The role of Information Technology in Green Manufacturing

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The world is smaller, flatter and hotter.
We need to approach Green Manufacturing by first understanding their impact to:

- **WATER**: Water is needed to generate energy and energy is needed to provide water.
- **ENERGY**: Energy production results in CO₂ emissions.
- **CARBON**: CO₂ emissions contribute to climate change, which impacts water systems.

Energy production results in CO₂ emissions.
Green Manufacturing not only encompasses conservation, pollution prevention, and more but also enables the creation of entirely new value and benefits.

- **Lower costs while overcoming operational barriers.**
- **Strengthen reputations while meeting regulations.**
- **Create products and services that give rise to new markets.**
An organization must take a systemic view of its value chain to realize the benefits of Green Manufacturing.
To achieve benefits from Information technology, organizations need:

1. **Sustainable solutions**
   - Increase organizational efficiency, abating impact of processes, products and people.
   - Create ability to measure, monitor, improve and report on processes.

2. **Intelligent Systems**
   - Optimized transportation systems.
   - Smart products
   - Use predictive analytics for water management.
   - Optimize power grid; control two-way flow of energy from power plant to plug.

3. **Green infrastructures**
   - Take out cost and improve the efficiency of IT and other infrastructure.
   - Enable readiness with regulatory compliance.
1. Developing sustainable solution for reduction of direct CO$_2$ for the most carbon generating industries

Direct CO$_2$ emissions in industry by sector and by region

Cement & Steel Industry are the major contributors

Technologies for reducing direct CO$_2$ emissions from industry - Iron & Steel

Improving energy efficiency – new tech / IT

CCS* - carbon capture and storage - DRI / BF Gas

Fuel and feedstock switching – DRI, Coke consumption efficiency etc.

*Source: International Energy Agency
Business Analytics and Optimization can reduce the inefficiencies in processes

Range if energy intensity varies from 20 GJ / t and 35 GJ / t * of steel production for an integrated steel plant

These differences can be explained by the economies of scale, quality of iron ore, operations and quality control

**Information technology** is the enabler for operations and quality controls

Reducing Agents Consumption in Blast Furnace in the world 2007/2008/2009 - > Source IEA

Coking coal blend optimizer - reduce costs by optimizing the blend of coking coal for better coke characteristics thereby improving blast furnace production yield

* APP- Asia Pacific Partnership on clean development and climate

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Sustainable solutions help account for the environmental and social impacts of doing business.

**Business Strategy**
- Develop sustainability strategic priorities
- Prioritize initiatives to reduce energy, water and CO2 emissions
- Align priorities and initiatives with overall corporate strategy and objectives and establish the roadmap to achieve results and streamline compliance

**Operations**
- Optimize the supply chain for service levels, quality, cost, and CO2 emissions
- Product Lifecycle Management
- Optimization of processes to balance environmental impact and cost by applying lean and six sigma principles
- RFID tagging and tracking systems
- Networked sensors and meters for environmental data collection

**Workforce & Stakeholders**
- Reduce real estate and facilities costs and decrease travel needs by enabling people to work productively from anywhere, any time.
- Strengthen Brand loyalty and attract and retain employees through corporate wide Sustainability Programs
- Efficiently bring together broad range of stakeholders to collaborate through online events and collaboration "jams"

**Business Performance & Advanced Analytics**
- Use Advanced Analytics technologies to model, simulate, redesign and automate processes for energy efficiency and environmental impact
- Monitor & analyze environmental KPIs across the full value chain and track overall performance via the Sustainability Balanced Scorecard
- Align sustainability strategies with overall corporate objectives, set performance targets and monitor and communicate outcomes and accomplishments through the Sustainability Management Model
Intelligent systems to provide insights for carbon management based on cost and carbon

**Examples of questions addressed**

- What effect does product design have on the products lifecycle carbon footprint?
- What is the impact on cost and carbon emission if I change **package sizes and/or packaging materials**?
- What is the impact of **manufacturing lot sizes** on supply transportation requirements and therefore the cost and carbon?
- How can I evaluate **alternative supply sources** in terms of cost and carbon contribution on the supply chain?
- How do my **inventory replenishment practices** influence my current carbon print and how can I change it?
- How much does ability to **consolidate orders** reduce my carbon footprint?
- What is the carbon footprint of my current distribution requirements planning (**DRP**) and how does it change if I change the plan?
- Does **component commonality** help reduce carbon footprint and if so how much?
- **Which components** contribute more than others to my carbon footprint?
Green Supply chain’s goal is to optimize cost, service, quality and carbon emissions

- Various key factors impact the supply chain cost and carbon footprint though complex multi-faceted interactions
- Typical supply chain optimization only considers the direct monetary costs
- Inventory & supply policies can be significantly different with the inclusion of broader environmental costs & constraints
- A good model can quantify both the cost and the carbon impact of various supply chain policies.
- A comprehensive model can identify areas where carbon and cost reduction can be achieved simultaneously (e.g. minimization of wastage, rework etc)
Quantifying the impact of on cost and carbon can help establish a greener inventory replenishment policy and routing efficiency.

