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The Essential Leadership Role of Senior Management in Adopting Architectural Management and Modular Strategies (AMMS), with Perspectives on Experiences of European Automotive Firms

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1. Introduction

Beginning in the 1990s, some researchers in strategic management and technology strategy began to suggest that designs of products based on modular architectures could become the basis for new kinds of product development processes and new kinds of product strategies offering greater product variety, more rapid technological upgrading, greater speed to market, *and* lower costs of product development and production (Garud and Kumaraswamy, 1993, 1995; Langlois and Robertson, 1992; Sanchez and Sudharshan, 1993; Sanchez, 1995, 1996; Sanchez and Mahoney, 1996; Sanderson and Uzumeri, 1997).

By the late 1990s and 2000s, research conducted in a variety of industries began to offer convincing evidence that firms that learn how to make effective strategic uses of *architectural management and modular strategies* (hereafter "AMMS") can in fact manage their product portfolios much more effectively and create substantial competitive advantages. These studies confirm that architectural development methods and strategic uses of modular architectures can increase product variety, improve speed to market, more rapidly upgrade products technologically, and reduce — in some cases, *radically* reduce — costs of design, development, production, and servicing of products (Asan et al., 2008; Funk, 2008; Sanchez, 2002, 2004, 2008; Sanchez and Collins 2001; Stephan, Pfaffmann, and Sanchez, 2008; Worren et al., 2002).

The objective of architectural approaches to managing new product development processes is a refocusing of development objectives from creating individual products to creating product architectures that can serve as "platforms" for families of products (Sanderson and Uzumeri, 1997). Managing product development with the objective of creating platform architectures rather than individual designs is an essential step in

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implementing modular development and design methods and in launching new kinds of product strategies enabled by the configurability of modular architectures (Sanchez, 2000).

In many industries today, modular strategies are widely discussed, and in some industries have already become the *dominant logic* for competing (Prahalad and Bettis 1986). However, firms in all industries exhibit widely varying levels of understanding and results in their efforts to implement AMMS. Drawing on both traditional academic research and the author's extensive consulting experience assisting firms in implementing AMMS, this paper suggests that the two most important factors in determining a firm's eventual success or failure in achieving AMMS are

(i) the *understanding of its senior management team* of the fundamental product strategy, organization, and management changes a firm must undergo in order to implement AMMS, and

(ii) *the willingness of the senior management team to provide essential leadership* for the significant strategy, organization, and management changes required for a successful implementation of AMMS.

The discussion in this paper therefore seeks to clarify the essential understanding of AMMS that senior managers must have and the essential leadership tasks they must be willing to perform in order for their organization to be successful in implementing AMMS.

This paper undertakes to help managers develop this understanding through a "bottom-up" approach to identifying the kinds of changes an organization must undergo to implement AMMS. We first identify how development processes in an AMMS regime differ from conventional development processes *at the working level.* We then consider the *changes in organization processes, structure, and culture* needed to convert an organization from conventional to AMMS development processes. We then draw on that discussion to identify the essential understanding of AMMS that senior managers must have and the essential leadership roles that they must fulfill in order to implement AMMS successfully. We then discuss two very different management approaches that senior managers may adopt in implementing AMMS, — the programmatic approach versus the incentives approach — and we assess the strengths and weaknesses of each approach when used in different kinds of business environments.

Throughout this discussion, we illustrate the challenges that we identify in implementing AMMS and the recommendations that we make by drawing on the experiences of several European automotive firms in implementing AMMS.

Accordingly, this paper is structured in the following way:

Section 1 identifies the *fundamental changes in development objectives and processes* that converting from conventional product development to AMMS requires of a firm.

Section 2 explains the considerable *changes in organization processes, structure, and culture* that an organization must accomplish in order to implement AMMS effectively.

Section 3 draws on the prior two sections to summarize the *essential understanding of AMMS and its processes* that senior management of an organization must have and the *essential leadership roles* that senior managers must fulfill in order for their organization to undergo the transformational changes needed to implement AMMS.

Section 4 elaborates the *two fundamental management approaches* that senior managers can follow in implementing and sustaining AMMS in their firms, which we characterize as "programmatic" *versus* "incentives" approaches. The section also explains the significant differences in leadership roles that senior managers may undertake in each of the two approaches to implementing AMMS. The section also suggests the kind of management approach and associated leadership role that are likely to be effective in four different kinds of business environments distinguished by their levels of complexity and rates of strategic change.

The paper concludes with *some counsel for senior managers* of firms who are interested in implementing AMMS, and/or whose firms' current AMMS implementation efforts are stalled, faltering, or not achieving their full potential.[1)]

2. How AMMS differs from conventional product strategies and development processes

This section summarizes how AMMS differs from conventional product strategies and development processes and identifies the fundamental changes that must take place at the working level when a firm converts from conventional product strategies and development processes to AMMS.

2.1 Conventional product strategies and development processes

Conventional product strategies are focused on picking what are thought to be the most promising "point targets" in markets for new products. Conventional development processes then apply traditional engineering optimization methods to create "peak designs" for the new products that are intended to serve each "point target" that a firm decides to pursue. Both aspects deserve brief explanation.

2.1.1 Conventional product strategies

Conventional product strategies rest on two implicit and thus often unrecognized assumptions: (i) for technical reasons, products must be developed individually, and (ii) developing products is costly. Both assumptions are now known to be incorrect, yet they persist in much management thinking, especially among senior managers unfamiliar with modular development methods. Nevertheless, these two assumptions still lead many managers to believe that at most only a few of the most promising new product possibilities must be chosen and developed.

As a consequence of these assumptions, the usual input to the product development process sought from the marketing function supporting a conventional product strategy is a statement of the product attributes and performance levels that are thought to be those of the most promising "point target" — the product attributes that marketing research suggests will attract the most potential customers in a targeted market or market segment. As suggested in **Figure 1 (a)**, in

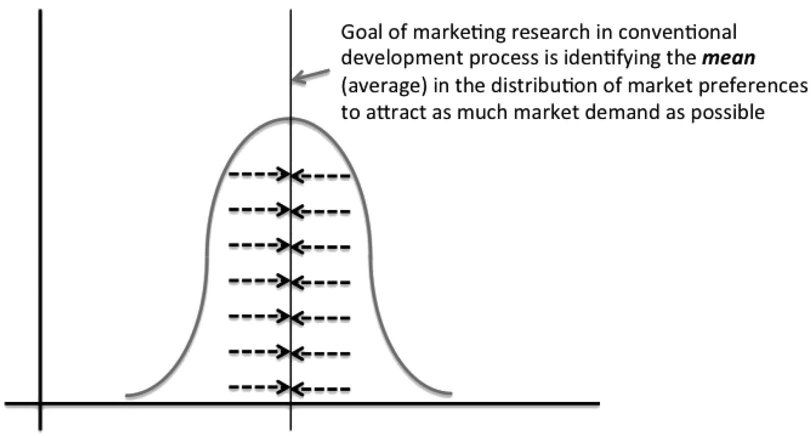

Figure 1 (a). Input from Marketing in Conventional Development

1) This paper, which focuses on senior management's role in implementing AMMS, is intended to be a complementary "companion piece" to the author's 2013 paper on "Building real modularity competence in automotive design, development, production, and after-service," pp. 205–236 in *International Journal of Automotive Technology and Management*, 13 (3).

conventional product strategies and development processes the product strategy input provided by the marketing function to product developers is a statement of *the mean* (*average*) *values of product attributes and performance levels* at the "middle" of the distribution of preferences in each market or market segment that the firm will target. By positioning a new product in the middle of certain market preferences, the new product is intended to attract a large number of customers with preferences that are at or near the middle of the overall distribution of preferences in a given market segment.

2.1.2 Conventional product development processes

Once the desired mean values for the functional and performance parameters for a new product are provided to developers, the development process essentially becomes an exercise in traditional *engineering design optimization*. The engineering design optimization process may take one of two forms: (i) *minimizing the cost* of a product design subject to achieving specified functional and performance goals for the product, or (ii) *maximizing the functional and performance characteristics* for the product subject to meeting a given cost target for development and production of the product. The output of this kind of design process is often called a cost- or performance-optimized design or a "peak design."

Note that this approach to developing new products rests on the further assumptions (i) that the most preferred functional and performance requirements for each new product in a market segment are clearly identifiable and relatively certain, and (ii) that the cost sensitivities of a target market with respect to the proposed new product's attributes are well understood. As we discuss below, however, in the many product markets today with high rates of change in consumer preferences and resulting uncertainties as to future market preferences, these assumptions may not be warranted.

