Competitive Sustainable Manufacturing

Personalized Production Paradigm

Exactly the product needed …

… Exactly when needed

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Competitive Sustainable Manufacturing

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

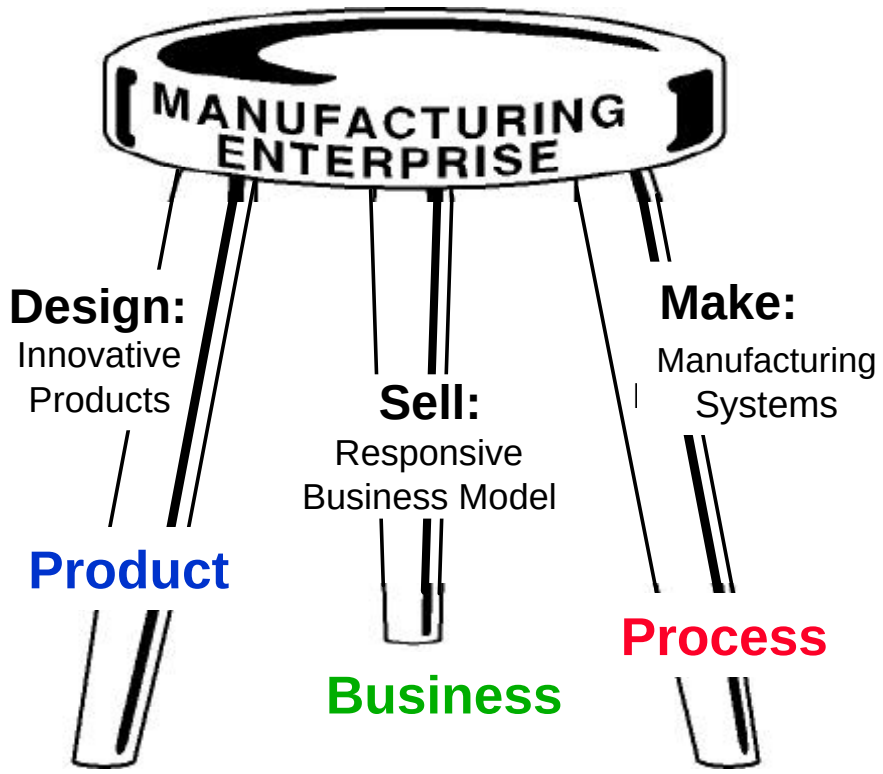
Manufacturing enterprises contain three main elements:
Product, Process, and business.

And three main corresponding actions:

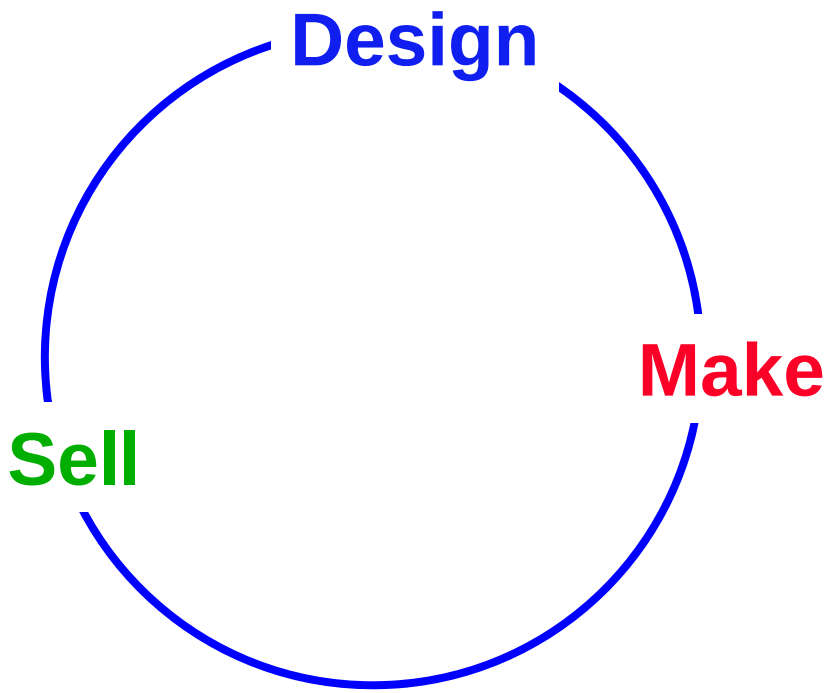
Design the product

Make the product

Sell the product



What are the Possible Sequences?



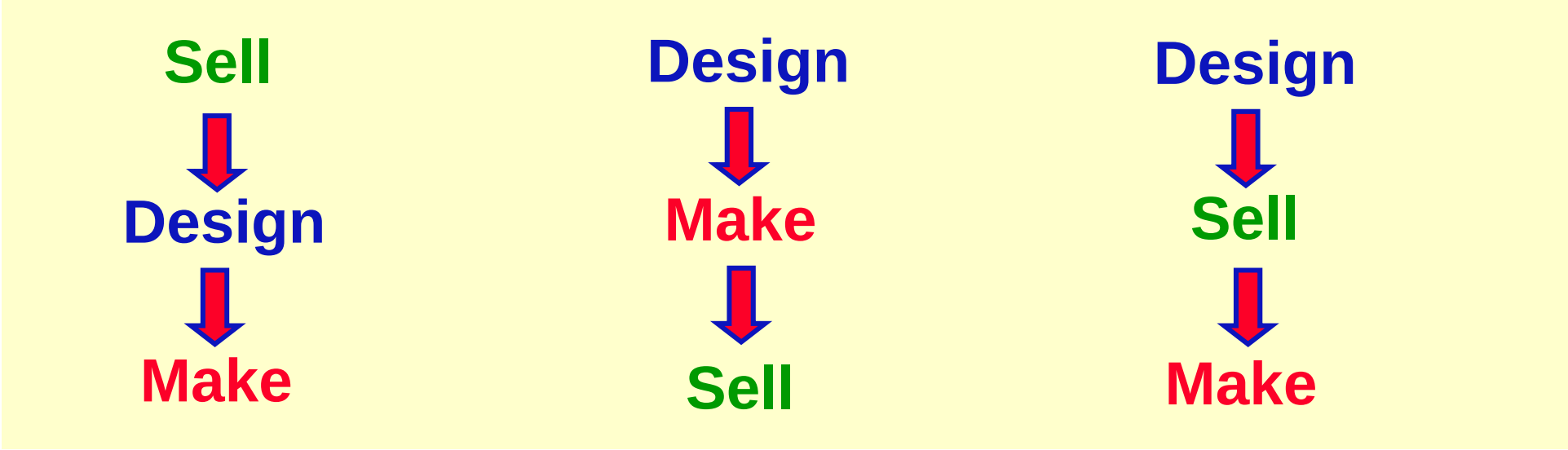
6 sequences

- Design, Make, Sell
- Sell, Make, Design
- Make, Design, Sell
- Make, Sell, Design
- Sell, Design, Make
- Design, Sell, Make

