Chains for the pharmaceutical industry – a collaborative approach

Clive Badman OBE

Vice President, Pre-Competitive Activities

GlaxoSmithKline R&D

Industrial Board Chairman, CMAC

GlaxoSmithKline: Our mission

To improve the quality of human life
By enabling people to

Do
more
feel
better
live
longer

The Business Environment has changed in Pharma

"For most of the postwar era, the pharmaceutical industry has been the most profitable sector of the U.S. economy by virtually any performance measure (return on equity, return on sales, etc.).

This superior performance was based on four structural pillars:
(1) latitude to charge relatively high prices, (2) long product life cycles, (3) 'blockbuster' drugs, and (4) relatively high R&D productivity."

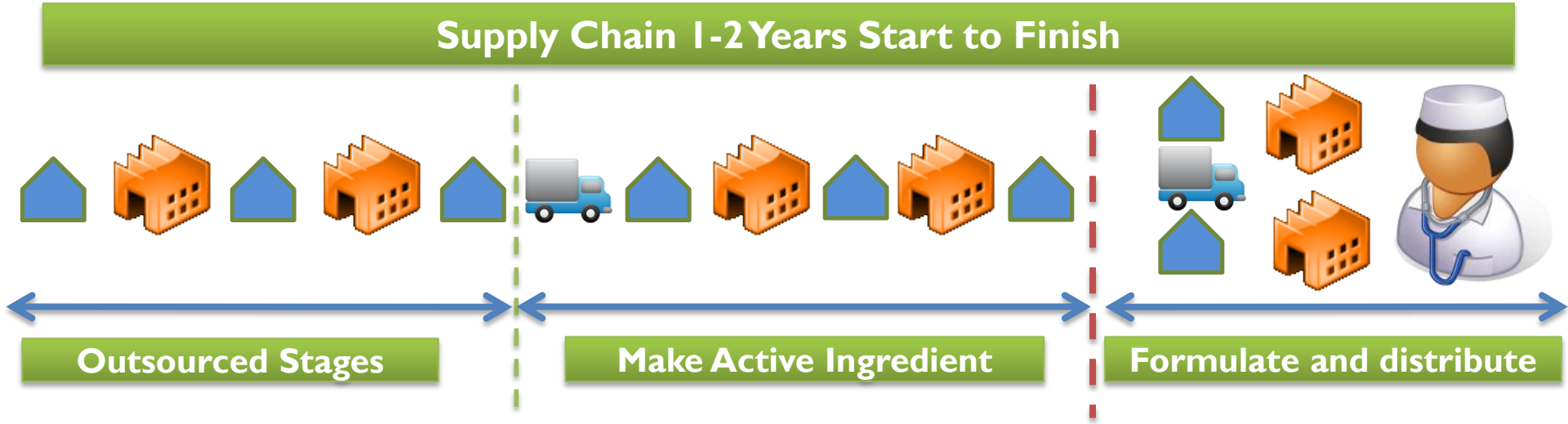
Professor Gary Pisano, Harvard Business School.
Quoted in Pisano, "Science Business: The Promise, the Reality, and the Future of Biotech," HBS, 2006

Pharmaceutical Industry Trends

Patent Cliff: $150bn pharma sales going generic 2010 – 2016.	Managing the transition
Blockbusters to smaller products: More frequent, targeted therapies	Current infrastructure sized for blockbuster volumes
Pressures on top and bottom line: new markets, efficiency programs	New market / patient needs Tight cost control
Societal Pressures: Rare diseases, diseases of the developing world	Smaller patient populations Cost sensitive needs
Working Capital Reduction Estimated to be $200billion!	Release working capital for re-investment

GlaxoSmithKline

Problem: Currently, It's a long way to the Patient



- Slow
- High Inventories between steps
- Long lags for changes to be seen in Formulated Product
- Risks mitigated by dual supplies, stocks and over capacity
- Product quality variability introduces cost and risk
- New technologies require patient-demand centric supply