2.2 Architectural Management and Modular Strategies (AMMS)

In its essential features, AMMS is very much the opposite of conventional product strategies and development processes. In contrast to conventional product strategies that pick "point targets" in markets for new products, AMMS typically targets *a range of market preferences* for which modular product strategies will seek to provide potentially large numbers of product variations and upgrades. Then, instead of applying traditional engineering optimization methods in designing single product designs, the modular product development process in AMMS will seek to *optimize the flexibility of a modular product architecture* to provide the product variety and upgrading the firm will use to serve the range of market preferences the firm is seeking to serve. Both of these aspects of AMMS deserve further explanation.

2.2.1 Modular product strategies

As noted above, conventional product strategies rest on the assumption that development of new products is costly and thus only a few most promising new product possibilities should be chosen and developed. Research conducted in the 1990s and 2000s shows beyond any reasonable doubt, however, that with the advancement of modular design methods worldwide, this assumption no longer holds. The fast, cost-efficient creation of modular architectures designed to support the leveraging of large numbers of product variations is not only possible today, but is already a norm in many industries (Sanchez and Mahoney, 1996). Indeed, research has shown that effective use of modular development processes can reduce the time and cost of product development by 50 to 80%— and at the same time can support radically increased levels of product variety and faster rates of technological upgrading (Sanchez and Collins, 2001; Sanchez, 2004). The increasing use of modular product designs in industries around the world — including the global automotive industry — suggests that modular design is fast becoming the new *dominant logic* (Prahalad and Bettis, 1986) for creating products of all kinds.

The potential for modular architectures to proliferate a broad spectrum of product variety at low cost suggests that the essential strategic inputs from marketing research to an AMMS modular development process are significantly different from those used in conventional development processes. As suggested in **Figure 1 (b)**, rather than receiving from marketing a list of mean-value point targets thought to be most attractive in some market segments the firm might serve, a modular development process needs to know the *range of market preferences* that exist in a target market or market segment, so that developers will understand the range of product variations it would be desirable to be able to leverage from a new modular architecture. The key product strategy input to a modular development process is therefore the *variance in the distribution of market preferences* that a modular architecture could potentially serve, not just the mean-values in the distribution of preferences.

Defining the range of product variety a new architecture will be developed to provide to a market is an inherently more strategic task — i.e., a task that calls for greater direct involvement of senior management — than simply having a marketing function provide developers with a list of point targets for some new products. In effect, deciding to create a modular architecture is equivalent to deciding that a firm will base its near- to mid-term market strategies on the ability of a new modular architecture to produce a certain range of product variations and upgrades. Senior managers therefore need to fully understand the range of new products that a new modular architecture could potentially provide, because the range of new product variations that can be leveraged from the modular architecture will determine the *strategic options* the firm will have for competing in its targeted markets (Sanchez, 1991; Sanchez and Mahoney, 1996; Baldwin and Clark, 2000).

Along with the need to provide new kinds of marketing inputs into an AMMS development process, a further challenge to senior managers often arises from the need for *both* technical and commercial managers to understand how much product variety and upgrading it is technically possible to "design into" a new modular architecture. Therefore implementing AMMS calls for a much more *intensive dialogue* between technical experts and senior managers (usually at the business unit and/or product line management level) in defining a firm's new modular architectures than typically occurs in defining specific new products to be

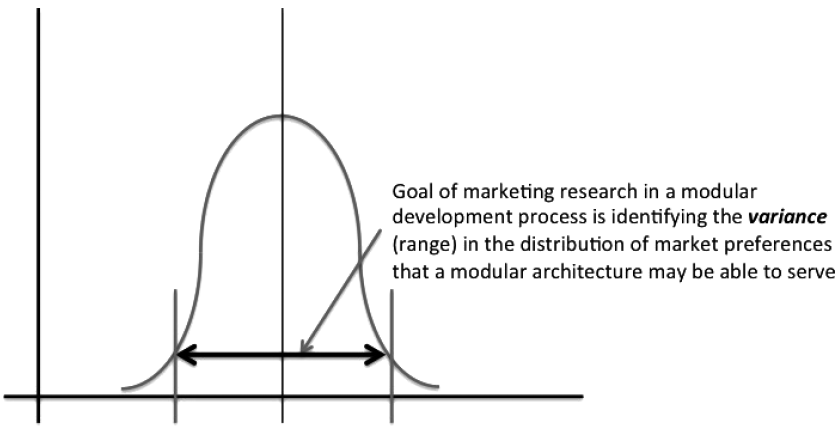

Figure 1 (b). Input from Marketing in Modular Development

developed through conventional development methods.

2.2.2 Modular development process

Although some firms have developed their own heuristic approaches to optimizing the strategic flexibility of a modular architecture, theoretically rigorous and practically implementable methodologies for optimizing modular architectures have not yet been developed or published in the management literature. Moreover, although considerable progress has been made in using options pricing models to determine the value of the product variations that can be derived from a modular architecture (Sanchez 1991; Baldwin and Clark 2000), a major impediment to development of well-specified methods for optimizing a modular architecture is a general lack of *appropriate costing systems* for modular architectures.

For single product designs, relatively accurate "out of pocket" cost information may be obtained from bills of materials, production cost schedules, and the like. In the case of modular architectures, however, new kinds of "system-wide and forward-looking" costing systems are required to capture the full economic impacts that use of such architectures would have on a firm. Such costing systems must be able to calculate, for example, cost reductions that *could be achieved system-wide* through greater use of common components across a firm's current products and/or that *could be achieved in the future* through re-use of components in future generation architectures. In effect, the economic concept of *opportunity costs* must become a central feature in any cost analyses for optimizing modular architectures, because in order to determine the optimal extent of common or re-usable components to be used in a new architecture, the expected out-of-pocket costs (and benefits) of creating and using common components and re-usable components must be compared to the opportunity costs of *not* using common and re-usable components in the architecture.

Despite the lack of rigorous, opportunity-cost based costing systems for optimizing architectures, however, the experience of the author in implementing AMMS with companies in many different markets and industries has been that the cost savings available through use of common and re-usable components are usually so great (i.e., "order of magnitude" effects) that sound economic decisions can often be made without developing detailed cost calculations.

As for the technical challenges in creating and optimizing modular architectures, the author's experience has been that creating architectures with substantial flexibilities to configure new product variations and upgrades is not nearly as technically challenging as one might imagine. Indeed, the author's experience with firms in various industries, including the automotive industry, would suggest that the real challenge in implementing AMMS is not technical, but rather resides in the need to change deeply ingrained human and organizational behaviors among development engineers who are accustomed to working in a conventional development environment. A critical first step in such a change process is to clearly communicate to a firm's development engineers that the traditional optimization objectives and methods they have been used to using are now changing — in fact, changing quite profoundly — to a new process whose objective is substantially increasing a firm's market coverage through use of configurable modular architectures. Once that change imperative is clearly understood and accepted by development engineers, the transformation from their familiar process of creating peak designs to the creation of strategically flexible, readily configurable modular architectures can begin.

The author's experience in working with engineering design and development groups to effect this transformation has almost always been that most development staff are re-invigorated technically and professionally by the transformation to modular development processes, and that they often produce surprisingly good modular architectures even on first effort.

That said, there is a learning curve to be mastered in using a new process of any kind, and AMMS is no exception. In the short run, the competitive advantages an organization will obtain from an AMMS process will depend on all participants in and managers of the development process having a full and correct understanding of how the AMMS process works, and then on the commitment of the people in the process to making the new process work. In the long run, the competitive advantages an organization can obtain from AMMS will depend on the personal commitment and technical skills its employees and managers bring to continuous improvement of their AMMS development process, as would be the case in any new process. As a firm's industry "goes modular" and other firms begin to implement AMMS, competition in "modular markets" will be based in important part on which firm can "learn its way" most rapidly down the AMMS learning curve. (See **Example #1**.)

Example #1: Interface specifications in the Smart car development process

The objectives set by Daimler management for the development of the Smart car were twofold: (i) create a new kind of trendy, environmentally friendly urban car that would attract a younger customer group than the firm's current customers for its Mercedes luxury automobiles; and (ii) create a modular vehicle architecture that could serve as a platform for coordinating the concurrent, distributed development processes carried out by a dozen or so suppliers who would become long-term development and production "partners" in the Smart car project.

