



Software Product Lines

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[From Individual to Standard]

- Before industrialization age, manufacturing was handcrafting
 - Handcrafting makes it easy to incorporate individual requirements



[Mass Production]

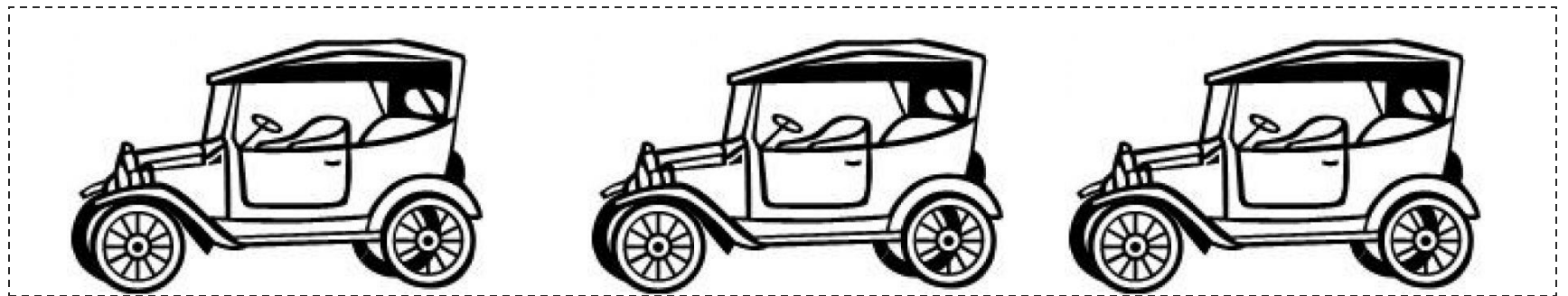
- In 18th century, mass production changed this landscape
- Mass production means standardization
 - It enables production for a mass market
 - Products are cheaper and have better quality than individual products
 - But, individual requirements are lost

Mass Market

- Production line reduces possibilities for diversification

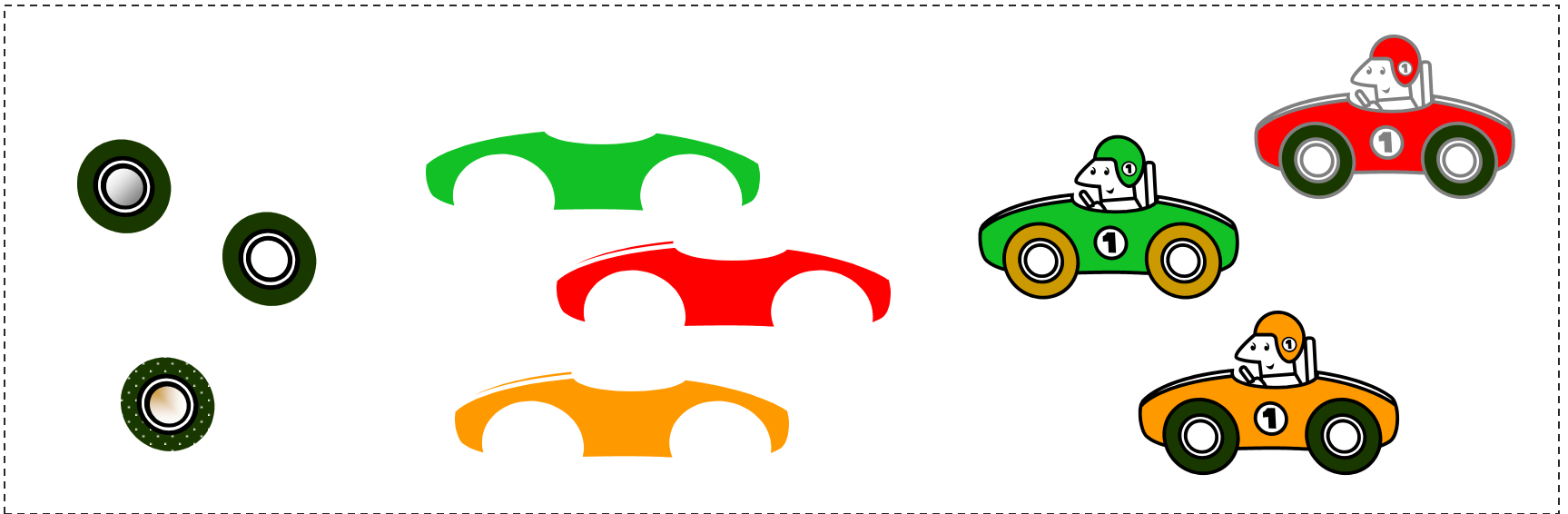
“Any customer can have a car painted in any color that he wants, as long as it is black”

Henry Ford



Back to Individualism

- In the 20th century, manufacturers increase diversity in their portfolios
 - They still use reusable parts, but combine them in different ways