- Higher cost/dose
- Formulation can be specific to source of active
- Limits access to medicines
- Little chance for process improvement

EPSRC
Centre for Innovative Manufacturing
in Continuous Manufacturing and Crystallisation

CMAC

Overview

- Established 2011, Demand led
- Portfolio of funding
  - EPSRC Centre; DTC, ICT
  - £34m UK RPIF Capital
  - £23m AMSCI Supply Chain
- 80 staff and rising : international talent
- Pre-competitive, leverage
- £100m Technology Innovation Centre @ Strathclyde, Glasgow physical hub
- 3 founding tier 1s GSK, AZ, Novartis.
- Tier 2 technology companies

Loughborough University · University of Bath · University of Strathclyde Glasgow · University of Glasgow · Heriot-Watt University · University of Cambridge IfM · GlaxoSmithKline · AstraZeneca · Novartis

EPSRC
Centre for Innovative Manufacturing
in Continuous Manufacturing and Crystallisation

CMAC

Facilities for Collaboration & Training: Forward Plans

- TIC building at Strathclyde, dedicated facility – Feb 2015
- Co-locate multidisciplinary teams - academic and industry researchers; collaborative ethos
- Processing, analysis and modelling
- **UK-RPIF – £11.4M Capital Award** to establish a ***World-Class Facility for Continuous Manufacturing and Crystallisation Research for Pharmaceutical Products.***
- **Wolfson award - £0.75M Capital Award – ToF-SIMS**

- **Continuous Processing Equipment**
- **State-of-the-art analysis and characterisation capabilities**
- **Comprehensive suite of PAT tools**
- **Continuous process skids for process development**
- **National PAT Network**

Facilities open to use by wider academic and industrial community *(www.cmac.ac.uk)*

EPSRC
Centre for Innovative Manufacturing
in Continuous Manufacturing and Crystallisation

6 month highlights

CMAC

- International Symposium 20/21st May 2014, Boston
  - 250 leaders: industry, regulators, academic
  - 8 white papers published
- Skills + Talent Pipeline
  - Out: Johnson Matthey, GSK, Mettler, Lilly, SME
  - In: academic recruits from Delft, GSK
  - New Masters program started, Doctoral Training
- Research impact increasing (80 people + growing)
  - Publications, conferences, licensing, patent
  - International US/ UK joint funding
  - Hosted recent national EPSRC Manufacturing the Future conf
- Higher TRL activity
  - Company projects, Collaborative RD –InnovateUK, AMSCI , skids
- Major Projects
  - £34m RPIF Capex , £22.7m AMSCI Remedies Supply Chain

Research Focus on Particles

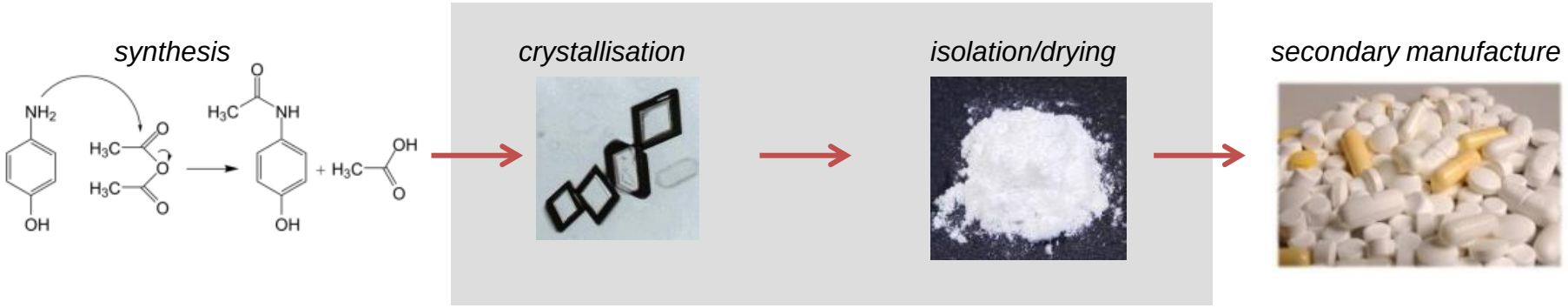
Exploit continuous manufacturing to deliver:

Consistent Particles	**Consistent drug substance throughout development and manufacture "Consistency by design"**
Better Particles	**Particles, processes and specifications for drug substance allowing optimisation of processes and product performance**
Novel Particles	**Isolate API in a form that delivers optimal drug performance allowing access to products beyond current manufacturing capability**

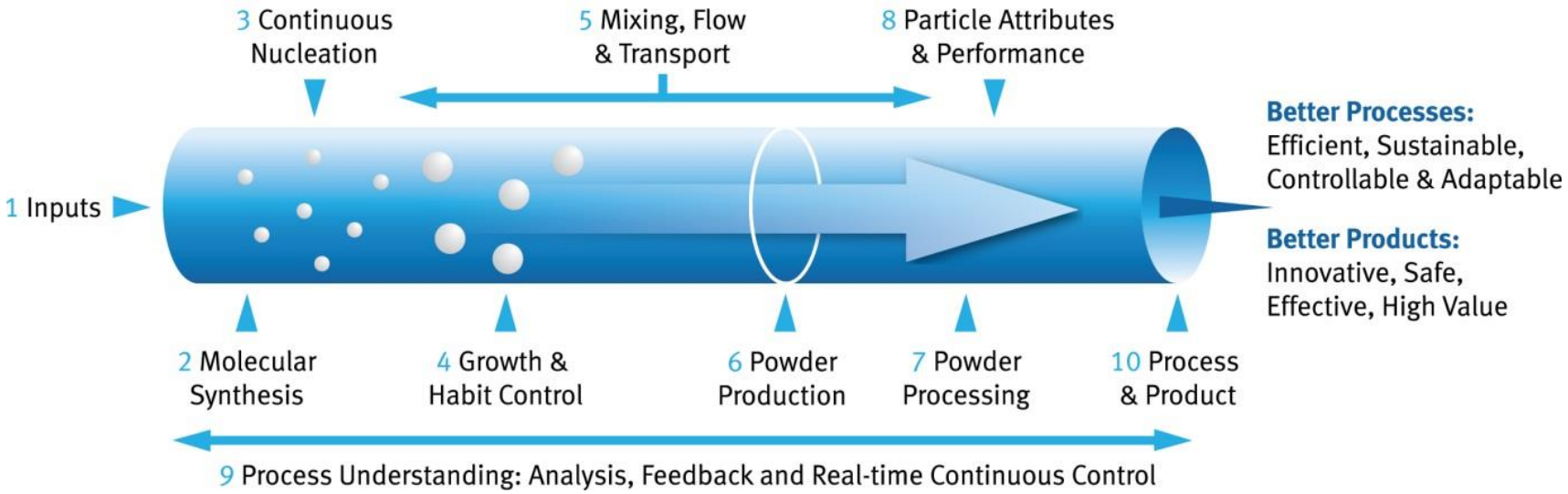
EPSRC
Centre for Innovative Manufacturing
in Continuous Manufacturing and Crystallisation