A study of the Smart development process by Stephan, Pfaffmann, and Sanchez (2008) documents that considerable effort was devoted to strategically partitioning the Smart vehicle architecture into subsystems and components that could be developed by participating developer-suppliers. However, less attention was paid to fully identifying and specifying the interfaces between the defined sub-systems and components to be developed. As a result, some interfaces were either overlooked or were not adequately specified. As the first Smart cars began to move through the new Smart Just-In-Time (JIT) production facility, not all the subsystems and components could "plug and play" in the vehicles as they were being assembled. The overlooked and inadequately specified interfaces were quickly determined to be the cause of the inability to assemble the vehicle as planned.

After an urgent review of the vehicle architecture to fully identify and specify all interfaces, the highly synchronized JIT assembly process for the Smart car could be carried out as originally intended. Smart developers learned (in this case, the hard way) how fundamentally important fully specifying all component interfaces is in enabling both concurrent component development and JIT assembly.

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3. Changes in organization processes, structure, and culture when implementing AMMS

This section explains the most important of the considerable changes in organization processes and structure that a firm must undergo in order to implement AMMS processes effectively at the working level. We consider in particular the changes in processes and structures required by the "new rules and new roles" of an AMMS development process (Sanchez 2000). We then consider how the high definition and discipline required to carry out AMMS effectively may also call for changes in a firm's culture.

3.1 Changes in organization processes — The "new rules"

Effectively implementing AMMS requires a much higher level of technical definition and organizational discipline than is usually found in firms using conventional product development methods, especially with regard to the "fast cycle" approach to using AMMS. We consider each of these process changes in turn.

3.1.1 Greater technical definition

The higher level of technical definition required by AMMS principally derives from the need to *fully specify all component interfaces* in a new architecture as the first step in a modular development process.

In the conventional approach to developing products, interface specifications are often only described in general terms at the beginning of a development process, and then are allowed to evolve as development proceeds. Typically, all component interfaces may only be fully specified as a last step in a conventional development process. An AMMS process for developing a modular product architecture, however, begins with the *full technical specification and standardization* (*freezing*) *of all component interfaces*.[2] Fully specifying component interfaces at the beginning of a development process (immediately after the "strategic partitioning" of an architecture into functional components) creates several strategically important advantages in an AMMS development process.

First, fully specifying and freezing component interfaces as the first step in developing a modular architecture creates a *stable technical structure* for and *embedded coordination* of the development processes for the subsystems and/or components that will be needed in the architecture. The stable technical environment of the architecture enables all subsystems and components to be developed concurrently, thereby radically shortening overall development time (Sanchez and Mahoney, 1996).

Second, fully specifying interfaces in a new modular architecture and making sure that the interface specifications are readily available to all developers constitutes a key first step in making the technical knowledge of developers in the organization visible and documented, so that their knowledge can be categorized, tested, improved, and shared within the organization. In many organizations, developers carefully guard their technical knowledge and are not in the habit of explaining their interface specifications or their presumed technical knowledge to other developers. Because an AMMS process is based on the principle that "interface specifications belong to the organization, not to individuals or component development groups," that behavior is simply not allowed in AMMS. (See **Example #2**.)

Third, fully specifying component interfaces at the beginning of a modular development process creates a very useful benchmark for assessing an organization's overall technical expertise in creating new architectures. When interfaces are fully defined and made visible at the beginning of development, if one or more interfaces are subsequently found to be inadequate or otherwise flawed during development, the organization has a clear and unambiguous signal that it needs to improve its expertise with respect to those interfaces and the components they interconnect. The AMMS discipline of fully specifying and standardizing interface specifications at the beginning of development thereby provides a means for both managers and technical staff to judge the strengths and weaknesses of the firm's technical knowledge in designing reliable products — and to do so much more accurately than when interfaces are merely described and allowed to change during a conventional development process.

2) In Chrysler's "platform" (modular architecture)development process, once interfaces are frozen in the development process, they are referred to a "hard points," because they are not allowed to change from that time forward.

Finally, when the interface specifications for a new architecture have been set, firms should also document and archive not just *what* interfaces have been specified, but also *why* the interfaces have been specified as they have. When product failures occur, the ability to "drill down" into the reasons behind a product design's interface specifications often helps to identify inadequate areas of knowledge that may have led to a product failure. Forensic analysis of product failures that can access not only the interface specifications for the product, but also clear explanations of why each interface was specified in a given way, usually enables identification of what needs to be added or improved in one or more interface specifications. Thus, full specification and archiving of interfaces and the rationales behind each interface can create a knowledge management process with enormous potential for identifying and improving a firm's technical knowledge used in creating reliable product designs.

Example #2: Interface specifications belong to the organization

The importance of the principle that "the interface specifications in an architecture belong to the organization, not to individuals or component development groups" can be illustrated by the experience of a European automotive company that will remain unnamed.

Like many car makers in the late 1990s and early 2000s, this firm faced the technological challenge of converting much of its vehicle architectures from electromechanical controls to microprocessor-based control systems. As growing numbers of microprocessors were introduced into its vehicle architectures, the firm clearly needed to define an electronic vehicle architecture (EVA) that would assure that all interfaces between microprocessors throughout the vehicle were compatible, so that the many microprocessors in the vehicle architecture would work together seamlessly. However, the firm encountered strong resistance to defining an EVA from its mechanical component and subsystem development groups, who claimed that they "owned" the microprocessors and interfaces used in their subsystem designs — and therefore that they had the right to define, design, and optimize the microprocessors for use in their respective subsystems and components. As a result, electronic interface specifications used in some development groups were only partially (and grudgingly) revealed to other development groups, even though in many cases all components and subsystems needed to work together seamlessly.

The firm's senior managers did not succeed in persuading or forcing some of the most influential and politically powerful development groups to fully reveal and coordinate their microprocessor interfaces with those of other development groups in order to create a coherent EVA. The result was that the firm's top-end vehicle line was put into production without adequate EVA coordination of microprocessor interfaces. Subsequently, widespread electronic failures immobilized thousands of vehicles and left many customers stranded in expensive vehicles that would not run. These failures of the firm's top-end vehicles ultimately cost the company substantial recall and replacement costs — and considerable loss of reputation for vehicle quality.

3.1.2 Greater organizational discipline

Perhaps the most critical aspect of an AMMS development process is the need for absolute organizational discipline in adhering to three principles of modular development processes:

(i) Strategic partitioning of components and fully specifying interfaces are always the first steps in a development process.

(ii) Interfaces must be specified to support a well-defined and clearly prioritized set of strategic objectives for each new architecture.

(iii) Once interfaces are fully specified, they must be standardized (frozen) to provide a stable technical environment and "embedded coordination" for concurrent component development processes (Sanchez and Mahoney, 1996).

In a conventional development process, the partitioning and interface specifications for a new product may change during development, as may the goals for the product and the technologies to be used in the products. As a result, when an organization converts to AMMS, adhering to the three strict modular development rules mentioned above is very likely to require forms and levels of organizational discipline that are quite unfamiliar to the organization's developers. Some developers may understand the benefits that such discipline can bring to the organization and support the new level of required discipline in development, but some developers may not be happy about adhering to a much higher level of discipline in development processes.

In fact, in many firms, developers — especially the most technically competent ones — are often given a great deal of freedom in developing new component designs. In such cases, many developers have come to enjoy their relative autonomy and may be jealously protective of their freedom to design components and make interface changes as they wish. In an AMMS development process, however, there are no privileged prima donnas and no independent technical fiefdoms. Everyone must adhere to the essential disciplines of fully specifying and freezing interfaces at the beginning of the development process, and of documenting the assumptions and methodologies used to create all interface specifications for each component in every architecture.

Just as important, developers must understand and accept that any change in component types or interface specification represents a change in architecture — and that such changes can only be made when senior management has made a strategic decision that a new architecture is needed to meet evolving market opportunities, technology possibilities, and/or competitive pressures. Thus, once interfaces are specified and frozen, developers are simply not allowed to make further changes to interface specifications, because doing so would almost certainly disrupt the concurrent development of components by developers relying on standardized interface specifications.

These two critical forms of organizational discipline required to sustain an AMMS development process — fully specifying and explaining interfaces at the beginning of a development process, and then freezing the interface specifications for the architecture — may seem like minor changes to senior managers, but they are very likely to be seen as very significant and unwelcome changes by developers accustomed to conventional development processes. Senior managers may even be presented with arguments by developers that fully specifying interfaces as a first step in development is "just not technically possible." Managers should understand that such self-serving claims are clearly contradicted by the success of many firms in implementing AMMS in all kinds of industries, and should be unambiguously rejected by managers. In organizational change processes, "carrots are preferred to sticks," but if necessary, senior managers must simply insist that developers accept and respect the new rules of an AMMS development process, or they will not be allowed to participate in the firm's modular development process. (See **Example #3**.)

