PROFESSIONAL EDUCATION

Short Programs

2. Fundamental Concepts of Platforming
Examples, Definitions, Approaches, & Metrics

a. Platform Mindset
b. Platform Examples
c. Platform Definitions
d. Platform Approaches
e. Platform Metrics
f. Platform Paradoxes

a. Platform Mindset

Platform Mindset

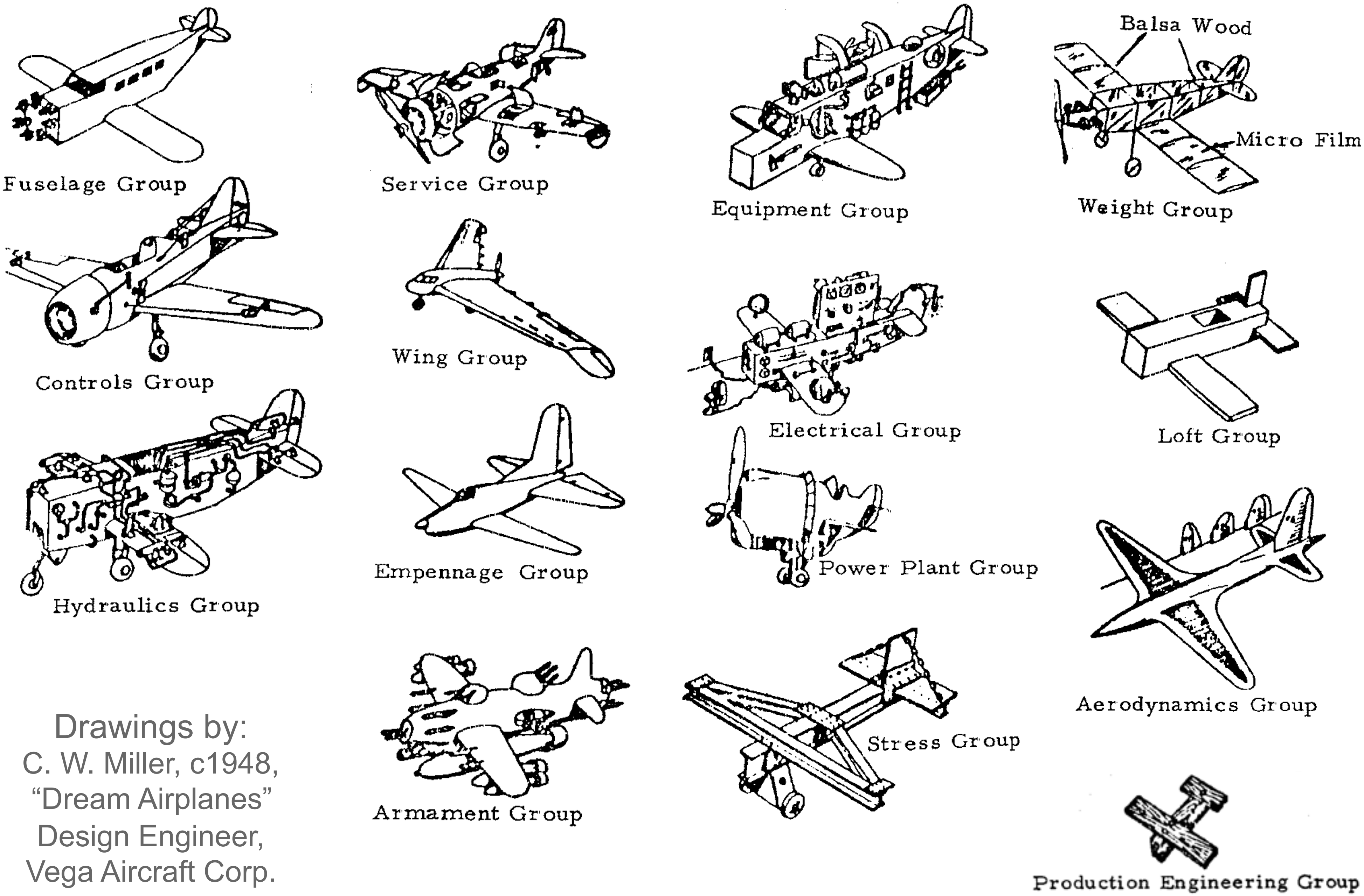
- Mindset =
  - “A fixed mental attitude or disposition that predetermines a person's responses to and interpretations of situations
  - An inclination or a habit”

  - American Heritage Medical Dictionary

- Platforming should be on everyone’s mind, not just the product designers and engineers
  - It becomes self-evident once you realize how important it is

- Think about Concurrent Engineering and drive for cross-functional teams…

Aircraft Design/Production Groups

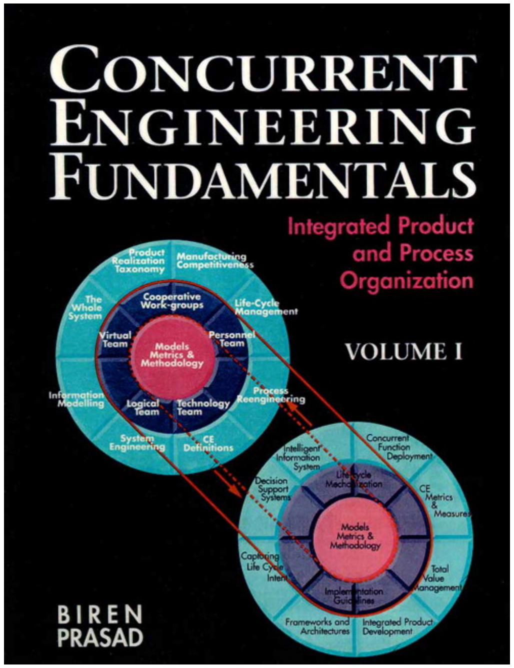


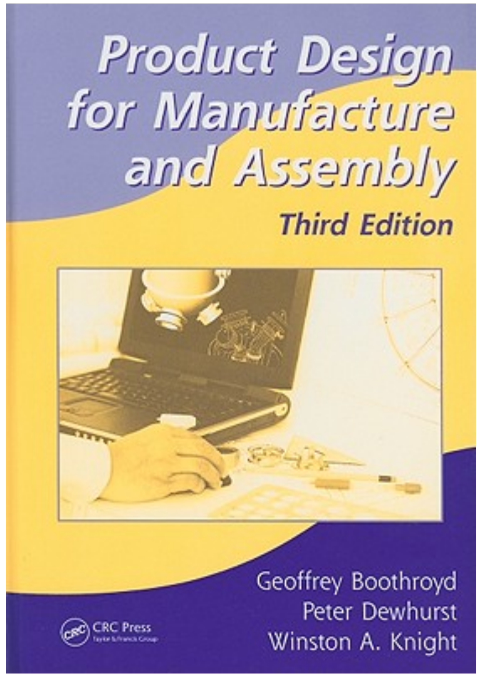
Drawings by:
C. W. Miller, c1948,
“Dream Airplanes”
Design Engineer,
Vega Aircraft Corp.

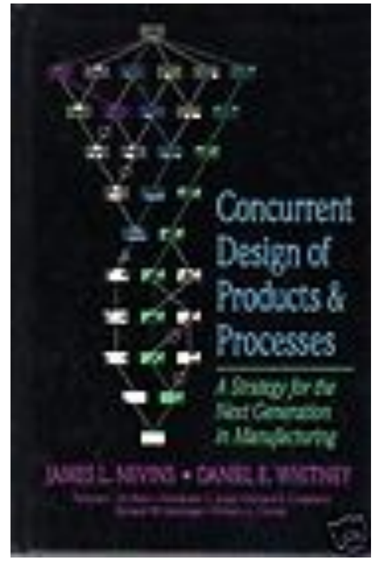
Evolution of Concurrent Engineering "Mindset"

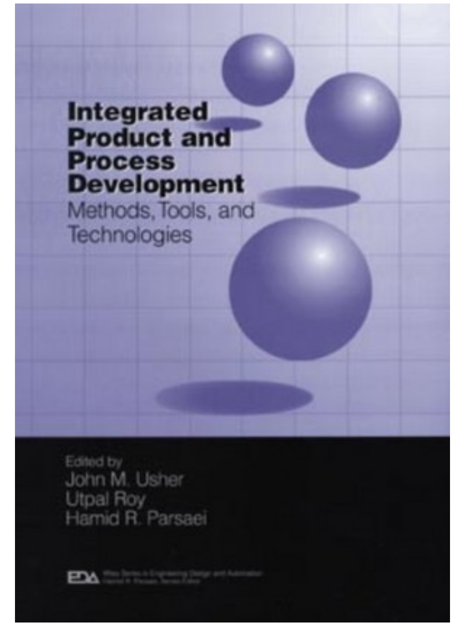
- 1980's
  - Automotive industry was being overtaken by Japanese
  - Intense period of scrutiny by researchers and companies
  - Tools and methods start to emerge
    - House of Quality & Voice of the Customer, 1988
    - Design for Product Assembly, 1989
- 1990's
  - *The Machine that Changed the World* published in 1991
  - New tools and methods quickly follow:
    - DFM, DFMA, DfX, FMEA, …
  - Concurrent Engineering becomes the new way to work
  - Cross-functional teams are refined and transformed into matrix organizations, integrated product teams, etc.
  - Then comes Lean Engineering, Lean Production, Lean Product Development System, …

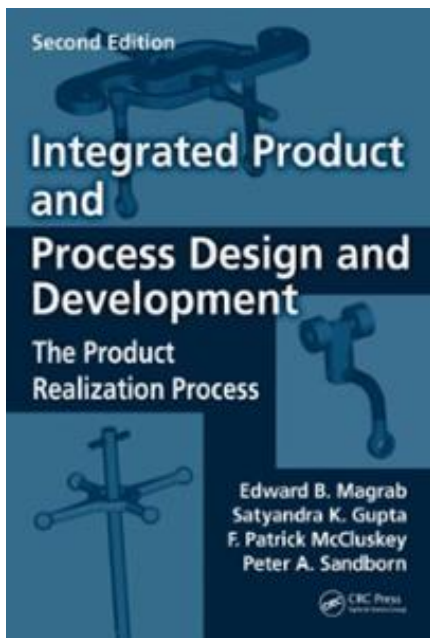
Concurrent Engineering Books Are Now Plentiful

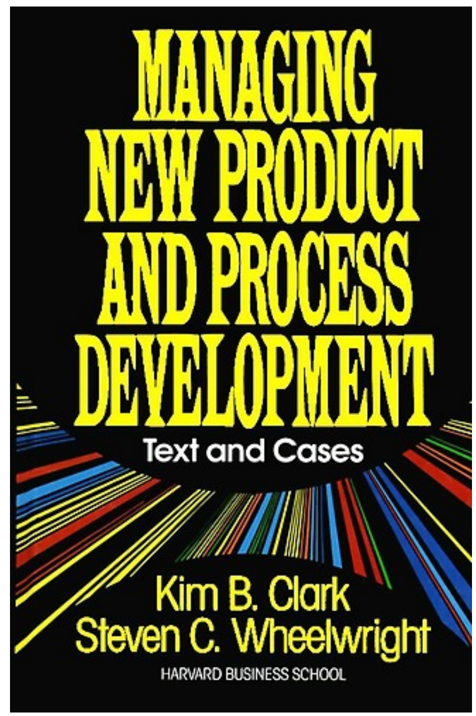


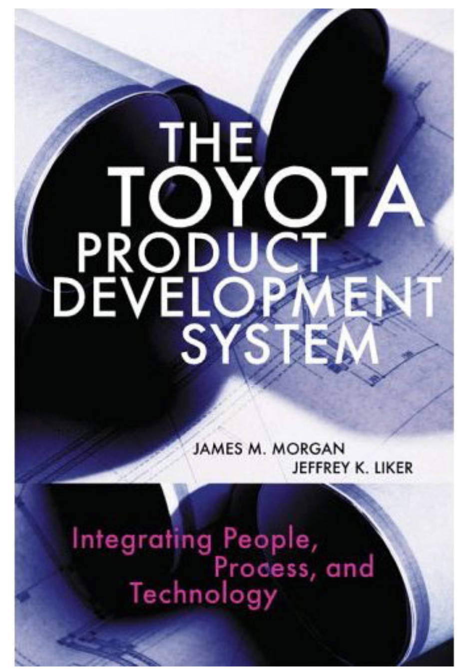










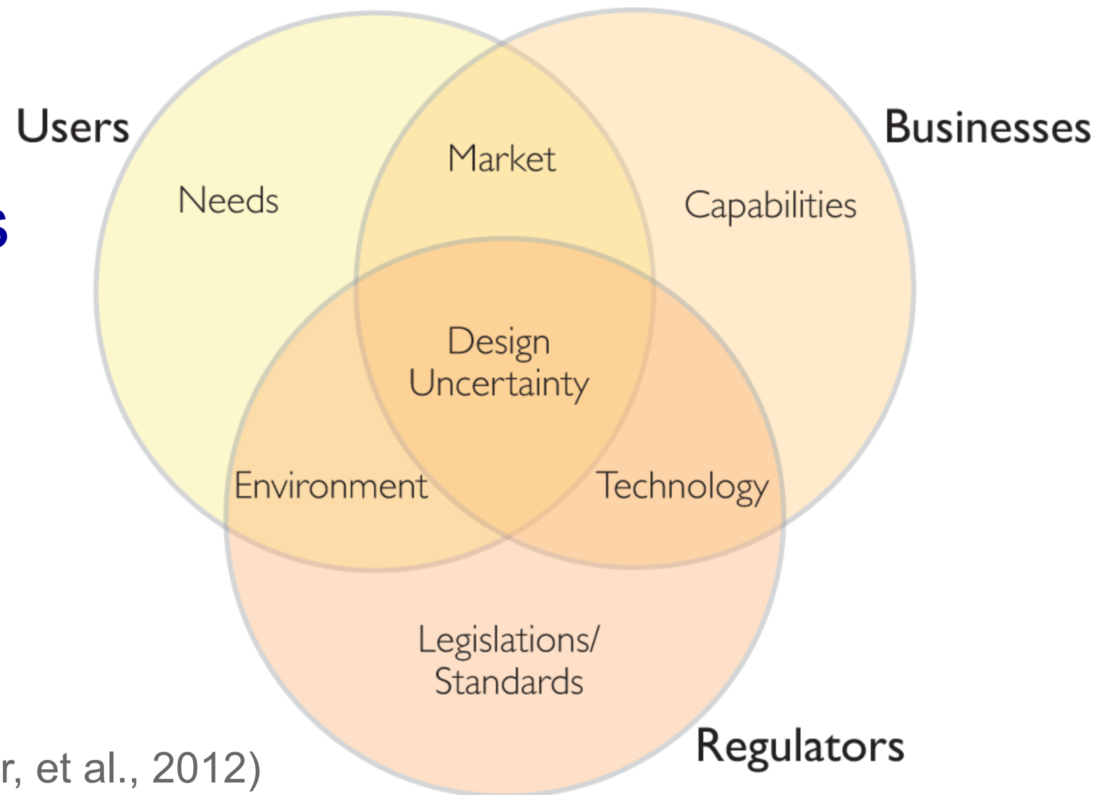


Moving to a Platform Mindset

- Product platforming is undergoing the same evolution
- Now, instead of thinking about cross-functional teams that span multiple disciplines, we seek to create platforms that span multiple product offerings
  - Leverage resources across multiple development projects
  - Reduce time-to-market, shorten lead-time, lower costs
  - Maximize commonality, reuse, standardization
  - Increase efficiency, improve responsiveness
- The importance of platforming has increased notably in the past 3-4 years as companies enter global markets
  - Platforms are often critical to remain cost effective while competing globally