### Shipment frequency

<table>
<thead>
<tr>
<th>Scenario 1</th>
<th>LOW shipment frequency</th>
<th>HIGH shipment size</th>
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</thead>
<tbody>
<tr>
<td>Inventory Cost</td>
<td><img src="image1" alt="Graph" /></td>
<td><img src="image2" alt="Graph" /></td>
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<tr>
<td>Transportation Cost</td>
<td><img src="image3" alt="Graph" /></td>
<td><img src="image4" alt="Graph" /></td>
</tr>
<tr>
<td>Carbon in Warehousing Cost</td>
<td><img src="image5" alt="Graph" /></td>
<td><img src="image6" alt="Graph" /></td>
</tr>
<tr>
<td>Inventory Cost</td>
<td><img src="image7" alt="Graph" /></td>
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</table>

### Scenario 2

<table>
<thead>
<tr>
<th>Scenario 2</th>
<th>HIGH shipment frequency</th>
<th>LOW shipment size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inventory Cost</td>
<td><img src="image9" alt="Graph" /></td>
<td><img src="image10" alt="Graph" /></td>
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<tr>
<td>Transportation Cost</td>
<td><img src="image11" alt="Graph" /></td>
<td><img src="image12" alt="Graph" /></td>
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<tr>
<td>Carbon in Warehousing Cost</td>
<td><img src="image13" alt="Graph" /></td>
<td><img src="image14" alt="Graph" /></td>
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<tr>
<td>Inventory Cost</td>
<td><img src="image15" alt="Graph" /></td>
<td><img src="image16" alt="Graph" /></td>
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</tbody>
</table>

### Routing efficiency

- **Inefficient routing**
  - ![Graph](image17)
- **Efficient routing**
  - ![Graph](image18)
Energy Management Solution (EMS) - Achieve environmental leadership and corporate sustainability through a comprehensive energy management program aiming to lower electrical costs, avoid infrastructure investment and reduce greenhouse emission.
Intelligent systems for green supply chain

**Intelligent Utility Networks**
- Increased operational excellence through an integrated view of the grid
- Reduced outages and a self-healing infrastructure enabled by preemptive action
- Improved utility energy efficiency through near real-time visibility of consumer energy usage

**Advanced Water Management**
- Strategic water information management of natural, utility, and enterprise water systems
- Smart water infrastructure solutions (e.g. smart levees, smart storm water management)
- Smart water meter management and asset management solutions

**Intelligent Transportation Systems**
- Road user charging and tolling practices
- Integrated fare management systems
- Transport information management systems
- Innovations in telematics, GPS, etc

**Smarter Products**
- Hybrid vehicles that increase energy efficiency and reduce CO2 emissions
- Electronic devices with smart energy saving features
- Fleet management solutions that use hardware and software to improve fleet efficiency and reduce fuel consumption
3 Green Infrastructure enabled by intelligent energy management.

**IT Equipment**
- Energy efficient hardware
- Virtualization and consolidation
- Active energy management
- Tiered storage

**Data Center**
- Accurate thermal and energy usage assessments
- Extend life of existing infrastructure
- Rationalize infrastructures across company
- Design flexibility into new data center infrastructure

**Applications and Data**
- Lifecycle management, retention, archiving of data
- Optimization of application servers
- Application performance monitoring
- Data deduplication, compression and clean up

**Energy Management**
- IT management dashboard
- Intelligent Building Management System interface
- Threshold controls
- Optimize assets for energy efficiency
- Track and verify energy efficiency
Information technology will play a pivotal role for Green manufacturing for development of sustainable solutions, intelligent systems and green infrastructure.

By systemically managing water and energy use, as well as greenhouse gas emissions, smart organizations will realize true sustainability while achieving real business benefits — driving growth at the individual, organizational and population levels.
Thank You

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Early Adoption of Sustainability Management as core Business Function

- **Define KPI’s** - Build carbon, water or solid waste key process indicator (KPI) set (regulatory & stakeholder driven)
- **Metering** - Deploy mobile metering capability, establish energy use baseline & identify opportunities for improvement
- **Deploy Carbon Console** – Deploy web based management system
- **Optimize Process** – Use applied Lean Sigma techniques to analyze, improve and optimize identified high energy (or other) use areas
- **Ongoing Control** – Deploy follow-on controls across defined kpi’s, deploy additional metering & management capability

Involves using the existing systems and Processes to include Sustainability parameters
1 Sustainable Solutions: Applications and benefits

**SMART IS**
Reinventing processes to use less water, energy and other chemicals.

**SMART IS**
Consolidating distribution centers to reduce emissions by 15% and fuel costs by 25%.

**SMART IS**
Integrating sustainability efforts into the overall business strategy granting them attention and extracting their full benefit.