Example #3: Claims of technical infeasibility in fully specifying interfaces

In the early 2000s, the senior managers of a well-reputed European auto maker (that will remain unnamed) realized that the high costs and long development cycles of the firm's conventional product development process were causing the firm's models to lag behind current market trends and to incur high development costs that increasingly rendered the firm's products unattractive and unprofitable. Senior managers decided to convert the firm to modular platform development to reduce both time to market and development costs.

However, this decision was strongly opposed by the firm's developers, who liked the familiar "peak design" processes and relatively low-discipline environment of the firm's conventional development process. Although management insisted that all new models had to be developed within modular platforms capable of leveraging several models and a broad range of vehicle options, development staff were able to persuade senior managers that "cars are just too complex to be able to fully define interfaces at the beginning of development." Unfortunately, management accepted this claim at face value and allowed the firm's "modular" development process to move forward with only general descriptions of interfaces in the vehicle architecture rather than full interface specifications.

The consequence was unfortunate, but wholly predictable. Various models developed within the firm's "modular" architecture ended up having differences in their component interfaces, even though all components conformed to the general description of interfaces used to develop the architecture. Many components that were supposed to be common components to be used in all models leveraged from the "modular" platform architecture would not "plug and play" in the vehicle architecture because of interface differences that were only discovered as new models were introduced into the assembly line.

The outcome of this debacle, however, was that the firm's senior managers accepted the claim by the firm's developers that "modularity can't work in developing automobiles — they are just too complex." Subsequently, other automotive firms that did successfully implement modular development methods began to introduce growing numbers of competitively-priced models that greatly diminished the firm's market share and eventually put the firm into deep financial crisis.

3.1.3 The "fast-cycle" approach to using AMMS

A "fast-cycle" development process is the heart of the AMMS engine that drives a firm's ability to compete on speed-to-market. Implementing and sustaining a fast-cycle development process requires absolute discipline in following the new rules for modular development processes.

Changes in product specifications and technology choices after a development project has started are common in a conventional development process and are often motivated by managers' desire to assure that the products a firm has under development can match the features and performance levels of the latest products offered by competitors. However, this well-intended desire of management to speed the latest "bells and whistles" to market by adding them mid-way through a development project usually produces the opposite result. Interrupting a development process to include new features offered by competitors often seriously disrupts a development process and may extend substantially the time required to bring products currently under development to market.

By contrast, the modular development process uses the *fast-cycle development strategy* for making sure that a firm's new products are market-leading or at least competitive in their functions, features, and performance levels. In the fast-cycle approach, instead of allowing product specifications or technology choices to change during an AMMS development process, product specifications and technology choices are frozen at the beginning of each architecture development process. Using the speed of simultaneous component development enabled by the full specification and freezing of interfaces at the beginning of the process, an AMMS development process can often be completed in one-fifth to one-half the time required to complete a conventional development process

(Sanchez and Collins, 2001). In this way a firm may be able to "fast cycle" through developments of successive generations of new product architectures at a much faster rate than competitors who allow frequent changes to interrupt their conventional development processes (Sanchez, 2004).

3.2 Changes in organization structure — The "new roles"

Effectively implementing AMMS requires both a redefinition of the traditional roles found in conventional development, and the creation of key new roles that are essential to the effective functioning of AMMS development processes. We consider each in turn.

3.2.1 Changes in conventional development roles

We now consider how key marketing and development management roles will change when converting from conventional to AMMS development.

Marketing

In conventional development processes, the marketing function holds significant decision rights, since they usually specify the functions and performance levels to be delivered by a new product. In AMMS, however, the marketing function no longer exclusively decides what the performance specifications will be for newly developed products. Instead, decisions as to which new product variations to leverage from a modular architecture may be made by following a process of "real-time market research" in which the market is given a chance to "vote with its dollars" in selecting among many product variations the firm may leverage from a new modular architecture (Sanchez and Sudharshan 1993).

It is possible that marketing staff may see their new role in AMMS as a significant diminishment of their decision rights (which it is!) and will resist giving up their old role of "product deciders" — a role that may be largely transferred to the market itself in AMMS. A key objective in converting an organization to AMMS should therefore be to refocus the marketing staff on using the firm's new modular platforms to expand a firm's offerings to its markets and to build new after-purchase relationships with its customers through upgrades and other after-purchase product variations enabled by modular architectures (Sanchez, 1999). (See **Example #4**.)

Example #4: Using modular architectures to deepen customer relationships

In addition to providing a platform for coordinating development and production of the Smart car by a network of suppliers, the Smart car's modular architecture was conceived as a platform for deepening Daimler's relationship with its Smart customers. The deepening of the relationship begins by presenting Smart car customers with a broad range of choices of body panels, interior styles, and options that can all be "mass-customized" for each customer on Smart's flexible production line in Hambach, France. The use of a modular product architecture to mass-customize Smart cars to each customer's preferences helps Daimler to signal its strong customer orientation to the market.

After a customer buys a Smart car, the modular architecture is further used to offer customers opportunities to change the exterior panels of their Smart cars to new color combinations, or to retrofit options like tachometers and other interior features as their preferences (or budgets) evolve. In this sense, the Smart car's modular product architecture provides a platform for interactions with customers that enable Daimler to deepen and extend its relationships with Smart customers during and after purchase.

Product development management

In blunt terms, implementation of AMMS development processes will simply eliminate most of the development management roles found in conventional development processes. Moreover, the tasks to be performed by the relatively few development managers who will remain in an AMMS process will be greatly simplified. The reasons behind this radical change in development management roles are suggested in **Figures 2 (a) and 2 (b)**.

As shown in Figure 2 (a), a conventional development process often begins with limited senior management involvement, and then requires substantial "hands on" involvement by mid-level managers. The author's research and consulting experience suggests that a very substantial part of the work performed by development and mid-level managers in a conventional development process is *adjudicating interface issues*. Because interfaces are not fully specified or frozen during conventional

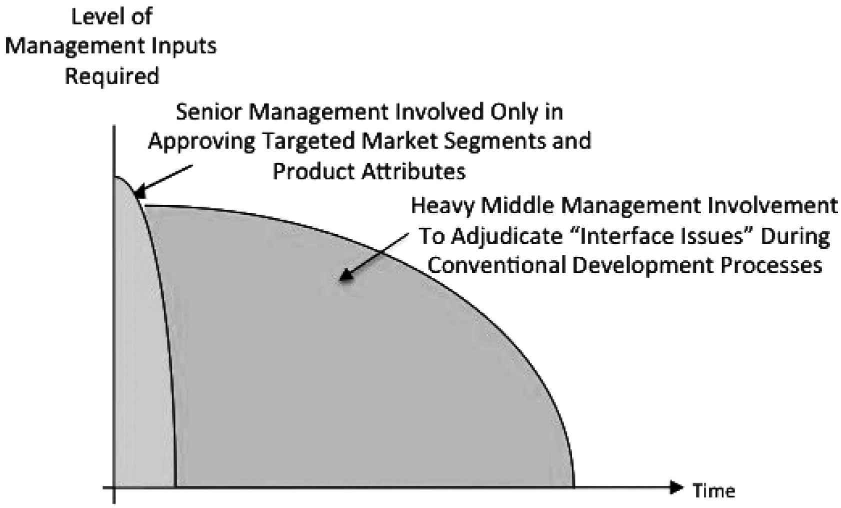

Figure 2 (a). Management Inputs in Conventional Product Development Process

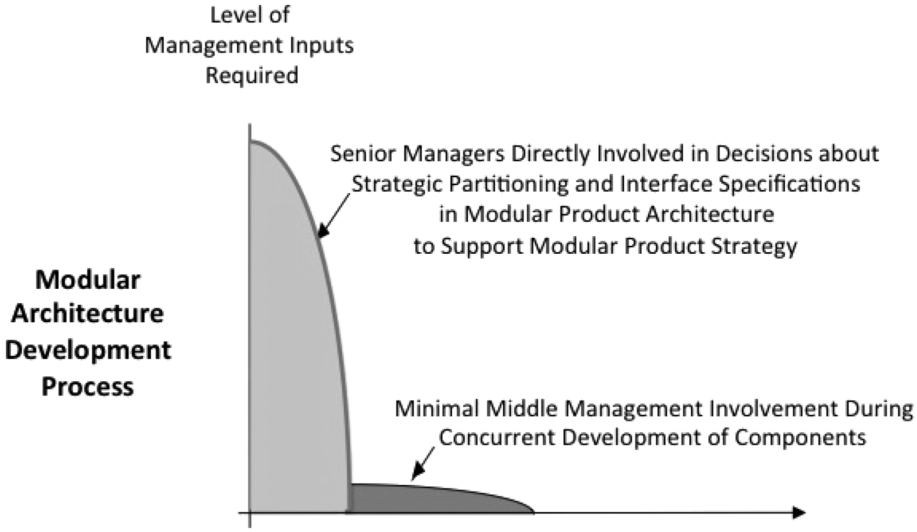

Figure 2 (b). Management Inputs in Modular Product Development Process

(Source: Ron Sanchez (2013). "Building real modularity competence in automotive design, development, production, and after-service," **13** (3), pp. 205–236, *International Journal of Automotive Technology and Management*.

development, various component development groups may make interface changes that are favorable to their component or development process, but that create technical difficulties for other component development groups. As different component development groups seek to make interface changes in an uncoordinated and often undisciplined way, conflict between component development groups over component interfaces is likely to become common.