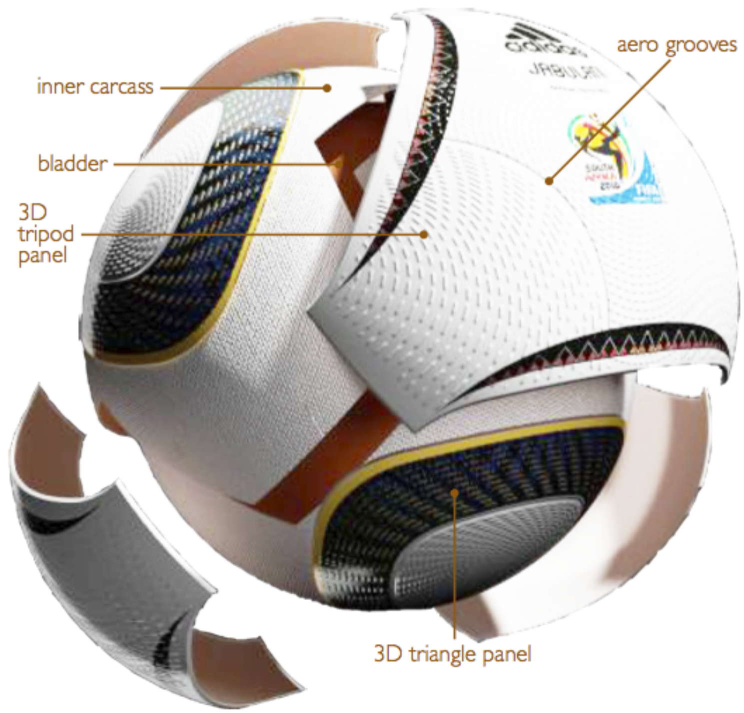
Platforming for Global Markets

- Addressing global market adds a host of complexities to platform design challenges
  - Global platform or regional platforms – or no platform?
  - Variation in user, regulatory, and business needs?
  - Brand perception: high-end vs. low cost?
  - Production (e.g., labor) costs
  - Supply chain issues
- Organization challenges
  - Localized design
  - Distributed teams
  - Cultural differences
  - Time zone differences
  - Reporting requirements



Source: (Nadadur, et al., 2012)

Examples of Global Products



Adidas Jabulani (2010)

Apple iPhone

Universal power adapter

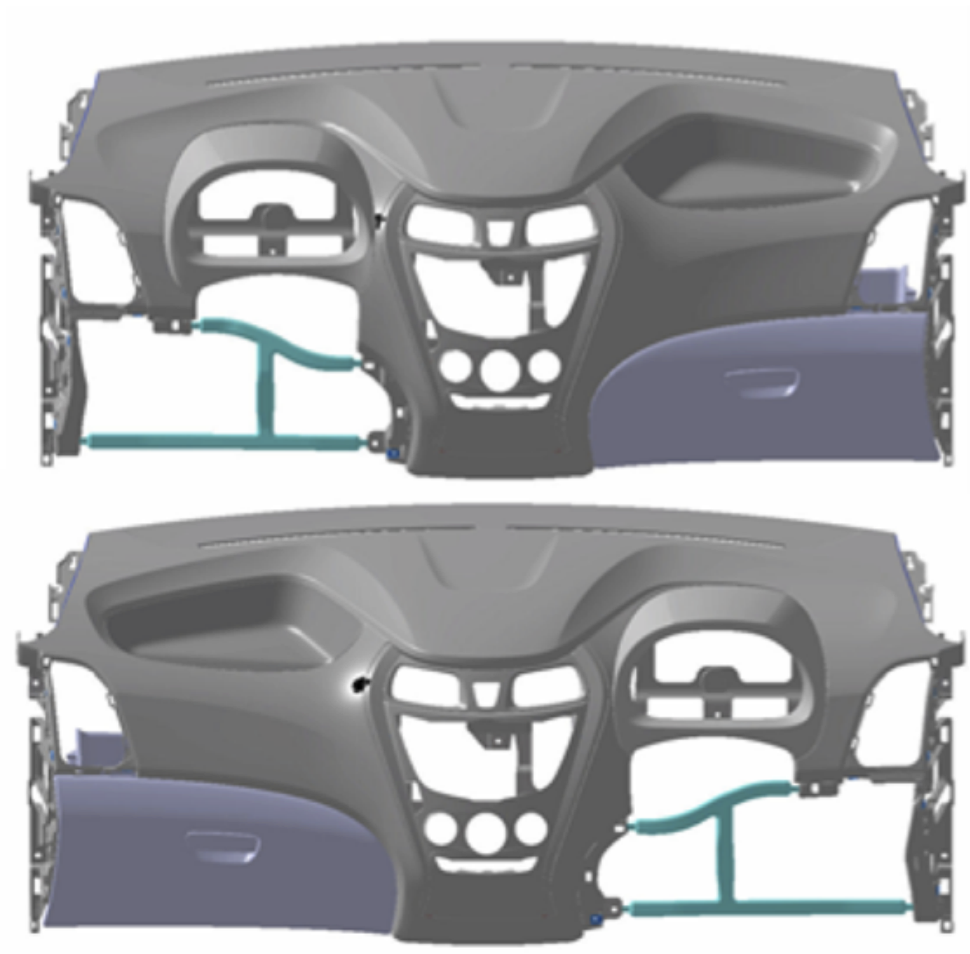
Citroen C4 Grand Picasso (2011)

Sources listed in (Nadadur, et al., 2012)

Hyundai Santa Fe (2011)

- How do car manufacturers handle left/right hand drive?

a) Cockpit design of the 2011 Santa Fe in Korea (top) and the U.K. (bottom)



b) Body design sketch of the left- and right- hand drive Santa Fe (top and bottom, respectively)

Source: Nadadur, G., Kim, W., Thomson, A. R., Parkinson, M. B. and Simpson, T. W. (2012) Strategic Product Design for Multiple Global Markets", *ASME Design Engineering Technical Conferences* , ASME Paper No. DETC2012/DTM-70723

Apple iOS Evolution

	Devices	# updates
iOS 1.x	iPhone; iPodT 1	8
iOS 2.x	iPhone, 3G; iPodT 1, 2	5
iOS 3.x	iPhone, 3G, 3GS; iPodT 1, 2, 3; iPad	4 (2 for iPad)
iOS 4.x	iPhone 3G, 3GS, 4; iPodT 2, 3, 4; iPad, 2; AppleTV 2	16 (3 for AppleTV 2)
iOS 5.x	iPhone 3GS, 4, 4S; iPodT 3, 4; iPad, 2; AppleTV 2	3 (7 for AppleTV 2)
iOS 6.x	iPhone 3GS, 4, 4S, 5; iPodT 4, 5; iPad 2, retina, mini; AppleTV 2	7 (4 for AppleTV 2)
iOS 7.x (beta)	iPhone 4, 4S, 5; iPodT 5; iPad 2, retina, mini; AppleTV 2	

- How do companies evolve their hardware and their software platforms?
- Apple iOS evolution is one of many possible examples
  - Hardware and software tend to evolve in parallel initially
  - Software updates are used to “refresh” hardware and give feature upgrades
  - Software leveraged across multiple devices
  - iTunes provides an additional “backbone” for the platform

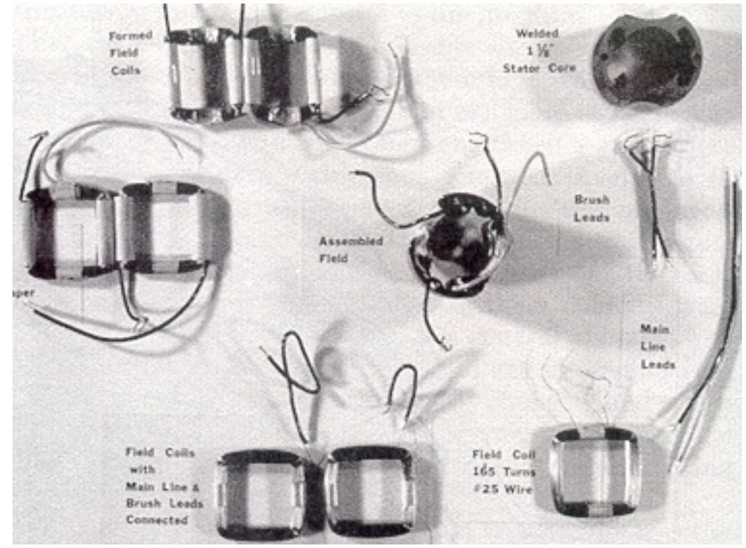
Why Platform Examples?

- Examples provide context for platform discussions
- Gain insight into successful platforming efforts
- Understand successes of similar product families
  - Identify commonalities and differences within your own products
  - HW vs. SW balance, industry, company size, type of product, costs, technology life cycles, time scales, customer behavior, risks
  - Level of platforming: product, subsystem, module, part, etc.
- Avoid pitfalls and learn from other's mistakes (e.g., K-car)

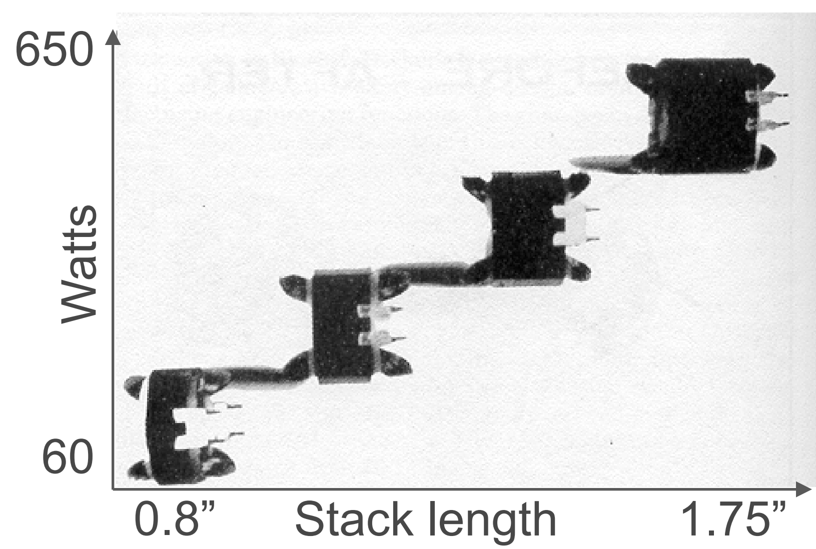
b. Platform Examples

BLACK&DECKER Universal Motor

- Universal motor is most common component in power tools
- *Challenge:* redesign the universal motor to fit into 122 basic tools with hundreds of variations
- *Result:* a common platform where
  - geometry and axial profile common
  - stack length varied from 0.8”-1.75” to obtain 60-650 Watts
  - fully automated assembly process
  - material, labor, and overhead costs reduced from $0.51 to $0.31
  - labor reduced from $0.14 to $0.02