[Product Line]

- A product line is a set of products that share substantial similarities
 - Product Line is *mass customization* applied to a *common platform*
- A platform is any base of technologies on which other technologies are built
- Mass customization is the large-scale production of goods
 - It addresses individual customer's needs

[Impact of Product Lines]

- In a period of three years, car companies using platforms increase sales by 35%
 - Similar pattern was observed in the camera industry (Fuji vs. Kodak)
- Nowadays, almost all major manufactures rely on product lines

[Example 1: Desktop Computer]

- Configuration options
 1. Select a general model

Desktop Computers & All-in-Ones



Shop All

View all Desktops for
Home



Inspiron Desktop Computers

For home and home
office



XPS Desktop Computers

Designed to be the
best



Alienware Desktop Computers

Best-in-class gaming
and VR ready



G Series Desktops

High-performance
gaming



Desktop Deals

For current Desktop
Deals

Customize your computer...

- Configuration options
 2. Select a processor...
 3. ... and a processor generation

Processor

- Intel® Pentium®
- Intel® Core™ i3
- Intel® Core™ i5
- Intel® Core™ i7
- Intel® Core™ i9
- AMD Ryzen™ 5
- AMD Ryzen™ 7
- AMD 7th Gen A-Series
- AMD Ryzen™



Processor Generation

- 8th Gen Intel® Core™
- 9th Gen Intel® Core™
- 10th Gen Intel® Core™

[Mass customization

4. Memory
5. Storage Drive Type
6. Drive Size
7. Form Factor
8. Operating System
9. Video Card
10. Shipping Speed
11. CD/DVD/Blue Ray
12. Gaming, etc. etc.

Memory (RAM)

- Up to 4 GB RAM
- 8 GB RAM
- 12 GB RAM
- 16 GB RAM
- 32 GB and up RAM
- 16GB Intel® Optane™ RAM

Storage Drive Size

- Less than 256 GB
- 256 GB – 500 GB
- 1TB and up

Form Factor

- All-in-one
- Standard Tower
- Tower

CD/DVD/Blu-ray

- CD/DVD Burner (Read and Write)

Storage Drive Type

- Solid State Drive
- Hard Disk Drive

Operating System

- Windows 10

Gaming

- VR Ready
- Casual Gaming

Shipping Speed

- Smart Selection, Ready to Ship
- Built to Order, Standard Shipping

Shop by Use

- Gamer
- Photo Editing
- Video Editing
- Multitasking

Video Card

- Integrated Graphics
- NVIDIA®
- NVIDIA® GeForce
- GDDR5
- NVIDIA® GeForce
- GDDR5
- NVIDIA® GeForce
- GDDR5
- NVIDIA GeForce G
- GDDR5
- NVIDIA® GeForce
- GDDR6
- NVIDIA® GeForce
- GDDR6
- NVIDIA® GeForce
- GDDR6
- NVIDIA® GeForce
- 11GB GDDR6
- NVIDIA® GeForce
- SUPER™ 8GB GDDR6
- NVIDIA® GeForce
- SUPER™ 8GB GDDR6
- NVIDIA® GeForce
- SUPER™ 8GB GDDR6
- AMD Radeon™ R4
- AMD Radeon™ R5
- AMD Radeon™ RX
- AMD Radeon™ RX
- GDDR6

[Example 1: Desktop Computer]

- ... with hundreds of thousands of different products, you choose yours



Example 2: Your Sandwich

OR YOU CAN BUILD YOUR OWN

- 1 PICK YOUR PATTY:** Chicken, Turkey Burger, Veggie Burger, Black Bean Burger, or 100% Choice Beef



Single / 5.49
Double / 8.09

- 2 CHOOSE YOUR CHEESE:**

American, Swiss, Bleu Cheese
Crumbles, Cheddar, Pepper Jack, Ghost
Pepper Jack, Feta, Provolone (.75)

Goat Cheese, Homemade Pimento,
or Queso (1.00)

- 3 PILE ON THE TOPPINGS:**

Lettuce, Tomato, Ketchup, Mustard,
Duke's Mayo, Onions, Pickles,
MoJoe's Sauce **No Charge**

Chili, Slaw, Chipotle Mayo **.50**

Mushrooms, Sauteed Onions,
Grilled Jalapenos, Green Peppers,
Fresh Pico de Gallo, Salsa Verde **.75**

Fried Egg **1.00**

Applewood-Smoked Bacon, Jalapeno
Bacon, Avocado, Guacamole **1.50**

[Specialized Software]

- Early software products were “handcrafted” for specific hardware and customer
 - Handcrafted software is challenging and expensive
- Solution is a similar strategy of other products: standardization

[Standardized Software]

- Mass production supports standardization
 - Example: MS Office
- However, mass production does not support individualism
 - Black car for every one?

