The Future Challenges of Sustainable Manufacturing

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Industry in 2050:
4 x output
0 x greenhouse gasses
0.5 x resources

Clean. Healthy. Equitable
Some mega-trends to 2050:

*Lean, globalization, more consumers, digitalization*

*More consumers, more urban & connected, digitalization, constrained resources, disruptions, big data, small factories*
What makes me angry

50% of edible food not eaten
33% of weight of building not used
1% of available chemical energy used to transport person in a car
10% of processed material reaches the customer
27% load factor in UK trucks

The IEA estimates that $523 billion was used to cut fossil fuel prices in 2011...??...
Best in Europe?

12% more profit
15% more jobs
4.5% less GHGs

Note: Numbered data points are companies who provided data confidentially or are not named for other reasons; all named companies are plotted based on publicly available information.

www.nextmanufacturingrevolution.org
Best this year? $CO_2$- Cement Factory

Day to Day Variation in $CO_2$ Emissions from Fuel

Average: 335kg/tonne

same profit
same jobs
19.7% less GHGs
Why?

One possible root cause

£ Billion of Costs
(Adjusted for inflation to £2011 and for production*) (Lines)

Million FTEs
(Bars)

UK manufacturing headcount (right hand axis)

UK manufacturing purchases of goods, materials and services (£mln)

UK manufacturing employment costs (£mln)

*Adjusted for Index of Production indexed to 1 in 2011.
Calculations by Lavery/Pennell
Externalities

Everywhere
Capturing value from biology
Efficiency

Value

Technology

System
Some early experiments
Innovating system *in Fast Fashion*
*(less raw material, longevity, circular)*
1 l/100kms cheaper than a Ford Focus > $10k profit
Innovating the system

The Foraging Factory
Key Influences to 2030

Business as usual, focus on efficiency, hoping for a growing market
- Location decisions change
- Strong focus on efficiency
- Increased information content (either free or paid for)
- Sensors in everything
- Increased provenance
- Automation everywhere
- Personalisation
- Co-creation

Disruption, experimentation, radical technology
- Multiple disruptions
  - food-water-energy politics
- New structures & governance
- Scale logic changes direction
- Resilience to disruptions (S/C’s)
- Search for value
  - chemistry
  - product
  - business model
- Big data
  - sensors for life
  - seeing everything
- Circular economy
  - Information replaces materials
  - Lightweight, complex materials
  - Bio-materials
  - Experiments everywhere

Longer & faster
- Specific & informing
- Biology & biological

Business Leadership
- Well-being as business goal
- Gentleman (actual limits)
- New forms of governance
  - Base of pyramid fully engaged
  - Business Leadership++

IfM Centre for Industrial Sustainability
Industrial Digitalisation Technologies

More data
More connectivity
More flexible automation
More analysis

Evidenced benefits
To Manufacturer
To Public
To Technology Supplier

(UK) benefits
12% profit++
SMEs to MEs New SMEs
4.5% CO₂ reduction

benefits
Reduced downtime, more (export) customers
SMEs to MEs New SMEs
Cheaper & stronger grid, Reduction in material imports, more UK added value
SMEs to MEs New SMEs

benefits
Reduced downtime, more added value
SMEs to MEs New SMEs
Clean air, clean energy, more jobs

Do more with less = productive
Benchmarking
Augmented Reality (AR) for energy
AI & IOT for energy
AR factory design

Be strong during disruption = resilient
Frequency response per process
F2G: factory to grid AI design
Exchange waste
Mapping material flows

Live within means = sustainable
Foraging factory
Re-manufacturing renaissance
Business model innovation
Circular making

Foraging factory
F2G: Factory to grid AI design
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experiments
Experiments Everywhere