Electric motor field components prior to standardization



Universal motor variants

Enabled a Line of Drills

Jigsaws

Source: Al Lenherd, Penn State ME/IE546, Guest Lecture, 2005

Sanders

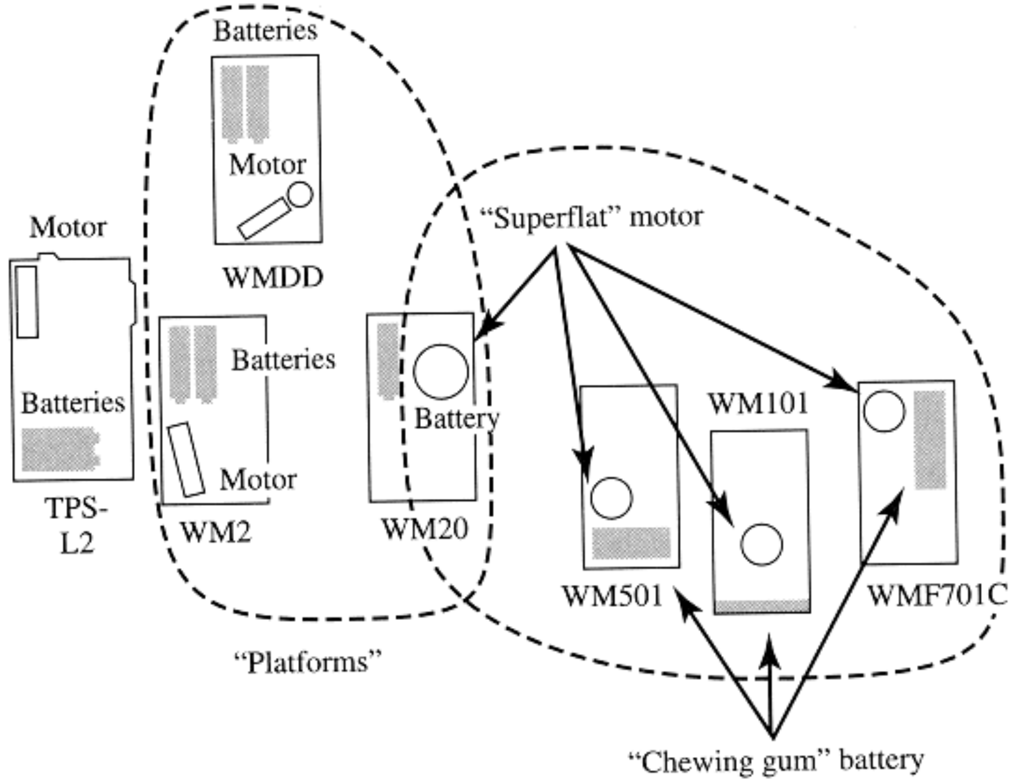
Source: Al Lenherd, Penn State ME/IE546, Guest Lecture, 2005

Niche Products: Rotary Cutter

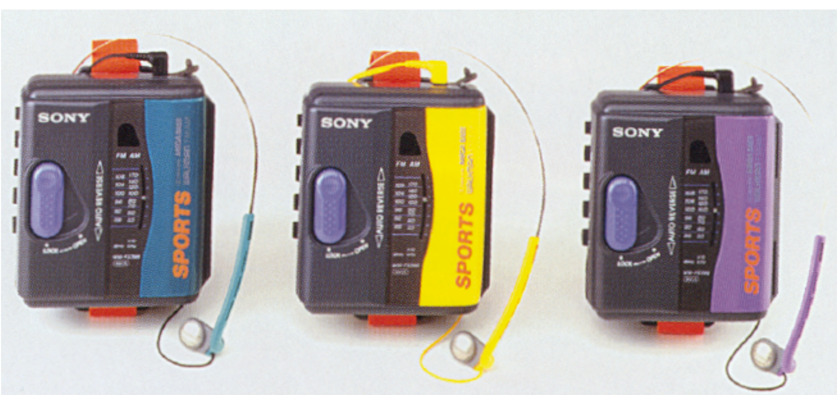
Source: Al Lenherd, Penn State ME/IE546, Guest Lecture, 2005

Sony Walkman® Platform Strategy

- In 1980s, Sony dominated portable stereo market with three basic platforms: WM2, WMDD and WM20



Incremental changes accounted for only 20-30 of the 250+ models introduced in the U.S.

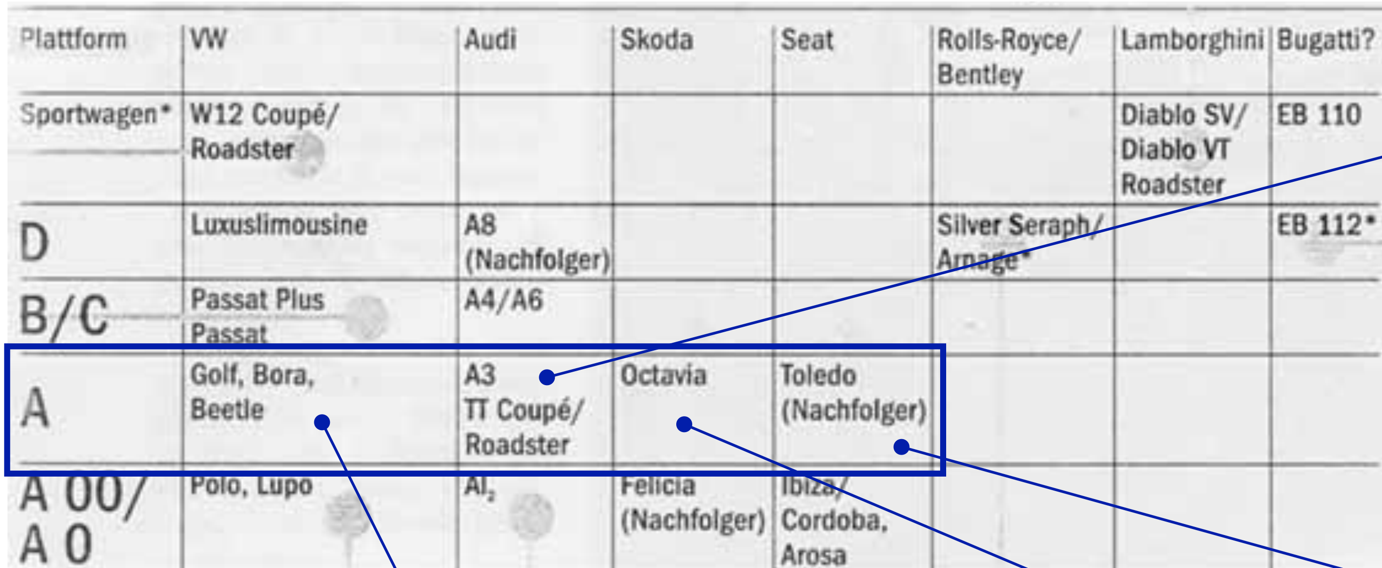


Remaining 85% of Sony's models produced from minor rearrangements of existing features and cosmetic redesigns of the external case

Ref: (Sanderson and Uzumeri, 1997)

Source: DAIMLERCHRYSLER
Development Car Division

Volkswagen A-Platform



Plattform	VW	Audi	Skoda	Seat	Rolls-Royce/ Bentley	Lamborghini	Bugatti?
Sportwagen*	W12 Coupé/ Roadster					Diablo SV/ Diablo VT Roadster	EB 110
D	Luxuslimousine	A8 (Nachfolger)			Silver Seraph/ Arnage*		EB 112*
B/C	Passat Plus Passat	A4/A6					
A	Golf, Bora, Beetle	A3 TT Coupé/ Roadster	Octavia	Toledo (Nachfolger)			
A 00/ A 0	Polo, Lupo	AI,	Felicia (Nachfolger)	Ibiza/ Cordoba, Arosa			

Audi A3

(3+ 5-door)

Audi TT coupe

Audi TT roadster

VW Golf IV

(3+5 door, station wagon, convertible, and Minivan)

VW Bora

(Bora sedan, coupe, convertible, and station wagon)

VW Beetle

(New Beetle, New Beetle convertible)

Skoda Octavia

(Octavia sedan, and station wagon)

Seat Toledo Successor

(Toledo, coupe, station wagon, and convertible)

- VW planned 19 vehicles based on A-platform
- VW estimates development and investment cost savings of $1.5 billion/yr using platforms

Under the Hood of the VW family

VW Golf

Audi TT

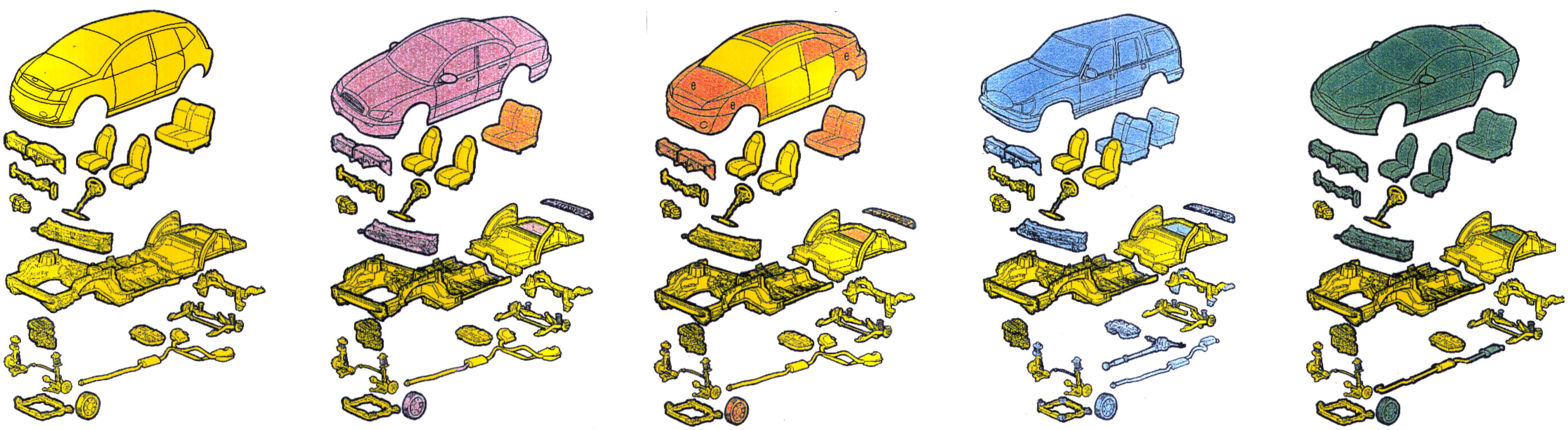
Audi A3

- Common hard points (interfaces)
- Similar packaging philosophy and relative arrangements
- Different engines

Automobile Platforms at Ford

Source:
(C. Moccio, K. Ewing,
G. Pumpuni, MIT, 2000)

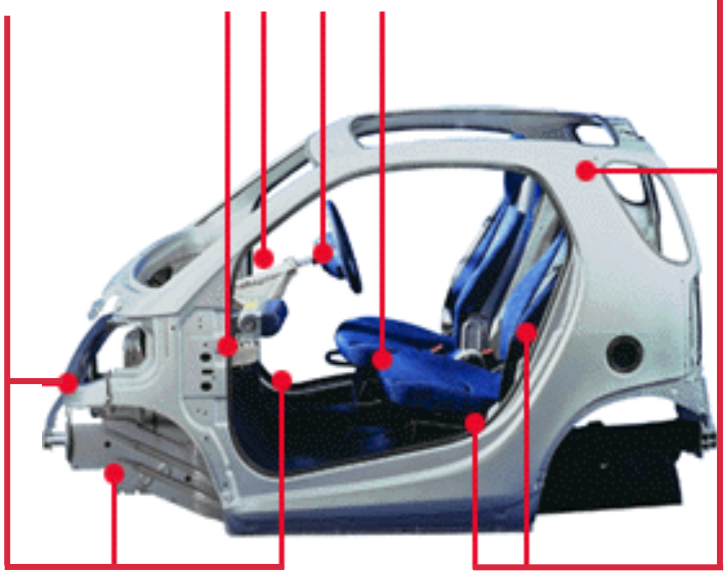
- At Ford, an automobile platform includes:
  - A common architecture (e.g., assembly sequence, joint configuration, system interfaces, etc.)
  - Definition of subsystem and module interfaces
  - A set of common hardpoints used by the range of products that share the platform and the manufacturing processes



- Ford defines a platform as a set of subsystems and interfaces that form a common structure from which a stream of derivative products can be efficiently produced

An important distinctive characteristic of the smart™ is the interplay between the bodypanels and TRIDION. The bodypanels - here in different colours - are screwed to the TRIDION. Simple to exchange for a repair, or if you simply feel like something new.

common car features



Source: http://www.smart.com

Moving Beyond a Mindset

- Exposing people to the idea of platforms and examples gets them thinking about it – and they think it is easy
  - Often get a few "easy wins" with minimal effort
- Platforming requires discipline
  - Learn, tailor, and use the tools and methods to your needs
  - Maintain the rigor to do it again, and again, and again…
- Team must develop a shared/common vocabulary
  - Product family
  - Platforms
  - Variants
  - Derivatives
  - Commonality
  - Subsystems
  - Modules
  - Parts/components
  - Options
  - Features

c. Platform Definitions

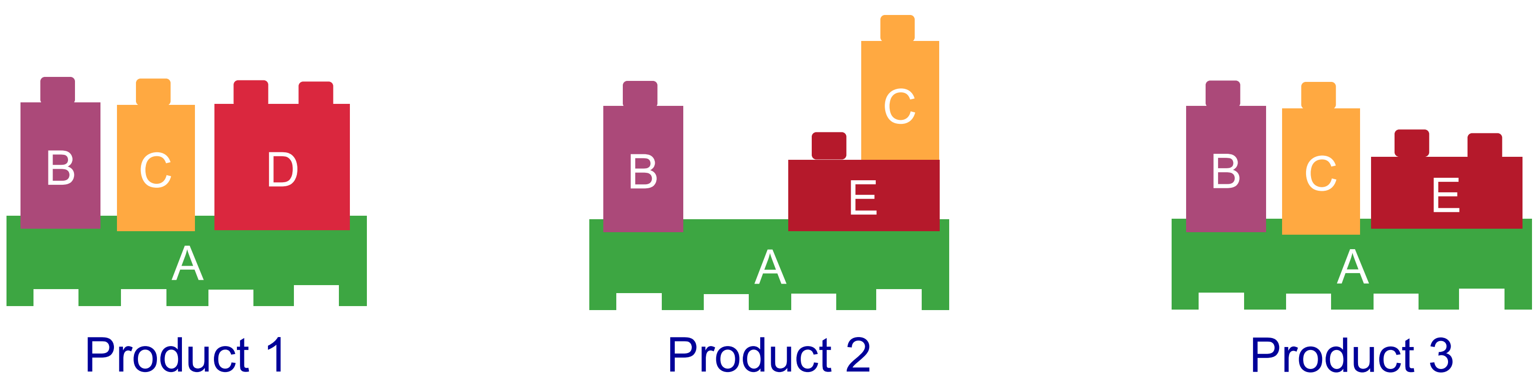
Definitions of Key Terms

- Product family
  - A group of related products that share common features, parts, and subsystems; yet satisfy a variety of markets
- Product platform
  - "Collection of the common elements, especially the underlying core technology, implemented across a range of products" (McGrath, 1995)
- Variants or derivatives:
  - Individual products derived from the platform by
    - By addition, removal, and/or substitution of one or more modules = *module-based product family*
    - By scaling or "stretching" the platform in one or more dimensions = *scale-based product family*

