What is the future for industry in a sustainable world?

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The challenge by 2050:

To quadruple output,
to be a clean neighbour,
to emit 80% less GHGs &
to reduce resource use 50%

The challenge requires radically new approaches we term Industrial Sustainability.
Industrial Sustainability

National Energy Demand

- buildings
- industry
- transport
- the rest
How might we get to our 2050 goals?

Eco-Efficiency
Eco-Factory & Eco-Technology
Sustainable Industrial Systems
There is no one in the factory at this time
Case: Martin-Baker Engineering
- Skin problems →
- Metal working fluid (coolant) contamination →
- Buy a centralised Metal Working Fluid (MWF) recycling system
  → save money on buying and disposing of coolant
Separating Metal Waste & Coolant

- less coolant in skips = £++ **SO...**
Hazardous Waste Reduction

Total No. of Tankers to Remove Hazardous Waste From MBA

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of Tankers</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>69</td>
</tr>
<tr>
<td>2001</td>
<td>73</td>
</tr>
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<td>2002</td>
<td>76</td>
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<td>2008</td>
<td>26</td>
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<tr>
<td>2009</td>
<td>26</td>
</tr>
<tr>
<td>2010</td>
<td>26</td>
</tr>
</tbody>
</table>
Hazardous Waste Reduction

Total disposal cost for alkaline & acid liquid waste

<table>
<thead>
<tr>
<th>Year</th>
<th>Cost (£)</th>
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<tbody>
<tr>
<td>2001</td>
<td>£59,965.95</td>
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<tr>
<td>2002</td>
<td>£65,332.24</td>
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<td>2003</td>
<td>£64,429.01</td>
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<td>2004</td>
<td>£23,604.87</td>
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<td>2005</td>
<td>£11,187.67</td>
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<tr>
<td>2006</td>
<td>£15,664.77</td>
</tr>
<tr>
<td>2007</td>
<td>£12,852.37</td>
</tr>
<tr>
<td>2008</td>
<td>£0.00</td>
</tr>
<tr>
<td>2009</td>
<td>£0.00</td>
</tr>
<tr>
<td>2010</td>
<td>£0.00</td>
</tr>
</tbody>
</table>
TOTAL FACTORY & FINISHING DEPARTMENT YEARLY WATER USAGE

Mains water Vol. m3

TARGET FIGURE

2001 2002 2003 2004 2005 2006 2007 2008 2009 2010

Target

Water Reduction
Case: Who is this?
TMM Europe Targets

1. Energy usage
2. Water usage
3. Volatile Organic Compounds (VOCs) released from painting operations
4. Waste to landfill
5. Degree of compliance with environmental regulations
6. Number of complaints from external (neighbourhood) parties

Actual (2001-2006)

1. - 44%
2. - 37%
3. - 32%
4. - 99%
5. All plants ISO14001
Sustainability in Manufacturing
- Towards Zero Emissions

Steve Hope
General Manager
Plant Engineering and Safety
Toyota Motor Europe
**Aim:** Zero Emissions

**Integrated Approach**

- Ultimate ECO Factory
  - Nº 1 Performance by 2010
  - Zero CO₂
  - Zero Incineration
  - VOC Free

**Organisational Learning**

- Problem Solving, Root Cause Analysis, Kaizen (Continuous Improvement) and Yokoten (Sharing)

- New Plant Design Criteria
  - Toyota Environment Management System
  - Substance of Concern Free
  - Renewable Energy
  - Zero Landfill
  - Recover Rainwater

- Control Criteria
- ECO Audit
- Internal Control Limits
- Risk Audit
- ISO 14001
- Prior Prevention

**Apply 5R’s Hierarchy**

- Refine, Reduce, Reuse, Recycle, Recovery to Energy

**Optimised Environmental Performance**

- Energy
- Air
- Land
- Water
- Toyota
- Production
- System

**Toyota Motor Europe**

**Green, Lean and Clean**

Towards the Ultimate ECO Factory

**Risk Reduction**

Zero Non Compliance & Complaint

S.B. Hope 1st August 2006
Key environmental priorities

- Energy use (CO₂)
- Water consumption
- Waste generated
- Volatile Organic Compound emissions
- Waste sent to landfill
Environmental KPI Results (TMUK)

Energy usage per vehicle (KWh)
Over 70% Reduction

Water usage per vehicle (m³)
Over 75% Reduction

Waste produced per vehicle (kg)
Over 60% Reduction

VOC emissions per vehicle (g/m²)
Over 70% Reduction
possible root causes...
Technology

Organisation
‘division of labour’

Impacts
‘externalities’
Conclusion #1

Efficiency is the critical first step
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Efficiency is the critical first step

How far can you (or your sector) go on resource efficiency?
How might we get to our 2050 goals?

