Order and Disorder in Product Innovation Models[1]

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This article argues that the conceptual development of product innovation models goes hand in hand with paradigmatic changes in the field of organization science. Remarkable similarities in the change of organizational perspectives and product innovation models are noticeable. To illustrate how changes in the organizational paradigm are being translated into changes in new product development (NPD) practices, five NPD models are presented: the sequential, compression, flexible, integrative and improvisational models. The evolution of product innovation management shows a move from planned and mechanistic, towards emergent and organic models. Such a process of re-orientation poses several challenges that are presented in the form of six propositions: from universal to contingent models, from invariant to flexible practices, from avoiding risks to taking advantage of opportunities, from planning to learning, from exclusive teams to inclusive networks, from structure to structured chaos.

Introduction

In the rapidly-changing environments characterizing most industries today, proficiency in the management of product innovation is a necessary although not sufficient condition for organizational survival (Shervani and Zerillo, 1997). Considering that environmental change requires organizational adaptation, then new product innovation models can be expected to be appearing in response to new competitive landscapes (Bettis and Hitt, 1995). In this article, the evolution of product innovation models is traced. It is argued that organizations are developing new approaches to the product innovation process as they realize that traditional approaches may no longer be appropriate, given the characteristics of today's competitive game. New competitive conditions may require thorough diagnosis and fast decision-making simultaneously, which implies the management of two opposite pressures (Dickson and Gigleriano, 1986): the needs of taking fast action (to avoid the closure of market windows by faster-acting competitors) and of reducing the risks involved in product innovation (through careful but time-consuming analysis). Such conflicting demands are changing the product innovation practice and research, and forcing new product innovation models to emerge. These new models and the way they accompany the general development of organization science will be discussed here. Aiming to parallel the developments of organization theory and NPD theory, this paper does not review the product innovation field in its entirety (for that purpose see e.g. Brown and Eisenhardt, 1995, or Wind et al., 1997); rather it reviews product innovation models, which have been central to new product and organizational success (Ernst, 2001).

The paper starts with the presentation of two alternatives on the ethos of organizing: organizing as order versus organizing as disorder. From the organizing as order to the organizing as disorder continuum, five product innovation models can be devised: the sequential, compression, flexible, integrative and improvisational models. These two sections will be followed by a final section in which six trends in NPD, derived from the previous discussion, will be presented.

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Organizational Paradigms: Order/Disorder

Organizations are complex social systems that can be approached from a variety of perspectives (Westwood and Clegg, 2003). The intrinsic diversity of organizations allows researchers to develop correspondingly diverse views of the several phenomena taking place inside them. Product innovation is no exception: it can be approached from sharply distinct departure assumptions, and proceed towards diverse descriptions and prescriptions.

In this section, this contention is illustrated by showing that two radically distinct perspectives about organization and organizing coexist in the literature: (1) an engineering-based perspective that views organization as order, and (2) a complexity-based perspective that equates organizing with a partially disordered process. These views are expected to illustrate how the general evolution of organization science is deeply penetrating into theory-building in the field of product innovation models. This conceptual discussion may be pertinent considering that, as claimed by several authors (e.g. Brown and Eisenhardt, 1995), product innovation is often viewed as a technical and an a-theoretical subject. This article's main assumption is that theorizing about product innovation is necessarily close to the conceptual frameworks available in organization science. Two major and contrasting perspectives on organizing will therefore be considered: organizing as order, and organizing as disorder.

Organization as Order

Organizations are often portrayed as open systems, and therefore as being vulnerable to the uncertainty coming from markets and technologies. Despite the inevitable impact of environmental factors, classical organization theory tried to find ways of protecting the core organizational processes from environmental interference (Thompson, 1967).

According to rationalist, engineering-based approaches, organizations should simultaneously buffer themselves from external influences while maintaining a controlled degree of porosity to the environment. These contradictory requirements can be achieved by regulating/controlling the external flows of information and resources. Stability was viewed in this approach as the essence of organizing (Shenhav, 1999).

Homeostasis was expected to be achieved through the introduction of slight, incremental innovations, developed in order to help adaptation of the organization to environmental changes. The top-management team was presumed to act as the driver of innovation and renewal, and to base its strategic decision-making processes on the premises of rationality. Organizations were expected to change mainly voluntarily and consciously, in order to maintain a state of fit with the external environment (Lawrence and Lorsch, 1967). The organizational landscape was mainly described as composed of cycles of negative feedback, and perspectives on organizing based upon sounding and comforting concepts, such as stability, regularity and predictability (Stacey, 1995). In this perspective, cause–effect relations could be known, organizations could be able to design their futures, and adaptation could be taken as the outcome of managerial competence. Under a rationalist framework, the organization pursues clear and shared goals, set by managers who are able to transform divergent and often ambiguous information into convergent solutions.