There are only three possible sequences**!**

And each sequence defines a paradigm

Three Paradigms



Craft Production

Unique Products

Fit the exact need

Market of One

Mass Production

Standard Products

Small Product Variety

High Volume per Product

Mass Customization

Options of Customized Standard Products

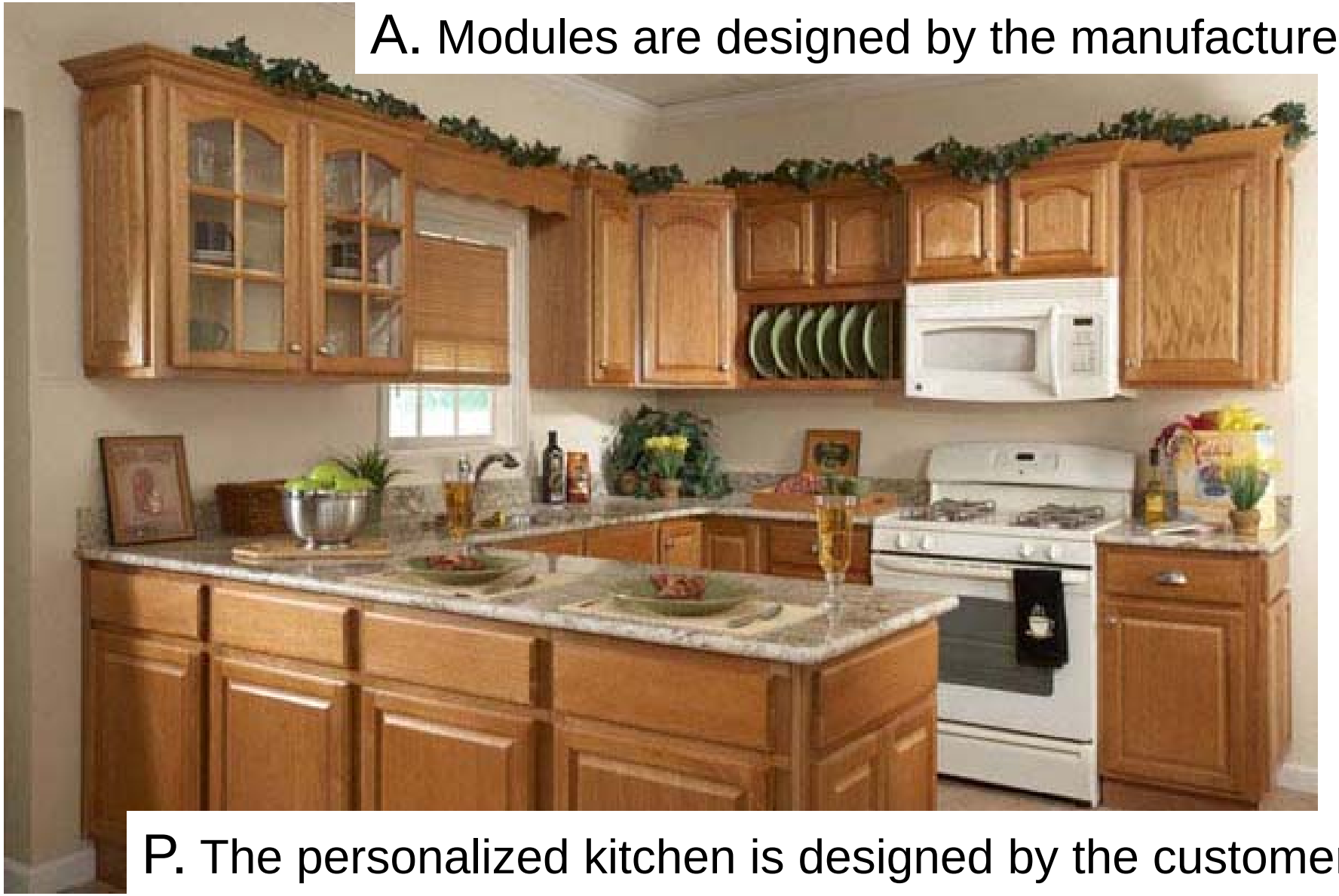
High Product Variety

Small Volume per Product

Is it possible to define a new paradigm?

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:

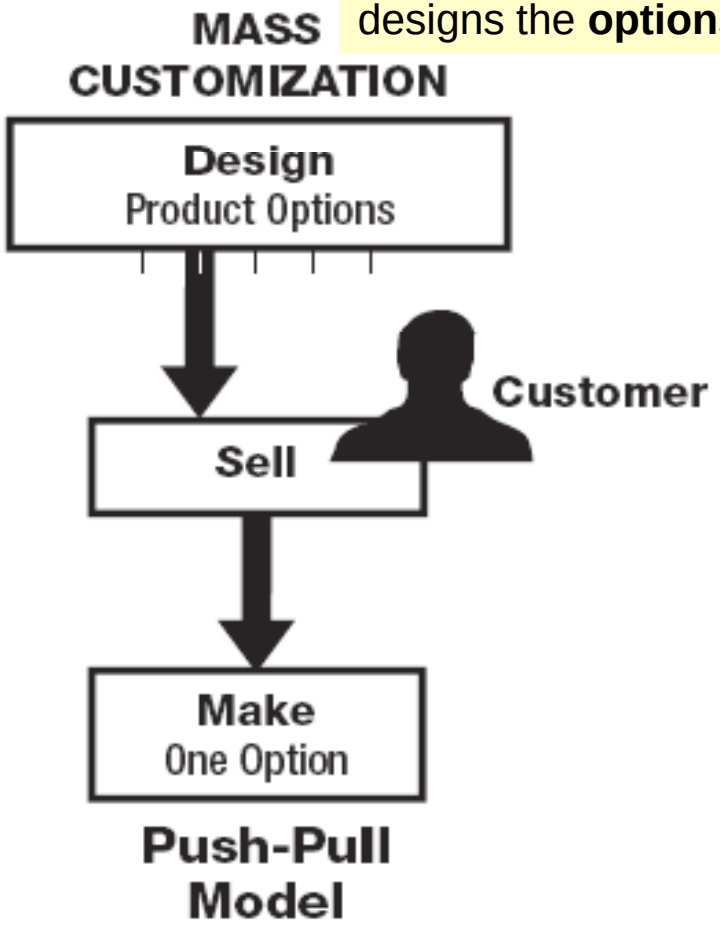
- An initial phase, **Design (A),** in which the product architecture is designed, and the range of modules is established.

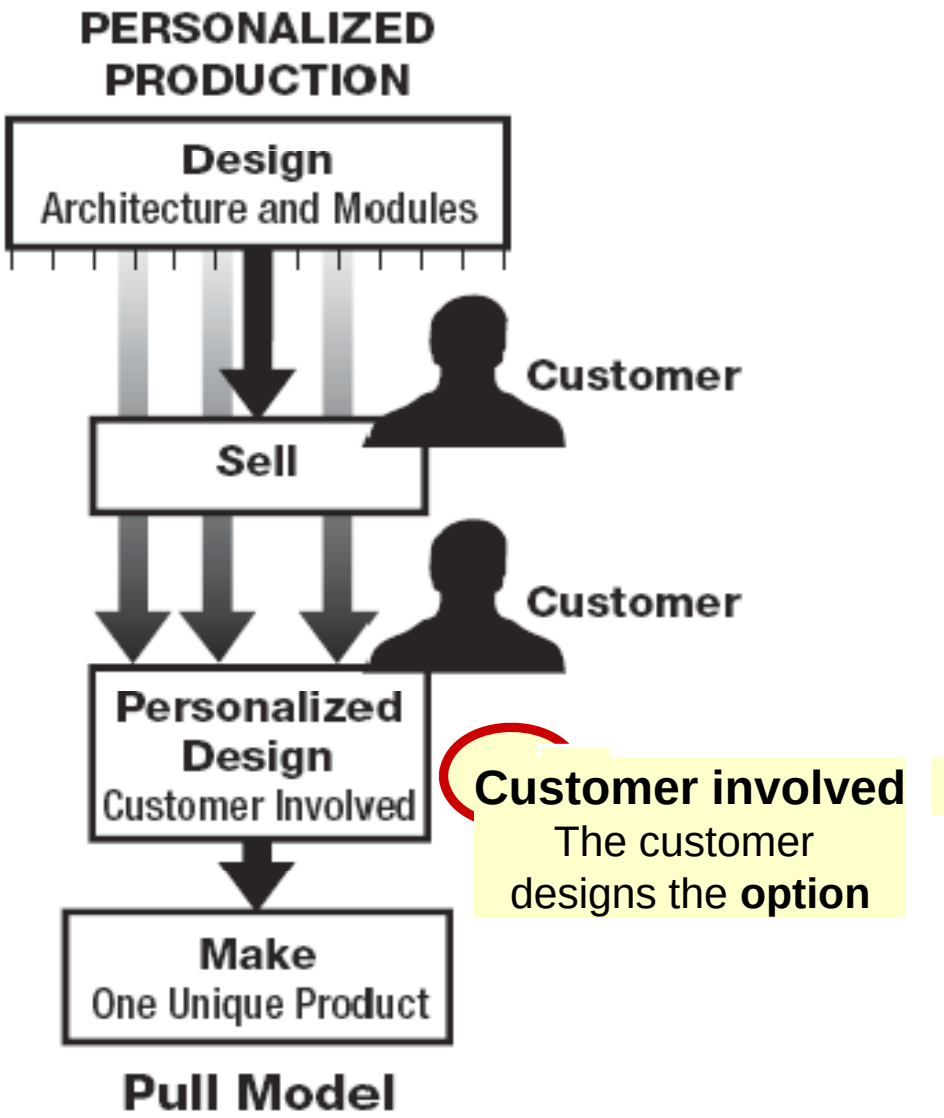
This design phase is a strategic decision done by the manufacturer.