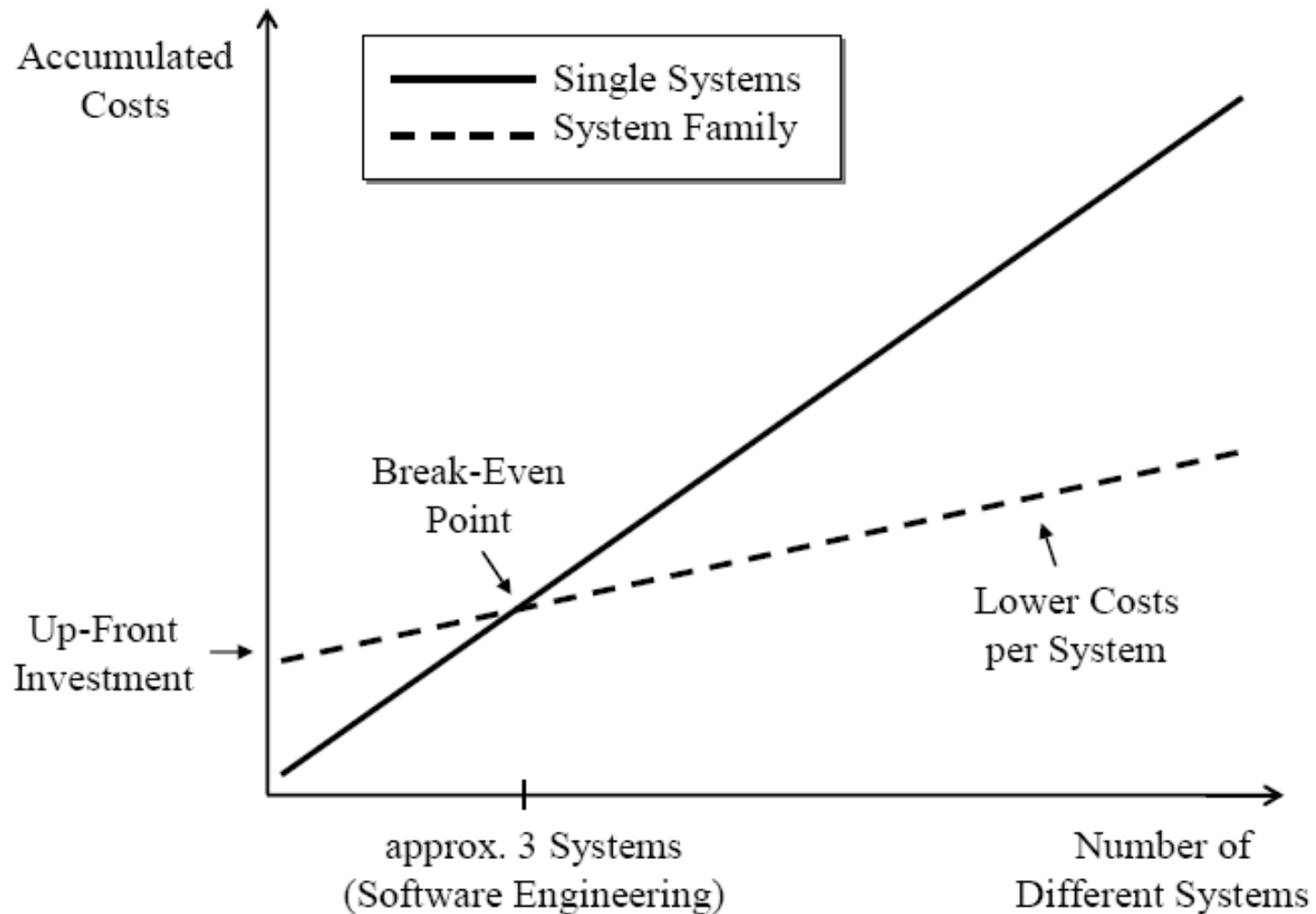
[Software Product Lines]

- “A software product line (SPL) is a set of software systems that share a common set of features satisfying the specific needs of a particular market segment...” [SEI]
- Software product line engineering (SPLE) is a paradigm to develop software applications using platforms and mass customization

