Service solutions

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3.3.2021

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The business of service solutions

- The service solutions business is about developing individual offerings to solve complex customer problems
- Service solutions are designed by combining product & service elements providing integrative added value (Evanschitzky et al., 2011)
- Success in the solution business requires ability to serve the customer, but also commercialization and industrialization capabilities (Storbacka, 2011)
- Modular design has proven to be a powerful enabler for the development of industrialization capabilities (Davies et al., 2007)

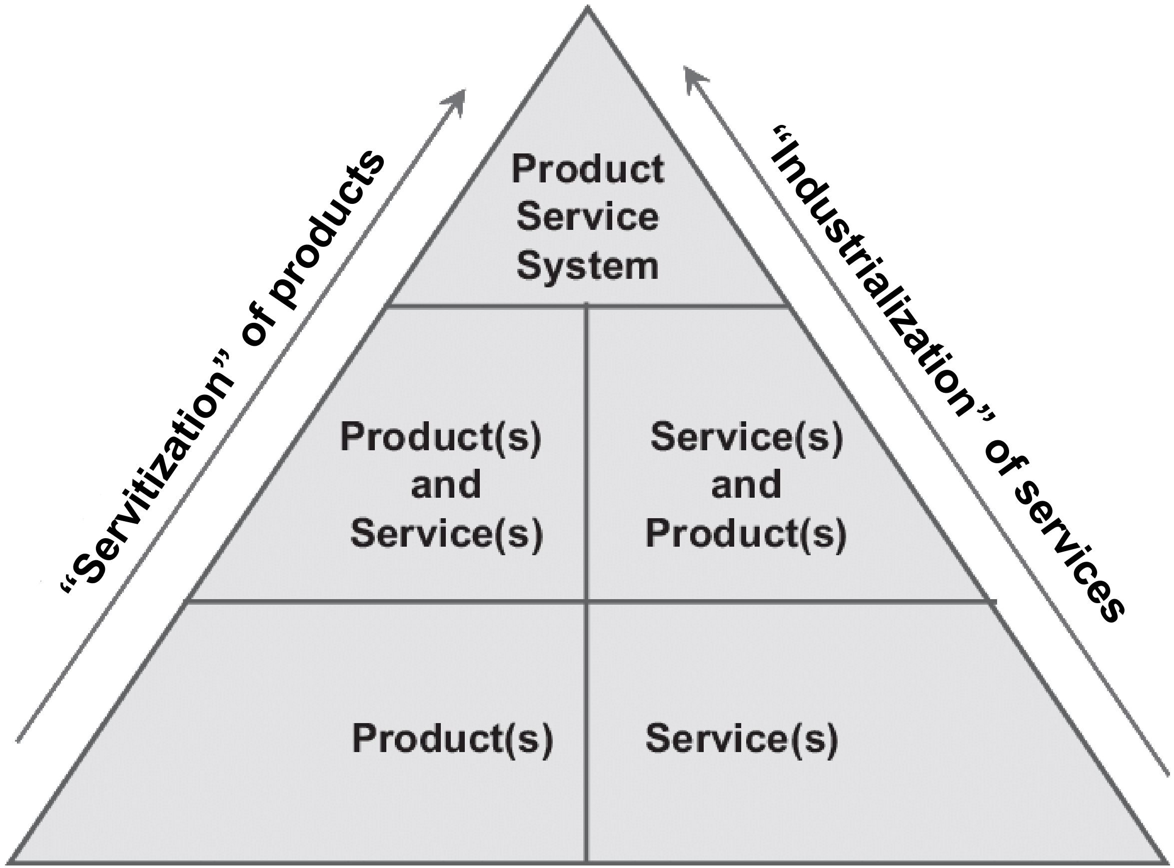
Davies, A., Brady, T., & Hobday, M. (2007). Organizing for solutions: Systems sellers vs. systems integrator. *Industrial Marketing Management*, 36(2), 183-193.
Evanschitzky, H., v. Wangenheim, F., & Woisetschläger, D. (2011). Service and solution innovation: Overview and research agenda. *Industrial Marketing Management*, *40*(5), 657-660.
Storbacka, K. (2011). A solution business model: Capabilities and management practices for integrated solutions. *Industrial Marketing Management*, 40(5), 699-711

Key considerations

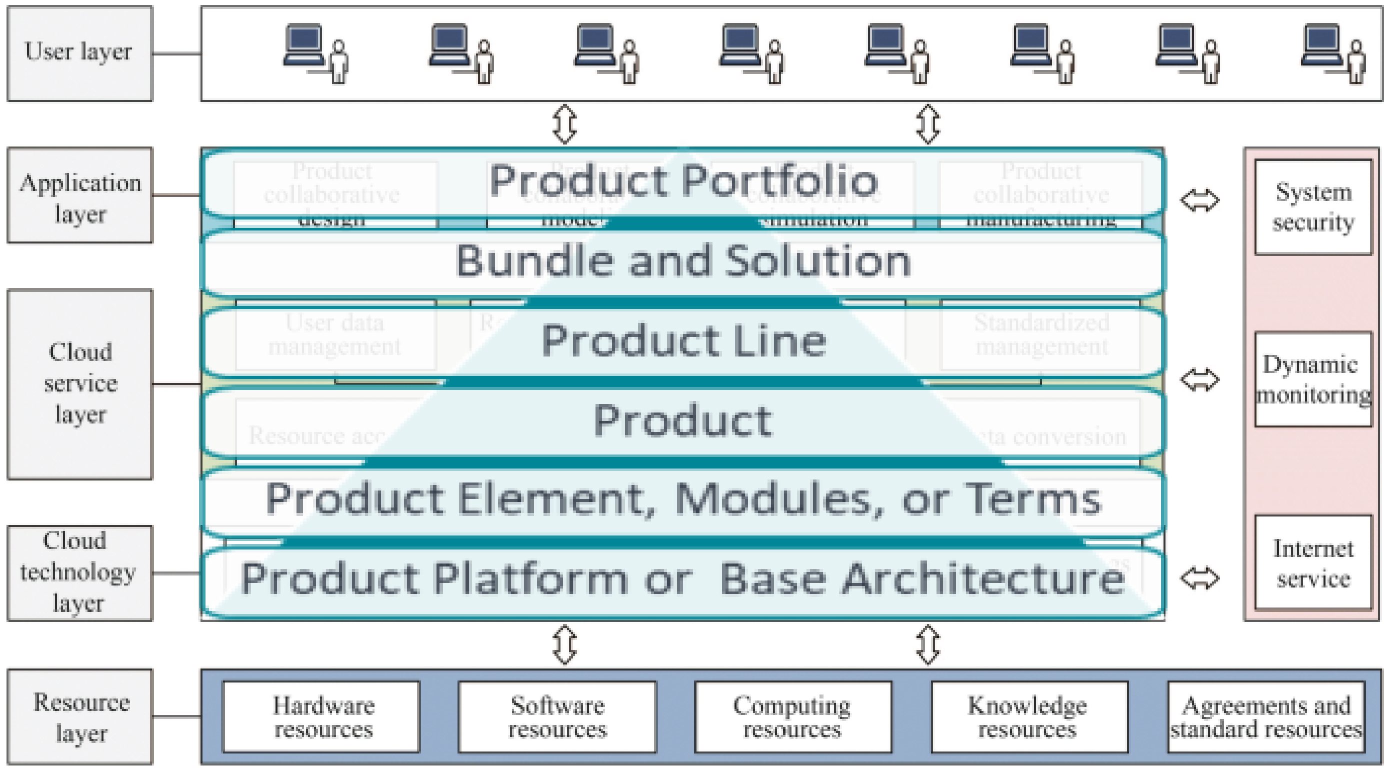
- Designers of service solutions face architectural choices regarding the nature and the degree of modularity, the nature of interfaces, and the degree of uniqueness of the derivatives.
- Developing organizational capacity to develop and deploy service solutions requires learning by doing.
- Which clients move the needle the most in the desired direction?
- What are denominators that can serve as the basis for all future solutions?

Product-service systems (PSS)

Transformations of service solutions



A layered view of product architectures



Adapted from Wei, W., Zhou, F., & Liang, P. F. (2020). Product platform architecture for cloud manufacturing. *Advances in Manufacturing*, *8*, 331-343.

