From Conventional To Adaptable Manufacturing Paradigms: A Systems Perspective

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Presentation Overview

- Background
- Motivation
- Case Study
- Future Work
- Conclusions
Background

Issues in Industry
- Global competition
- Unpredictable market conditions
- Diverse customer demands / mass customization
- High Investment costs leading to outsourcing

Major challenges
- Shorter lead times
- Reduction in downtimes
- Quick response to changes
- Adaption to market fluctuations
- Low investment costs
- Sustainable systems

Need for a change in conventional manufacturing approach!
Before embracing new production paradigms:

- Identification of existing strengths & weaknesses
- Impact analysis of modifications on system elements

A production system is an SoS!
Motivation

Before embracing new production paradigms:
- Identification of existing strengths & weaknesses
- Impact analysis of modifications on system elements

Required: A Holistic analysis of existing systems from a system’s perspective!
Case Study: SenseAir AB, Sweden

New Ventures:
CO₂ (Automotive)
Ethanol (Automotive)
Freon (Refrigeration)
Methane (Fracking & Mining)

Identify areas of modification & adopt a new manufacturing approach!
Methodology

- Identification of system elements & boundaries
- Recursive system decomposition
- Mental Models
  - Systemigram
  - Systems Coupling Diagram
- Quantitative Analysis
- Survey
Systems of Interest (SOI)

Flood & Carson, 1993
Systems of Interest (SOI)

Narrow System of Interest
- Sensors, Components, PCBs, etc.
- Assembly (Glueing, curing, soldering)
- Labeling, Scanning codes, milling
- Calibration
- Final Assembly & tests
- Packaging
- Inventory, Warehouse

Narrow Environment
- ESD protection
- Gas regulations
- Controlled climate

Wider System of Interest
- R&D
- Logistics
- Administration
- Human Resource
- Tech. Support
- Customers
- Raw material suppliers
- Quality Control

Wider Environment
- Global market trends
- Population growth
- Environmental awareness
Methodology

• Identification of system elements & boundaries
• **Recursive system decomposition**
• Mental Models
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Recursive Decomposition
Methodology

- Identification of system elements & boundaries
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Systemigram
Systems Coupling Diagram

Reference: Lawson, 2010
Case # 1: Efficient Resource Utilization

**Situation**
Global economic recession
- Sensor X demand ↓
- Robot 1 in use
- Robot 2 idle
- Manual labeling

**How to utilize resources efficiently?**

**Respondent System**
Robot 2 utilized for automatic labeling robot by changing tool and adjusting its parameters.

**Control Element:**
Sensor group X team leader

**System Assets**
- Pick & Place Robot 1
- Pick & Place Robot 2
- Soldering Robot
- Glueing Robot
- Manual labeling Curing station
- Calibration Station
- Customer specific assembly (CSA)
- Packaging
- Inventory
- Personnel, etc.

**Results:**
- Delivery time significantly reduced
- Efficient utilization of resources
- 100 % customer satisfaction
Case # 2: Timely Order Fulfillment

**Situation**
- Sensor X production doubles
- Sensor Y production same
- Workload at CSA station increased

**How to fulfill the orders on time with the same number of resources?**

**Respondent System**
Soldering operations rescheduled and soldering robot shared by CSA station when not in use by sensor Y station.

**Control Element:**
Operations Group

**System Assets**
- Pick & Place Robot 1
- Pick & Place Robot 2
- Soldering Robot
- Glueing Robot
- Manual labeling
- Curing station
- Calibration Station
- Customer Specific Assembly (CSA)
- Packaging
- Inventory
- Personnel, etc.

**Results:**
- No Manual overload; reduced labor cost
- Timely fulfillment of orders
- Customer Satisfaction
Methodology

- Identification of system elements & boundaries
- Recursive system decomposition
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  - Systemigram
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- Survey
Quantitative Analysis

A Behavioral model of the system using Simulink/SimEvents
Methodology

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• Survey
Survey Findings
Summary

- Applications of systems thinking & systems engineering on SenseAir Production System

- Improvement suggestions based on the study & survey
Future Work

• Possible system modifications required for incorporating adaptable production solutions
• Change Management Model over the production life cycle
• Implementation of IEC/ISO 15288
Conclusion

“It is in the nature of systemic thinking to yield many different views of the same thing and the same view of many different things.”

- Russel Ackoff
Thank you!
Questions ?