Alternative Definition of a Platform

Source:
www.prtm.com

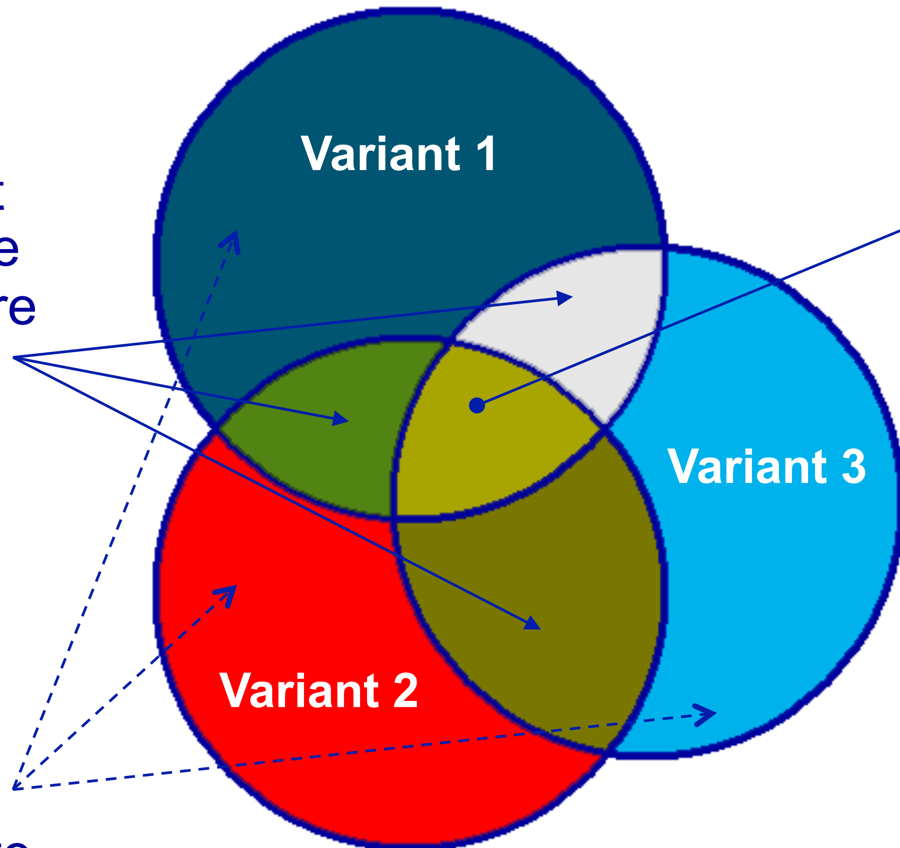
- Platform = set of platform elements and architectural rules that enable a set of planned product offerings
  - ❑ Platform enables multiple product offerings, allowing increased leverage and re-use across the product line
  - ❑ Architectural rules/standards govern how technologies and subsystems (“platform elements”) can be integrated
  - ❑ Defines the basic value proposition, competitive differentiation, capabilities, cost structure, and life cycle for a set of products
- Elements are the building blocks of a platform that can be varied within certain platform constraints



Common, Variant, & Unique Parts

- Consider a set of three product variants

Variant parts are shared by two or more products that differ in one or more aspects (e.g., feature size, color, etc.)



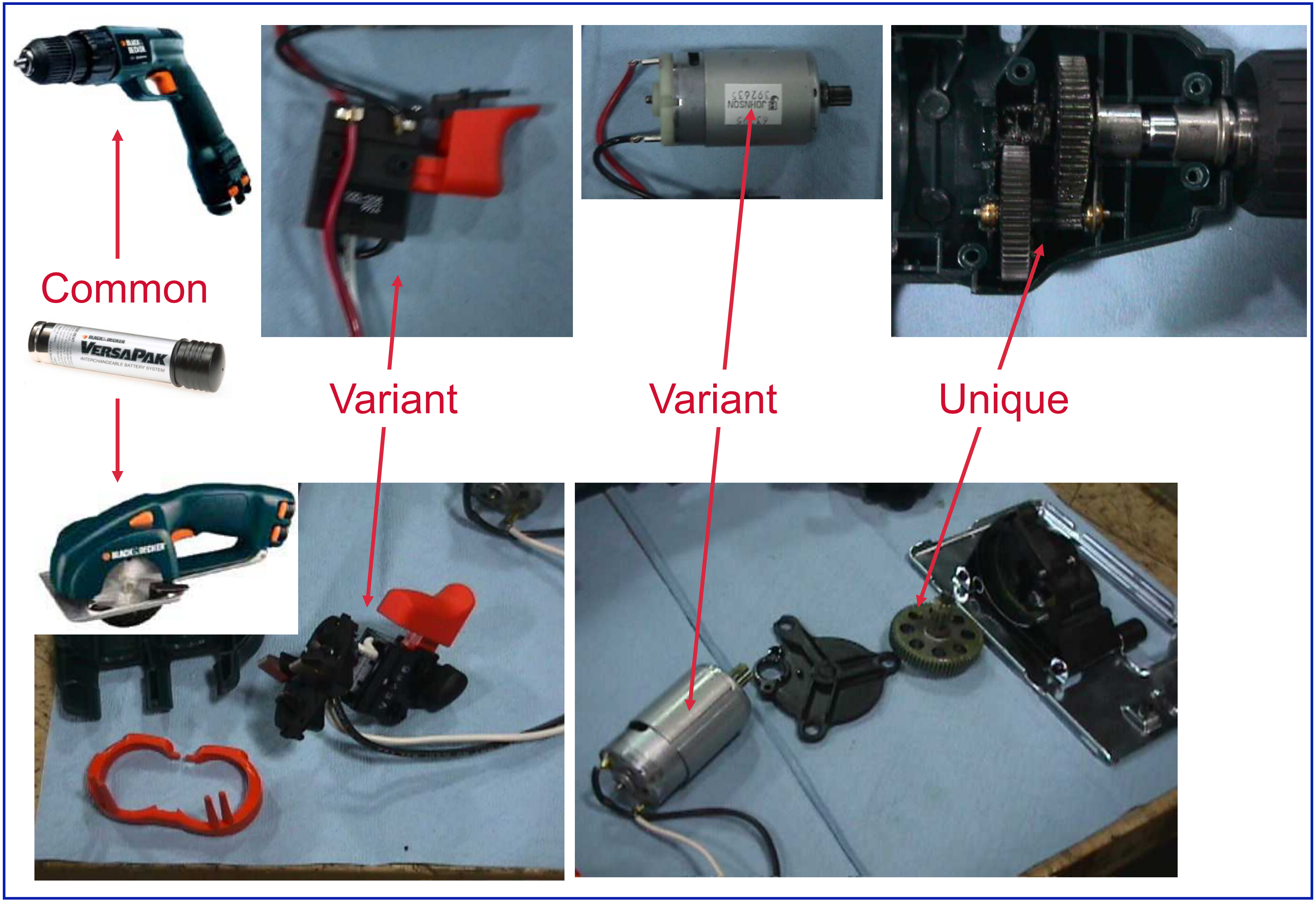
Common parts are shared by all of the product variants and are identical → the platform elements

Unique parts are used to differentiate a variant from others

When designing a product family, the goal is to:

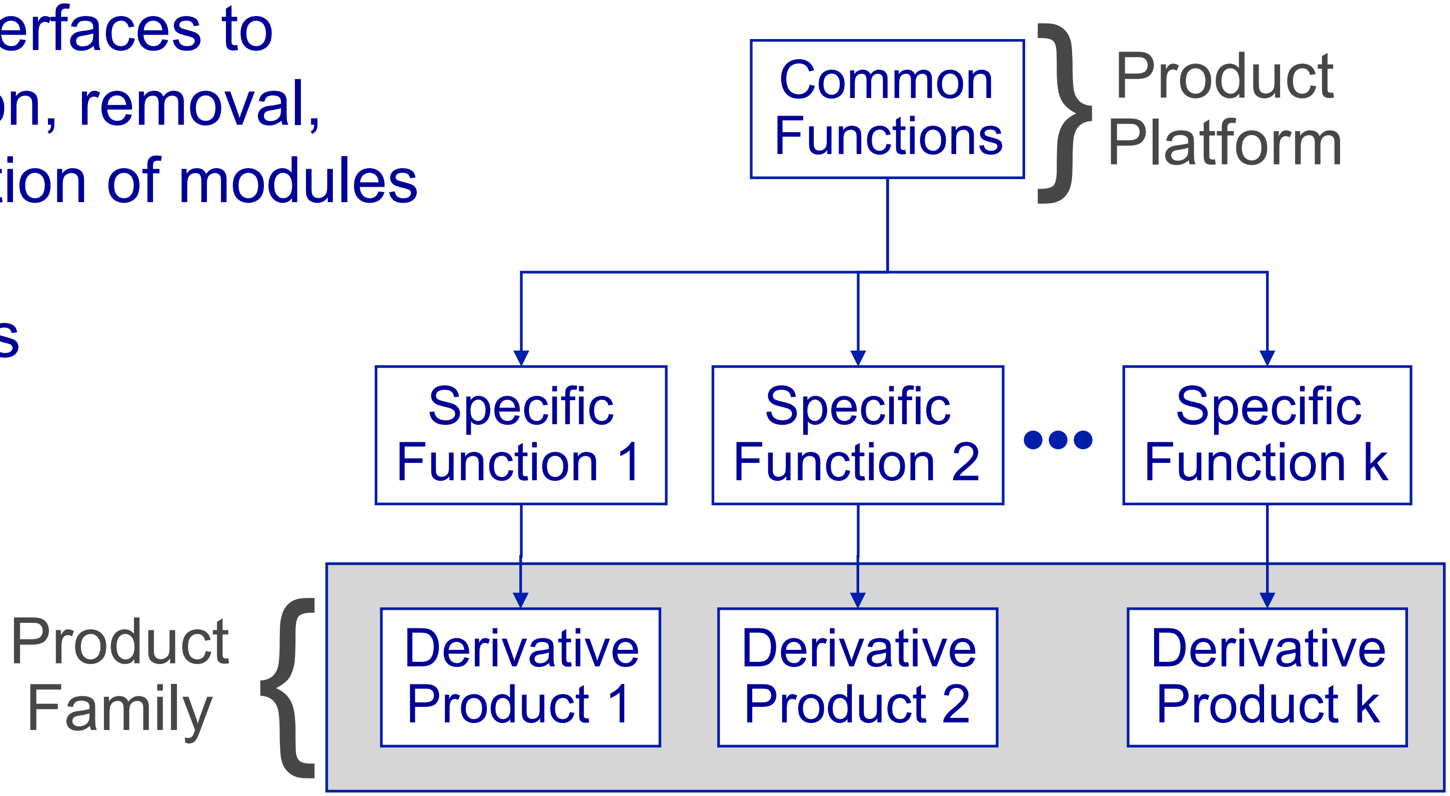
- maximize the number of common parts,
- minimize the number of unique parts, and
- use the cheapest variant parts possible

Example: B&D Versapack® Toolkit

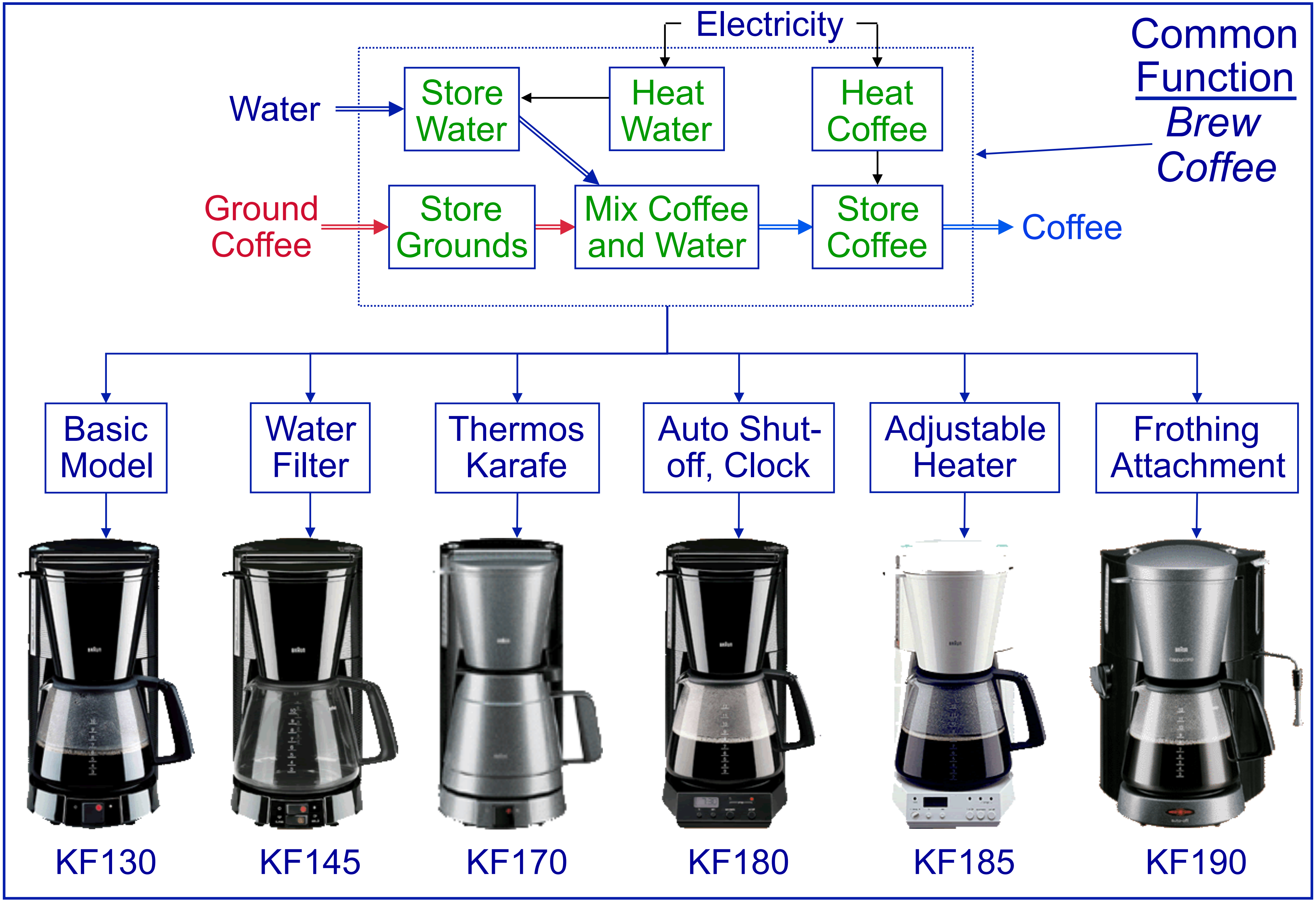


Creating a Module-Based Product Family

1. Decompose products into their representative functions
2. Develop modules with one-to-one (or many-to-one) correspondence with functions
3. Group common functional modules into a common product platform
4. Standardize interfaces to facilitate addition, removal, and/or substitution of modules to create product variants