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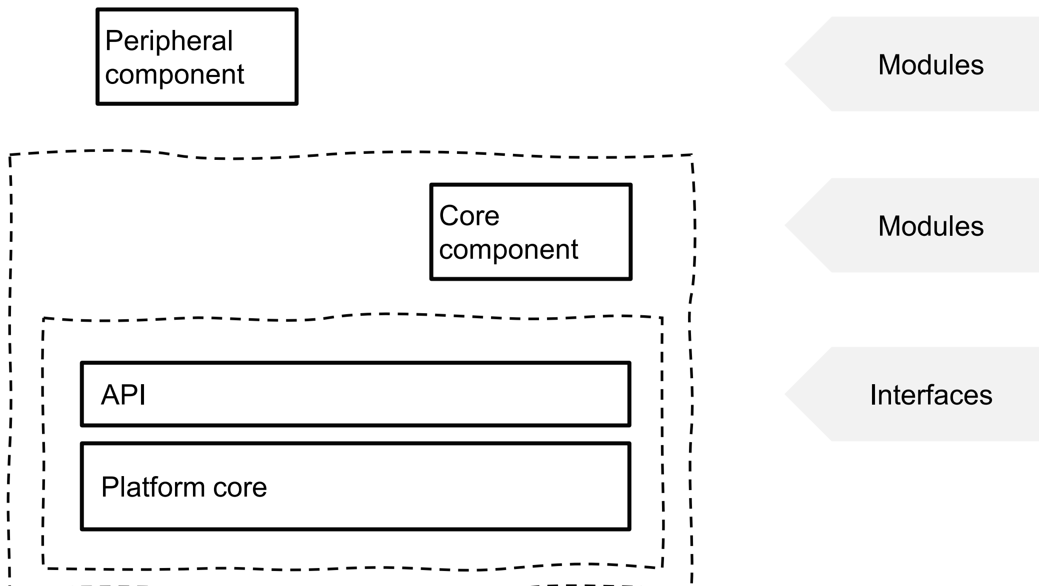
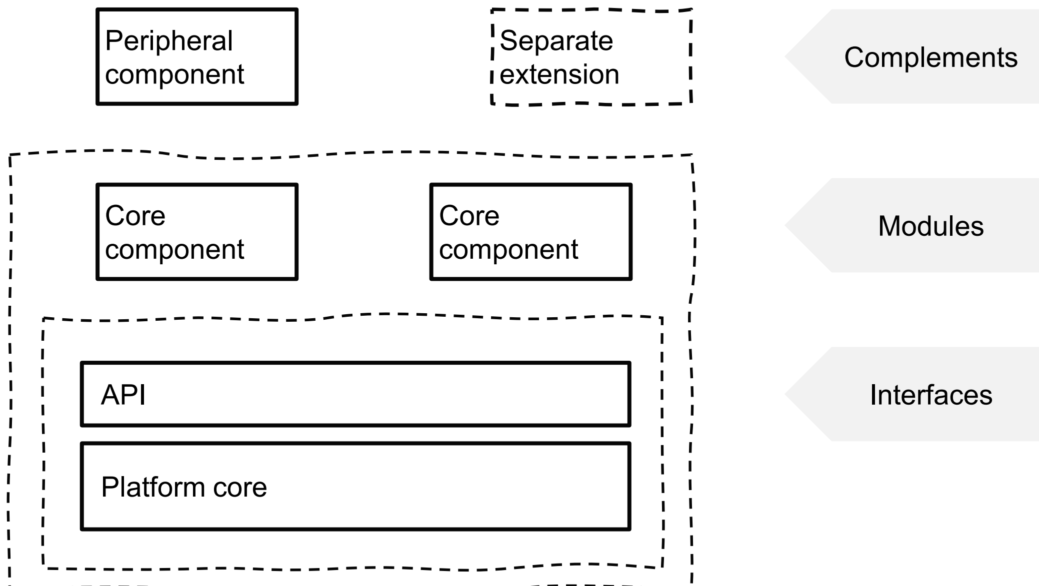
Product platforms as foundations for solutions

- Product platforms are structures that allow multiple products or solutions to be built within the same technical framework.
- Companies invest in platforms in hope that future deliverables can be built cheaper, faster or more reliably.
- A layered structure of a product platform allows for making use of modular solution architectures.
- Internal-facing product platforms serve new product development within the organization or its production network.
- External-facing platforms serve external customers directly.

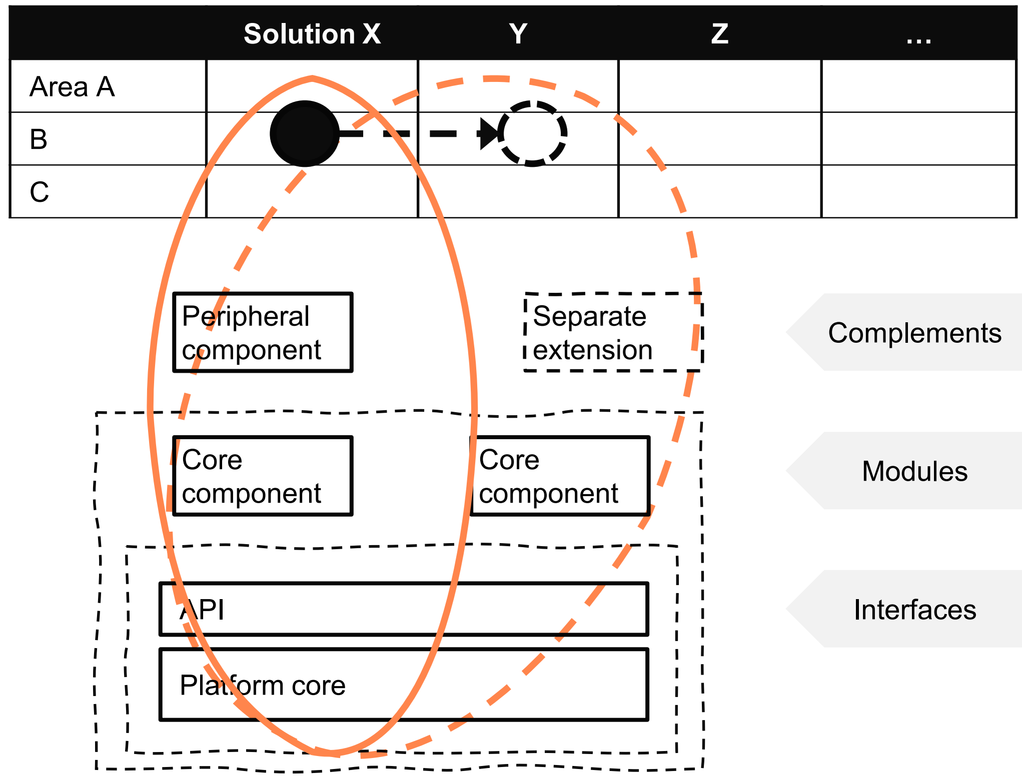
Platform-based architecture for modular solutions



Platform-based architecture for modular solutions



Platform-based architecture for modular solutions



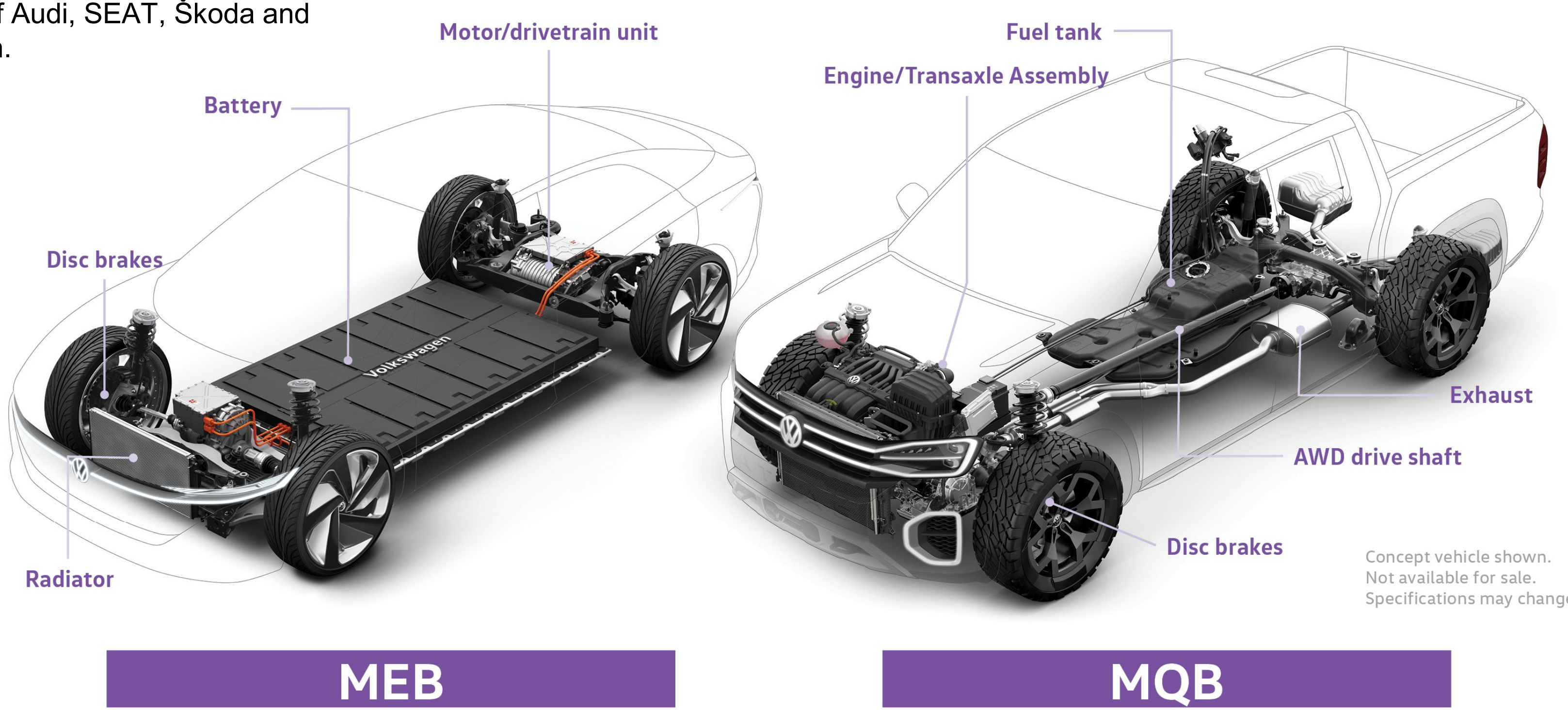
Group discussion:

In a 4-minute discussion, identify some **pros** and **cons** of the product platform approach to developing solutions.