Development managers may then be called on to make a number of difficult decisions. These include

(i) Which interface changes should be allowed?
(ii) Whose budgets should be charged (or performance evaluations affected) when an interface change sought by one component group would cause significant redesign work in another group?
(iii) What level of priority should be given to requested interface changes? For example, should a component development group that has gone on to another project stop the work they are now doing to rework their component design to accommodate a requested interface change from a project they are no longer working on?

Besides the difficult and time-consuming nature of making such decisions, there is also a risk that development managers may make poor decisions. Especially when a "heavyweight" development group comes into conflict with another influential component development group over an interface, there is a possibility that the decision needed to resolve the conflict will have to be escalated up the management hierarchy. Unfortunately, it is often the case that the higher a manager is in the management hierarchy, the less likely the manager is to be both technically qualified and adequately informed to make good decisions about specific conflicts in a given development process. Poor decisions often result.

As noted, a fundamental principle of AMMS development processes is that all interfaces are fully specified and frozen *before* development of components begins. As suggested in Figure 2 (b), one salutary consequence of disciplined adherence to this modular development principle is that interface conflicts during development essentially disappear, because once component development has begun, all component development groups are obliged to develop components that conform to the standardized interface specifications. In a modular development process, the work of development managers is largely focused on checking that the various development groups are on time and on budget. This minimal monitoring task can often be performed by a single development manager with responsibility for an entire architecture development project.

3.2.2 New roles in AMMS development processes

Implementation of AMMS requires the creation of some key new development roles. We next consider the new roles needed when development is undertaken within a single business unit, and then consider the need for additional new roles when a development process involves more than one business unit.

Product and process architects

If "coordination is the essence of organization" (Thompson 1967), then accurate and timely information is the essential input needed to achieve coordination and thus organization. In an AMMS process, the new roles of *product architect* and *component facilitators* perform the essential tasks of gathering, archiving, and distributing information about the interfaces used in a firm's architecture (s) and about the available components that can "plug and play" in a given architecture.

Note, however, that these new roles should be understood as coordinating and facilitating roles, not as management roles vested with decision rights. Because in AMMS the "interfaces belong to the organization" and not to component development groups, decisions affecting the components and interfaces of an architecture must involve and be approved by senior managers. Once interface decisions are made and confirmed at the senior management level, component facilitators must make sure that the interface specifications for their component are kept up to date for each architecture the business uses and are readily available to all development groups. They must also maintain an up-to-date library of all component variations that are known to "plug and play" reliably in the various architectures used by the business.

The product architect for a given architecture is then responsible for making sure that all the information about interfaces and available components provided by component facilitators is correct and up to date for the architecture for which he or she is responsible.

In addition, an effective AMMS development process will also need to have *process architects,* who are responsible for maintaining correct definitions and descriptions of the process capabilities available to a firm in realizing the products to be leveraged from its product architectures. When a firm is using modular architectures capable of leveraging a range of product variations, the key information about processes that process architects must provide is *descriptions of the flexibilities of the processes* the firm can use to realize its products. Most critically, process architects must make available clear statements of the *range of variations in inputs* and *the range of variations in outputs* that each process the firm can use is capable of accepting and providing. Having this information available to all developers of a new product architecture can bring two important benefits: (i) to assure that a firm will be able to produce and support all product variations that it leverages from a given architecture; and (ii) to identify any new process capabilities the firm may need to develop or access in order to produce and support products that can be leveraged from a new product architecture under development.

Architecture coordinating committees

Deciding what kind of architecture a business unit will develop is a challenging strategic task. This challenge is significantly amplified when one business unit tries to develop a new architecture that will be developed and used in conjunction with other business units. Arriving at decisions about architectures that will be used by multiple business units requires detailed consideration of each business unit's current and future product strategies. To fulfill this key deliberative function, an *architecture coordinating committee* should be established for each architecture that will be used by more than one business unit.

The coordinating committee for a given architecture must then decide the *strategic partitioning* (Sanchez 2014) of and the component interfaces to be used in an architecture that can best serve the strategic interests of the cooperating business units. The essential decisions about a shared product architecture are

- which parts of its architecture will be used in common by all business units using the architecture (i.e., the *common components* to be used by all or most of the business units);
- which parts of the architecture can be targeted for re-use in future generation architectures (the *re-usable components*);
- which parts of the architecture will be used by each business unit to create product variations and upgrades for its own business unit (the *variety-enhancing or differentiating components*);
- what interface specifications will best support the kinds of components and objectives defined above.

Similarly, the architecture coordinating committee should review the process architectures available to each business unit to decide (i) which process capabilities available to one business unit could be used in common with some or all of the cooperating business units to obtain cost or performance advantages, and (ii) which process capabilities will only be used by individual business units to support their individual product variations and upgrades.

3.3 Changes in organization culture

The foregoing changes in organizational process rules and roles imply much more than technical changes in the way an organization works. In many if not most cases, converting an organization to AMMS requires nothing less than a transformation of an organization's culture.

We draw on the field of anthropology (the study of human cultures) to define *culture* as a set of deep values and associated norms of behavior that characterize a given social setting (Sanchez and Heene, 2004). Like culture in other kinds social settings, cultures in organizations reflect the deep values of people in the organization — by which we mean the *actual values in use* in an organization, not the *espoused values* prepared for public consumption and typically presented in nice "Corporate Values" statements (Argyris, 1976). Norms of behavior in an organization are expressed as characteristic ways of dealing with people and issues — the "corporate behaviors" that people come to expect from individuals in a given organization.

Implementing AMMS may deeply challenge the established culture of most organizations. Some of the most likely ways in which organizations may be challenged are summarized below.

From atomistic to coordinated action

A well-known consequence of adopting both "profit center" and "cost center" approaches to evaluating the performance of units in an organization is that managers who are only responsible for their own bottom line have no incentive to cooperate and coordinate with other business units in the organization if doing so would not directly contribute to their own bottom line. In such cases, managers' only incentive is to support activities that bring a direct net benefit to their business unit — no matter what benefits other activities could bring to other business units and the overall organization. As a result, the pervasive demand for and focus on "bottom-line performance" in businesses today has led managers with bottom-line responsibilities to adopt a very narrowly focused "atomistic" view of their work with little or no concern for the potential value to the overall organization that may sometimes be derived from cooperation among business units.

In addition, some managers may engage in "empire building" or other territorial behaviors and may resist any efforts to coordinate the work of their unit with the efforts of other units in the organization. When managers seek to create a fiefdom in the part of the organization they are managing — a component development group, for example — they may refuse to cooperate with other units in finding architectural solutions that are in the best interest of the overall organization.

As the discussion in Section 4 of this paper will suggest, both forms of atomistic thinking and behavior can undermine the effective implementation of AMMS. Getting the greatest benefit from AMMS through cooperation among multiple business units therefore requires a re-orientation of business unit managers from a reliance on "atomistic" thinking and action undertaken wholly within their own business units to a strong interest in engaging in coordinated development with other business units. In effect, implementing AMMS requires creating a new organizational culture (supported by new kinds of incentives) in which cooperative, collaborative action within and across business units is seen by managers as the best means to achieve both the best collective outcomes for the organization and the best individual outcomes for business units and their managers.

From secrecy to open information

The truism "information is power" explains much common but unhelpful corporate behavior in which people actively seek to keep important information secret in order to gain influence within corporate hierarchies. Implementing AMMS, however, requires the creation of an organizational culture in which people readily and proactively share information about market opportunities and technology possibilities, so that more opportunities for profitable collaborative action can be discovered and exploited to the benefit of the whole organization.