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

Mass Customization & Personalization

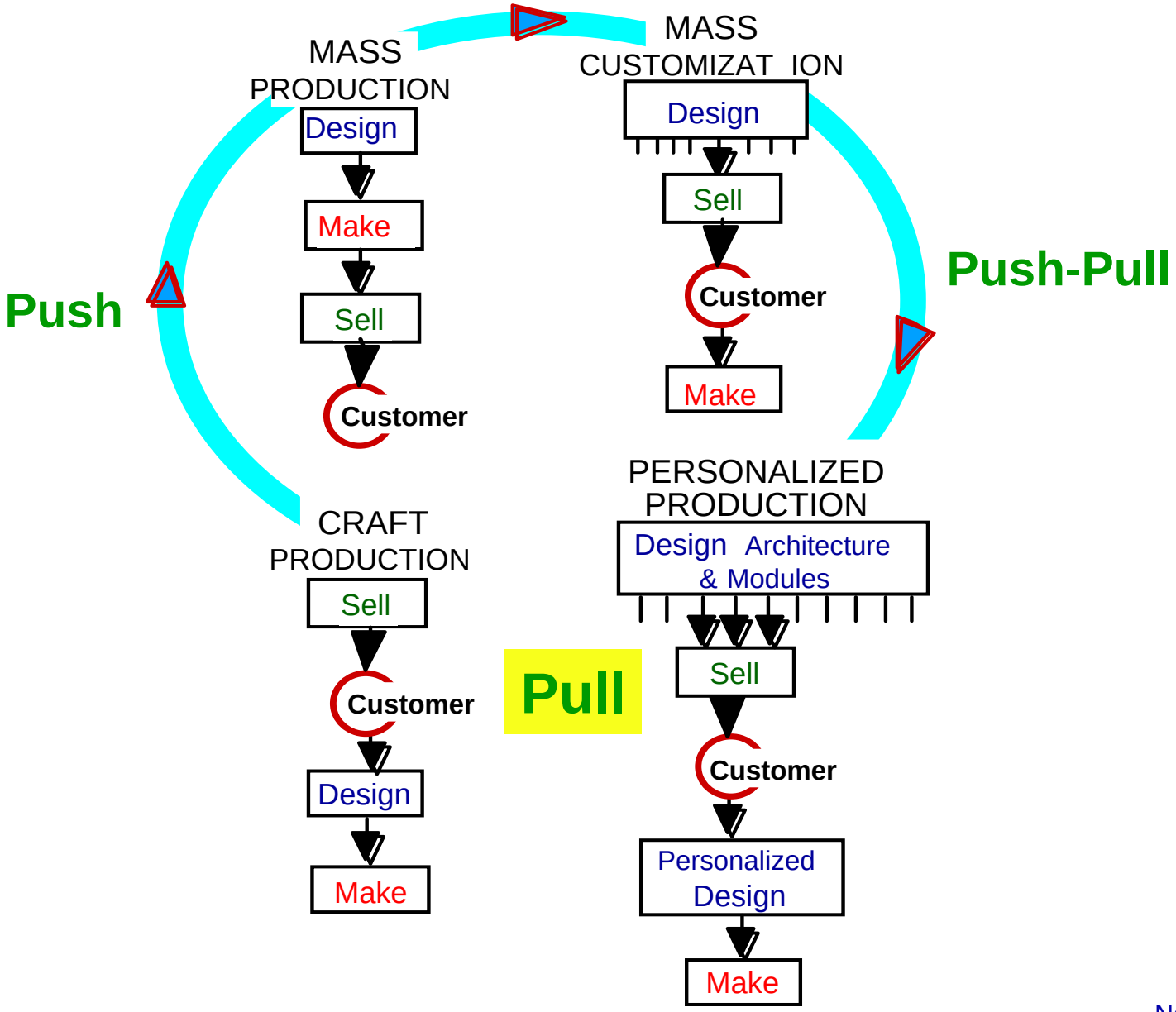
The manufacturer designs the **options**





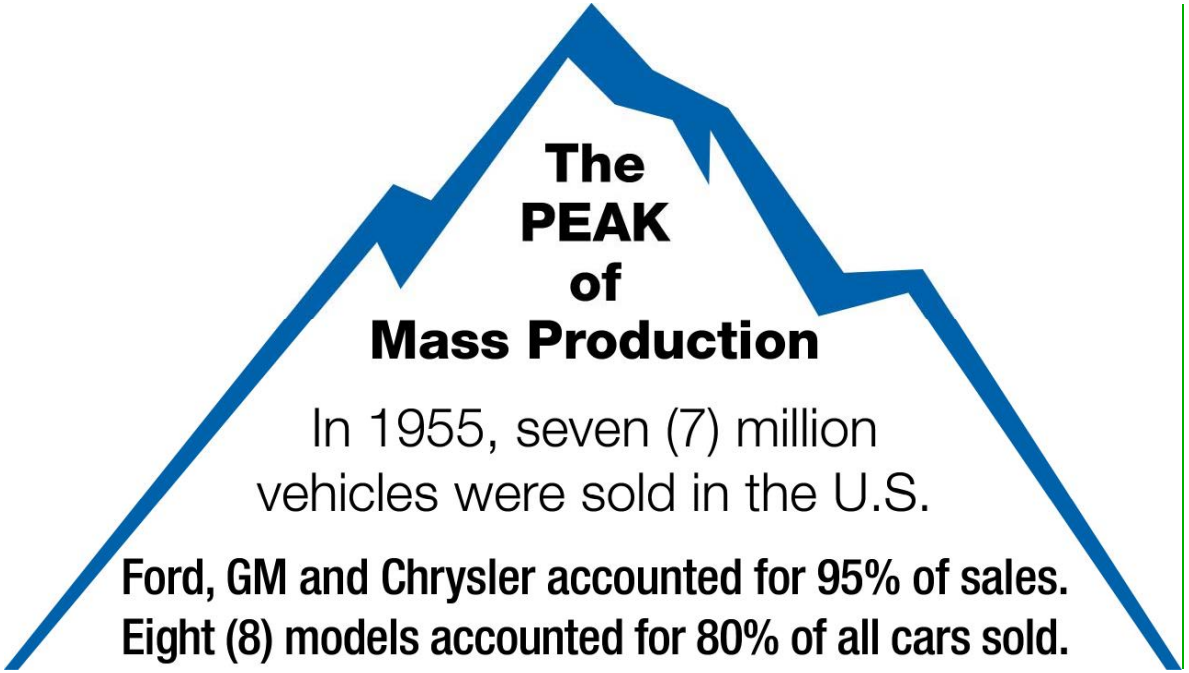
Customer involved
The customer designs the **option**