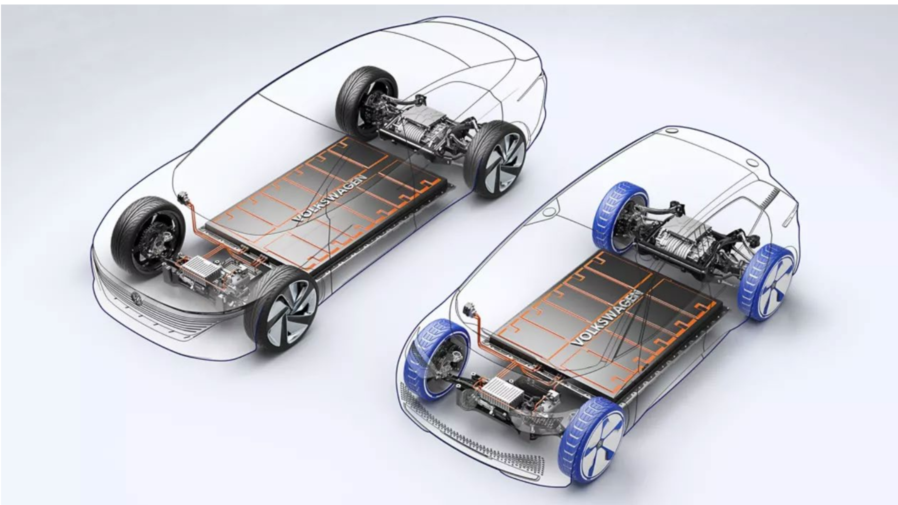
Examples of product platforms

The VW **MEB platform** is a modular car platform for electric cars. It is used in models of Audi, SEAT, Škoda and Volkswagen.

The VW **MQB platform** is a shared modular design construction for front-engine, front-wheel-drive & four-wheel-drive layout) automobiles. VW Group spent roughly $60bn developing this platform and the cars employing it.



Platform-based product derivatives



Product platform effects

Therefore VW Group based its strategy on dedicated platforms in 2015…

26 m. cars

~33 bn. invest

Battery supply secured

3 World regions
China, USA, Europe

1st wave | **2nd wave**

Our advantage

- **Strong group position in EU/CN** guarantees **scale effects**
- **Early decisions on dedicated BEV platforms** unleash value
- **Multi-brand platforms** in dedicated plants provide efficiencies

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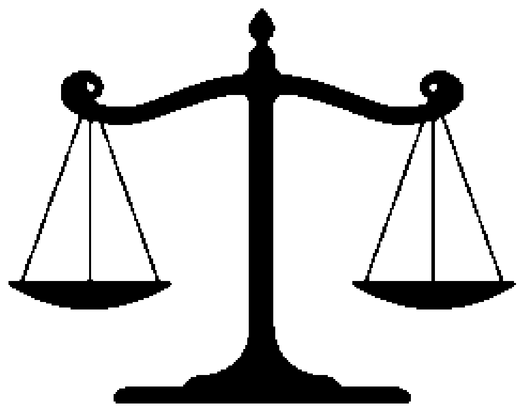
Trading off flexibility vs. investment in a product platform

More functionality?

What is needed to serve our current customers in the best possible way?

Time to launch?



Can we solve multiple clients' needs with one set of functionality?

What is our MVP?

Which clients should we serve to move on to the desired direction?

Aggregating the revenue & costs of a solution

Sales and engineering costs attributable to solutions can be aggregated as part of performance measurement. Ideally, sales and costs are recorded at regular time intervals, t, throughout the entire product cycle:

$$S_{p,v,f} = \sum_{t=1}^{T_C} (S_{p,v,f})_t \quad \text{and}$$

$$C_{p,v,f} = \sum_{t=1}^{T_D} (C_{p,v,f})_t$$

Over long product cycles, it is desirable to correct for inflationary effects in the economy. A deflator is computed for each time period relative to the desired base year:

$$S'_{p,v,f} = \sum_{t=1}^{T_C} (S_{p,v,f})_t D_t \quad \text{and}$$

$$C'_{p,v,f} = \sum_{t=1}^{T_D} (C_{p,v,f})_t D_t.$$

Variables

S = Sales attributable to a platform or derivative product within a product family.

C = Costs attributable to a platform or derivative product within a product family.

D = The deflator factor relative to a base year. Used to correct for inflationary effects for very long product cycles.

Indices

N_p = Number of platforms in a product family *excluding* the initial platform version or architecture.

N_v = Number of platform extensions, or generations, created off the base platform architecture, *excluding* the initial platform version.

N_f = Number of derivative products in a platform, or platform extension, excluding the initial platform version.

N_{TD} = The total number of derivative products in a family excluding the initial platform version.

T_D = The last time period number prior to entering the commercial cycle.

T_C = The last time period for which sales were recorded in the commercial cycle.

p = Platform index; p = base, 1, 2, 3, . . . , N_p.

v = Platform version index; v = base, 1, 2, 3, . . . , N_v.

f = Derivative product index; f = base, 1, 2, 3, . . . , N_f.

Meyer et al. (1997). Metrics for managing research and development in the context of the product family. *Management Science*, 43(1), 88-111.

Product platform efficiency

An **average R&D leverage** of a product platform (at the follow-on product level) can be defined as the engineering costs of developing a derivative product, divided by the engineering costs incurred in developing the version of the platform upon which the products are derived:

$$= \frac{\text{R\&D Costs for Derivative Product}}{\text{R\&D Costs for Platform Version}}$$

The efficiency of developing an **individual derivative** product relative to its base platform can be calculated as:

$$E_{p,v,f} = \frac{C'_{p,v,f}}{C'_{p,v,\text{base}}}$$

The **average platform efficiency** for a particular version of a product family can be defined as:

$$\bar{E}_{p,v} = \frac{\frac{1}{N_f} \sum_{f=1}^{N_f} C'_{p,v,f}}{C'_{p,v,\text{base}}}$$

Another way to assess platform efficiency is the development time perspective, based on development cycles (e.g., months)

$$E^{CycleTime}_{p,v,base} = \frac{T_{p,v,f}}{T_{p,v,base}}$$

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Meyer et al. (1997). Metrics for managing research and development in the context of the product family. *Management Science*, 43(1), 88-111.

Product platform effectiveness

Platform effectiveness considers R&D returns as accumulated profits divided by development cost. Here, it is estimated by the sum of the sales of products based on a platform version divided by the sum of the R&D costs for creating those products:

$$L_{p,v} = \frac{\sum_{f=\text{base}}^{N_f} S'_{p,v,f}}{\sum_{f=\text{base}}^{N_f} C'_{p,v,f}}$$

Platform leverage may be further aggregated across all platform versions within a product family and then used to compare the platform effectiveness between distinct product families:

$$L_p = \frac{\sum_{v=\text{base}}^{N_v} \sum_{f=\text{base}}^{N_f} S'_{p,v,f}}{\sum_{v=\text{base}}^{N_v} \sum_{f=\text{base}}^{N_f} C'_{p,v,f}}$$