Example: Braun Family of Coffee Makers



Mercedes Vario Research Car

Mercedes Vario Research Car

Mercedes Vario Research Car

Mercedes Vario Research Car

Scale-based Product Families

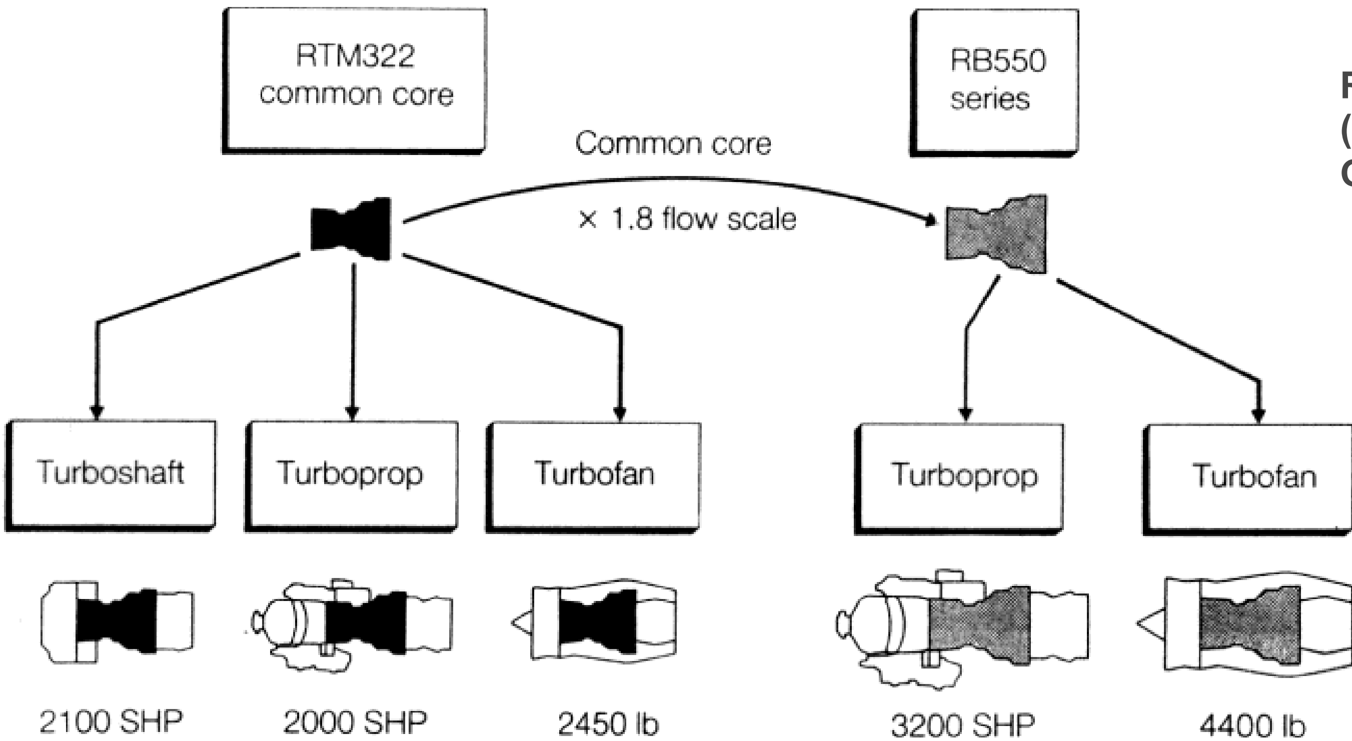
- Develop a product platform that can be “scaled” or “stretched” in one or more dimensions to satisfy a variety of market niches

- Boeing 737 is divided into 3 platforms:
  - Initial-model (100 and 200)
  - Classic (300, 400, and 500)
  - Next generation (600, 700, 800, and 900 models)

- The Boeing 777 has also been designed knowing that it will be “stretched”

Example Leveraging Strategies: Rolls Royce

- Rolls Royce scaled its aircraft engines to satisfy a variety of requirements and expedite testing/certification

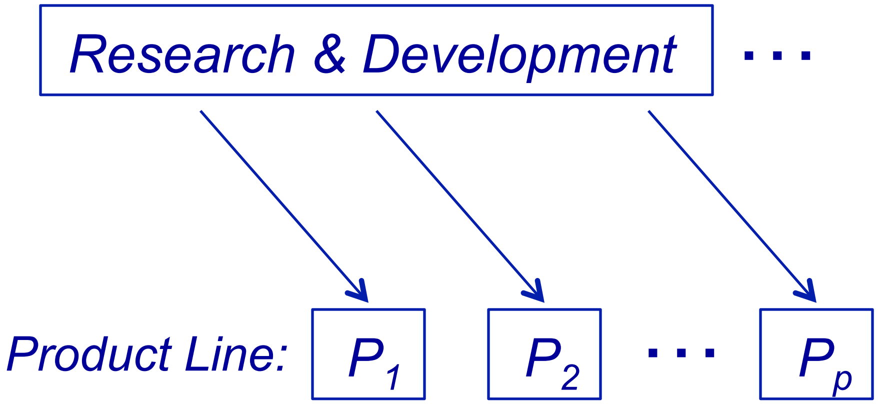


Reference: (Rothwell and Gardiner, 1990)

- ❑ Incremental improvements and variations made to increase thrust and reduce fuel consumption
- ❑ RTM322 is common to turboshaft, turboprop, and turbofan engines
- ❑ When scaled 1.8x, RTM322 serves as the core for RB550 series

d. Platform Approaches

Traditional Product Development



In many companies, R&D generates a steady stream of new products

"Since many companies design new products one at a time, the focus on individual customers and products often results in a failure to embrace commonality, compatibility, standardization, or modularization among different products or product lines." - Meyer and Lehnerd, 1997

- The end result:
  - diversification of products and components with proliferating variety and costs → unwanted costs, eroding profit margins

Approaches to Product Family Design

Top-down Approach:

- A company strategically manages and develops a family of products based on a product platform and its module- and/or scale-based derivatives
- E.g., Volkswagen, Sony, Ford

Bottom-up Approach:

- A company redesigns/consolidates a group of distinct products by standardizing components to improve economies of scale and reduce inventory
- E.g., Lutron, Black & Decker

Black & Decker

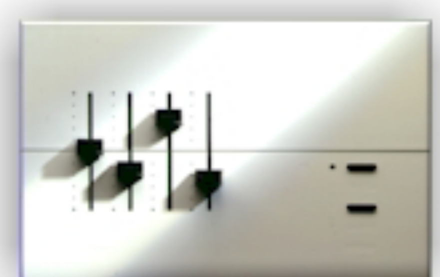
Sony

LUTRON®
THE WORLD LEADER IN LIGHTING CONTROLS SINCE 1961

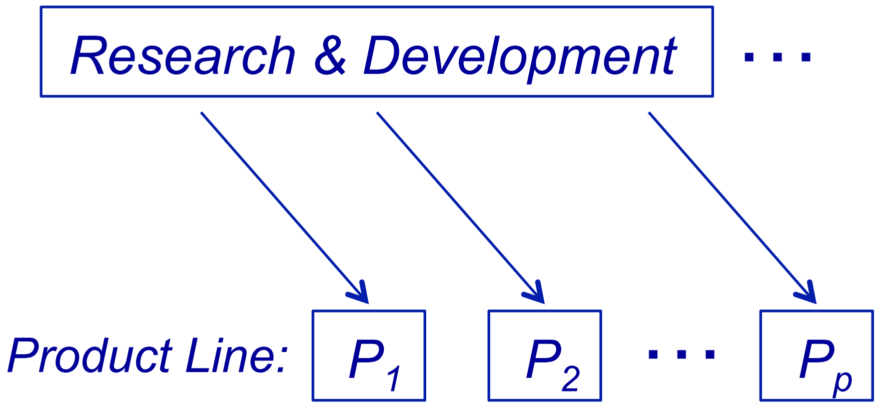
Reference: (Pessina and Renner, 1998)

- Lutron makes customizable lighting control systems for commercial and residential applications including hotel lobbies, ballrooms, conference rooms, and exec offices.

- Lutron has rarely shipped the same lighting system twice.
  - Work with individual customers to extend the product line until they have 100+ models from which to choose.
  - Engineering and production redesign the product line with 15-20 standardized components that can be configured into the same 100+ models.

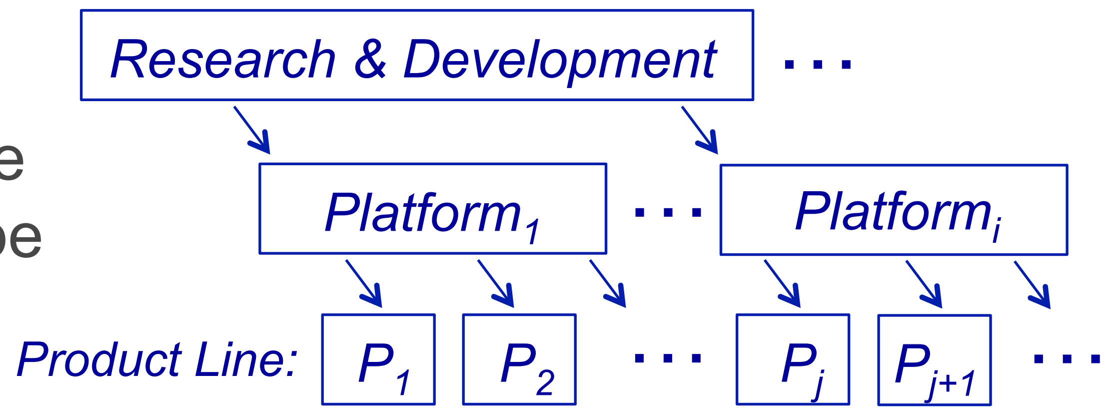


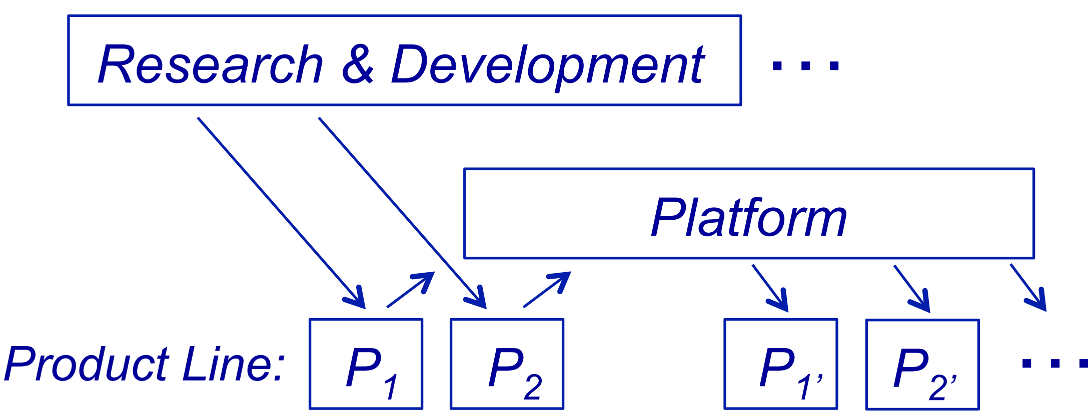
Top-Down vs. Bottom-Up



- Traditional product development must be realigned and transformed…

- Top-down enables:
  - R&D/technology leverage
  - Economies of scale/scope
  - Organic growth