For example, one advanced AMMS organization has instituted an "open information environment" in which all information not restricted by law (privacy laws, for example) or specific company policy (which is very limited) is available to anyone in the organization (Sanchez and Collins, 2001). The free sharing of information about markets, technologies, and other factors within the organization has created a highly successful process for discovering new commercial opportunities and technological possibilities that has consistently brought significant growth both to the firm's top line and to its bottom-line profits.

Once a firm has an AMMS capability, creating an open information environment within the firm can enable the firm to discover more opportunities to use its new "rapid sense and respond" development capability (Haeckel, 1995) to identify and exploit new growth and profit opportunities.

From risk-avoidance to risk-taking

Large and long-established firms tend to become focused on conserving current value rather than creating new value. As a result, over time they tend to attract senior managers who are risk-averse to varying degrees and who are content to focus on the conservation of existing value rather than the creation of new value. Although AMMS can certainly be used to pursue a value conservation strategy (for example, by providing products intended to defend existing market shares), the greater potential and more common use of AMMS is to create new platforms for achieving new levels of value creation in existing or new markets.

Effectively implementing and using AMMS to create and capture new value, however, may require a significant change in the risk attitudes of a firm's current management. Especially if an organization has gone though a significant period of low to moderate growth or of just "holding steady," there is a possibility that many of the firm's managers have "self-selected" into the firm because they like the stability, security, and low-challenge environment of the conservative management process in the firm.

If that is the case, the firm is unlikely to actually make a successful transition from conventional product strategies and development processes to AMMS — simply because the significant organizational change required to make this transition is likely to be seen by its managers as too challenging and risky. If a conversion to AMMS does begin, there is a likelihood that risk-averse managers will limit the strategic objectives for AMMS to very modest and ultimately inadequate goals for organizational change. Thus, both to implement AMMS successfully and to get the greatest benefit from a firm's new AMMS capability, the culture of a firm may need to be shifted by being "repopulated" with managers who are more open to taking on challenges and managing risks and by introducing new incentives to encourage and reward such behaviors (see Section 4).

4. Essential understanding and leadership roles for senior managers

This section draws on the two preceding sections to identify the essential understanding that senior managers must have about AMMS and the essential leadership roles that they must fulfill in order to prepare their organizations for successful implementation of AMMS.

It is important to recall that only in the mid-1990s did management researchers and some firms begin to realize the potential for systematic, strategic uses of architecture and modularity concepts in managing product creation processes and in carrying out new (and previously unimaginable) product strategies. Even today, although awareness continues to grow, relatively few management researchers and practitioners fully grasp the full strategic potential of AMMS — and the organizational capabilities needed to make AMMS work well.

This author's experience with numerous organizations suggests that inadequate and even erroneous understanding of AMMS by senior managers, development managers, and technical staff remains quite common — and simple lack of understanding is likely to be the leading factor limiting an organization's ability to implement and use AMMS effectively. For example, many managers still regard AMMS as simply a technical design concern and fail to understand the extensive transformations that AMMS would bring to a firm's strategies, management processes, and organization structures. As a result, relatively few senior managers fully grasp the essential roles that they must play in leading an AMMS implementation process.

We now consider several key points of understanding that senior managers must have and the related leadership roles they must be willing to undertake in order to implement AMMS effectively and use AMMS to greatest strategic effect.

4.1 Implementing AMMS requires a systemic transformation

Many of the organizational aspects of AMMS discussed in this paper are interrelated and thus often closely interdependent — but that is to be expected when discussing the features of a new *system*. Senior managers must first and foremost understand that the effective implementation of AMMS will require a *systemic transformation* of their organization's product strategies and supporting development processes. As with any other transformative process, implementation of AMMS will require deep changes "in the ways an organization thinks and acts" (Sanchez and Heene, 2004: 116–118). Tentative, partial, or half-hearted efforts to implement AMMS will not work. Many — perhaps even most — of an organization's processes, structures, and culture related to product strategies and product creation will probably need to be retooled, usually extensively.

Managers therefore need to understand that AMMS is a *new system* for creating products and carrying out market strategies, and that either they must have the understanding and courage to put the whole AMMS system in place, or they would probably be better off just to stick with a conventional development process. (However, the latter option comes at the risk of being attacked by competitors whose managers do succeed in implementing an AMMS system successfully).

4.2 A systemic transformation to AMMS will pose risks

Systemic organizational change will always face a range of potential risks. Not least among those risks is likely to be the risk that people perceive in simply shifting from the familiar to the unfamiliar — in this case, from familiar (though relatively ineffective) product strategies and development processes to very different kinds of modular product strategies and development processes. In addition, there will also be risks that will be specific to an organization (e.g., Can certain key development people be persuaded to support the transformation?) and to its markets (e.g., How much competitive advantage can we gain by using modular strategies?).

Senior managers must understand that some real risks are involved in implementing AMMS — and then they must be willing to take ownership of those risks in leading organizational change processes and in finding ways to manage risks. Leading an organization into the new world of AMMS can bring an organization significant strategic benefits, but those benefits are unlikely to be achieved by risk-averse or faint-hearted managers.

4.3 Senior managers have an essential direct support role to play

Because implementing AMMS is a systemic transformation of an organization and not just an organizational “fine-tuning” process, managerial responsibility for leading the implementation of AMMS cannot be delegated to mid- or lower-level managers. Implementing AMMS will require that senior managers take a very active, directly involved, fully informed, and visibly committed role in making this major organizational transformation happen. Moreover, senior managers will need to make available the organizational resources needed to start and sustain a transformation process that may well take 2–3 years or more to accomplish. The most important of these resources in any organization — and the most critical resources in converting an organization to AMMS — are senior managers’ time, informed attention, close support, and personal courage to provide leadership.

4.4 New capabilities must be built in the organization

Sanchez and Heene (2004, pp. 2–8) describe the role of strategic managers as “designers of organizations as systems for sustainable value creation and value distribution.” In performing their role as system designers of their organizations, strategic managers must be prepared to identify, invest in, and develop the new capabilities needed to make an AMMS system work effectively.

While some new engineering and technical capabilities may be needed to implement AMMS in a given organization, the author’s experience with many firms suggests that the critical new capabilities most likely to be needed will be *process-based managerial and organizational capabilities*, such as creating an efficient, properly incentivized managerial decision-making process through which managers will identify and agree on common development goals for shared new architectures. In particular, senior managers must understand that obtaining long-term competitive advantages from AMMS will depend heavily on adopting new organizational and managerial performance measures and incentives to motivate fast collaborative action in defining, developing, and deploying new architectures.

As always, senior managers have an essential leadership role to play in building new organizational competences and processes — especially so in building the new managerial and organizational processes and capabilities required to implement AMMS (see Section 5).

4.5 Senior managers must become directly involved in architectural decisions

In conventional development processes, senior managers at the business unit level are usually not involved in discussions of the technical structure or interface specifications of a product design, because such discussions would only concern a single product and therefore are usually not of broad strategic importance to a firm.

When a firm implements AMMS, however, the strategic partitioning and interface specifications used in each architecture will fundamentally determine the extent to which product variations and upgrades can be configured within a modular architecture, as well as the overall cost basis and time-to-market requirements for the architecture. Therefore senior managers, marketing staff, and technical developers must jointly consider the strategic implications of alternative technically feasible approaches to the strategic partitioning and interface specifications for a new architecture.

Substantial senior management participation at the business unit level will be required to define clear strategic goals and priorities for each new product architecture, and then to confirm with technical staff that the interface specifications adopted for an architecture will support the configuring of the strategically desired range of product variations and upgrades intended to serve those goals. If technical constraints in strategic partitioning or creating interfaces require that trade-offs have to be made between cost and performance goals for the architecture, the strategic implications of those trade-offs must be understood and assessed by senior managers.

An on-going leadership role for senior managers is therefore being actively involved in assessing and selecting the strategic partitioning and interface specifications for each new architecture at the beginning of an AMMS development process. (See **Example #5**.)

Example #5: Active senior management involvement in Volkswagen's platform strategy

A key reason for the success of Volkswagen's much heralded modular platform strategy is the ongoing, close involvement of Volkswagen's senior managers in modular platform decisions in the company. Although the active participation of senior managers in platform decisions is no doubt facilitated by the deep technical backgrounds of Volkswagen's senior managers, Volkswagen's senior managers have always regarded platform decisions as vital strategic decisions that determine the strategic options available to the firm to serve market opportunities in the future. As a result, platform specifications and derived projections of potential market coverage available form a platform are routinely reviewed and approved at the senior management level before being sent to platform managers for development.