Variables

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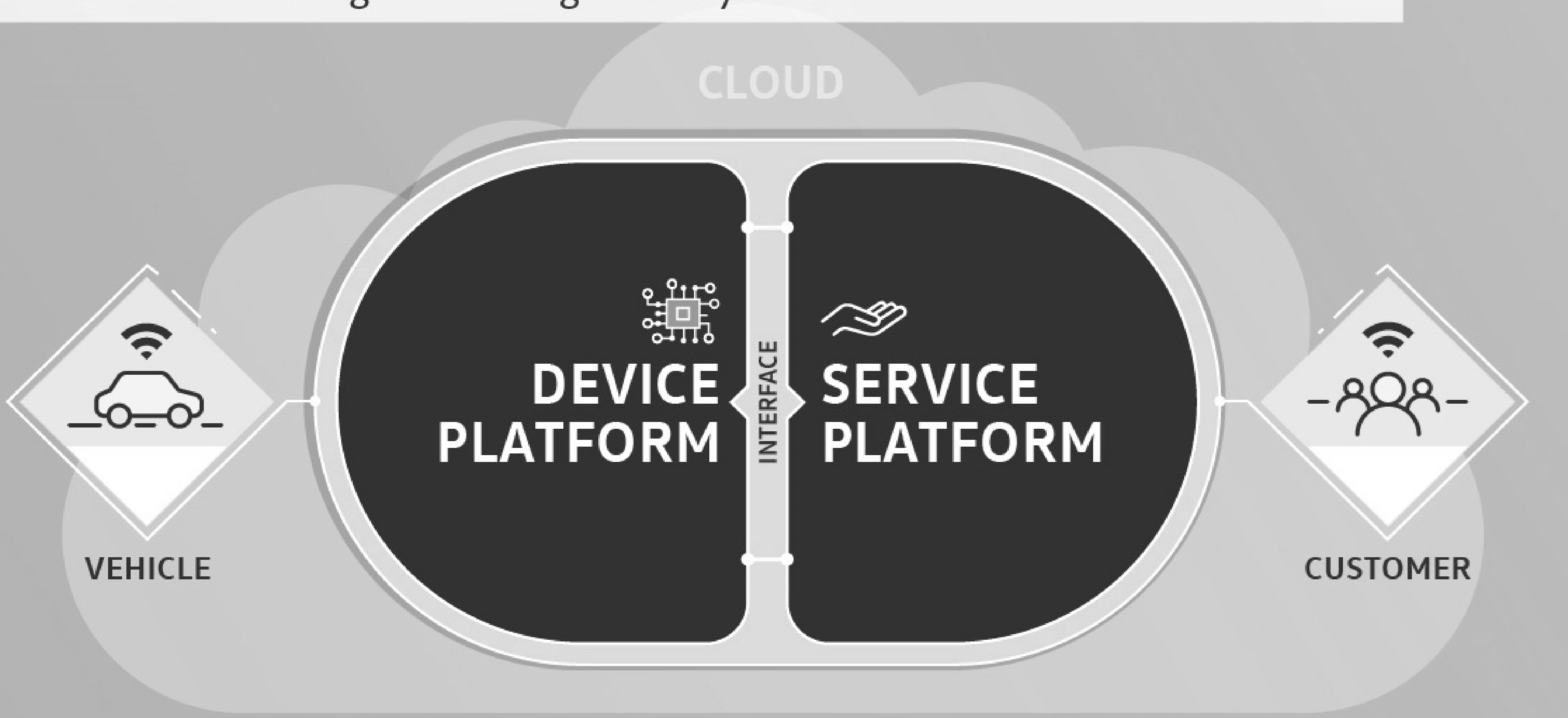
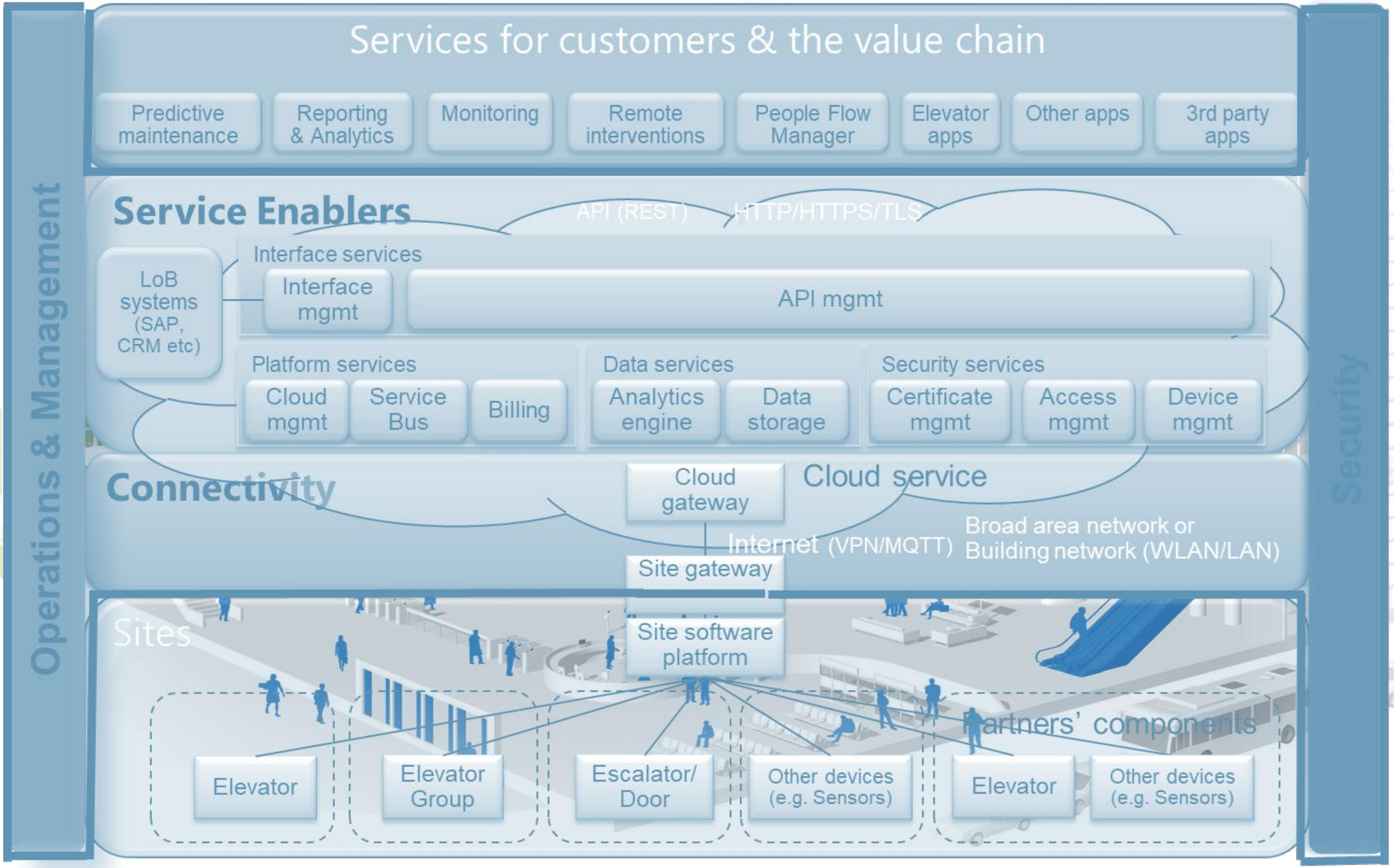
Meyer et al. (1997). Metrics for managing research and development in the context of the product family. *Management Science*, 43(1), 88-111.

ONE DIGITAL PLATFORM

Backbone of Volkswagen's new digital ecosystem





Services for customers & the value chain
Predictive maintenance
Reporting & Analytics
Monitoring
Remote interventions
People Flow Manager
Elevator apps
Other apps
3rd party apps
Service Enablers
API (REST)
HTTP/HTTPS/TLS
LoB systems (SAP, CRM etc)
Interface services
Interface mgmt
API mgmt
Platform services
Cloud mgmt
Service Bus
Billing
Data services
Analytics engine
Data storage
Security services
Certificate mgmt
Access mgmt
Device mgmt
Connectivity
Cloud gateway
Cloud service
Broad area network or
Building network (WLAN/LAN)
Internet (VPN/MQTT)
Site gateway
Site software platform
Sites
Partners' components
Elevator
Elevator Group
Escalator/ Door
Other devices (e.g. Sensors)
Elevator
Other devices (e.g. Sensors)
Operations & Management
Security

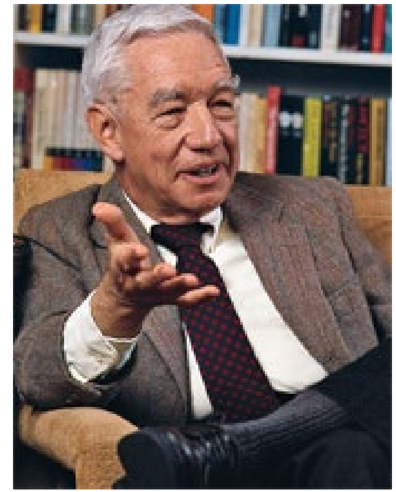
Solutions integrated by design

(Canatu of Aalto University’s Nanomaterials Group)

Reasons for developing modular service solutions

Structure is to follow strategy

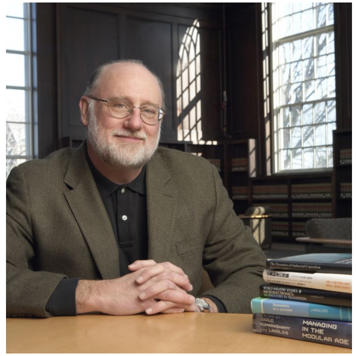
Managerial hierarchies allow for adapting modern management methods, including specialized units and the perfection of the basic techniques of mass production, mass distribution and quality control. (Alfred D, Chandler Jr., 1980)



Chandler, A. D. (1980). The growth of the transnational industrial firm in the United States and the United Kingdom: a comparative analysis. *The Economic History Review*, *33*(3), 396-410.

External economies drive modern corporations

The focus has shifted away from the *internal structures* of the modern corporation to the *external economies* created by interactions between firms. ie., the so-called *production network paradigm.* (Langlois & Robertson, 1995)



Richard N. Langlois

Paul ROBERTSON

Langlois, R. and P. Robertson (1995), Firms, Markets and Economic Change. Routledge: London and New York.

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Modularity emerges as a design principle

Modularity is a powerful concept in dealing with complex systems. Modules are structurally independent units in a larger system that work together. The system must therefore provide a framework –an architecture– that allows for independence of structure and integration of function. (Baldwin & Clark, 2000)

Carliss BALDWIN

Elder Kim B. Clark

Baldwin, C. Y., Clark, K. B., & Clark, K. B. (2000). Design rules: The power of modularity (Vol. 1). MIT press.

Modular organizations are flexible

Modular organization is a new paradigm in response to the *need for flexible, learning organizations* that continuously change and solve problems through interconnected, coordinated and self-organizing processes.
(Daft & Lewin, 1993)

Richard L. Daft

Arie Lewin

Daft, R. L., & Lewin, A. Y. (1993). Where are the theories for the" new" organizational forms? An editorial essay. Organization science, i-vi.

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Modularity – a new paradigm for industrial organization?

- The complexity of a solution may be handled by *reducing the number of units* and by *grouping these units into subsystems* (Frandsen, 2017).
- Manufacturing firms can overcome the *productivity paradox of services* by leveraging a modular platform approach (Marion et al., 2015).
- Modularity enables *external economies* and *production networks* (Prahalad, C. and G. Hamel, 1990).

Frandsen, T. (2017), "Evolution of modularity literature: a 25-year bibliometric analysis", *International Journal of Operations & Production Management*, Vol. 37, No. 6, pp. 703-747.

Marion, T.J., Meyer, M.H., Barczak, G., 2015. The influence of digital design and IT on modular product architecture. *J. Prod. Innov. Manag*. 32, 98–110.

Prahalad, C. and G. Hamel (1990), 'The core competence of the corporation,' Harvard Business Review, May–June, 79–91.