The essence of classic approaches to management and organization consisted in the maintenance of order and control as paths to organizational equilibrium and stability. To achieve these goals, companies sought to rationalize work processes and to introduce operating routines. The rationalist perspective follows, in sum, an organizational archetype based on control and rationality, from which chaos has been removed (Nonaka, 1988).

Organization as Disorder

Recent theoretical developments, implicitly or explicitly associated with such ideas as complexity (Stacey, 1995), paradox (Clegg, Cunha and Cunha, 2002) or emergent designs (Hatch, 1997) are challenging the traditional representation of organizations as orderly systems. Under these approaches, organizations tend to be portrayed as messy and partly disorganized systems (Abrahamson, 2002). They should then be viewed as systems of interrelated, complex and not fully predictable behaviours.

Management, by consequence, calls not only for logic and analysis, but also synthesis, intuition and analogy. In consequence, processes like change and innovation involve not only a sequence of planned activities, but also a parcel of emergence and improvisation, as will be discussed below. Table 1 summarizes the main characteristics of traditional and emergent perspectives on organizing.

The central argument of this paper is that the general changes taking place in the field of organization science are penetrating product innovation models: after trying clearly

Table 1. Rational and emergent perspectives of organizations

Features \ Perspective	Traditional	Emergent
Object	Organization	Organizing
Essence of organizing	Order, clarity	Disorder, ambiguity
Role of people	Information processors	Information creators
Nature of the approach	Static	Dynamic
Unit of analysis	Decision	Interaction
Basis for action	Planning	Discovery

structured, uncertainty-avoiding models, some organizations are now engaging in the use of minimally structured, uncertainty-accommodating ones. These models make use of concepts such as team-working, real-time decision-making, improvisation and collective discovery. After having accepted the premises of the traditional paradigm, organizations are now trying to implement more nimble and faster processes. New organizational architectures are becoming more dynamic and less mechanical, as captured by such labels as 'modular', 'virtual' or 'barrier-free' organizational forms (Dess et al., 1995). Product innovation models seem to be evolving in the same direction: modular, virtual and barrier-free, are all labels that can be applied to developments in the management of product innovation (Adler and Zirger, 1995). The following section provides a discussion of product innovation models, ranging from engineering/mechanistic models, to emergent/organic ones.

Product Innovation Models

NPD is a necessary condition for organizational adaptation and renewal. The dynamics of competition may be viewed as compulsory stimuli for product innovation. Product innovation is a prominent strategy for renewal: by launching new products, firms may stay closer to customers (Schilling and Hill, 1998), counterbalance the organizational tendency towards inertia (Hannan and Freeman, 1984), out-innovate competitors (Moore, 1993) and influence the characteristics of their environments (Utterback, 1993). Product innovation is thus a powerful mechanism for organizational adaptation.

Many organizations, however, develop incomplete or inadequate new product innovation processes (Cooper, 1993). These deficient processes may be partly responsible for the high levels of new product failures reported in many industries, which are calling for a re-examination of how companies plan and implement their product innovation processes (Wind and Mahajan, 1988). Empirical evidence shows that successful and unsuccessful new products frequently follow different paths of development, with failures being the result of incomplete, inadequate or deficient innovation processes (Edgett, 1994).

Despite the existence of empirical data showing that innovative firms tend to perform best (Deshpande, Farley and Webster, 1993), product innovation is still an uncertain and risky activity, which must be rigorously managed for organizations to increase their chances of success. In the remainder of this section, five product innovation models will be presented, ranging from assumptions of order to assumptions of disorder. This presentation will make clear that the first condition for the success of product innovation may not consist in the proper implementation of any universal model, but rather in the choice of an appropriate model for particular environmental or project contingencies.

The models fall into a continuum ranging from more planned to more emergent approaches, and can be classified according to the types of learning they rely upon: sequential and compression models try to develop increasingly efficient and reliable routines, while the flexible, integrative and improvisational models look for an increment of resilience and agility. These two forms of learning have been identified in the organizational literature (Sitkin, 1992) and seem to be helpful for capturing and interpreting the assumptions underlying each model.

The Sequential Model

The sequential, step-by-step approach to product innovation, constitutes the dominant

Table 2. Characteristics of the sequential model

Model	Sequential
Environment	Placid clustered
Assumptions underlying the model	Buffering the process from unnecessary change and uncertainty
Process characteristics	Explicit
Process goals	Efficiency, predictability, incremental change
Major raw material	Product innovation principles
Key organizational functions	Introducing discipline and control, evaluating each phase
Fundamental assumptions about organizing	Certainty, equilibrium, stability, predictability, mechanicism
Shortcomings	Rigid, early lock-in, fitted to long-cycle products, vulnerable to crystallization/centripetal forces, risk of 'missing the boat'

Figure 1. Sequential model

perspective in the management of product innovation (Cooper, 1993; see Table 2 and Figure 1). Step-by-step models are presented as blueprints for safe and efficient new product development projects. These models are mechanical tools intended to guide product managers along the entire product innovation journey. They are expected to reduce the uncertainty inherent to innovation (Dosi, 1988) by suggesting a number of steps to be made in sequence (see Figure 1). Between phases, there are decision gates or points for deciding about whether the process should continue (i.e. 'go') or be interrupted ('killed', according to the model's jargon). The number of phases varies amongst authors, from two (e.g. Moenaert et al., 1994), to six (e.g. Cooper, 1988) or even nine (e.g. Hardingham, 1970).