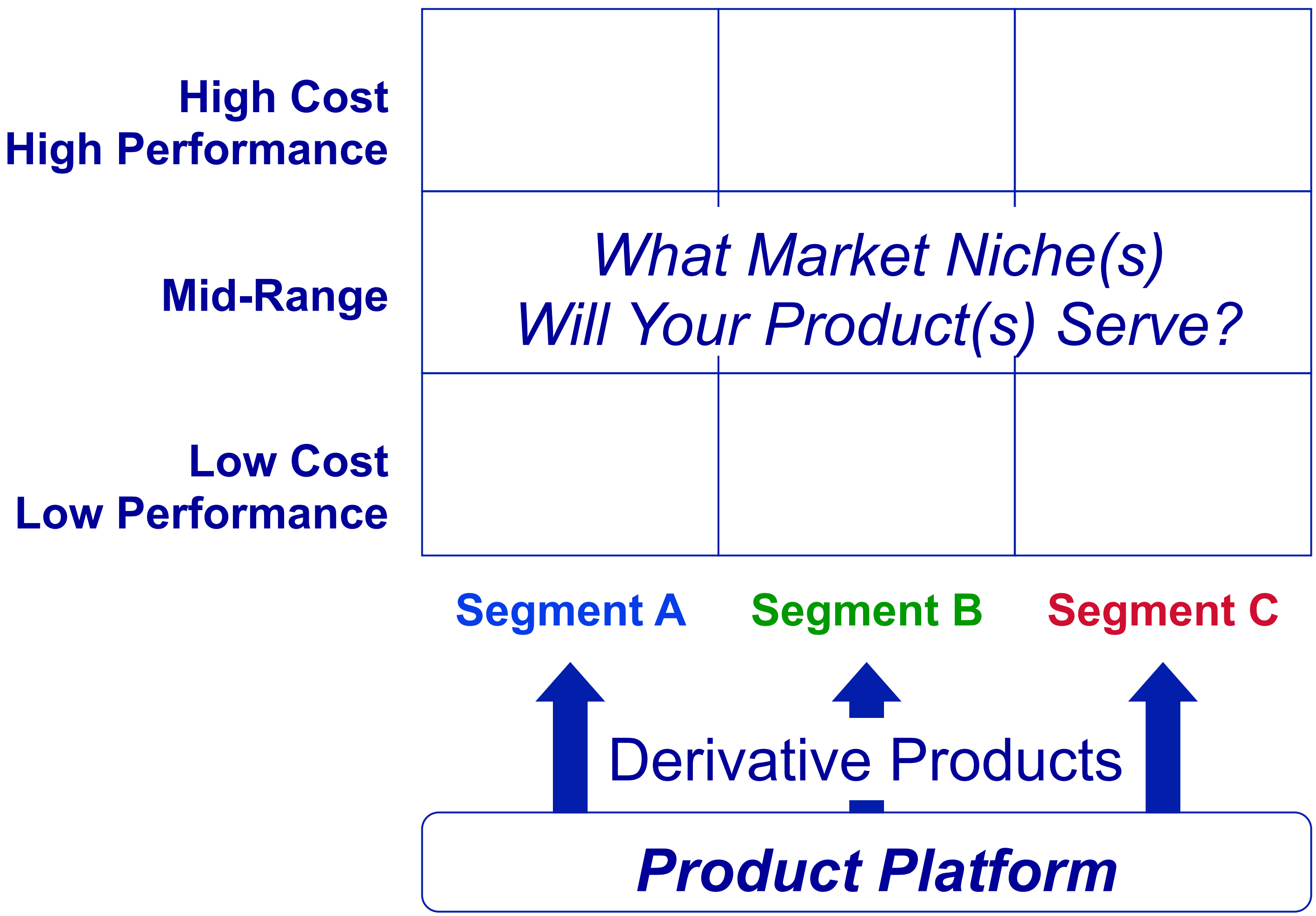




- Bottom-up arises from:
  - Standardization
  - Consolidation
  - Cost savings
  - Mergers/acquisitions

Platform Leveraging Strategies

- Market segmentation grid can be used to identify and map platform leveraging strategies (Meyer, 1997)



Platform Strategies: No Leveraging

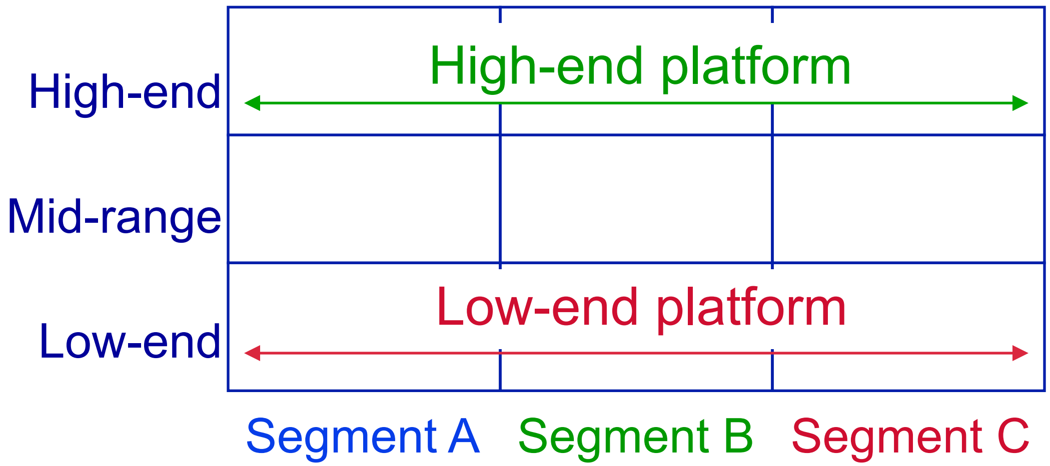
- Niche-specific platforms (products) with little sharing of subsystems and/or manufacturing processes

	Segment A	Segment B	Segment C
High-end	Product 1	Product 3	Product 4
Mid-range	Product 2		
Low-end			

- Disadvantages:
  - R&D can be easily duplicated by different product teams
  - Manufacturing and capital investments much higher
  - Manufacturing improvements not adopted by others
  - Potential for synergy in marketing development is lost
- Result: myriad of products, higher costs, low margins

Platform Strategies: Horizontal Leveraging

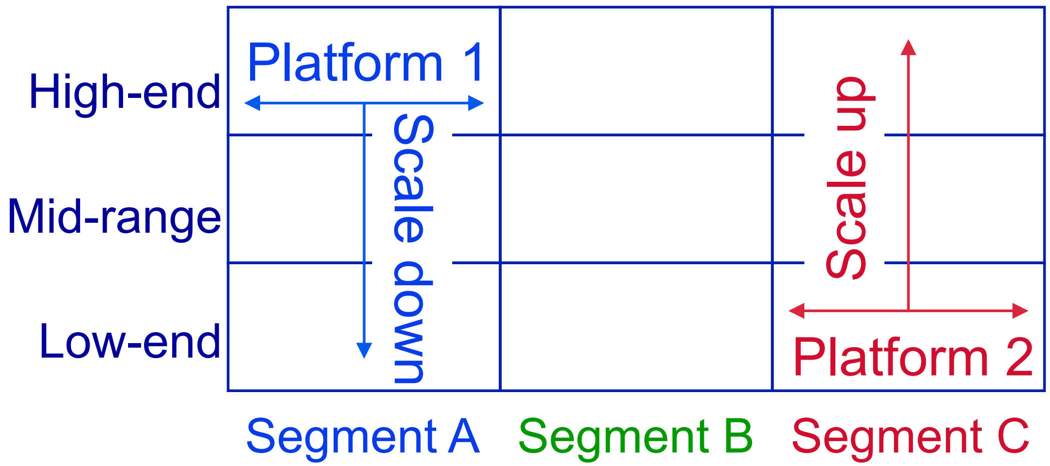
- Horizontally leverage platform subsystems and/or manufacturing processes across different segments



- Benefits:
  - Introduce series of related products for different customer groups without having to "reinvent the wheel"
  - R&D can develop products more rapidly and with less risk (since technology has been proven in other market segments)
  - Manufacturing procurement and retooling costs can be minimized

Platform Strategies: Vertical Leveraging

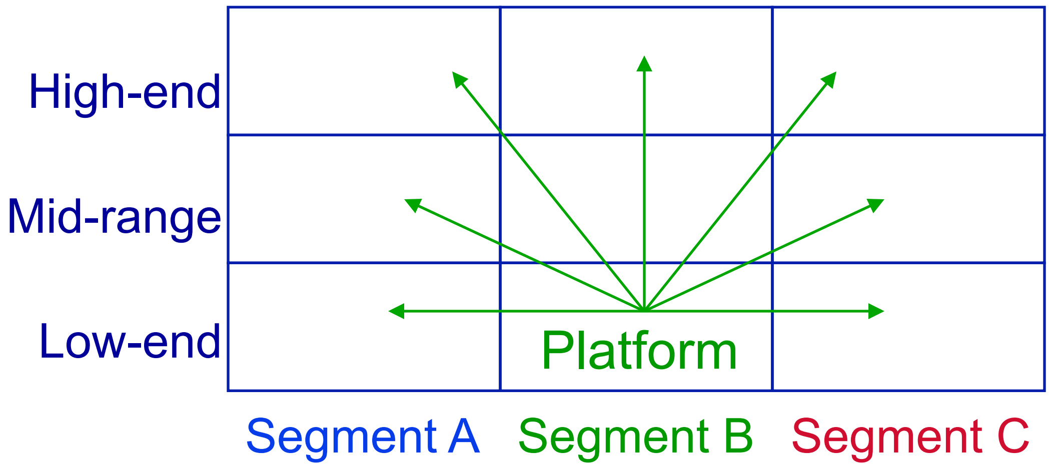
- Vertically scale key platform subsystems and/or manufacturing processes within a market segment



- Benefits:
  - Leverage knowledge of customer wants and needs within a given market segment
  - Product development is less costly (R&D and manufacturing enjoy same benefits as horizontal leveraging)
- Risk:
  - Weak platform may undermine competitiveness of family

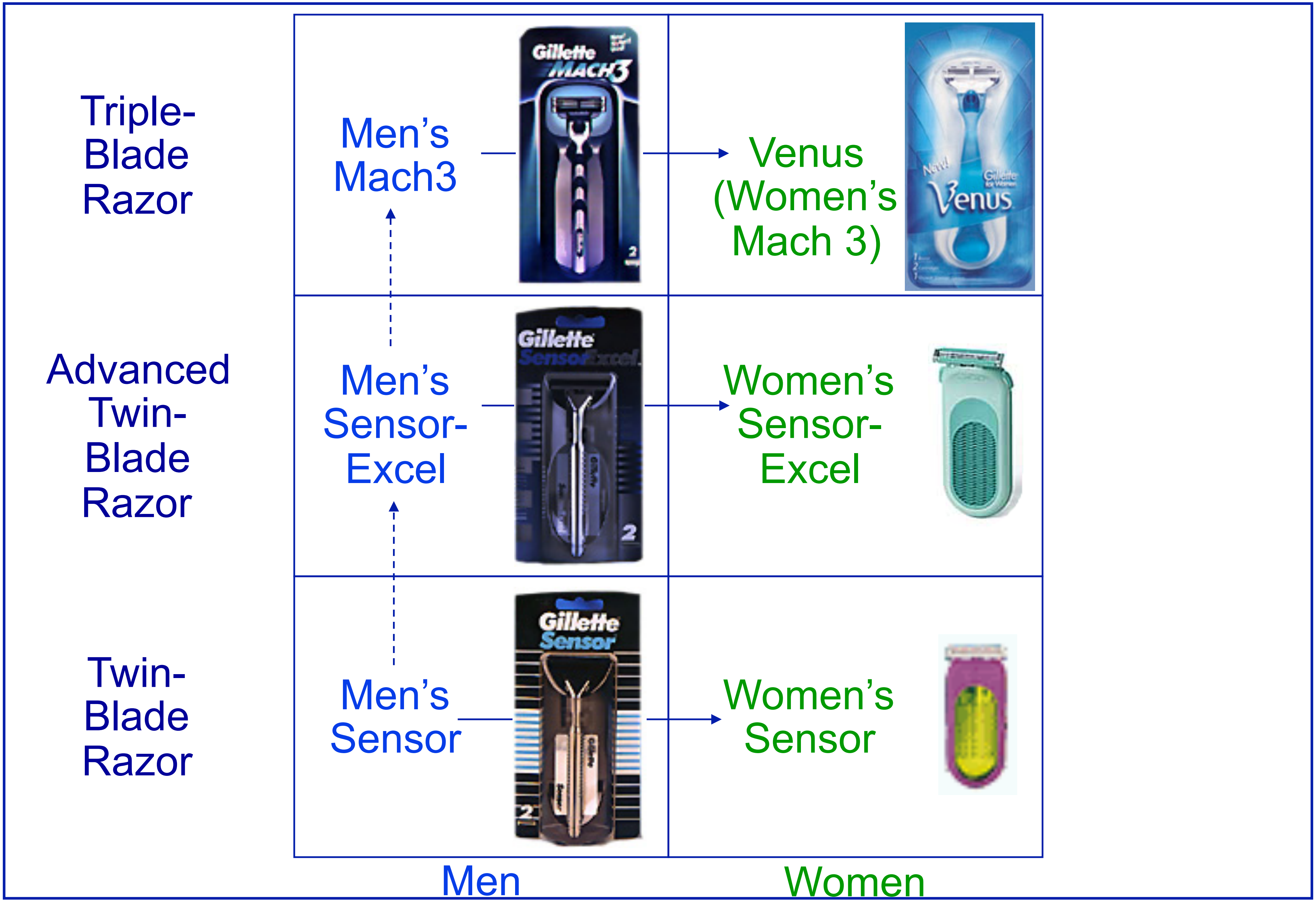
Platform Strategies: Beachhead Approach

- Beachhead approach combines horizontal leveraging with upward vertical scaling



- Key Aspects:
  - Develop low-cost, effective platform and efficient processes
  - Scale up performance characteristics of low-cost platform to appeal to needs of mid- and high-end users
  - Extend platform for customers in different market segments
  - Combine extensions and scaling to provide step-up functions required by mid- and high-end users in other segments