Examples of products with modular designs

Products	Form of modular product design	References
Aircraft	Common wing, nose, and tail components allow several models to be leveraged by using different numbers of fuselage modules to create aircraft of different lengths and passenger/freight capacities (used by Boeing, McDonnell-Douglas, and Airbus Industries).	Woolsey (1994)
Automobiles	Automakers have long used many basic modular components specified by the Society of Automotive Engineers.	Nevins and Whitney (1989)
	Some automakers use common (modular) components in many different models. Also, the Taurus platform design is leveraged to provide a basis for the Taurus and Mercury Sable sedans and wagons and for the Ford Taurus Windstar minivan.	*Automobile* (1994)
	Ford is converting its auto and truck engines to modular engine designs with high levels of common (modular) parts. The 4.6 L V-8 introduced in 1992 was Ford's first modular engine.	*Ford Engineering World* (1990)
	Chrysler's LH car designs are modular. Several models have been leveraged from common power train and engine components. The interior of each model is composed of four easy-to-install units that arrive ready-built from separate suppliers. The Chrysler Neon uses numerous modular assemblies.	Tully (1993)
Consumer electronics	Over 160 variations of the Sony Walkman were leveraged by 'mixing and matching' modular components in a few basic modular product designs.	Sanderson and Uzumeri (1990)
	Several upgraded models of Sony HandyCam video cameras were leveraged from an initial system design by successively introducing improved modular components.	Sanchez (1994a)
Household appliances	General Electric leverages several models of dishwashers by installing different modular doors and controls on common assemblies of enclosures, motors, and wiring harnesses.	Sanchez and Sudharshan (1993)
Personal computers	Personal computers often consist largely of modular components like hard disk drives, flat screen displays, and memory chips, coupled with some distinctive components like a microprocessor chip and enclosure.	Langlois and Robertson (1992)
Software	Software designs are creating modules of routines which can be combined to create customized applications programs.	Cusumano (1991)

Sanchez, R., & Mahoney, J. T. (1996). Modularity, flexibility, and knowledge management in product and organization design. Strategic management journal, 17(S2), 63-76.

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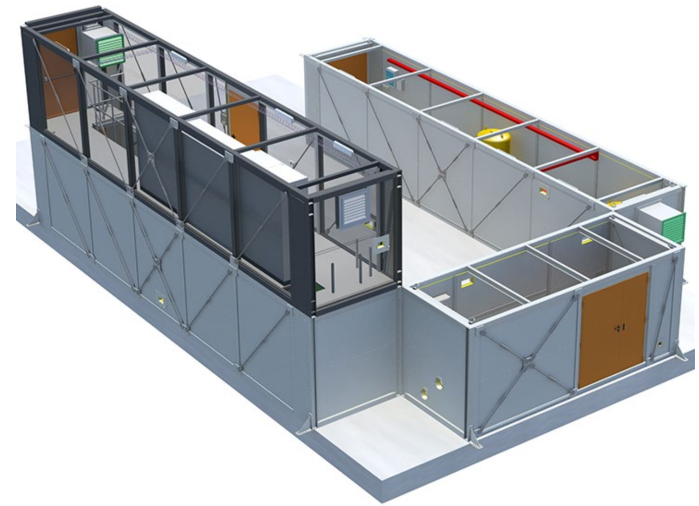
Advantages of a modular solution design

- **Prefabricated modular design allow for plug-and-play variability**
- **Highly efficient components that have lower lifecycle costs**
- **Scalable solution grows when needed**
- **Redeployable for use elsewhere, offering new business models, like “X as a service” or rentals**
- **Configurable design can flexibly adapt to external systems**
- **Reduces installation time**
- **Easier integration with other systems**



Wärtsilä Modular Block solution to power generation (https://www.wartsila.com/energy/modular-block)

Challenges of a modular design

- Mass production / Limited variety
- Higher amount of complex decisions & up-front investments in design
- All important cross-module dependencies must be addressed via design rules
- Risk related to the dependency on fewer suppliers
- Transportation costs & risk in the delivery of prefabricated components
- Difficult financing process

Montreal's Habitat 67 in the Expo 67 World's Fair
(Photo: Wladyslaw, via Wikimedia Commons)

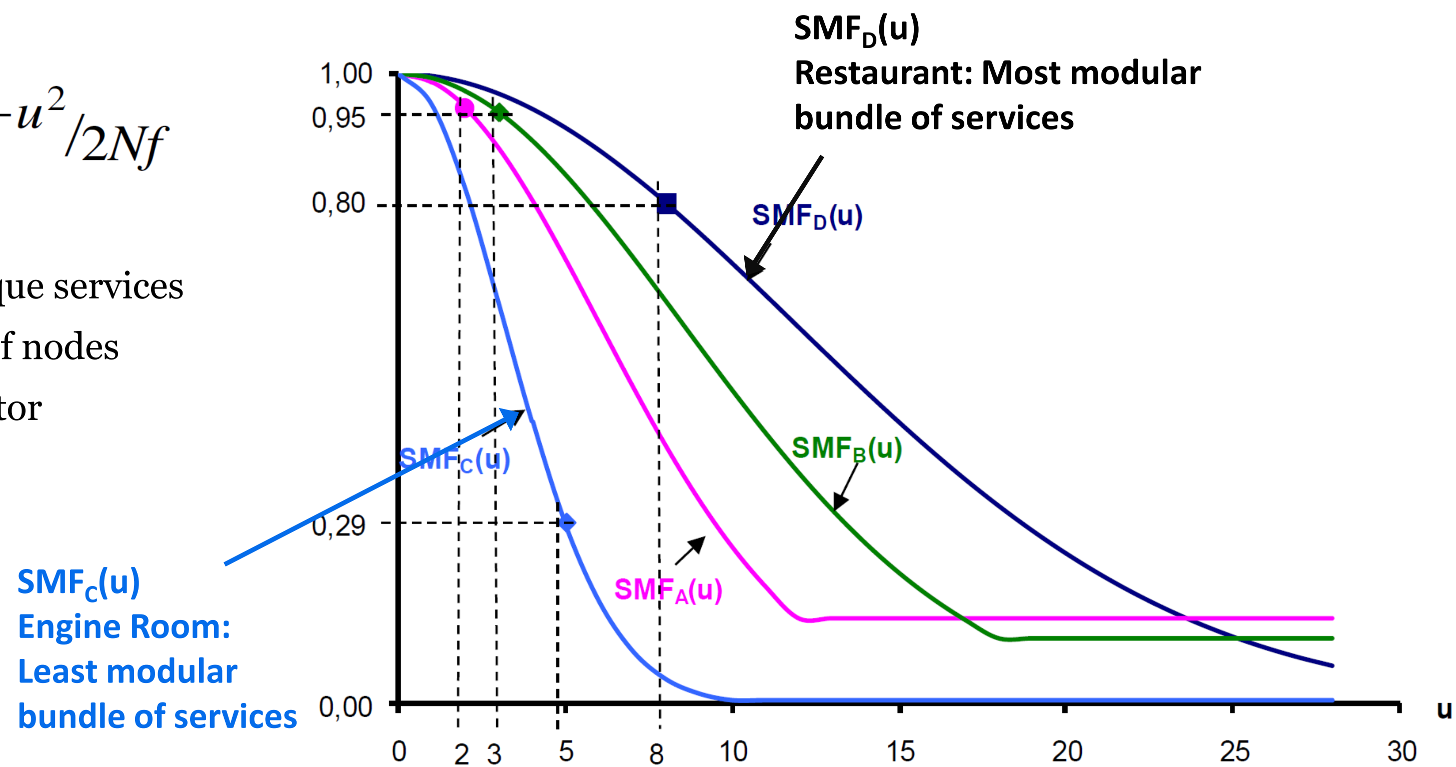
Degree of service modularity – SMF(u)

$$SMF(u) = e^{-u^2/2Nf}$$

u - number of unique services

N - total number of nodes

f - replicability factor

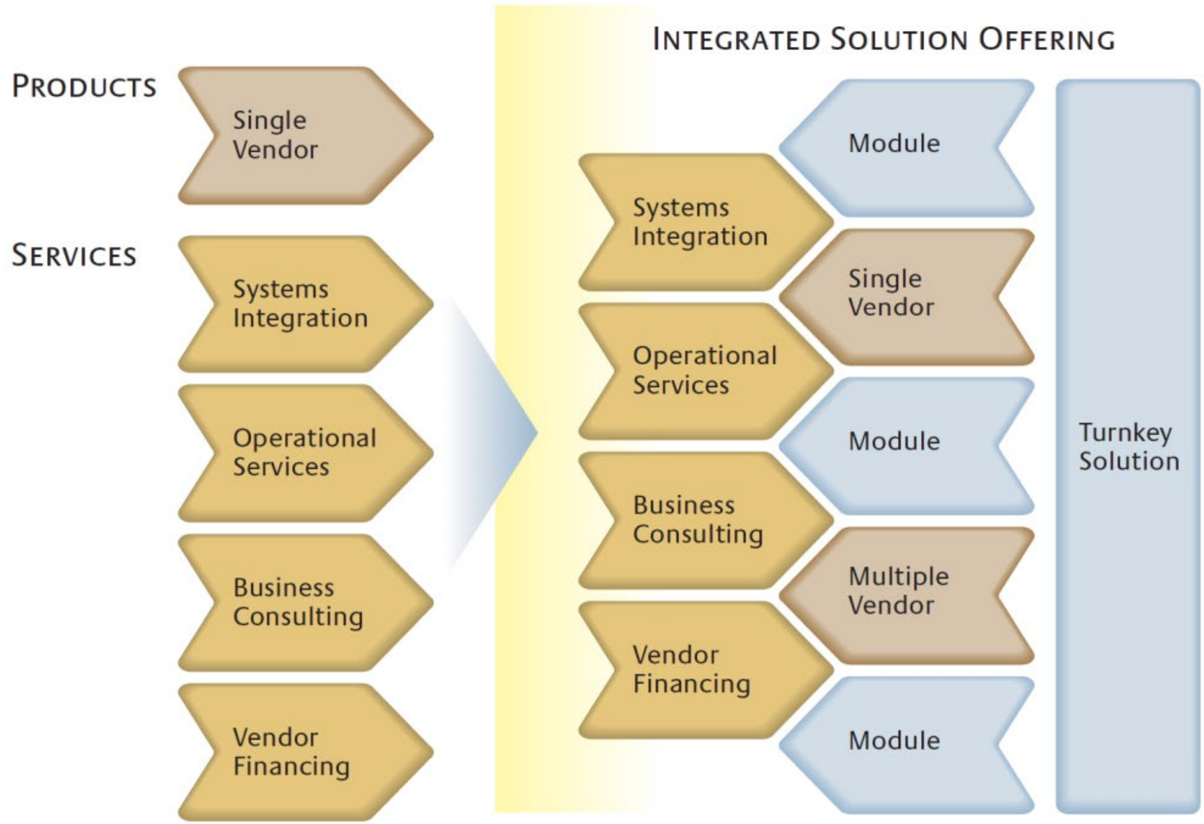


Voss, C. A., & Hsuan, J. (2009). Service architecture and modularity. *Decision Sciences*, *40*(3), 541-569.

