Competitive Sustainable Manufacturing

**Personalized Production Paradigm**

Exactly the product needed …

… Exactly when needed

Yoram Koren and Jun Ni
The University of Michigan, Ann Arbor
1. How can the US and Europe sustain manufacturing jobs?
   Products in which short delivery time is critical will be produced domestically.

2. How can we create new Small Business (SB) mfg. industries?
   Products of large-variety & small-volume to be produced by domestic SB.

3. How can the US and Europe sustain a strong auto industry?
   A new direction to the auto industry, of which domestic manufacturing is advantageous because it requires a short delivery time.

We will show that a new paradigm of personalized design of automobile interiors responds to these issues.
Manufacturing Paradigms

Our society experienced three manufacturing paradigms

Craft Production

Mass Production

Mass Customization

and more recently the emerging paradigm of

Personalized Production

The personalized production paradigm can sustain a strong auto industry in the US and Europe, and create new Small Business industries.
Product-Process-Business

Manufacturing enterprises contain three main elements:
Product, Process, and business.

And three main corresponding actions:
Design the product
Make the product
Sell the product
What are the Possible Sequences?

There are only three possible sequences!
And each sequence defines a paradigm.

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November 2009 #5
Is it possible to define a new paradigm?

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November 2009 #6
Two Phases in Personalized Kitchens

A. Modules are designed by the manufacturer

P. The personalized kitchen is designed by the customer
Product Design Phases in the personalization paradigm

The product design in the personalization paradigm has two phases:

• An initial phase, **Design (A)**, in which the product architecture is designed, and the range of modules is established.

  This design phase is a strategic decision done by the manufacturer.

• The personalized design phase, **Design (P)**, in which the final tailored-design takes place with close interaction with the customer.
Mass Customization & Personalization

The manufacturer designs the **options**

- **Mass Customization**
  - Design Product Options
  - Sell
  - Make One Option
  - *Push-Pull Model*

- **Personalized Production**
  - Design Architecture and Modules
  - Sell
  - Personalized Design
  - Customer Involved
  - Make One Unique Product
  - *Pull Model*

**Customer involved**
The customer designs the **option**
Paradigm Transition

MASS PRODUCTION
Design
Make
Sell
Customer

MASS CUSTOMIZATION
Design
Sell
Customer
Make

CRAFT PRODUCTION
Sell
Customer
Design
Make

PERSONALIZED PRODUCTION
Design Architecture & Modules
Sell
Customer
Personalized Design
Make

Push
Push-Pull
Pull

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November 2009 #10
Mass Production of Automobiles

The opening of the moving assembly line by Henry Ford in 1913 in Dearborn, Michigan, started the mass production paradigm.

The PEAK of Mass Production

In 1955, seven (7) million vehicles were sold in the U.S. Ford, GM and Chrysler accounted for 95% of sales. Eight (8) models accounted for 80% of all cars sold.

The auto industry is still using the serial moving assembly line, 100 years after its invention.
Changeable Automobile Interior

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Michigan Engineering
Customers’ Wishes of Their Automobile Interior

- Dog bed
- Air bags inside the safety belt
- Folding Table
- Computer docking station
- File cabinet
- Additional Storage area
- TV
- Refrigerator
Small Business Industry for Car Modules

Should be Open-Architecture standards for
• Mechanical
• Electrical
• Information
  Module interfaces

Module interfaces are designed according to the open-architecture standards

Computer stations; Clothing-racks
Microwaves; Refrigerators
Weight storages; Folding Beds
Portable-potty for kids; Folding tables
Dog baskets; File cabinets

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Challenge #1: Creating New CAD Technologies

- Anthropometry
- Realistic Imaging
- 3D Immersive Environment
- Interactive Environment

Feedback embedded in CAD

- Psychology
- Physiology
- Aesthetic
- Design Conflicts
- Safety
- Mfg. Constraints
Paradigm Transitions Over Time

**Product Architecture**

- **Unified Architecture**
- **Modular Architecture**

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**Challenge #2:** Reconfigurable, Non-Serial Assembly system

- **Serial Assembly Line**
  - Invented in 1913

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- **1850**
- **1860**
- **1913**
- **1955**
- **1980**
- **1994**
- **2010**

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**Product Volume per Model**

- **Mass Production**
- **Customization**
- **Personalized Production**

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**Product Variety**

- **Craft Production**
- **TIME SPAN**

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**Yoram Koren and Jun Ni**

- Michigan Engineering

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*November 2009*
The Number of Possible Configurations

Configurations of assembly systems with 5 stations.
In practice there may be over 50 stations

**Challenge:** How to design a configuration which is not a serial line

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November 2009 #18
A RMS is a system designed at the outset for rapid changes in structure, in order to quickly adjust production capacity and functionality when needed.

**Challenge #2:** Similar RMS concepts should be developed for cost-effective assembly of personalized interiors of automobiles.
A Reconfigurable Assembly System – an Example

Ford’s serial assembly line that was invented in 1913, should be substituted

Example of assembly system of personalized automobile interiors
Example: Reconfigurable Assembly System

Another example of assembly system of personalized automobile interiors

This layout resembles the layout of a reconfigurable shoe factory in Italy

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Reconfigurable Shoe Factory

Example of the shoe factory in Vigevano, Italy
Fast delivery of personalized shoes
Summary

Personalized Products – the buyers are actively involved in the design of their products

Two engineering challenges to make the personalized paradigm a reality

Challenge #1: Creating New CAD Technologies

Exactly the product needed …

Exactly when needed

Challenge #2: Reconfigurable Assembly System