CMAC

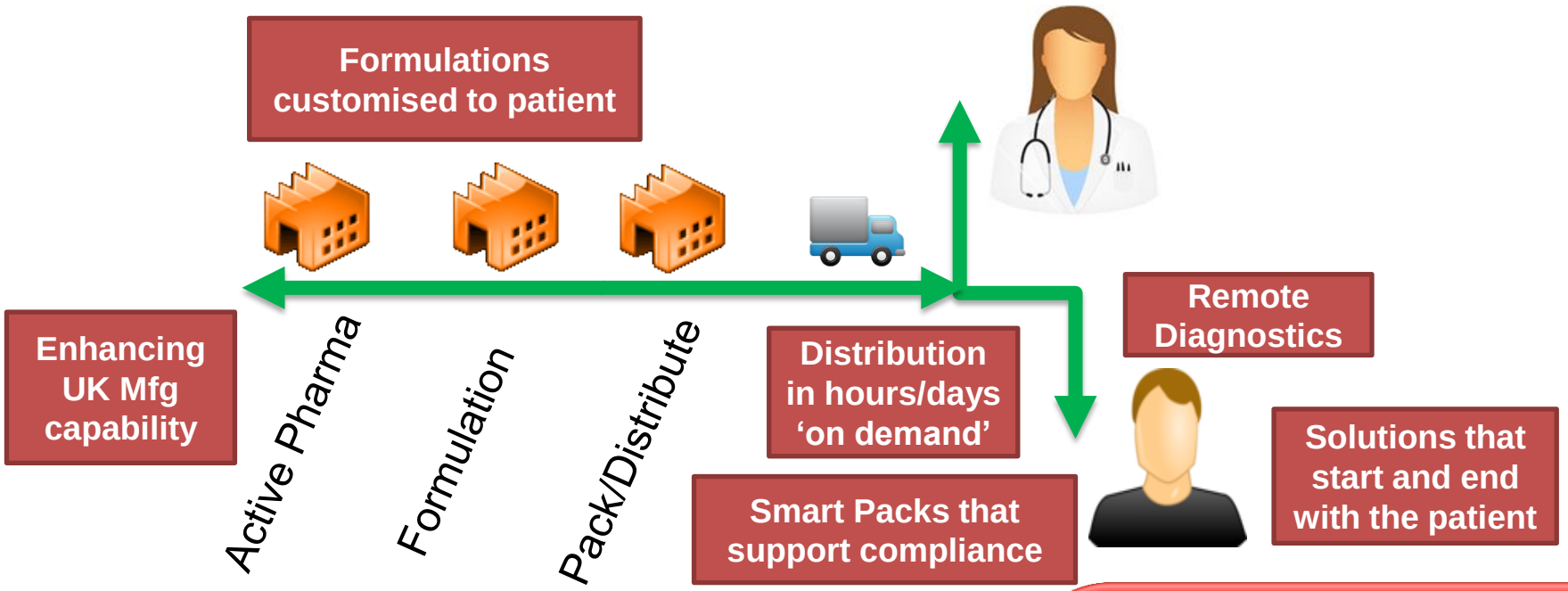
Demand-Led Scope: from synthesis to formulated product



Continuous Manufacturing of Robust New Solid Particles Optimised for Exploitation in Products



Opportunity: Patient-driven responsive supply model



End-to-End Supply Chain Opportunity
Reducing Inventory within primes from 216 days to c. 70 days
Manufacturing – cost of quality, Achieve >5σ, Right-First-Time
1-2 yrs Inventory days of supply – opportunity to reduce 50%
Reduce Cycle Time by half (start materials to pack)
Reduced Drug Development by 10% (cost to market)
Enhance Flexibility and Service to patients
Safeguard UK jobs and retain UK's leading global position

PLATFORM AND APPLICATION PROJECTS

Processes and Technologies developed:

- Continuous Manufacturing techniques that shrink factory scale, provide speed. low cost
- Improved Purification Technologies that support quality and yield improvements
- Improved Analytical Technologies for in-line monitoring and quality assurance
- Supportive Regulatory Regimes for these emerging technologies
- Developing new End-to-End SC platforms that support patient-centric supply models