Learning to develop modular service solutions

The migration to integrated solutions

For manufacturers and service companies alike, the ability to sell integrated solutions requires new organizational structures and capabilities.



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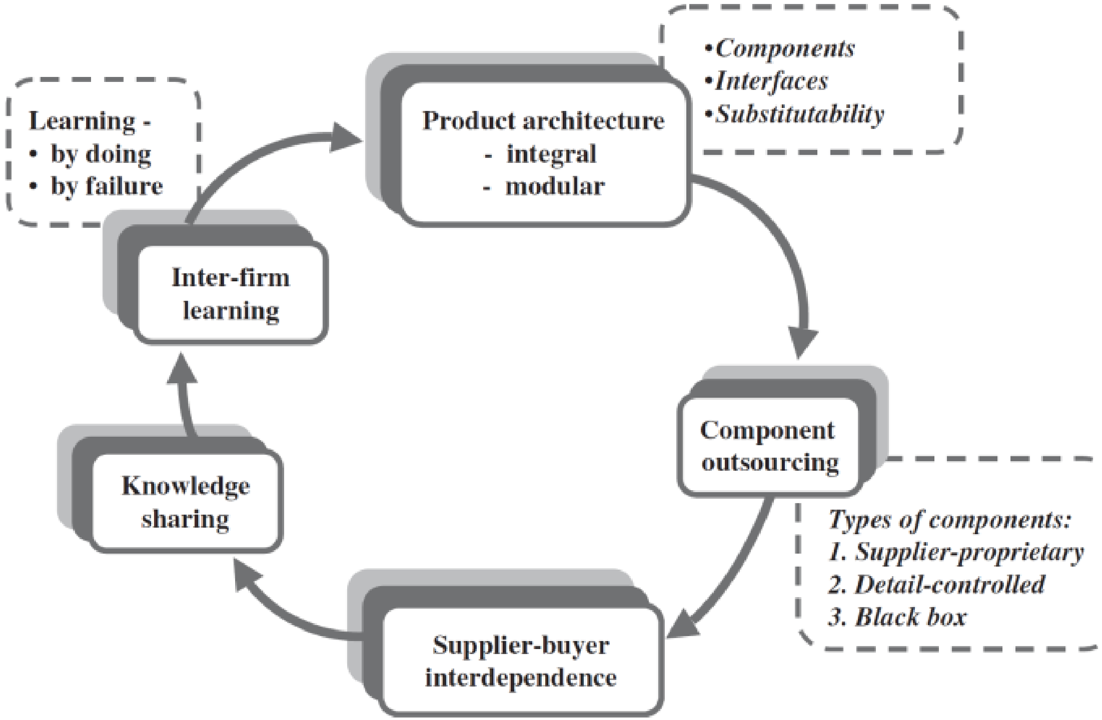
Davies, A., Brady, T. & Hobday, M. (2006). Charting a Path Toward Integrated Solutions, MIT Sloan Management Review, 47(3),

Outsourcing and inter-firm learning for modular solutions



Mikkola, J. H. (2003). Modularity, component outsourcing, and inter-firm learning. R&D Management, 33(4), 439-454.

Exploitative vs. explorative learning

Exploitation

- use and refinement of **existing** knowledge and technologies to strengthen the excellence of the current operation (Levinthal & March, 1993).
- **efficient** use of resources, incremental improvement of production & implementation.
- associated with **mechanistic** structures, path dependence, stable markets & technologies.
- connected with fewer partners, lesser knowledge diversity, and **stronger integration** among the partners (Rothaermel & Deeds, 2004).

Exploration

- **search for new** knowledge, the use of unfamiliar technologies, and the creation of products with unknown demand (Levinthal & March, 1993).
- capturing new resources through search, **variation**, experimentation, risk-taking, play, flexibility, discovery, and innovation (March 1991).
- **flexible future-oriented** process, which adapts itself to new configurations the firm can discover through radical innovation.
- strategic path breaking, focus on emerging markets and **radically new** technologies.

Group discussion:

In a 4-minute discussion, identify at least one practical example of **explorative** and **exploitative** learning in the development of service solutions.

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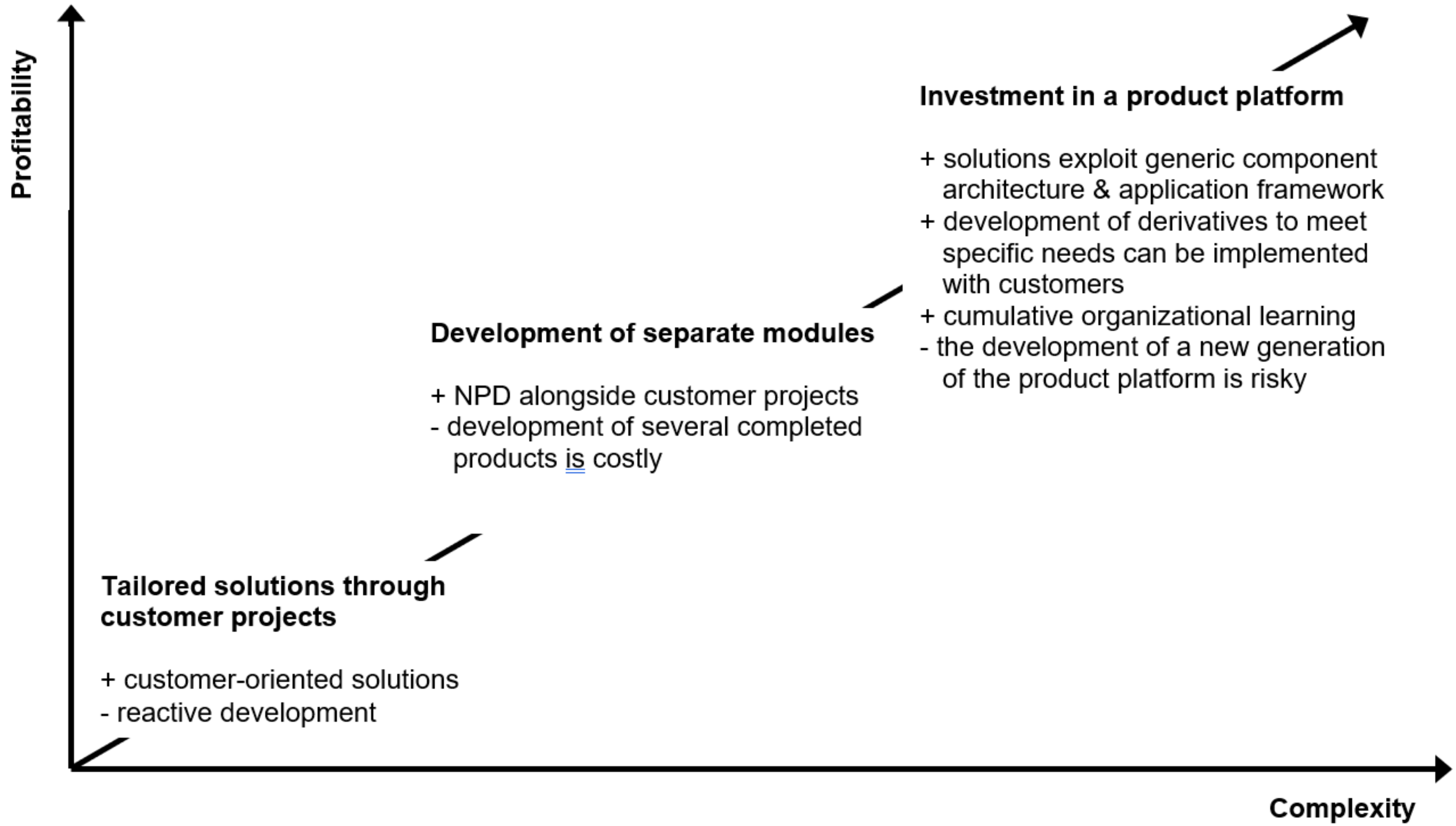
Organizing for repeatable solutions

Three levels of maturity with different types of learning processes, capability-building activities and changes in organizational design.