Paradigm Transition



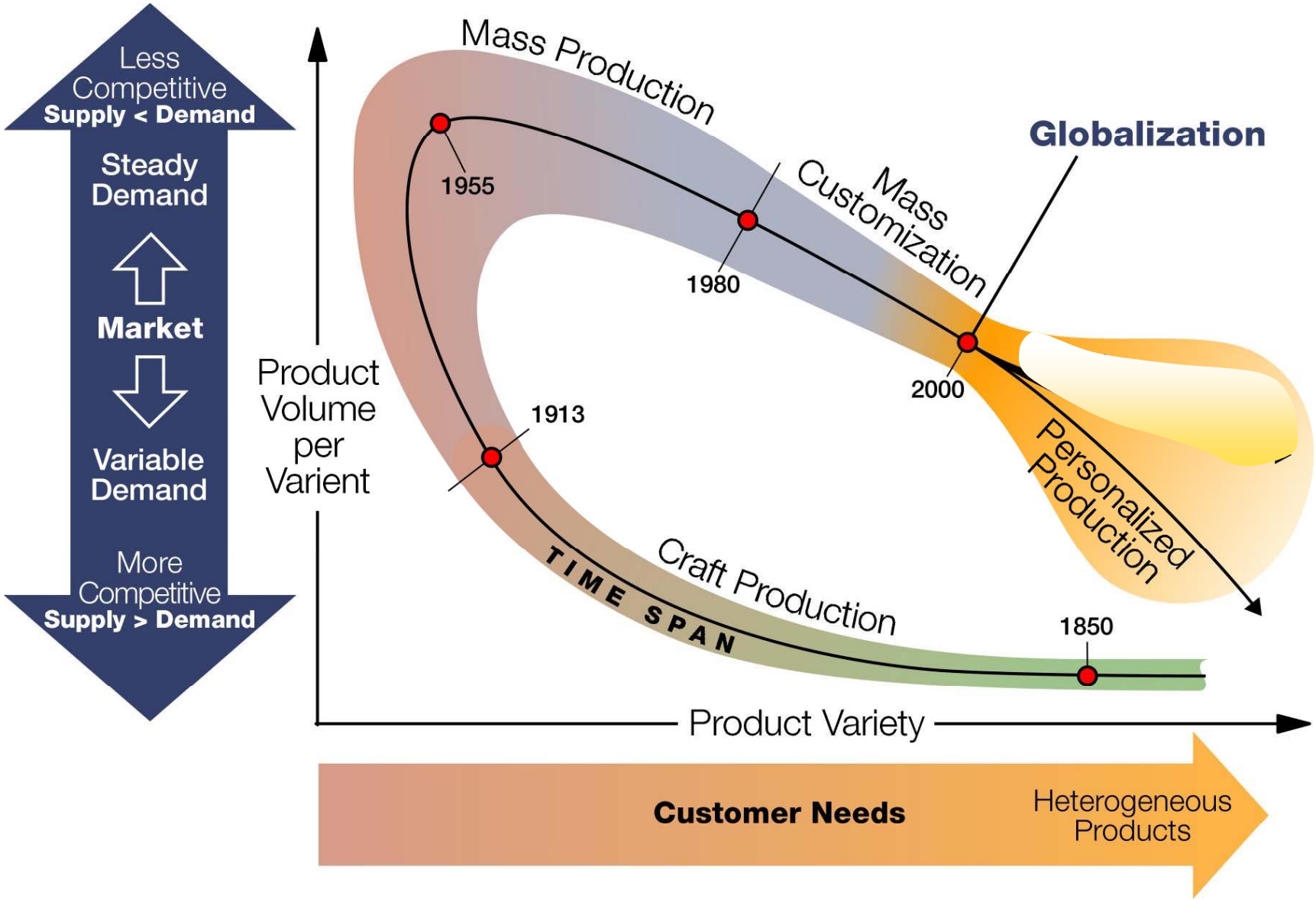
Mass Production of Automobiles

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



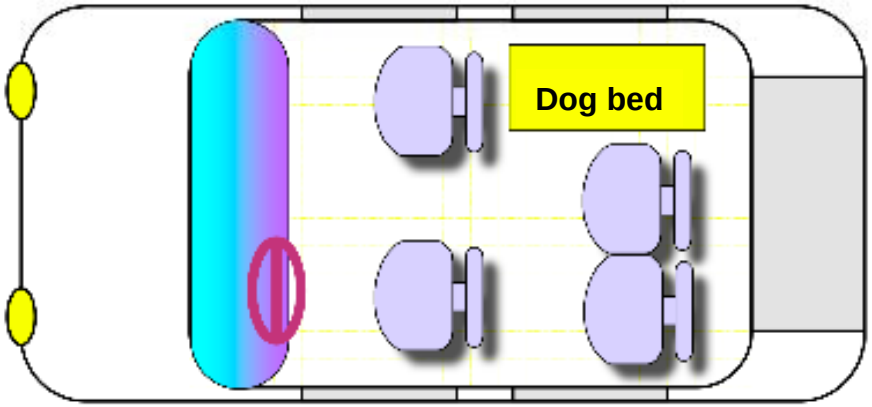
The auto industry is still using the serial moving assembly line, 100 years after its invention