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5. Two fundamental approaches to implementing AMMS

Initiating systemic change in an organization calls for concerted organizational analysis of the changes to be made and careful thought about how best to manage essential organization change processes. This section elaborates two fundamental approaches to managing organizations, including organizations that need to undergo significant change in order to implement AMMS. We explain and compare the two approaches, which we refer to as the "programmatic" *versus* "incentives" approaches. We also explain and compare two fundamentally different kinds of leadership roles that management may provide to an organization, which we refer to as "personal" *versus* "institutional" leadership roles. We then consider how each of these leadership roles relates to programmatic approaches or incentives approaches to managing. We also consider the characteristics of a firm's business environment that are likely to determine which kind of management approach and leadership role is likely to be most effective in managing the conversion of a firm to AMMS.

5.1 Two management approaches

Once the strategic goals for a firm are decided, there are two fundamentally different approaches that senior managers can take to managing the processes that must be undertaken to achieve the firm's strategic goals.

5.1.1 The programmatic approach

In what we will refer to as the *programmatic approach* to managing a firm, senior managers take a very "hands-on" approach and directly manage the processes to be undertaken by the firm. Senior managers (perhaps working with various experts) define in detail — i.e., "program" — how each process in the firm is supposed to work, and then define detailed process measures intended to tell them whether all steps in each process are working correctly (i.e., as designed). When the process measures indicate that some step in a process is not working as intended, senior managers intervene directly to figure out why the process is not working as intended and to take corrective measures to bring the process back within an acceptable range in its process measures.[3)]

3) In the programmatic approach to managing, the management processes of monitoring intermediate process measures and directly intervening to correct deviations from expected process measures is sometimes called "managing by exceptions."

5.1.2 The incentives approach

In the incentives approach, senior managers take a more "hands-off" approach to managing the processes to be undertaken by the firm. Senior managers *define the desired outputs from each process* the firm undertakes, and then empower employees and provide the infrastructure and other resources required for employees to achieve the objective (s) defined for each process. Instead of defining detailed process measures intended to signal whether all steps in each process are working as expected, senior managers (i) define output performance measures for each process, (ii) empower process managers and staff to monitor and manage the process they are responsible for, and (iii) design incentives (based on the defined output measures for each process) to motivate the managers and staff who will have responsibility for running a process to maintain high output performance (Sanchez and Heene, 2004).

The incentive system defined by senior managers should reward process managers and staff for delivering good output performance, and may also provide various sanctions for failing to maintain high performance. When the output performance measures are not met, rather than intervening directly to try to correct a process themselves, senior managers offer technical or other support to help process managers and staff determine how to restore good performance to the process. Although responsibility for the performance of the overall organization always rests with senior managers, in the incentives approach to managing, direct responsibility for maintaining good performance in each process carried out within the organization is vested in the firm's process managers and staff.[4)]

5.2 Two kinds of leadership roles

There are two fundamentally different kinds of leadership that senior managers can try to provide to their organizations. These different kinds of leadership are characterized by Sanchez and Heene (2004: 206–208) as the "personal leadership" model and the "institutional leadership" model. As indicated in **Figure 3**, the two leadership models differ fundamentally in their assumptions about the roles that senior managers play in (i) defining the *vision* (strategy) for an organization and (ii) motivating the organization to take action to carry out the vision.

5.2.1 Personal leadership model

In the personal leadership model, the senior manager as leader is presumed to be the source of

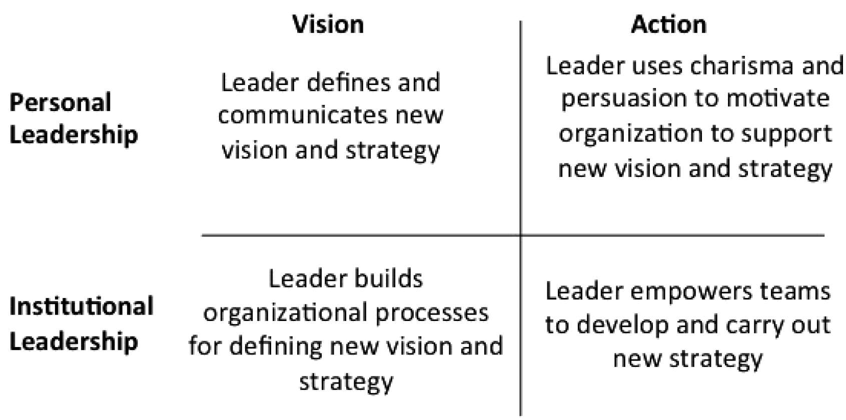

Figure 3. Two Models of Leadership

(Source: Sanchez and Heene, 2004: p. 207)

4) In the incentives approach to managing, the managerial processes of defining and monitoring output measures and supporting process managers and staff in maintaining desired output performance is sometimes called "managing by objectives."

the vision for an organization. In providing the vision for the organization, senior managers are assumed to be capable of monitoring and interpreting trends in markets and technologies and of identifying the best strategic opportunities for the firm in the future. In motivating the organization to pursue the vision, senior managers are assumed to be charismatic enough to be able to persuade people in the organization to accept and pursue the vision that senior managers have articulated.

The personal leadership model has long been the dominant model of leadership communicated to managers in articles and books, as well as in management education and consulting. Although this model of leadership may be possible in organizational contexts with fairly simple and stable environments, questions have been raised about the actual cognitive feasibility of such a model, especially in environments with complex and changing markets and technologies (Sanchez and Heene 2004: 206–208). Moreover, with more and more firms taking on the characteristics of knowledge-based enterprises employing many knowledgeable people with deep understanding of markets and technologies, it seems unlikely that the senior managers of such firms will always be the best sources of insights into market and technology trends and resulting future opportunities. Nevertheless, in the discussion below, we do suggest some business environments in which the personal leadership model may be feasible, at least to some extent.

5.2.2 Institutional leadership model

The institutional leadership model, originally articulated by Andrew van de Ven (1986), presents a very different model of leadership that is almost the opposite of the personal leadership model in basic respects. In the institutional leadership model, the senior manager is not presumed to be the only or even the best source of the strategic vision for an organization. On the contrary, instead of laboring to define his or her own vision for the organization, the senior manager creates institutional processes that involve many people in the organization in proposing ideas for the future of the organization, in debating and evaluating new ideas, and in selecting the best ideas for the future of the organization.

Once a consensus forms in the organization around the best new ideas people in the organization have been able to imagine for its future, senior managers do not have to try to use personal charisma to lead the organization to action. Rather, senior managers become the "servant of the organization" by empowering people to take action on the ideas they have helped to develop, by providing the resources that people in the organization will need to implement the new ideas, and by creating incentives that will motivate people and reward them for making the new ideas successful.

5.3 Different management approaches and leadership models for different kinds of business environments

We now consider some key characteristics of a firm's business environment that are likely to determine which kind of management approaches and leadership roles are likely to be most effective in managing the implementation of AMMS.

We broadly divide business environments — which include both internal and external environments of the firm — into high versus low *complexity* and high versus low *rates of change*, as shown in **Figure 4**.

5.3.1 Environments of low complexity and low rates of change

In environments of low complexity and change (example: a fast food business), programmatic approaches to managing a firm combined with the personal leadership role for senior managers may be effective, as well as cognitively feasible. Low complexity processes should be amenable to full definition by managers, and it should be possible to establish intermediate process measures to indicate

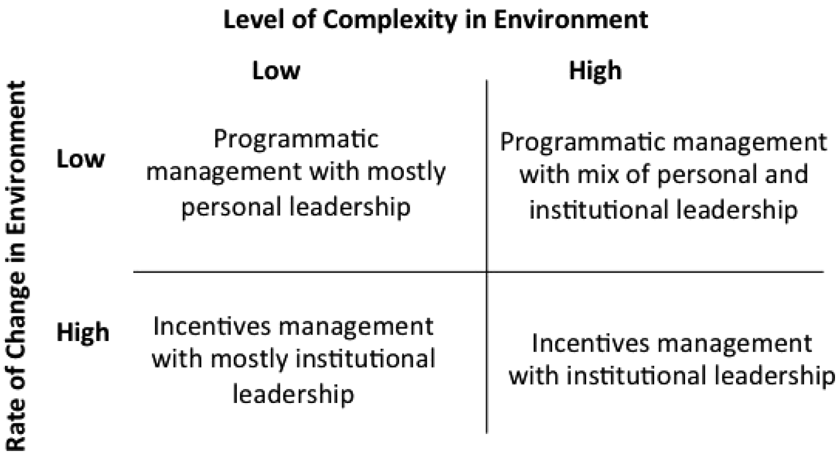

Figure 4. Alignment of Management Approach and Leadership Role with Environment of Firm

whether all processes are functioning as expected. As long as managers understand the simple processes of the firm, they should be able to intervene directly when a process needs correction.