Eco-Efficiency
Eco-Factory & Eco-Technology

Sustainable Industrial Systems
The key sources of future innovation:

• efficiency
• internalisation
  • *deliberately bringing activities & value into the business model that others leave outside*
• collaboration & co-ordination
  • *working with partners up and down and outside the current value chain*
• system design
  • *optimising the whole system*
Case: Riversimple
Riversimple's 7 point strategy

1 l/100kms cheaper than a Smart > $10k profit
2. Sale of service, not cars

- Selling miles travelled as a service, rather than a car as a product
- Profit maximised through low running costs and longevity, rather than high running costs and obsolescence
- Allows access to revenues generated in secondhand market
Riversimple's 7 point strategy

1. Network electric car
2. Sale of service, not cars
3. Sale of service upstream
4. City by city strategy
5. Distributed manufacturing
6. Open Source Design
7. Shared ownership
New Value Forms

• Value missed and value destroyed:
  – Value delivered but not exchanged
    • May not be to the customer!!
  – Resource depletion, pollution
  – Genuine consumer engagement

• Value opportunities:
  – Value can be delivered anywhere across your stakeholders
  – Capturing the value of resource availability (‘circular economy’)
  – Social and economic well-being that is already or easily delivered: employee welfare and wages, better livelihoods, health...
3 stages:

Initial workshop

Detail analysis

Synthesis workshop
Archetype – create value from waste (single firm)

Source: British Sugar
Conclusion #2

Internalisation & collaboration are the next steps

a.k.a. New Business Models

= a new logic for value exchange
Conclusion #2

Internalisation & collaboration are the next steps

a.k.a. New Business Models
= a new logic for value exchange

How might your business model change over the next 10 years?
Conclusion #3

Re-design of the industrial system is needed

_a single company can not be sustainable nor resilient_

We are entering a period of experimentation, led by business, with few rules and little guidance.
Aim and Goals
WHY WE WORK SO HARD

Our Challenge – by 2050:
• To quadruple output
• To emit 80% less GHG
• To halve resource use

To Deliver:
• Knowledge
• Tools & methods
• Leaders
• Policy support & influence
• Visions for a successful future

By 2016:
20 Grand Challenge Projects
Engage with 200+ manufacturers
Start over 88 PhDs
Build over 100 Quick Guides
Influence policy in UK, EU and BRICS
Past 12 Months

- 95% of attendees would recommend us to a colleague
- PhD cohort has doubled from 11 to 22
- 6 postdoctoral researchers added, taking our total to 10
- 35 new papers, reports and book chapters
- 12 new tools and guides developed

Progress

- Recruit best staff & researchers
  - 11 academics
  - 10 post docs
  - 22 PhDs
- 6 main research projects
- 25 smaller projects
- 8 quick guides
- 10 tools
- 50+ papers
- Policy support
  - UK Government Foresight
  - UNIDO UNESCAP
- 16 members
- 37 collaborators

Explore how the entire industrial system might change.
How to transform our factories and products.
How to make current products in a low-carbon, resource efficient manner.
The Future of Manufacturing: A new era of opportunity and challenge

Professor Steve Evans, University of Cambridge
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.
Future Manufacturing

Business as usual, focus on efficiency, growing market

- Location decisions change
- Strong focus on efficiency
- Increased information content (either free or paid for)
- Increased provenance
- Automation everywhere everywhere
- Personalisation

Disruption, experimentation

- Scale logic changes direction
- Circular economy
- Information replaces materials
- Lightweight, complex materials
- Bio-materials
- New business models;
- New value forms;
- Robust supply chains

New configurations for a constrained world

- Manufacturing supply chain flattens with a new geography
- Local making
- PositiveFactory
- Enabling product architectures;
- Public good internalised;
- New governance;
- Base of pyramid fully engaged
Future of manufacturing

Things will change:

• Lean & Clean, not Mean,
• Never saying goodbye,
• Making it everywhere,
• Keeping in touch,
• Kissing frogs,
• Slow & Caring making.

AKA:

eco-efficiency,
closed-loop,
local making,
selling service,
new collaborations,
& high-value.

‘please can we have your factory at the end of our street?’
Conclusion #4

Technology is changing faster than ever. The ability to use technology and knowledge to generate value will be critical to success.

How might technology change affect your business over the next 10 years?
Mahatma Gandhi

There are seven things that will destroy us:
• Wealth without work,
• Pleasure without conscience,
• Knowledge without character,
• Religion without sacrifice,
• Politics without principle,
• Science without humanity,
• Business without ethics.