	Level 1 Grow the front end	Level 2 Build the back end	Level 3 Refocus
Learning processes	Explore new approaches and structures for integrated solutions delivery Learn from vanguard projects and use tacit knowledge gained in subsequent projects Systematically capture and transfer learning from project to project	Explore new approaches and structures that support front-end units Develop and implement strategy to replicate solutions-ready components Learn from front-end experiences and codify the knowledge gained	Exploit corporatewide learning and leverage knowledge assets Strategic center manages front-back and internal-external flows of knowledge
Capability-building	Front-end capability embodied in vanguard projects Move from customized to standardized offerings (e.g., standardized service portfolios for reuse in subsequent projects)	Develop menu of standardized solutions-ready components to support the front end Create and refine product platform and services portfolio	Create and refine corporatewide capabilities — front, back and center — which support large-scale and repeatable solutions delivery Balance front-end pull of customization and back-end push standardization
Organizational change	Embed response to new solutions opportunity in: • existing business unit • separate pilot organization Work with lead customers Use partners to fill gaps in capabilities	Create stand-alone back-end product and/or business units Strategic partnerships with major customers Strategic partnerships with product and/or service component suppliers	Focus activities of company or business unit on integrated solutions provision Move out of peripheral businesses Establish structures (front, back and center) that support repeatable solutions delivery Prevent back-end units from having direct contact with customers

Davies, A., Brady, T. & Hobday, M. (2006). Charting a Path Toward Integrated Solutions, MIT Sloan Management Review, 47(3),

From tailored to modular solutions



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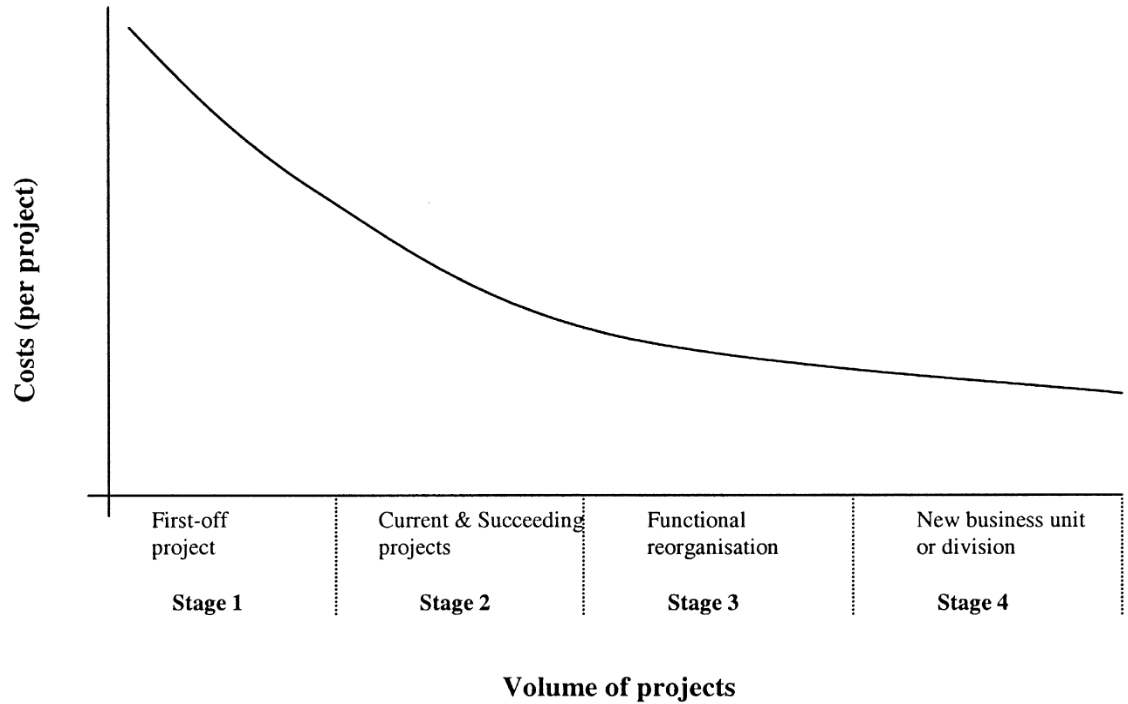
Exploitative organizational learning often focuses on reducing costs



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Davies, A., & Brady, T. (2000). Organisational capabilities and learning in complex product systems: towards repeatable solutions. *Research policy*, *29*(7-8), 931-953.

Strategic learning of service solutions

Type of learning	Focus of learning in modular solutions	Objective and rationale	Examples
Advantage-seeking exploitation	• Modules • Interfaces • Order-fulfillment processes	Cost reduction and efficiency in component production as well as in order-fulfillment and supply chain processes are vital to the economies of scale of the solution business.	KONE has reinforced the relationships between the selected core component providers and invested in platform development for more efficient integration of the solution components.
Opportunity-seeking exploration	• Customer needs and market trends • Search of complementary components • New ways of integrating the components	Sensing of customers' readiness to adopt new types of solutions and development of the competitive position are keys to long-term effectiveness.	KONE brings together designers, salespeople, R&D experts and management to annual customer experience events to improve the understanding of what really matters for customers in the business of integrated solutions.

Modes of learning on modular solutions

Sanchez, R., & Mahoney, J. T. (1996). Modularity, flexibility, and knowledge management in product and organization design. Strategic management journal, 17(S2), 63-76.

Learning about Component Interactions and Configurations ↓ / Learning about Component Functions and Designs →	Moderate	Significant
Moderate	**Incremental Learning at the Component Level** Incremental learning through component development leads to limited functional improvements and design variations in components used within an existing product architecture.	**Modular Learning at the Component Level** Learning about new kinds of component technologies leads to significant changes in feasible component functions and designs that can be accommodated within an existing product architecture.
Significant	**Architectural Learning** Learning about new product market opportunities leads to new product architectures based on changes in the ways existing kinds of components are combined and configured in product designs.	**Radical Learning at Architectural and Component Levels** Learning about new market opportunities and new product and component technologies leads to major changes in both kinds of components used and ways components are configured to form a product architecture.

Figure 1. Modes of learning in product creation processes

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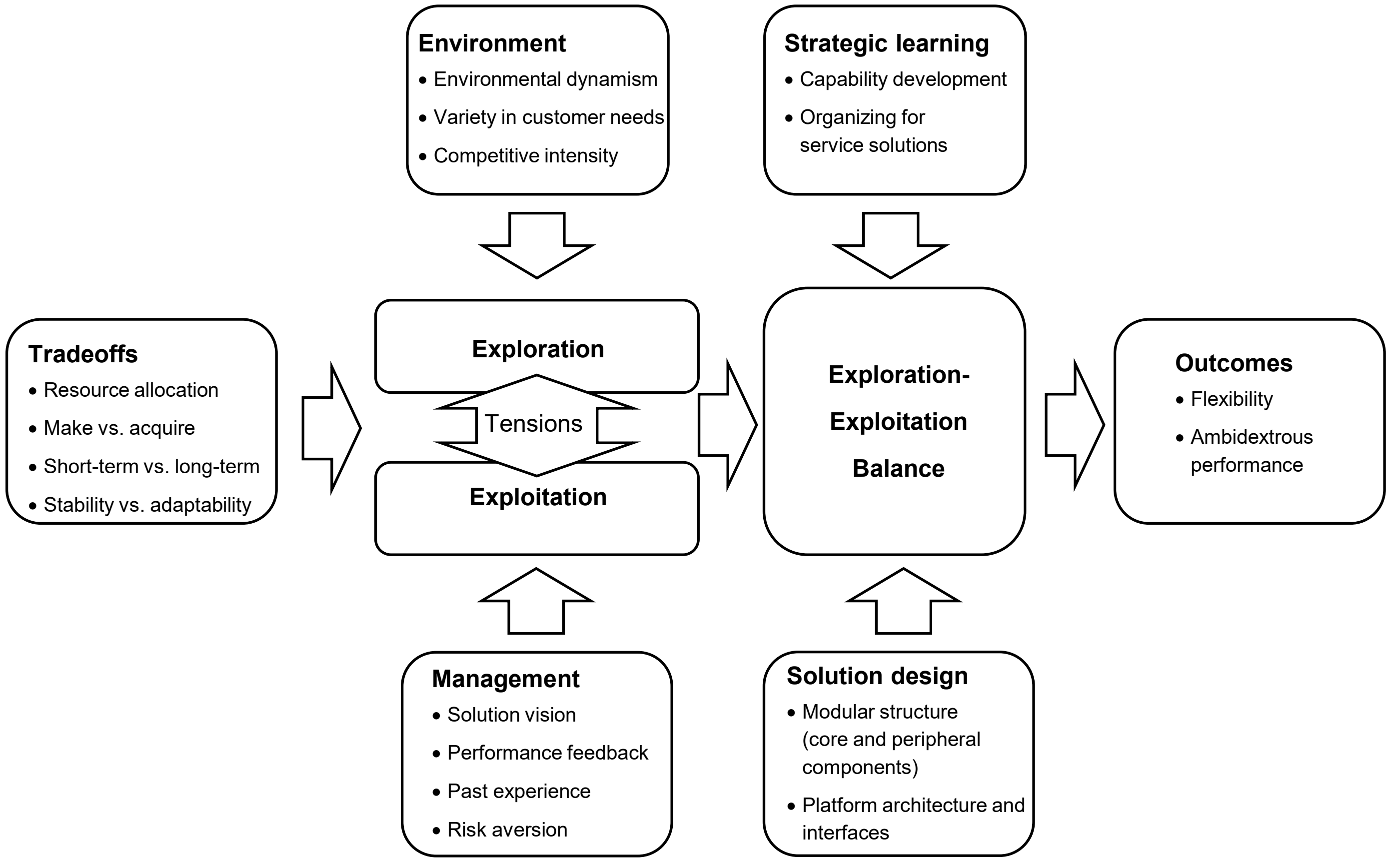
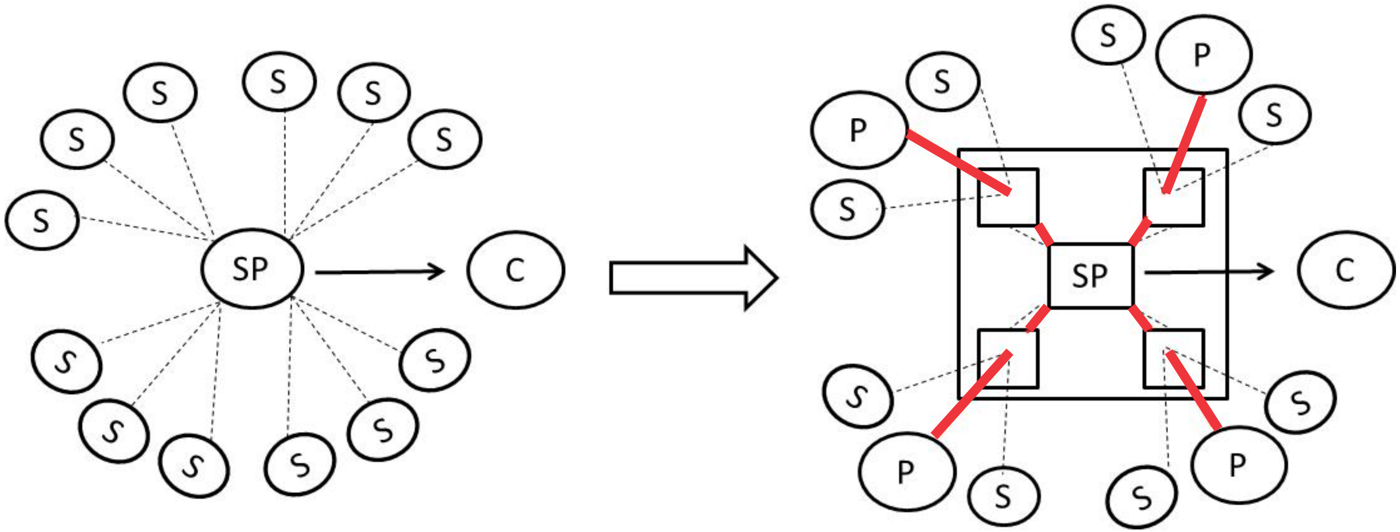
Combining explorative & exploitative learning for ambidextrous performance