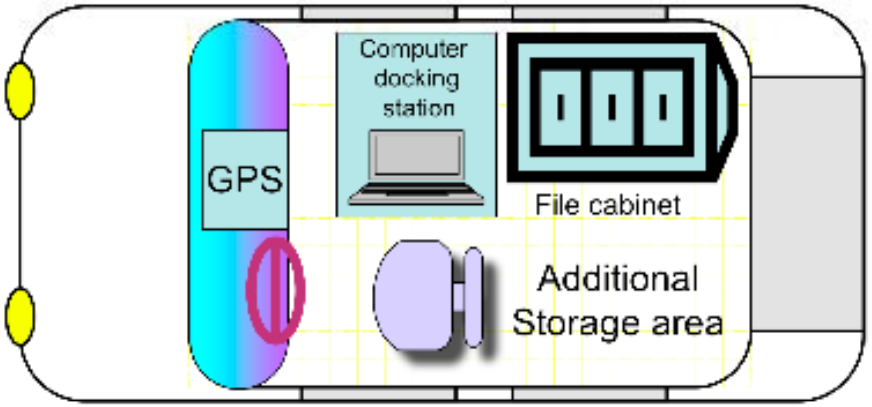
Paradigm Changes



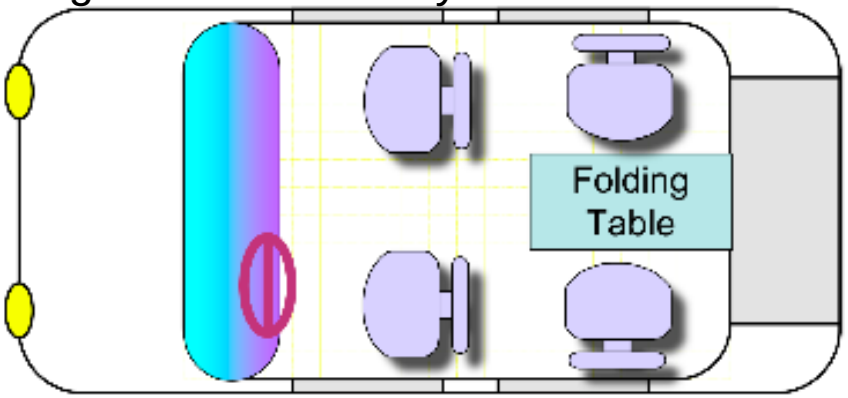
Changeable Automobile Interior

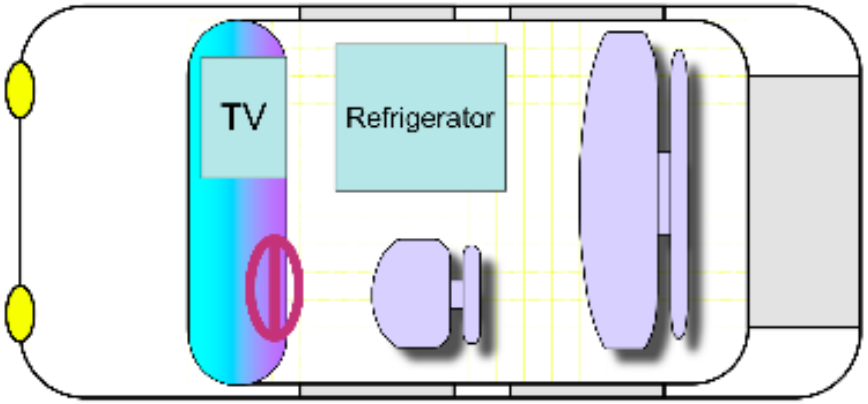
Customers' Wishes of Their Automobile Interior

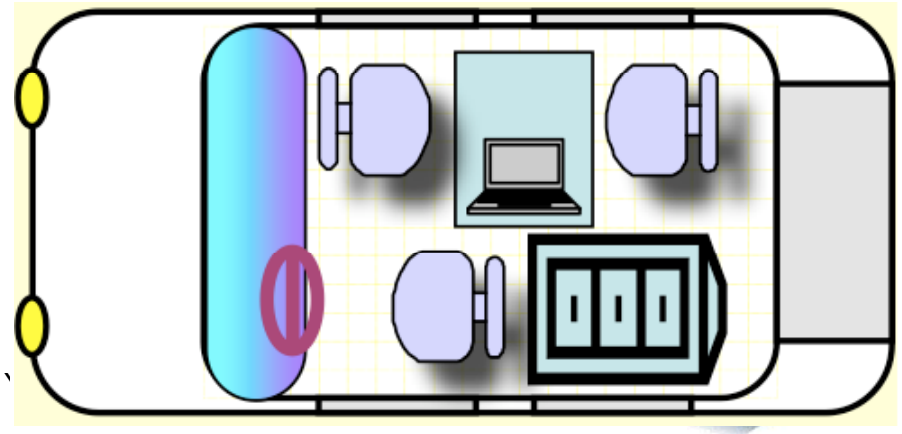


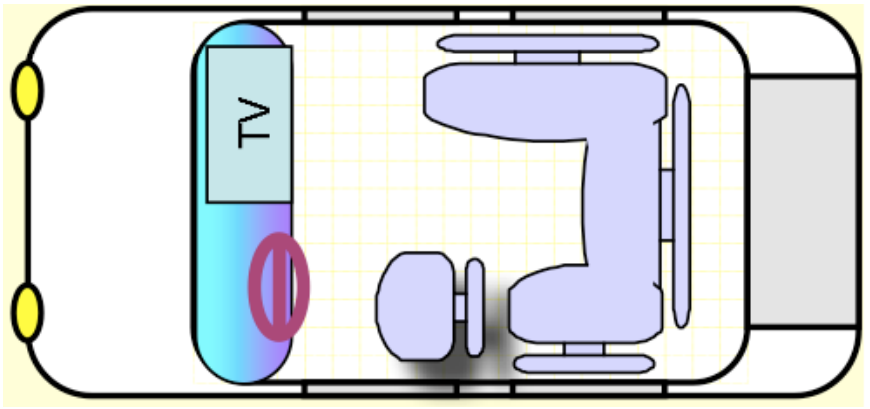


Air bags inside the safety belt









Small Business Industry for Car Modules

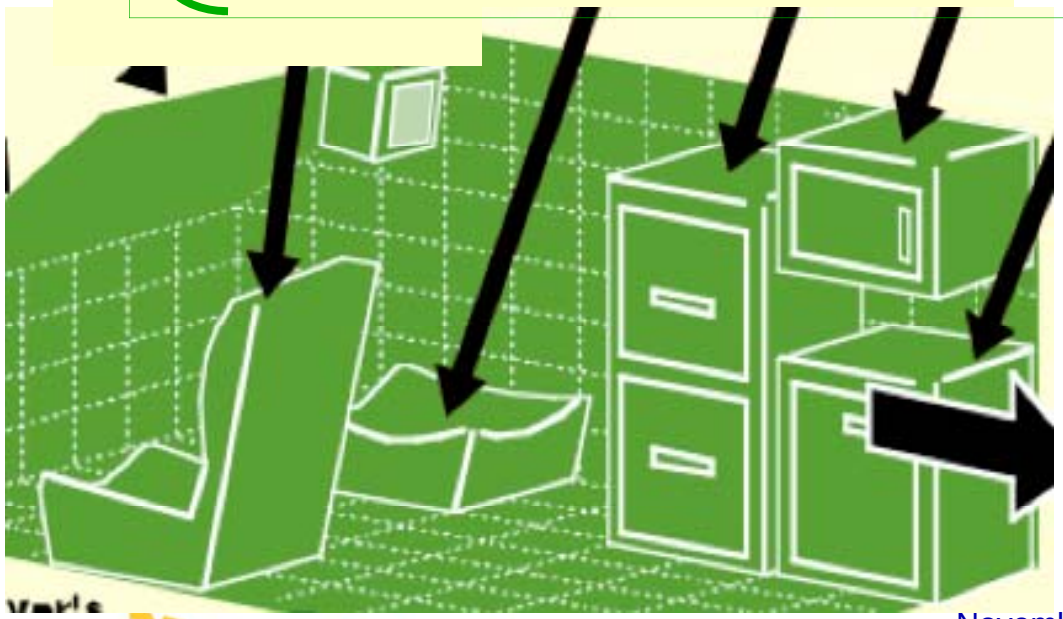
Should be Open-Architecture standards for

