Sustainable Manufacturing: Is It Resilient?

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NIST Advanced Manufacturing Technology Partnership for Research and Innovation in Sustainable Manufacturing (PRISM)

THIS IS NOT BUSINESS AS USUAL.

Discovery Themes

THE OHIO STATE UNIVERSITY

THIS IS NOT BUSINESS AS USUAL.
Sustainability is the capacity for:
- Ensuring economic prosperity
- Protecting ecological resources
- Enhancing societal well being

Resilience is the capacity for:
- Overcoming unexpected crises
- Adapting to turbulent change
- Flourishing in a chaotic world
Why Exponential Growth?

- Climate
- Crowding
- Connectivity

Global Annual Natural Disasters 1900-2010
Black Swans are Multiplying
Synergies and Trade-offs

- More sustainable (ecological footprint)
  - Lean production
  - Cellulosic biofuels
- More resilient (adaptive capacity)
  - Decentralization
  - Smart grids
- Less resilient
  - Traditional practices
  - Corn ethanol
- Less sustainable
  - Redundancy
  - Diesel backup

Control Activities

Risks cannot always be anticipated

Risks may be hard to quantify

Adaptation may be needed to remain competitive

Objective Setting

Event Identification

Risk Assessment

Risk Response

Control Activities

Limitations of Risk Management
Managing in Turbulent Times

Resilience Strategies

ADAPT & TRANSFORM
- Resilience to fundamental gradual trends

STEER & ADJUST
- Resilience to routine fluctuations

SURVIVE & FLOURISH
- Resilience to catastrophic sudden events

SENSE & RESPOND
- Resilience to turbulent disruptions

Magnitude of change

Abruptness of change
Security  
Flexibility  
Capacity  
Efficiency  
Visibility  
Adaptability  
Anticipation  
Recovery  
Dispersion  
Collaboration  
Organization  
Market position  
Financial strength


Increasing Capabilities  
Erosion of profits  
Zone of balanced resilience  
Exposure to risk

Increasing Vulnerabilities  
Turbulence  
External pressures  
Connectivity  
Deliberate threats  
Resource limits  
Sensitivity

Resilience Strategies
Triple Value Framework

- **Economy**
  - Supply Networks
  - Companies
    - Production
    - Profitability

- **Environment**
  - Extraction
  - Value Recovery
  - Pollution
  - Ecosystem Services

- **Society**
  - Institutions
  - Communities
    - Consumption
    - Well-Being

- **Integrated Assessment**
  - Financial & Human Resources
  - Goods & Services
  - Waste
  - Restoration
Innovation Opportunities

Green chemistry: Benign by design

Risk Mastery: Supply chain resilience

Biomimicry: Nature’s solutions

Adaptability: Crisis & disaster resilience

Global needs: Health and dignity

Industrial Ecology: Waste elimination

Eco-Symbiosis: Productive harmony

Positive Impact: Restorative emissions

Integrated Assessment
Economic Value Creation

Shareholder Value Added
- After-tax operating profit
- Capital Charge

Increase Revenues
- GROWTH
  - Product preference
  - License to operate
  - New markets

Decrease Operating Costs
- EFFICIENCY
  - Lean & clean processes
  - Resource conservation and recovery

Manage Assets
- UTILIZATION
  - Process simplification
  - Supply chain streamlining
  - Business continuity

Decrease WACC
- LOW RISK
  - Incident prevention
  - Crisis response
  - Compliance

Value Proposition
<table>
<thead>
<tr>
<th></th>
<th>Top-line growth</th>
<th>Operating profit</th>
<th>Asset utilization</th>
<th>Risk reduction</th>
<th>Intangible value</th>
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</thead>
<tbody>
<tr>
<td>Dow Chemical</td>
<td>Expand into new markets</td>
<td>Avoid excessive costs</td>
<td>Right-size fixed assets</td>
<td>Business continuity</td>
<td>Customer loyalty</td>
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<tr>
<td>L Brands</td>
<td></td>
<td>Anticipate shipment delays</td>
<td></td>
<td>Business continuity</td>
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<td>AEP</td>
<td></td>
<td>Maintain electrical service</td>
<td></td>
<td></td>
<td>Community quality of life</td>
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<tr>
<td>Cisco</td>
<td>Resilient product design</td>
<td></td>
<td></td>
<td>Supply chain visibility</td>
<td></td>
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<tr>
<td>Veolia</td>
<td></td>
<td>Assess true cost of water</td>
<td>Optimize infrastructure</td>
<td>Avoid water shortages</td>
<td>Reputation and brand</td>
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**Value Proposition**
Aerospace Industry: Opportunities for Value Creation

<table>
<thead>
<tr>
<th>Sustainability</th>
<th>Resilience</th>
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<tbody>
<tr>
<td><strong>Product design</strong></td>
<td><strong>Resilience</strong></td>
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<tr>
<td>• Reduce energy demands</td>
<td>• Enhance security</td>
</tr>
<tr>
<td>• Avoid toxic constituents</td>
<td>• Ensure durability</td>
</tr>
<tr>
<td><strong>Supply chain processes</strong></td>
<td><strong>Supply chain processes</strong></td>
</tr>
<tr>
<td>• Minimize assembly cost</td>
<td>• Minimize disruptions</td>
</tr>
<tr>
<td>• Facilitate disassembly</td>
<td>• Ensure availability</td>
</tr>
<tr>
<td><strong>Community well-being</strong></td>
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</tr>
<tr>
<td>• Enhance natural and social capital</td>
<td>• Enable adaptability in times of crisis</td>
</tr>
</tbody>
</table>
“Crisis”

Danger  Opportunity

Ancient Wisdom
Sustainable and Resilient Economy

Mission: Accelerate the development of sustainable and resilient production and consumption systems that enhance the value and reduce the adverse impacts of global material and energy flows.

External Collaborators & Sponsors:
Universities, Research Institutes, Corporations, Agencies
Joseph Fiksel
**Design for Environment**
Second Edition
A Guide to Sustainable Product Development

Joseph Fiksel
**Resilient by Design**
How Companies Thrive in an Age of Turbulence
(Island Press, 2015)