Example Leveraging Strategies: Gillette



Example Leveraging Strategies: B&D

Industry (Heavy) Use

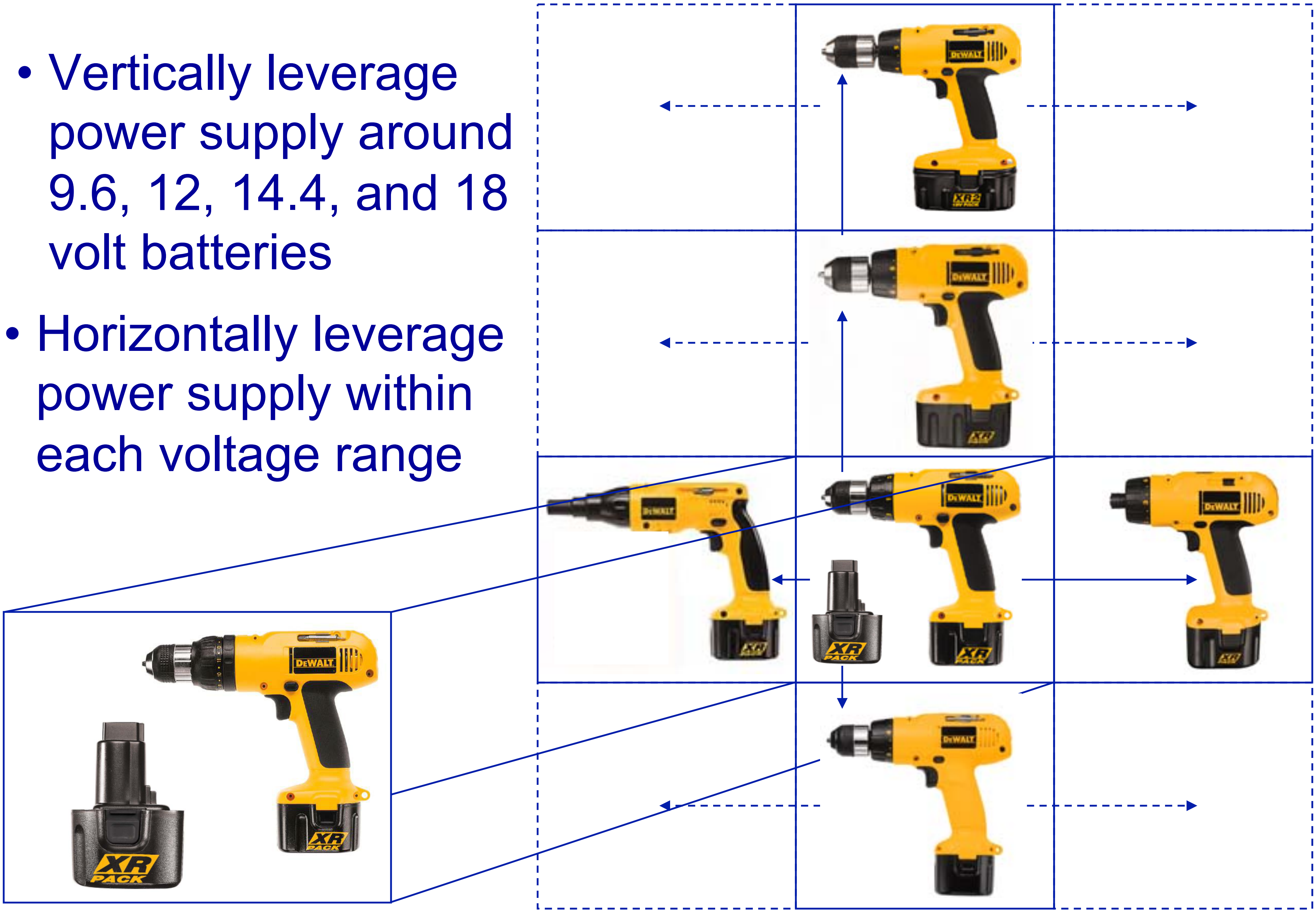
Mid-Range

Home (Light) Use

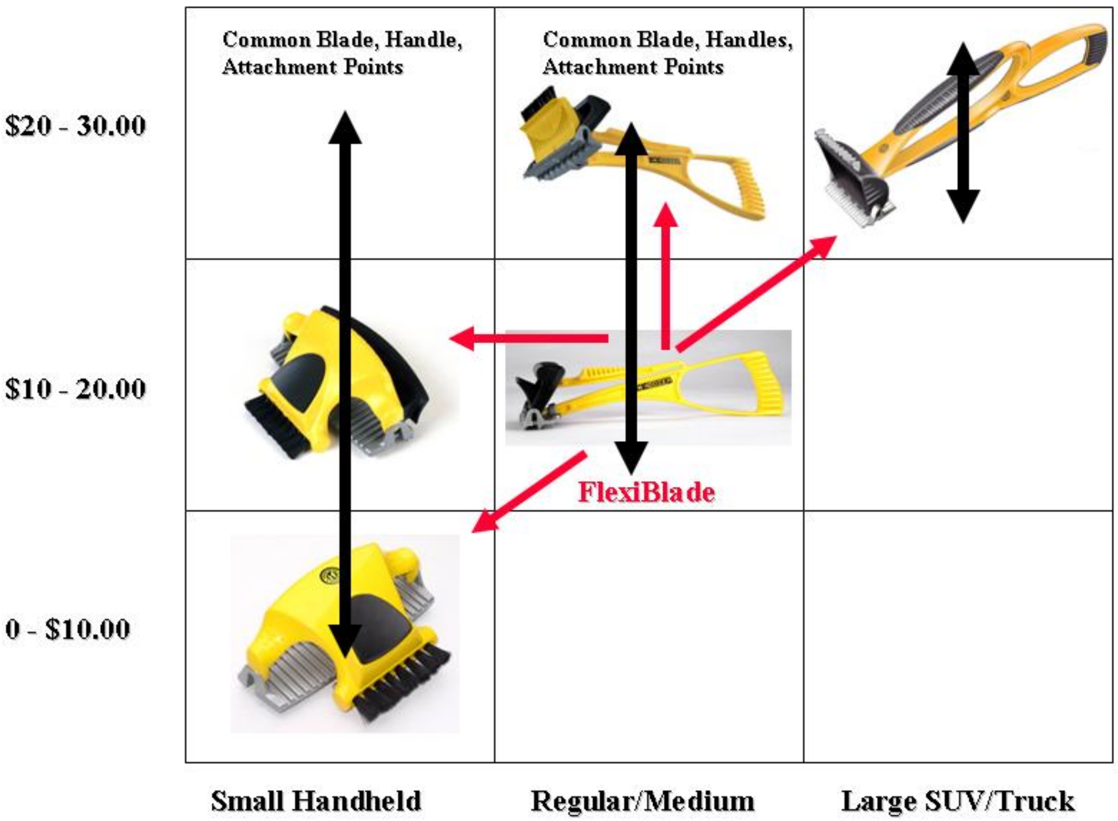
Saws | Drills & Drivers | Lighting

Example Leveraging Strategies: B&D (cont.)

- Vertically leverage power supply around 9.6, 12, 14.4, and 18 volt batteries
- Horizontally leverage power supply within each voltage range

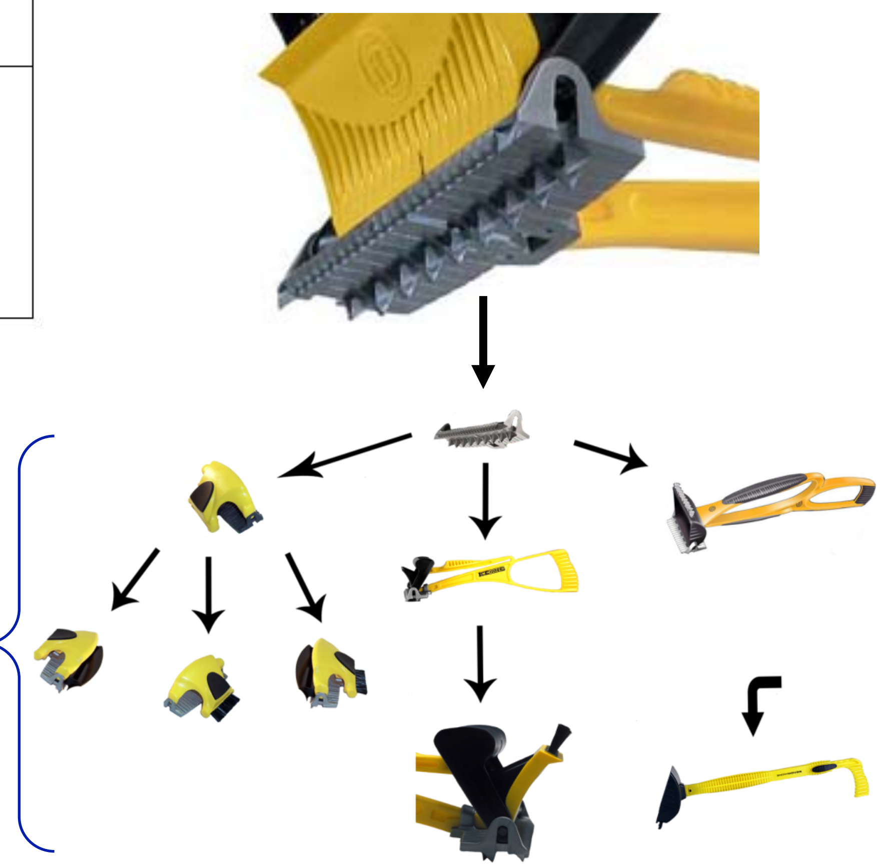


Example Leveraging Strategies: Innovation Factory



- Market analysis led to market segmentation into three sizes (small, medium, large)

→ FlexiBlade® Platform



Ice Scraper Family

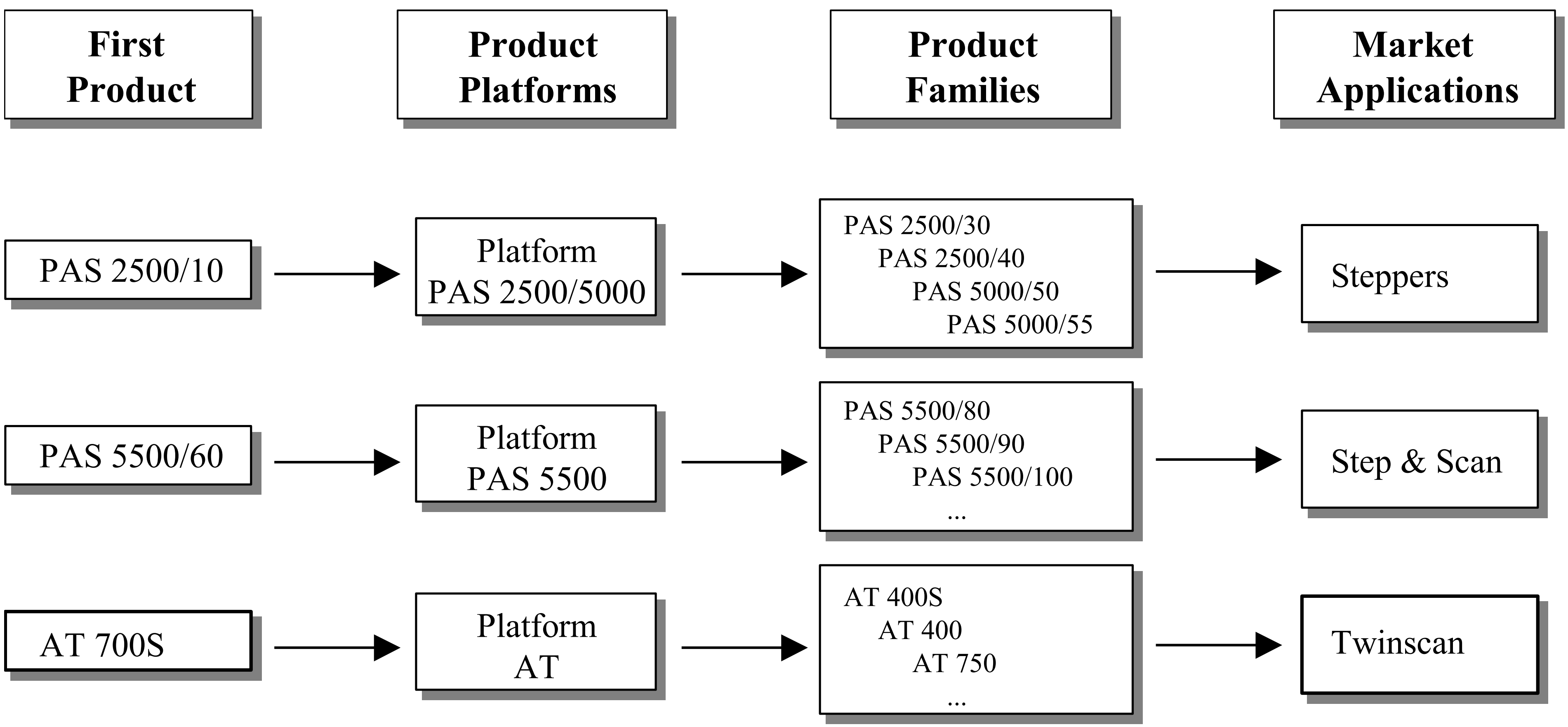
Platform-Driven Product Development Examples

	ASML	Skil	SDI
Products	Microlithography systems for the semiconductor industry (high-end)	Power tools for the consumer market (low end)	Systems for digital print and pre-print applications (high-end)
Market	1 market segment with different applications (stepper, scanner, twin scan)	Different applications (saws, drills, etc.) each in 2 market segments (opening price point, lower price point)	2 market segments with different applications (graphic arts, textile printing) and a potential new market (photo printing)
Platform potential	High commonality between products within an application (reuse of basic modules)	Very high commonality within applications (across segments), high commonality across all products (components)	Two available technologies for solutions in both market segments (general purpose modules)
Expected benefits	Efficiency (volume and costs, maintenance) Flexibility (time to market, assembly) Effectiveness (training, learning curve)	Efficiency (costs and time; high variety) Flexibility (time to market, styling) Effectiveness (brand identity, understanding the structures)	Efficiency (time and costs for product variation) Flexibility (serving two market segments) Effectiveness (products are easier to explain)

Source: Halman, J. I. M, Hofer, A. P. and van Vurren, W. (2005) “Platform-Driven Development of Product Families: Linking Theory with Practice,” *Product Platform and Product Family Design: Methods and Applications (Simpson, T. W., Siddique, Z., and Jiao, J., Eds),* Springer, New York, pp. 27-47.