- **Mechanical**
- **Electrical**
- **Information**

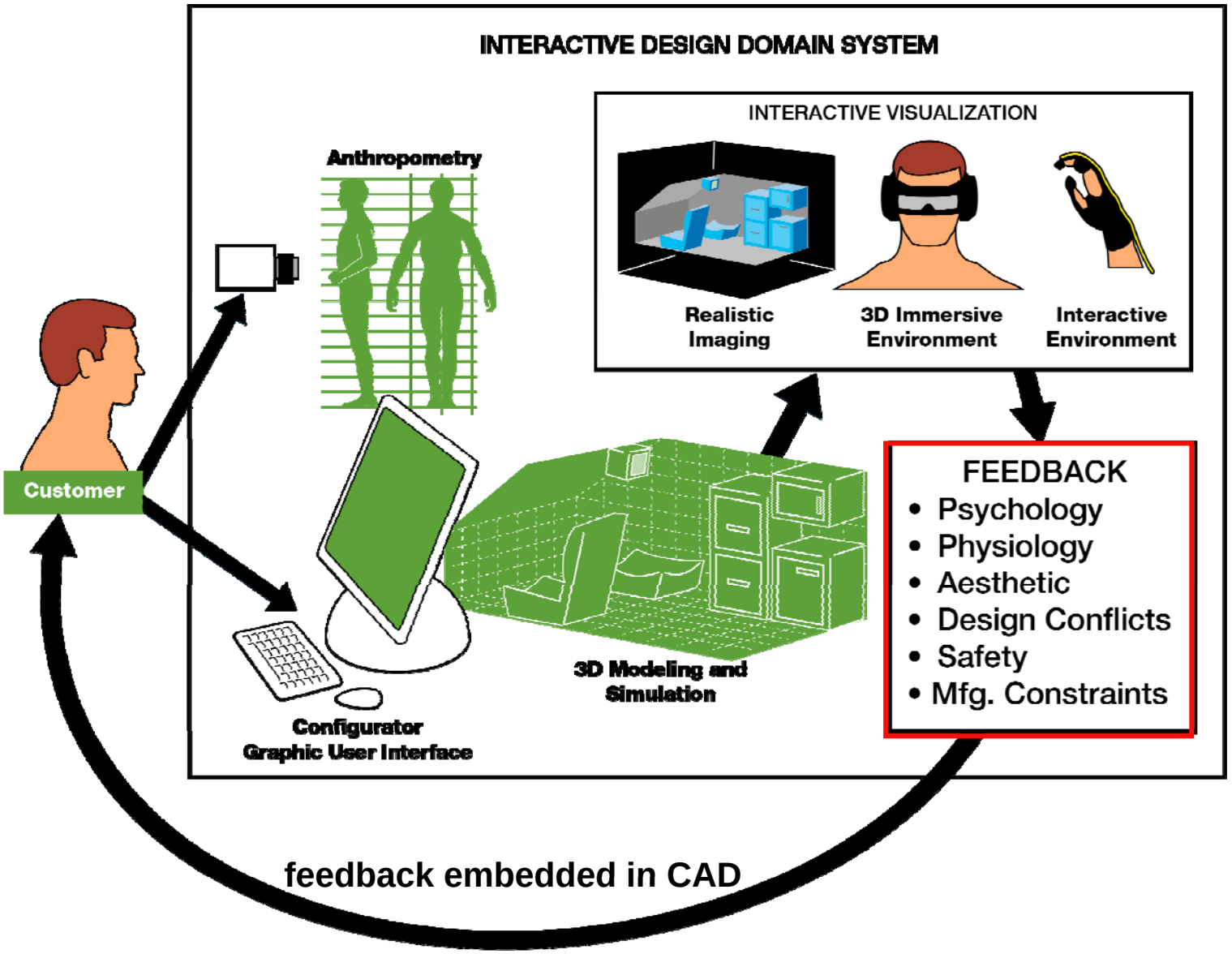
Module interfaces

Module interfaces are designed according to the open-architecture standards

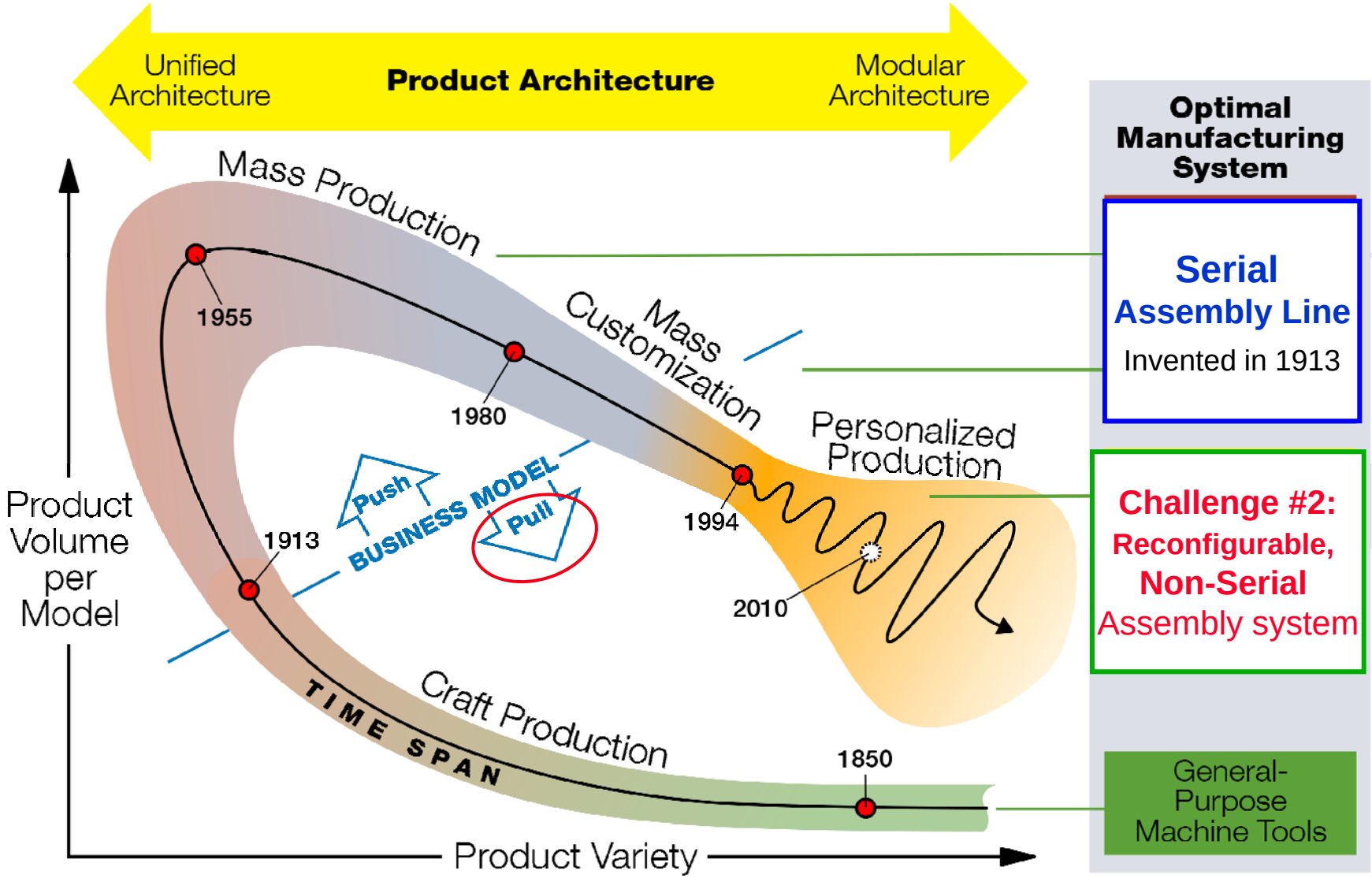
Computer stations; Clothing-racks
Microwaves; Refrigerators
Weight storages; Folding Beds
Portable-potty for kids; Folding tables
Dog baskets; File cabinets



Challenge #1: Creating New CAD Technologies



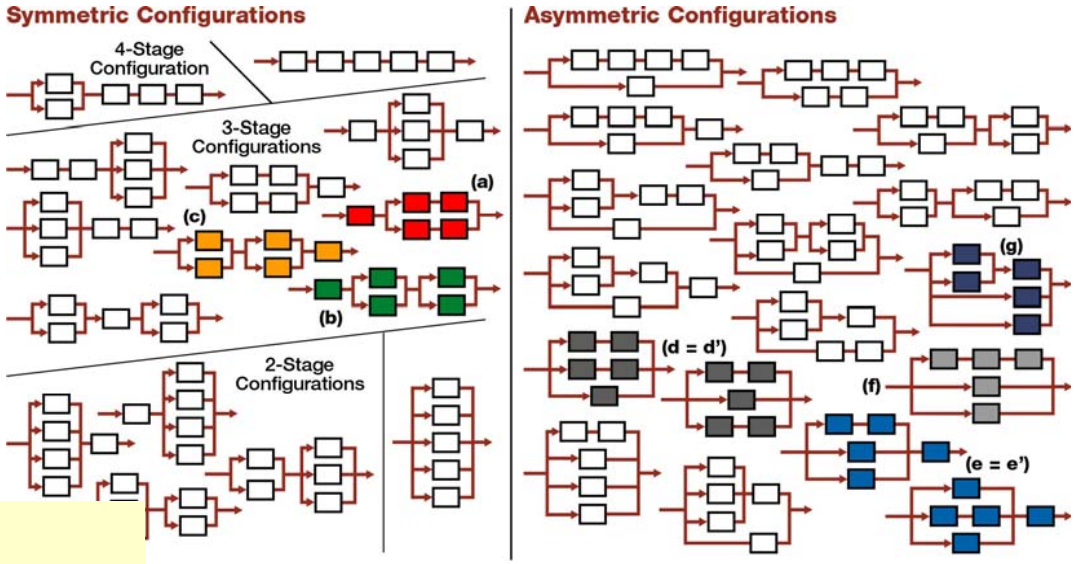
Paradigm Transitions Over Time



The Number of Possible Configurations

Configurations of assembly systems with 5 stations.