(Adapted from Lavie, D., Stettner, U., & Tushman, M. L. (2010). Exploration and exploitation within and across organizations)

Modularity of the production system

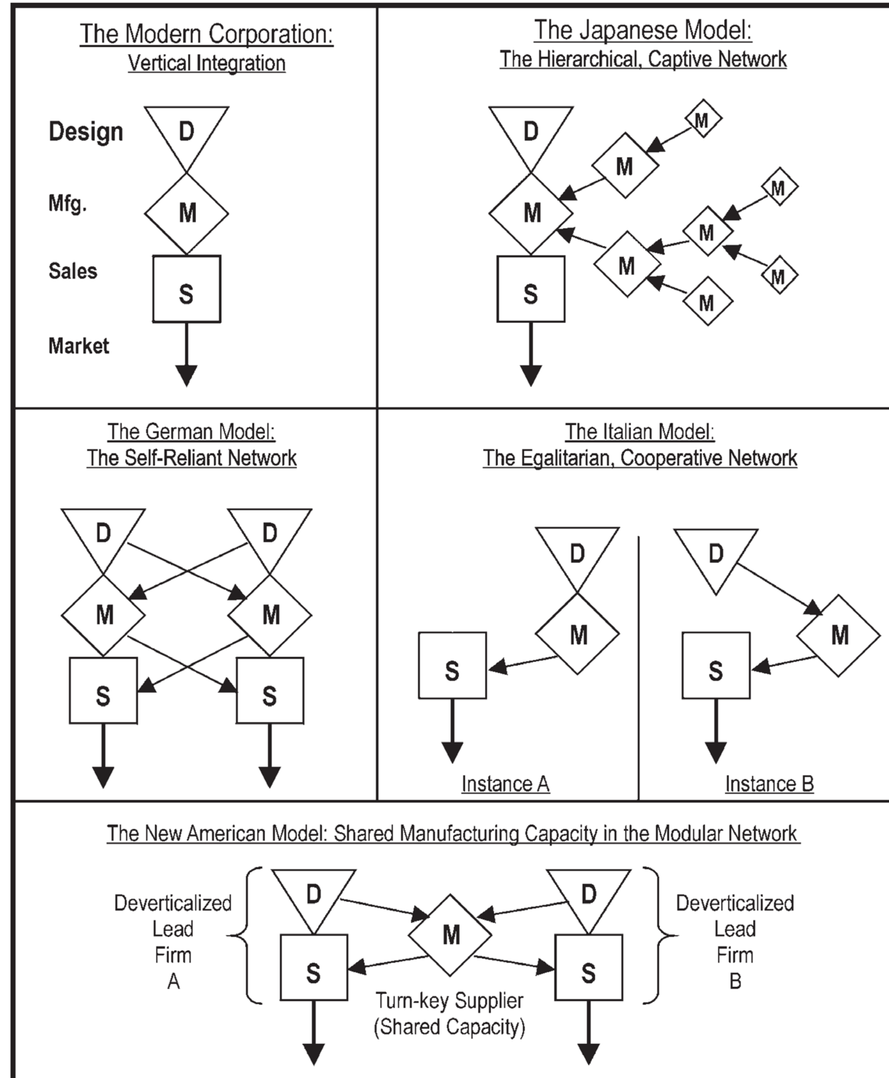


SP: Solution provider
S: Supplier
C: Customer
P: Partner

Subsystem
Integrated solution

Predefined interface
One-off integration
Strong network tie
Weak network tie

Supply chain implications of modularity



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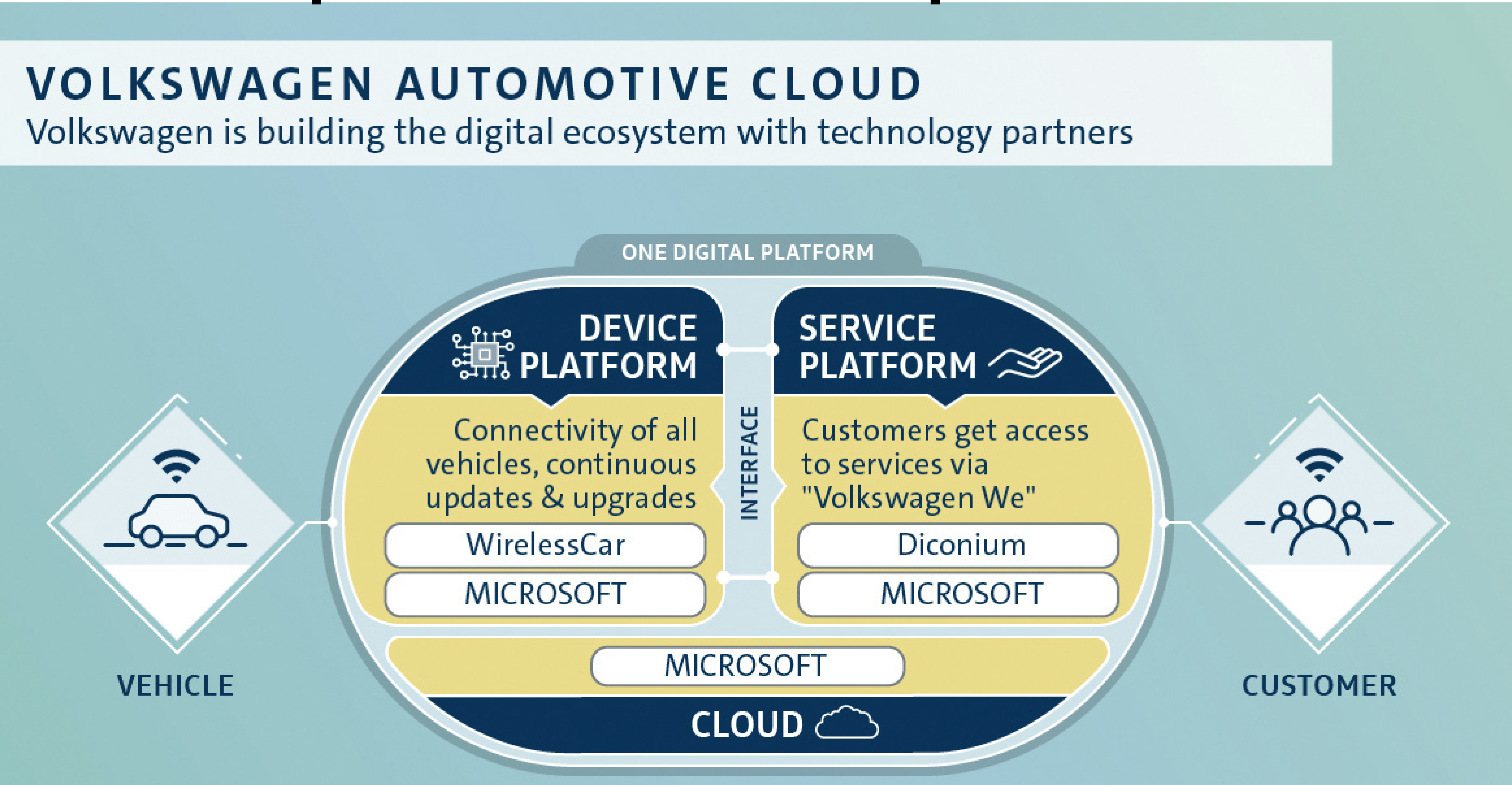
Product platform to service platform



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