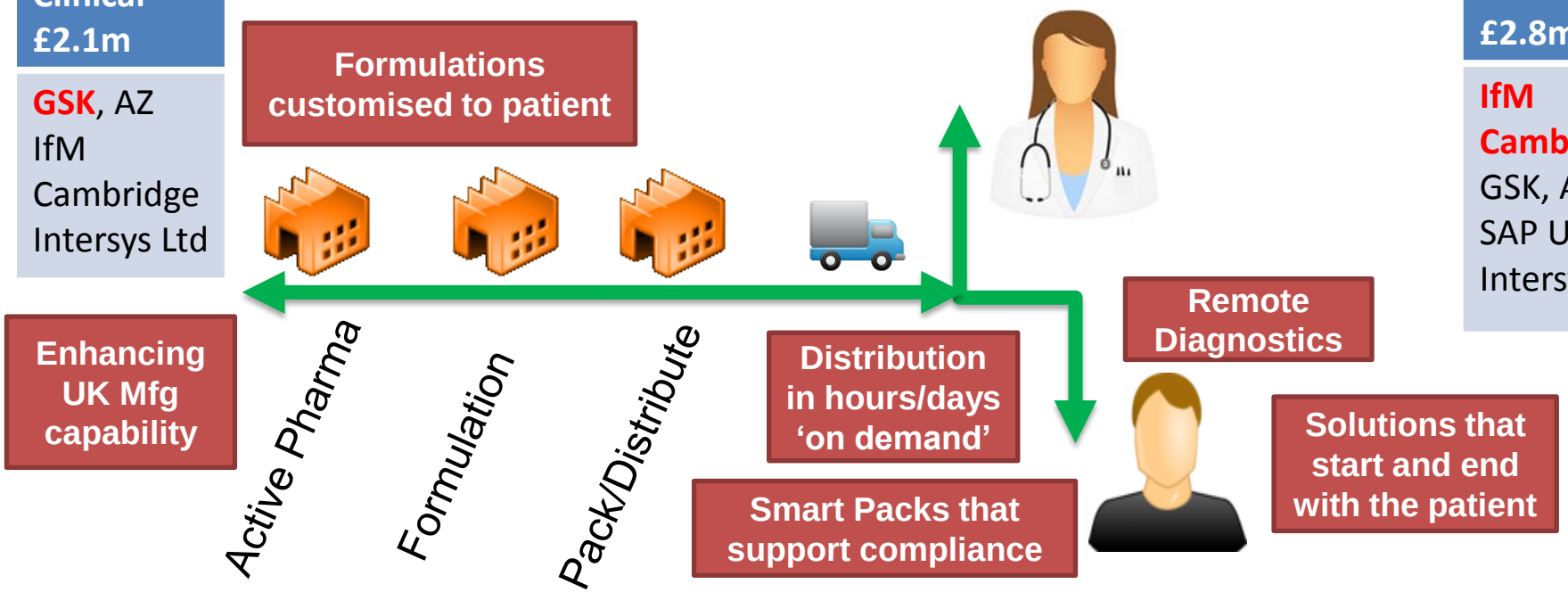
Proposed Supply Chain Collaborations

Platform Clinical £2.1m

GSK, AZ
IfM Cambridge
Intersys Ltd

Platform Commercial £2.8m

IfM Cambridge
GSK, AZ
SAP UK Ltd
Intersys Ltd



App A : API £7.4m

Univ. of Strathclyde (CMAC)
GSK, AZ
Chirotech Technology Ltd
Robinson Brothers Ltd
C-tech Innovation Ltd
Cambridge Reactor Design
Syrris Ltd
IntensiChem Ltd

App B : Primary to Secondary £7.6m

AZ, GSK
Alconbury Weston Ltd
Cogent SCC
Process Systems Enterprise Ltd
Perceptive Engineering Ltd
Britest Ltd
GEA Process Engineering Ltd
Mettler-Toledo Ltd
University of Strathclyde (CMAC