In practice there may be over 50 stations

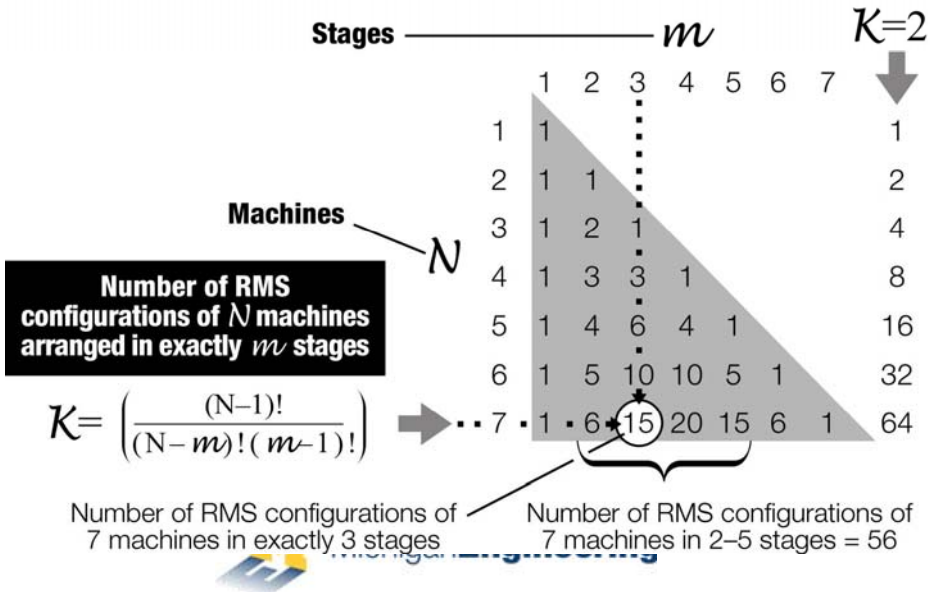


Challenge: How to design a configuration which is not a serial line

Number of RMS configurations of N machines arranged in up to N stages

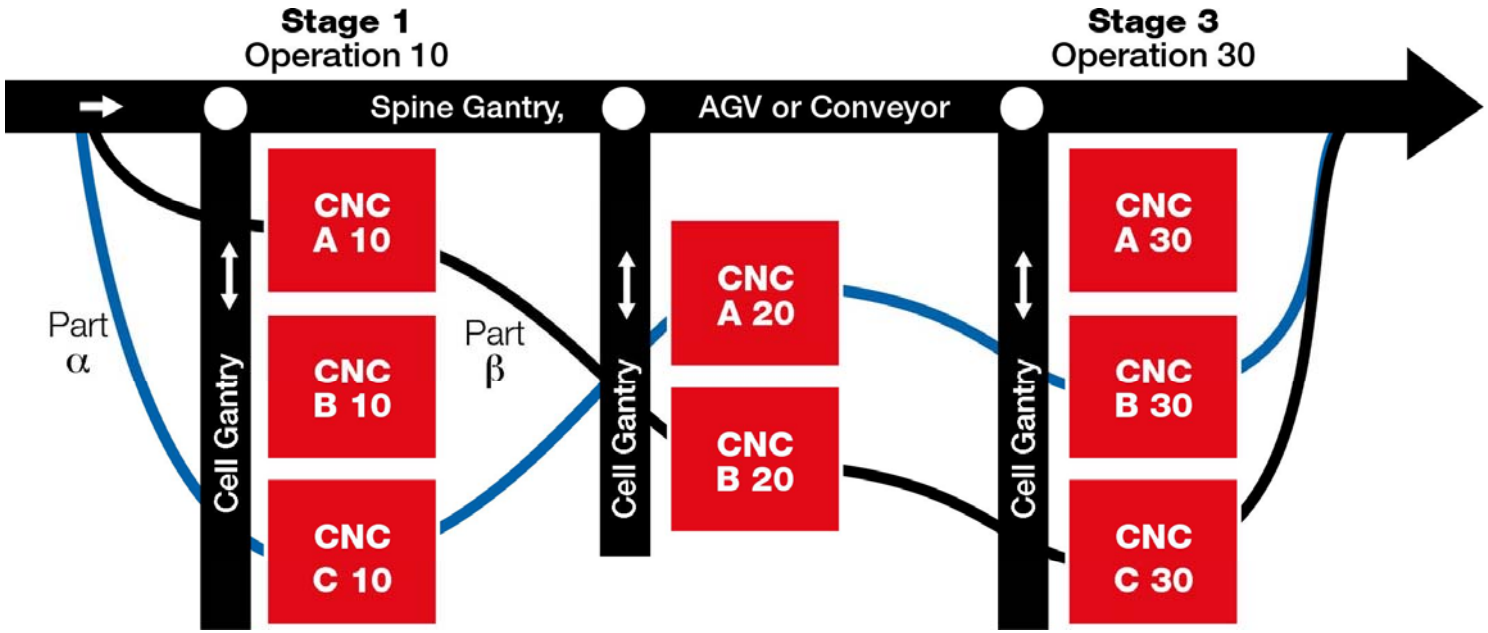
Number of RMS configurations of N machines arranged in exactly m stages

$$K = \left(\frac{(N-1)!}{(N-m)!\,(m-1)!}\right)$$



Reconfigurable Manufacturing System - Example

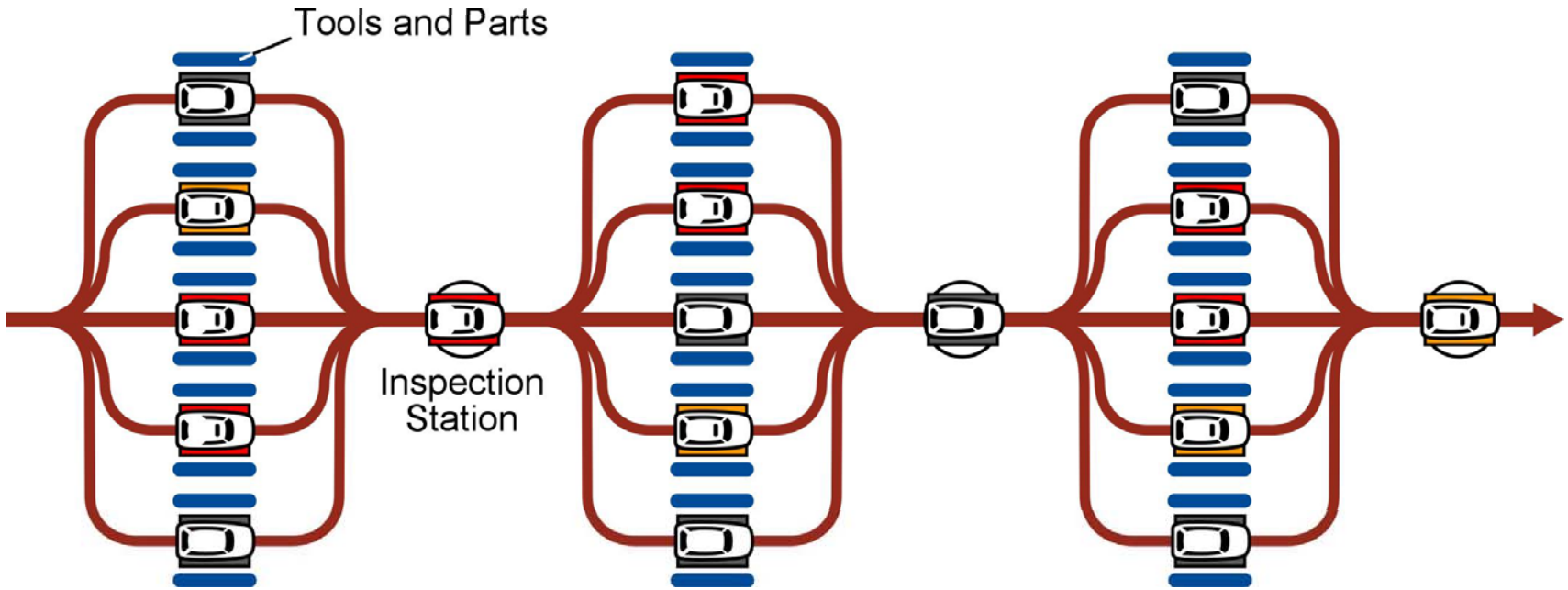
A RMS is a system designed at the outset for rapid changes in structure, in order to quickly adjust production capacity and functionality when needed