When moderate strategic change is needed, senior managers who understand their firm's simple, stable markets and technologies may be able to identify the firm's best opportunities for the future and to personally motivate people to pursue the new vision. (That said, even in simple and stable environments, senior managers may find that many other people in the firm also have good ideas for the future of the organization.)

5.3.2 Environments of high complexity and low rates of change

In environments of high complexity but low rates of change (example: the airline industry), programmatic approaches to managing a firm may be technically feasible (and in the airline industry example may even be mandated by regulation). As long as managers are themselves technical experts with understanding of specific processes within the overall complex operations of the firm, they may be able to define processes and intermediate process measures, detect unacceptable deviations from intermediate process measures, and intervene directly when a process needs correction. In time, standard ways of intervening to correct various kinds of deviations may also be defined and implemented programmatically.

When moderate strategic change is needed, senior managers who are aware of their firm's complex but stable markets and technologies may be able to develop a new vision for the firm and to personally motivate people to accept and pursue the new vision. However, in complex market and technology environments, senior managers should always sustain a dialogue with the non-managerial market and technology experts in the firm to solicit their ideas about possible future opportunities for the firm.

5.3.3 Environments of low complexity but high rates of change

In environments of low complexity but high rates of change (example: fashion retailing), programmatic approaches to managing a firm may be technically feasible, and managers may be able to define process measures and to intervene directly to correct unacceptable deviations from process norms. In time, interventions to correct recurring kinds of process deviations may be possible to define and implement programmatically.

To manage frequent strategic change, however, senior managers alone are unlikely to be able to consistently provide the best new vision for the firm, and maintaining an open dialogue between senior managers and staff who are deeply involved in ongoing market and technology changes is likely to provide the best means of finding the best ideas for the future of the firm. Significant incentives should then be used to promote the generation and fast implementation of new ideas.

5.3.4 Environments of high complexity and high rates of change

In environments of high complexity and high rates of change (example: fast-moving consumer goods), programmatic approaches to managing a firm are likely to be either cognitively infeasible or prohibitively slow and costly to administer. Senior managers are likely to have no practicable alternative to managing by defining and monitoring output performance measures rather than intermediate process measures, by defining incentives for maintaining good output performance, and by empowering process managers and supporting them in maintaining good output performance.

To manage frequent strategic change in the firm's complex environment, senior managers should not presume that they can always provide the best new vision for the firm, but rather should institutionalize an on-going open dialogue between senior managers and all staff who are knowledgeable about changes in markets and technology. Once this dialogue identifies what appear to be the best ideas for the future of the firm, significant incentives should be used to motivate the implementation of new ideas for the future of the firm.

Conclusions

This discussion concludes with some suggestions for senior managers of firms who are interested in implementing AMMS, including firms' whose current AMMS implementation efforts are stalled, faltering, or not achieving their full potential. We do so by considering three likely causes of failures to implement AMMS effectively that senior managers in particular should be aware of.

Inadequate senior management understanding

Unfortunately, this author is aware of several firm initiatives to implement AMMS that were launched by senior mangers who liked the idea of having platforms for fast, flexible configuration of new products, but who really did not understand the profound strategic and organizational transformations that real implementation of AMMS would require of their organizations. In some cases, mid-level managers and technical staff were also unwilling — or were not given time — to educate themselves adequately about AMMS, and the firm's AMMS implementation efforts lost their way and stalled early in the change process. When it comes to AMMS, like any other process, "You can't manage well something that you really don't understand." Senior managers must therefore be willing to invest the time and attention required to fully grasp how AMMS works and to understand what a transformation to AMMS would mean for their organization.

One critical understanding that senior managers must have is that AMMS can have many possible strategic objectives — and thus may require different organizational forms, processes, and priorities to support the specific strategic objectives for a given architecture. Since the strategic objectives for AMMS are likely to vary significantly from industry to industry and from firm to firm according to the business environment each firm faces within its industry, senior managers should not make the mistake of thinking that they can simply imitate the successful AMMS strategies and processes used by another firm. Instead, senior managers must be willing and able to think deeply about the specific business environment their firm faces and about the specific priorities for AMMS that their firm's unique situation will require. In effect, in adopting AMMS strategies and processes, "one size does not fit all," and there is no substitute for the hard intellectual work to be done in defining the AMMS strategy and processes that can best serve each firm's particular business situation. (See **Example #6**.)

Similarly, in multidivisional firms, senior managers should not make the mistake of thinking that a single approach to managing AMMS can be used consistently across business units that operate in different market and technology environments. Each business unit is likely to need its own distinctive set of AMMS strategies, processes, and priorities. In effect, there will be no substitute for doing the extensive work required to define the AMMS strategies, processes, and priorities that will best serve each individual business unit. At the same time, senior managers must put in place management processes that can identify and support collaborative AMMS processes that can help various business units work together to, for example, (i) lower costs through development of common components used by more than one business unit, (ii) improve product performance by sharing the costs of developing new technologies, and/or (iii) improve value capture by developing and sharing new marketing capabilities.

Example #6: One successful modular strategy does not fit all situations

Volkswagen's much heralded platform strategy is based on a set of standard mechanical and safety-related components that are used in common across all models leveraged from a given platform. For example, the Volkswagen A4 platform in the early 2000s provided a set of common powertrain, suspension, steering, braking components, crash cage, and passenger seat components used in the Volkswagen Golf and New Beatle, the Audi A3 and A4, the Skoda Octavia, the SEAT Leon, and the Audi TT. Handling and other performance differences used to distinguish models in the marketplace were accomplished with very limited changes in a few key components intended to provide different vehicle driving characteristics for the various models. Interfaces between the common components and various models' body shells were defined to allow the common component set to "plug and play" in a broad range of body styles.

Volkswagen's avowed objective in this approach to defining its modular platform was to significantly reduce its overall vehicle costs by achieving economies of scale in producing large numbers of common components. In this sense, Volkswagen's modularity strategy can be characterized as an "inside-out" architecture strategy in which a platform of standard common mechanical components can be used with a broad range of product body shapes.

By contrast, another European automaker has adopted what might be characterized as an "outside-in" strategy in which the main body components that determine vehicle shapes are standardized for various classes of cars. Suppliers who develop components for the various vehicle classes are then required to develop components that will fit within the physical spaces defined by the main body components used for that vehicle class. This company adopted an architectural strategy that is very different from Volkswagen's because its business situation is very different from Volkswagen's. Unlike Volkswagen, this company outsources most of its mechanical components, so its main cost-reduction concern is to reduce body panel production and assembly costs by standardizing body shapes, while leaving the challenge of reducing component costs to its suppliers.

Each firm has used a different kind of vehicle architecture and development process to achieve strategic cost reductions and competitive advantages within their individual business environments.

Inadequate senior management involvement

The author has witnessed other unfortunate efforts of developers and even mid-level managers to implement AMMS through a "bottom-up" process — i.e., a grass-roots movement working to implement AMMS without the full understanding and direct support and involvement of senior managers. Such efforts have invariably failed, because the extensive managerial and organizational changes required to make an AMMS system work cannot be made without senior management's understanding and support. While much of the detailed work required to implement and use an AMMS system can and must be done at the working and mid-management levels of an organization, the systemic, interrelated organizational changes needed to implement AMMS will have to be consistently understood and supported by senior managers, for the simple reason that the breadth and depth of organizational changes required to implement AMMS will assuredly exceed the authority of mid-level managers to make essential strategy and organization changes.

Senior management failure to lead organization change

Leading significant organizational change can be difficult and risky. In firms whose senior managers have been unwilling to rise to the challenge of leading strategic change in their organizations, senior managers have sometimes made the mistake of trying to graft AMMS strategies and processes onto existing organization structures and processes. Such half-way measures will not work, because AMMS processes are not compatible with conventional development structures, processes, and strategies. Senior managers who do not have the confidence and courage to lead significant organization change should not delude themselves that a "light" version of AMMS can be implemented in their organization without undergoing significant managerial and organizational changes.

The old saying about meeting the challenges of politics applies with equal force meeting the challenges of adopting AMMS: "If you can't take the heat, you better stay out of the kitchen."

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