Embedding Modularity in Firm Strategies and Management Processes

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Main Points from 2017 Presentation on "Organizing and Managing Modular Strategies and Development Processes"

• Achieving the full benefits obtainable from modular product strategies requires *new kinds of organization designs* and the adoption of *new kinds of modular management processes*.

• Implementing modular organization designs and modular management processes requires *systemic change* in the ways organizations work and in the ways managers manage.

• Most organizations using modularity have not undergone the systemic organizational and management changes needed to achieve the full benefits of modular product strategies.

• The biggest impediments to achieving the full benefits of modular strategies are
  -- *Lack of real understanding* of modularity strategies
  -- *Lack of top-level leadership* in making systemic changes to traditional organization designs and management processes

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Main Points To Be Addressed in this Presentation

I. What is *modularity*?

II. What are *modularity strategies*?

III. What does an organization have to do to adopt and implement modularity strategies – i.e., how do you *manage modularity* to gain strategic advantage??

IV. Examples from firms that have successfully implemented modularity strategies and learned how to manage modularity.
**Essential features** of modular strategies and development processes

**Product Architecture:**

1. A decomposition of the overall functionalities of a product into specific functions and *functional components*:

   ![Component Diagram 1]

   - Component A
   - Component B
   - Component C
   - Component N

2. The full specification of the *component interfaces* – i.e., the inputs and outputs of each component – that define how components *interact* in the product as a system:

   ![Component Diagram 2]

   - Component A
   - Component B
   - Component C
   - Component N

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### Types of Interfaces to be defined and specified in an architecture

(source: Sanchez 1999)

<table>
<thead>
<tr>
<th>Type of Interface</th>
<th>What the Interface Specification Defines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attachment interface</td>
<td>Defines how one component will physically attach to another component</td>
</tr>
<tr>
<td>Spatial interface</td>
<td>Defines the physical space a component will occupy in a system design</td>
</tr>
<tr>
<td>Transfer interfaces</td>
<td>Defines the input(s) that a component will transform into some kind of output(s)</td>
</tr>
<tr>
<td>Control and communication interface</td>
<td>Defines how one component will exchange signals with another component (used to monitor and control the behaviors of components in a system design)</td>
</tr>
<tr>
<td>User interfaces</td>
<td>(a) Defines the intended ways in which a user will interact with a component in a system design;</td>
</tr>
<tr>
<td></td>
<td>(b) Defines how a component will interact with the user's &quot;macro-system&quot; context</td>
</tr>
<tr>
<td>Environmental interfaces</td>
<td>(a) Defines how a component is expected to interact with the ambient environment of the product design;</td>
</tr>
<tr>
<td></td>
<td>(b) Defines how the functioning of one component affects the functioning of other components in the product design.</td>
</tr>
</tbody>
</table>
Essential features of modular strategies and development processes

Product and Process Architectures may have two levels of modularity:

Technical Modularity:
The interfaces between components are
- specified to allow the substitution of a range of component variations
- standardized (i.e., not allowed to change) for some period of time

Strategic Modularity:
Product and process architectures are strategically partitioned to
- Achieve a “One-to-One Mapping” of specific customer benefits into individual modular components or subsystems
- Interfaces are specified to technically decouple components to “Contain” product variety and technological change in individual components

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**Essential features** of modular strategies and development processes

**Coordinated “Platform” of Modular Product and Process Architectures**
(Source: Sanchez 1999)

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Results of applying Modular Platform strategy in Philips’ Powered Toothbrush Business:

✓ Product Variations Increased from <100 to 300+

✓ 48% Reduction in Delivered Cost/Unit

✓ Lead Time Reduced from 6 weeks to 5 Days

✓ Order Fulfillment Increased from "80%" to 99%
The “New Rules and New Roles” of modular development processes

“Fast-Cycle” Modular Development Process
(Adapted from Sanchez and Mahoney 1996)
Essential features of modular strategies and development processes

Example of Strategic Partitioning of a Modular Architecture into Differentiating Components and Stable Components, with “One to One Mapping” of functions into single components
I. **Essential features** of modular strategies and development processes

Strategic Partitioning can motivated by a number of **Strategic Objectives:**

**Product Strategy Objectives (Design Issues):**

- **Increase product variety** by designing in greater configurability
- **Improve product performance** by designing in rapid technological upgrading
- **Increase speed to market** by adopting the modular development process
- **Reduce development costs and time** through disciplined design for re-use and redundancy design methods
- **Reduce product costs** through component commonality and design for re-use
- **Improve predictability** of new product introductions

**Process Strategy Objectives (Operational Issues):**

- **Reduce production costs** through modular design for assembly
- **Reduce customers’ operating costs and complexity** by maintaining commonality of customers’ knowledge and skill base

**Management Strategy Objectives (Organizational Issues):**

- **Reduce management complexity and costs** by using well specified modular architectures to coordinate development, sourcing, and customer support processes -- both out-sourced and in-sourced
Essential features of modular strategies and development processes

Alternating Cycles of Synthesis and Decomposition in Modular Development Processes

Essential features of modular strategies and development processes

Senior Management Inputs Required in Conventional vs. Modular Development
II. What are the most common failures of firms to implement effective modular strategies and development processes?