Challenge #2: Similar RMS concepts should be developed for cost-effective assembly of personalized interiors of automobiles

A Reconfigurable Assembly System – an Example

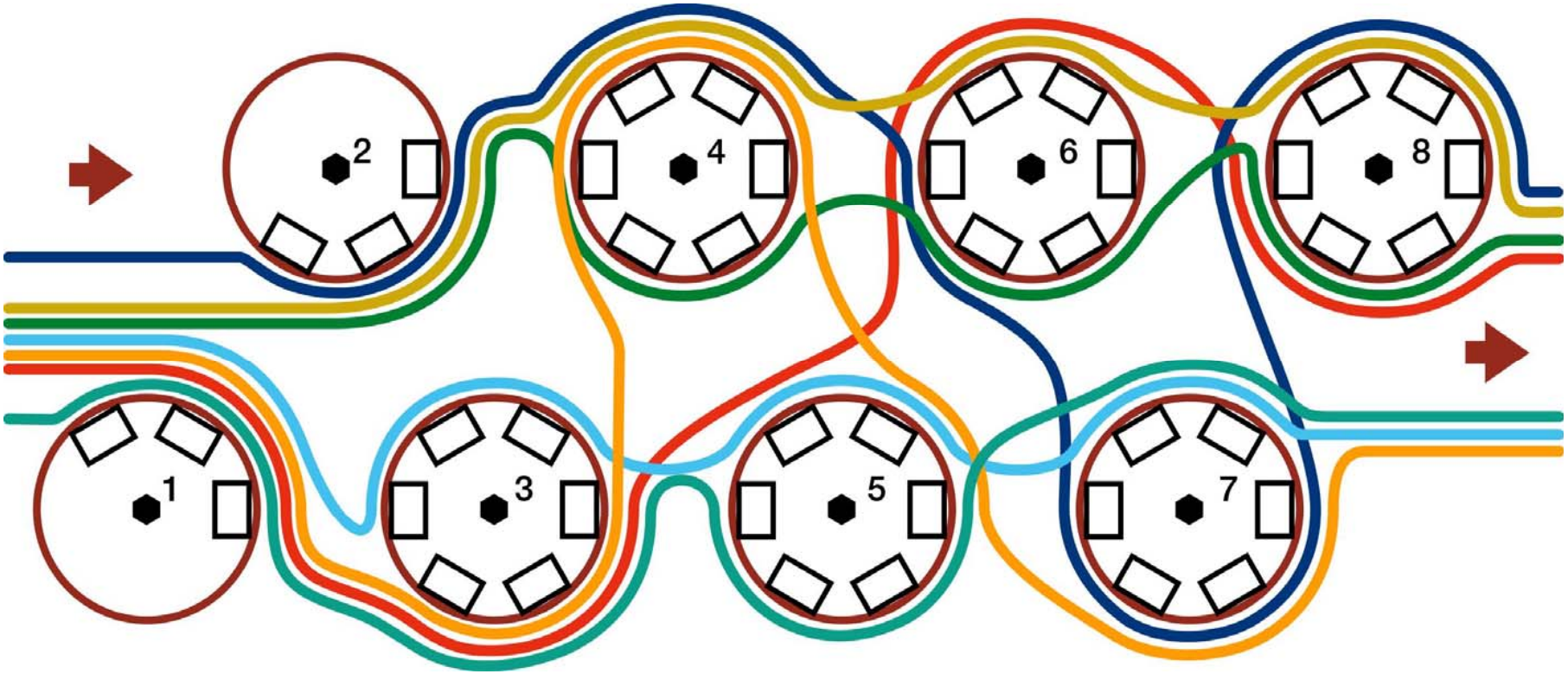
Ford's serial assembly line that was invented in 1913, should be substituted



Example of assembly system of personalized automobile interiors

Example: Reconfigurable Assembly System

Another example of assembly system of personalized automobile interiors

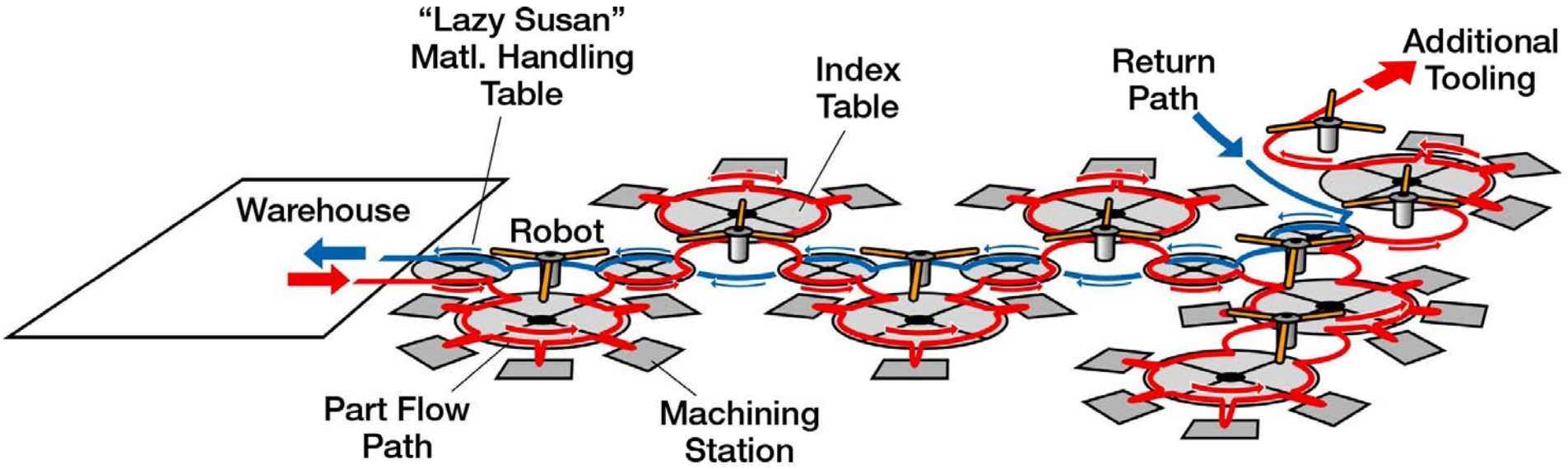


This layout resembles the layout of a reconfigurable shoe factory in Italy

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