**IBM Burling FAB:** Retooled its chip-making process to cut annual water use by 20 million gallons, chemical use by 15,000 gallons and electricity use by more than 1.5 million kWh.

**Fronterra:** a large New Zealand dairy co-operative, leverages IBM ILOG Supply Chain Management technology to optimize their supply chain - removing 4,000 truckloads off the road annually, and the potential to exit 12 third-party warehouses.

**Cosco:** Utilized IBM’s Supply Chain Network Optimization Workbench (SNOW) to reduce distribution centers from 100 to 40. Lowered logistics costs by 23% and reduced CO2 emissions by 15% while maintaining service levels for clients.
2 Intelligent systems: Applications and benefits

SMART IS
Knowing exactly where a power outage occurs and instantly dispatching a crew to fix the problem.

DONG Energy: Installed remote monitoring and control devices to gain an unprecedented level of information about the current state of the grid, lessening outage times by a potential 25-50%.

SMART IS
Lowering congestion and carbon emissions by influencing traffic patterns on a city scale.

Stockholm, Sweden: Implemented an intelligent toll system that uses cameras, sensors and central servers to identify vehicles and charge drivers based on when and where they drive—cutting traffic by 20% and emissions by 12%.

SMART IS
Observing and modeling natural water systems at multiple scales to guard against pollution, flooding, and depletion of fishing stock levels.

Galway Bay, Ireland: Paving the way for smarter environmental management and development of Galway Bay, IBM and the Marine Institute of Ireland have deployed a real-time advanced analytics platform to monitor wave conditions, marine life, and pollution levels in and around Galway Bay.

SMART IS
New hybrid systems that can improve fuel efficiency in urban delivery vehicles by up to 70%

Eaton: Developed a smarter hydraulic hybrid powertrain system for UPS. If half of all urban delivery vehicles in the U.S. used this type of technology, we could realize a $1.5 to 2 billion annual savings in fuel cost, and reduce CO2 emissions by 8 million metric tons (EPA).
Let’s Build a Smarter Planet

3 Green infrastructure: Applications and benefits

SMART IS
Building green data centers to support corporate brand objectives

SMART IS
Proactively addressing information growth and environmental regulation.

SMART IS
Holistic view of energy consumption that enhances the efficiency of buildings, fleets and physical assets.

**kikai\Leiner:** Designed and built new energy efficient scalable modular data center – reducing electrical consumption by up to 40%. The new data center extended their environmental strategy to include their data center.

**Douglas Holding:** Green infrastructure built to anticipate and respond to information growth, measure and verify performance and achieved data compression rates of up to 80%.

**Star Technology Services:** Can manage both power and cooling capacity and begin to include non-IT resources into its event management. They use the same infrastructure monitoring IT to monitor and measure non-IT devices and view overall power use.
## Business Component Map for Steel - Overview

<table>
<thead>
<tr>
<th>Business Development</th>
<th>Sales &amp; Service</th>
<th>Distribution</th>
<th>Production</th>
<th>Equipment &amp; Plant Management</th>
<th>Business Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales Channel Strategy</td>
<td>Integrated Sales-operation Planning</td>
<td>Transportation Planning</td>
<td>Purchase Planning</td>
<td>MRO Material &amp; Service Purchase Planning</td>
<td>Human Resources Planning</td>
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<tr>
<td>New Product/ New Demand Strategy</td>
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<td></td>
<td>Production Planning</td>
<td>Facility Maintenance Planning</td>
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<tr>
<td>New Business Strategy</td>
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<td></td>
<td>Quality Management</td>
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### Plan
- New Product Development Project, R&D Monitoring
- New Product Development, R&D Performance Management
- Sales Force Management
- Contract Management
- Accounts Receivables & Credit Management

### Control
- Logistics Monitoring & Performance Management
- Finished Product Inventory Monitoring & Management
- Quality Tracking
- Supplier Performance History Management

### Execute
- Inquiry Processing
- Quality Management for Inquiring Order
- Offer/order Processing & Billing
- Claim Management
- Technical Support
- Shipping
- Purchasing
- Inbound Logistics
- Raw Material Inventory Management
- Production Order Management
- Production
- Facility Maintenance Execution
- Facility Order Processing
- Facility Acquisition
- Public Relations

<table>
<thead>
<tr>
<th>Impact Level</th>
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<tbody>
<tr>
<td>Some carbon/GHG impact</td>
</tr>
<tr>
<td>Moderate carbon/GHG impact</td>
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<tr>
<td>Major carbon/GHG impact</td>
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