App C: Excipients £1.4m

Albany Molecular Research Ltd (UK)
GSK,AZ
Crystec Ltd

App D Agile packs £1.0m

AZ, GSK

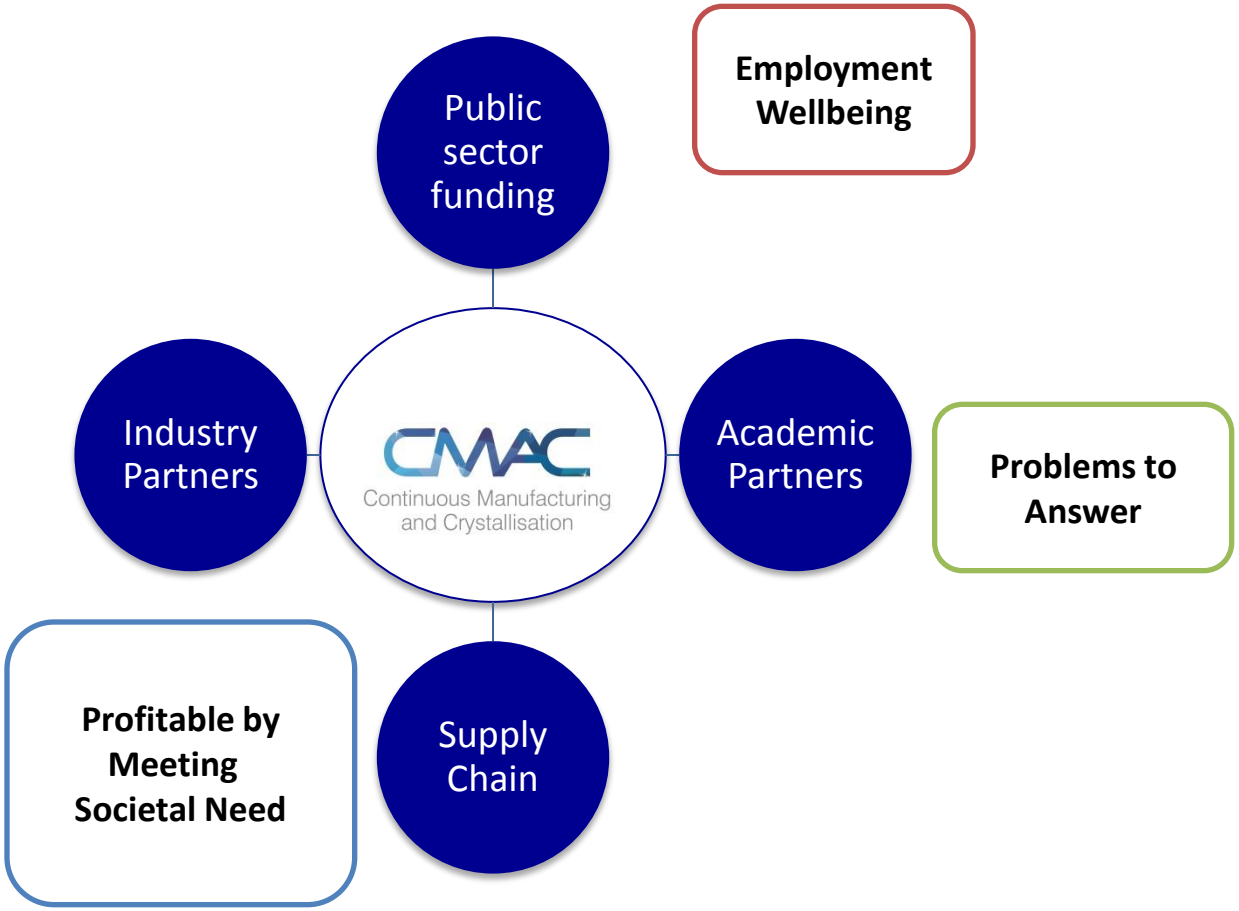
App E Printed Electronics £0.4m

Centre for Process Innovation (CPI)
GSK, AZ

The Size of the Change is Vast. (and not a journey you can make on your own…)

The level of change requires Collaboration…

- IMI (Innovative Medicines Initiative)
- CMAC



Why?

- Collaboration in this space will build on existing manufacturing and scientific strengths.
- Linking Academia and Industry in this way will provide the skills to succeed.
- These technologies will be part of a shift in to manufacturing being controlled by countries with the best skills not the lowest labour costs.

If we want a part of this we need the right Academic and Industrial landscape to thrive.