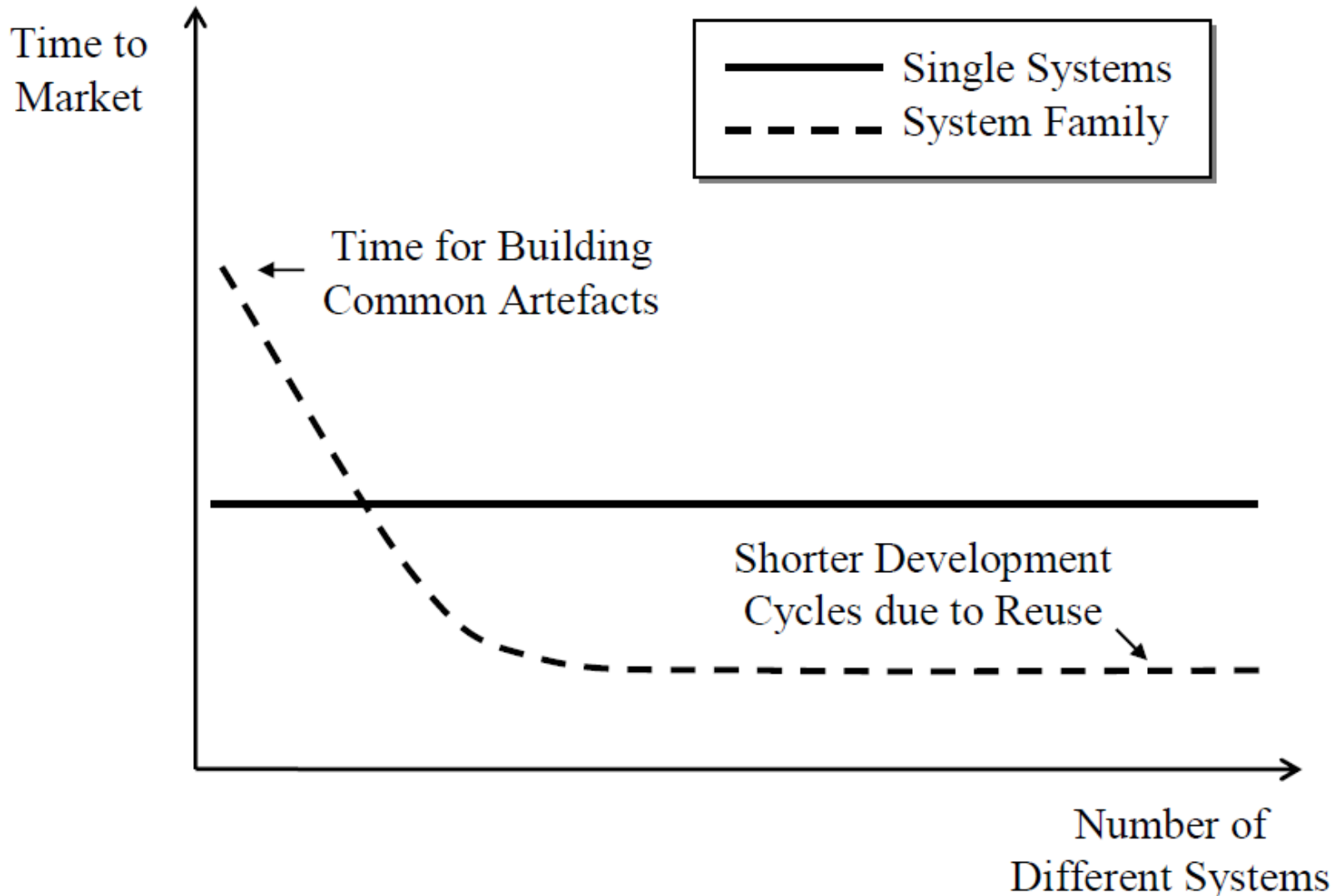
[Motivation for Adopting SPL]

- Reduction of Development Costs
- Reduction of Time to Market
- Enhancement of Quality
- Reduction of Maintenance Effort

[Lower Development Cost]



Reduction of Time to Market



[Quality and Maintenance]

- Enhancement of Quality
 - Artefact in the platform are reviewed and tested in many products
 - Extensive tests imply increasing quality of all products
- Reduction of Maintenance Effort
 - Reuse of test procedures (for instance) helps to reduce maintenance efforts

[Prerequisites for SPL]

- Product line entered in software engineering domain much later
- Prerequisites to take into consideration in the adoption of SPL
 - Enabling Technologies
 - Process Maturity
 - Domain Characteristics and Expertise

[Enabling Technologies]

- Adequate technology is required for applying SPL principles in an easy way
 - Object oriented programming is a major enabling technology
 - Component technology enables developers to package software
 - Late-binding techniques allow late configuration choices (at runtime)
- Other technologies are also desirable

[Process Maturity]

- The lack of maturity can affect the success of SPL adoption
 - Process models (such as CMMI) help to identify the weak parts of a process
- Abstraction plays a major role in making complexity manageable
 - Modelling notations (such as UML) help developers to identify variability

Domain Characteristics

- Only people who know their market can identify commonalities and variability
 - Wrong choices of variability lead to additional costs
- The stability of the domain is also important
 - If everything changes, the investment costs never pay off

[Bibliography]

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 - Chapter 1
- S. Apel, D. Batory, C. Kastner, G. Saake. **Feature-Oriented Software Product Lines**. Springer, 2013.
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