(1) Failure simply to understand what modularity means

(2) Failure to adopt “New Rules and New Roles” of modular organization design and management processes

(3) Failure to partition modular architectures strategically

(4) Failure to fully specify and freeze interface specifications before beginning development processes.

(5) Failure to adhere to specified interfaces during development

(6) Failure to capture learning in improved component designs and interface specifications
## Modularity Maturity Model

<table>
<thead>
<tr>
<th>Maturity Level</th>
<th>Management Understanding</th>
<th>Design and Development Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Modularity as framework for <em>identifying and developing new strategic competences</em></td>
<td>Architectural management function directly involved in <em>identifying goals for strategic competence development</em></td>
</tr>
<tr>
<td>6</td>
<td>Modularity as framework for <em>strategic integration</em></td>
<td>Architectural management function directly involved in <em>setting market, technology, and business strategies</em></td>
</tr>
<tr>
<td>5</td>
<td>Modularity as framework for <em>knowledge management</em></td>
<td>New architectural knowledge created in development is captured in <em>improved interface specifications</em></td>
</tr>
<tr>
<td>4</td>
<td>Modularity seen as means to <em>reduce time to market</em></td>
<td>Modular development process based on “new rules and new roles” enables <em>concurrent component development</em></td>
</tr>
<tr>
<td>3</td>
<td>Modularity seen as means to <em>increase product variety</em></td>
<td><em>Strategic partitioning</em> to decouple stable from variable components to enable configuration of product variations</td>
</tr>
<tr>
<td>2</td>
<td>Modularity seen as means to <em>reduce product costs</em></td>
<td>Early form of modular development process seeks to use <em>common components</em> and <em>re-usable components</em></td>
</tr>
<tr>
<td>1</td>
<td>Modularity seen only as <em>engineering issue</em></td>
<td>Conventional development process uses <em>technical modularity</em> to reduce design time and cost</td>
</tr>
<tr>
<td>0</td>
<td>Unaware of modularity</td>
<td>Conventional development process with no systematic use of modularity</td>
</tr>
</tbody>
</table>
Systematic Use of Architectural Framework at Automatix, Inc.

**New Product Ideas**
*(functions, features, performance, cost)*

- **Product Component Managers:**
  Can we leverage this product from existing product architectures?

- **Product and Process Component Managers:**
  Can we leverage this product by using new component variations in existing product and process architectures?

- **“Wish List” Committee:**
  Is this a product opportunity that warrants investing in creating a new process capability?

- **Executive Committee:**
  Should we create a new product and/or process architecture?

- **Leverage new product from existing components**
- **Leverage new product using new product components in existing product and process architectures**
- **Leverage new product using new components in both product and process architectures**

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Management Processes Supporting Development of "Common Module Family" in Renault-Nissan Alliance

Based on ongoing joint research with

Professor Tomoatsu Shibata
Tohoku University, Japan

From forthcoming paper
Fig. 1. Conceptual diagram of common module family (CMF)

Source: Nissan global site

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Fig. 4 Applying CMF architecture to all of market segment in Nissan

<table>
<thead>
<tr>
<th>Car width</th>
<th>price</th>
</tr>
</thead>
<tbody>
<tr>
<td>A segment (CMF A)</td>
<td></td>
</tr>
<tr>
<td>B segment (CMF B)</td>
<td></td>
</tr>
<tr>
<td>C/D segment (CMF C/D)</td>
<td></td>
</tr>
</tbody>
</table>

- X-TRAIL (2013)
- Qashqai (2013)
- Kicks (2016)
- Micra (2016)
- redi-GO (2015)
Alternating Cycles of Synthesis and Decomposition in Modular Development Processes

Fig. 2. Organizational system for formulating design rules

- Alliance director
- Design rule formulation
- Strategic view
- Technical view

CCT (Cross company team)
- JSC#1 component
- JSC#2 architecture
- JSC#3 electronics
- JSC#4 market

Joint steering committee
- Information sharing
- Adjustment
- Registration

Component department
- USFT#1
- USFT#2
- USFT#75
- USFT#76
Fig. 5  Project leaders for keeping CMF modular concept

C/D segment

Engine
FR under Body
Cockpit
RR under body

ABML responsible for component sharing in big module

B segment

Engine
FR under body
Cockpit
RR under body

CVE responsible for maximizing value of specific vehicle

APFL responsible for component sharing in this segment

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Fig. 3. Process of resolving road blocks

- **2009**
- **Source:** Nissan

- **Number of unresolved road blocks**
- **Total number of road blocks**
Thank You!

Questions or Comments?