ASML Product Roadmap

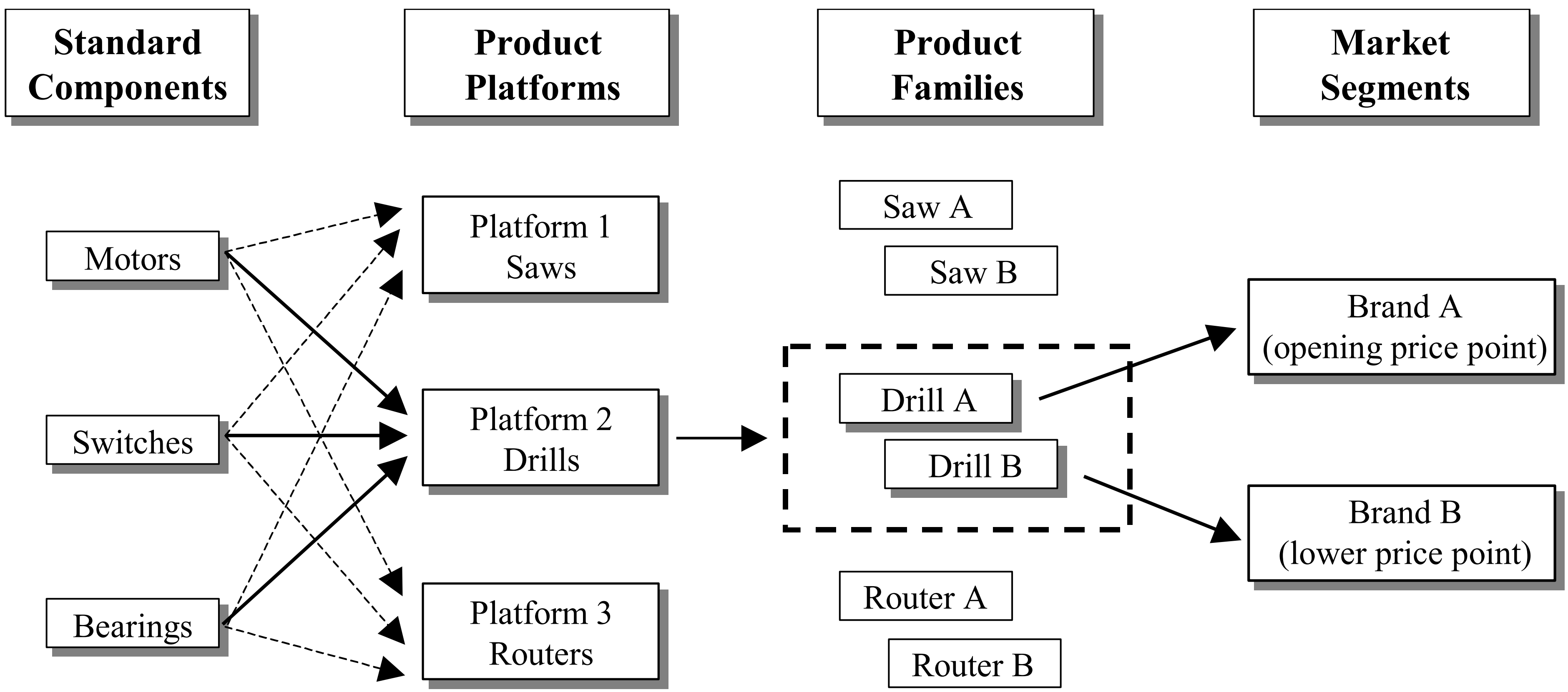
- Product-driven platform-based development of family
  - 3 platforms for 3 market applications
  - 80% commonality within family; low commonality b/n families



Source: (Halman, et al., 2005)

Skil Product Roadmap

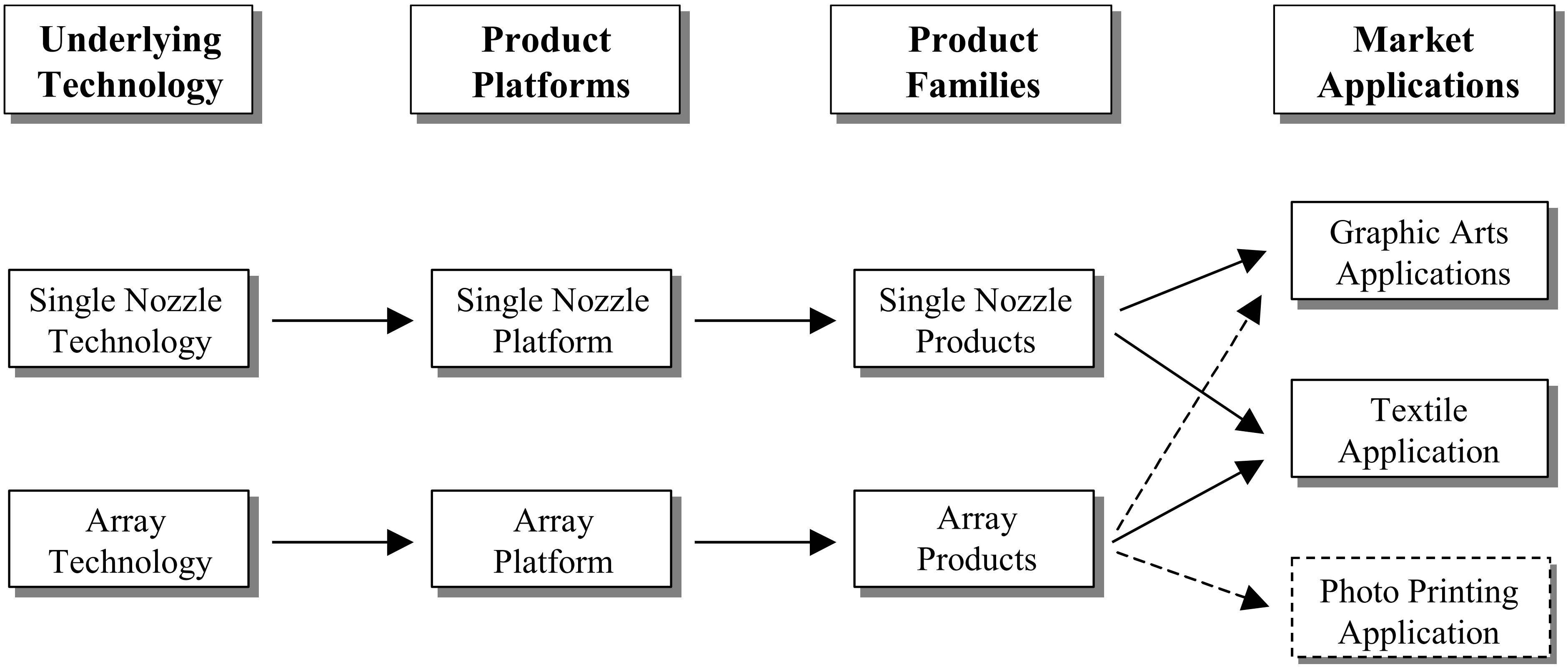
- Component-based platform-driven development
  - Product platform for each tool type
  - 80% commonality within family; 50% commonality b/n families



Source: (Halman, et al., 2005)

SDI Product Roadmap

- Technology-driven platform-based development
  - 2 platforms → multiple products → many market applications
  - 70-80% commonality within products of same family



Source: (Halman, et al., 2005)

Risks with Platform-Based Development

Source: (Halman, et al., 2005)

- ASML
  - Development time and costs of platform
  - Rigidity in design
  - Restrictions on the integration of new technologies
  - Incorrect forecast of future user needs
  - Change form one platform to another
- Skil
  - High cost and time for integration of existing elements
  - Platform development becomes easily a goal in itself
  - Mistakes made in the beginning have a high impact
  - Failure to forecast customer needs correctly
- SDI
  - Development time and costs to meet specifications of all target markets
  - Development process becomes more complex
  - Restrictions for all market segments
  - Selecting the right platform

e. Platform Metrics

Market-Facing Metrics

- Some metrics drive consumer focus during platforming

Metric	Formula	Source
Time to market	Total product development time	---
Multiple use	$\frac{\text{\# product variants required by customers}}{\text{Total \# modules required for all variants}}$	Ericsson and Erixon (1999)
Used variety	$\frac{\text{\# perceived variants}}{\text{\# all possible variants}}$	Piller (2002)
Platform efficiency	$\frac{\text{R\&D time for derivative product}}{\text{R\&D time for platform version}}$	Meyer et al. (1997)
Platform effectiveness	$\frac{\text{Net sales of derivative products}}{\text{R\&D time for platform version}}$	Meyer et al. (1997)
Interface complexity	$\frac{\Sigma \text{ Assembly time for one interface}}{\text{Ideal assembly operation time}}$	Ericsson and Erixon (1999)
Customizable attributes	# new introduced customizable attributes; # eliminated customizable attributes	Blecker et al. (2003)

Sources listed in: Blecker, T., Abdelkafi, N., Kaluza, B., Friedrich, G. (2003) Key Metrics System for Variety Steering in Mass Customization, *2nd World Congress on Mass Customization and Personalization*, Oct. 6-8, Munich, Germany.

Production-Facing Metrics

- Other metrics drive the cost side of platforming

Metric	Formula	Source
Commonality index	Numerous formulations will be discussed	Various
Production process commonality	# common production processes / # all production processes	Blecker et al. (2003)
Purchasing process commonality	# standardized purchasing processes / # all purchasing processes	Blecker et al. (2003)
Setup duration	Σ (# products in a process) * (avg. time for the process) / Σ (avg. total lead time to manf product)	Martin and Ishii (1996)
Capacity utilization	Processing time / (Processing time + Idle time)	Mueller (2001)
Work-in-process turnover	Total sales / Value of the work-in-progress inventory	Pine (1993)
Delivery time	Agreed delivery time / Real delivery time	Blecker et al. (2003)

Metrics for Platforming

- Most companies use a combination of metrics to track platform development and deployment
  - Clearly define what you are trying to achieve by platforming
    - Reduce cost? improve reuse? increase revenue? lower risk?
  - Balance number of metrics with their usefulness
    - Tracking too many metrics will waste time
    - Tracking at “high level” may not be helpful
  - Different divisions can have different metrics

- Make sure to establish a *baseline* at start of the effort
  - Many companies fail to capture where they start
  - This helps show progress and generate “buy-in”

“Measure what you want to improve, reward what you want to see.” *– Paul H. Silvis, Founder, Restek & CEO, SilcoTek, 2013*

f. Platform Paradoxes

Advantages - Reported Benefits

- Reduction of inventory *(Baker et al., 1986)*
- More standard parts *(Martin and Ishii, 1996)*
- Shorter product design lead times *(Ulrich, 1995)*
- Easier coverage of market niches *(Meyer and Lehnerd, 1997)*
- Reduced design risk and cost – technology already proven
- Faster response to changing market needs (always?)
- Standard manufacturing processes and tooling

Disadvantages and Potential Downsides

- Introduction of undesirable functions and unexpected technical problems in different variants based on the same platform (e.g., Audi TT problems with rear wheel down pressure)
- Cannibalization of high-end products by low-end products based on the same platform product family, especially when customer awareness is high (e.g., Golf versus Skoda)
- Loss of performance competitiveness if the degree of commonality is chosen too high and market segment is price insensitive
- Effects of platforming on long-term product innovation

Paradoxes of Platforming

Expectation is:	What may happen is:
Reduced lead-times	Longer lead-times
Reduced development costs	Higher development costs
Increased commonality	Lack of distinctiveness
Part/module reuse	Lack of innovation
Reduced technological risk	Widespread recalls
Shortened time-to-market	Outpacing customer renewal
Platform leveraging	Over/under-designed products
Product variety	Cannibalization
Cross-functional teams	Culture clashes
Streamlined development	Added hierarchical burden

Other Downsides of Platforming

- Developing a product platform can cost 2-10 times more than a single product (Ulrich & Eppinger, 2000)
  - In automotive industry, up to 80% of total vehicle development cost is spent on platform including engine and transmission (Muffato, 1999); ~60% according to (Sundgren, 1999)
- Data collected at one firm over a five-year period further showed the platform-based development approach to be negatively correlated with profitability (Hauser, 2001)
- Sharing components across low-end and high-end products can increase unit variable costs due to overdesigned low-end products (Gupta & Krishnan, 1998; Fisher, et al., 1999)
- Platforms are not appropriate for extreme levels of market diversity or high levels of non-platform scale economies (Krishnan & Gupta, 2001)
- Platform development requires multifunctional groups, and problems may arise over different timeframes, jargon, goals and assumptions (Robertson & Ulrich, 1998)

Establishing a Platform Mindset

- Review Platform Examples
- Develop a Shared Vocabulary
- Review Platform Approaches
  - ❑ Top-down Approach
  - ❑ Bottom-up Approach
  - ❑ Platform Leveraging
- Identify Appropriate Metrics
- Understand Platform Paradoxes
- Formulate a Platform Development Strategy
- Work to Achieve Platform Discipline
  - ❑ Monitor and track metrics
  - ❑ Resolve platform divergence
  - ❑ Convene project post-mortem
  - ❑ Develop governance plan

Day 1 Wrap-Up

- On a separate sheet of paper, please answer the following and hand it to an instructor before leaving (this can be done anonymous or not)

  - ❑ Of the things you learned today, what are the 1-3 things you will tell your colleagues about when you get back?

  - ❑ What was the most confusing or puzzling thing that we discussed today?