Sequential models rely heavily on planning, anticipation and control. Their rationality, however, does not seem to fit the way most organizations actually work: as reported by Cooper (1988), less than 1 per cent of the firms examined in his study used a complete sequential or stage-gate approach. The question then is: why do companies resist the step-by-step approach? To answer this question, it should be considered that step-by-step models are 'tools to manage, direct, and control . . . product innovation efforts' (Cooper, 1990, p. 44). Or, to phrase it differently, they are tools for rationalizing and controlling product innovation. As such, they are not learning or creativity-oriented tools, but means of control through standardisation (Perrow, 1986). This characteristic may make them more appropriate for managing routine, incremental innovations, than for discovering radical innovations (those that deviate a company from current courses of action). The definition of tight steps to follow while developing new products inhibits the development of innovations that require unexpected movements, i.e. radical or frame-breaking innovations. These, in fact, cannot be expected to be accomplished 'by a simple application of programmed switching rules' (March and Simon, 1958, p. 175). One of the dangers inherent to these models is the creation of habits of mind (Louis and Sutton, 1991) or automatic ways of dealing with problems that may instead require learning and flexibility. The physical and social separation of activities implied by sequential models also seems to work against learning because social interaction – facilitated by physical proximity and intense cross-functional communication – is a fundamental means for knowledge creation and diffusion (Brown and Eisenhardt, 1997). Some organizations may also decide not to follow the complete set of instructions provided by step-by-step approaches, because the model may not be adequate to the kind of products they are developing: in the case of new service development, for example, the technical development phase may be greatly reduced or even absent, while in the case of manufacturing this is the most time-consuming and costly phase of the whole new product-development process (Meidan, 1984).

Despite the potential pitfalls mentioned above, step-by-step models have many potential advantages. They can be instruments for developing systematic, standardized and comprehensive product innovation practices (Cooper, 1993). As such, they provide a clear-cut, easy-to-learn and easy-to-standardise set of guidelines for developing new products. This road map, however, does not seem to be a universal solution. Some goals, namely the exploration of novel opportunities and high speed of response, may require different means for managing product innovation. This latter necessity led to the introduction of the compression model.

The Compression Model

The compression model may be thought of as a version of the step-by-step approach adjusted to high-velocity environments (see Table 3). As in the previous model, a sequence of steps forms the basis for developing new products under a compression model (for an illustration, see Figure 2). However, as a result of market pressures, collapsing product life cycles, and the competitive importance of time (Kessler and Chakrabarti, 1996), these steps sometimes need to be accelerated or compressed. There are several ways of achieving compression: improving planning, simplifying the process, eliminating unnecessary steps, involving suppliers, shortening the completion time of each step, overlapping steps and rewarding people for speed of development (Eisenhardt and Tabrizi, 1995). The crucial phase of a compression approach is predevelopment planning: if pre-development planning is accurate, the entire process may be rationalized, delays eliminated and mistakes detected earlier. Careful planning is presented as a determinant of quick development. Deficient planning, on the other hand, can lie at the root of numerous product pathologies, like stop gaps, disruptive re-orientations (Brown and Eisenhardt, 1997), hidden costs, low profit/high triviality, or unexpected inefficiencies (Crawford, 1991). Other practices that facilitate speed of development include knowledgeable leadership, the use of cross-functional teams, and an organization-wide support for the project (Maber, Muth and Schmenner, 1992).

The compression model implements Cooper's (1994) and Clark and Wheelwright's (1993) suggestions for parallel processing of the activities involved in product development. With parallel processing, organizations strive to integrate the advantages of sequential

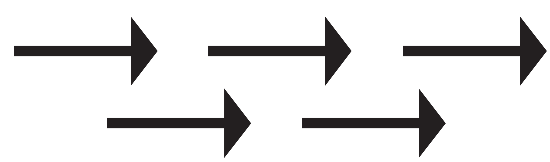

Figure 2. Compression model

Table 3. Characteristics of the compression model

Model	**Compression**
Environment	Placid clustered, high speed
Assumptions underlying the model	Rationalizing the process as a way of adapting
Process characteristics	Explicit
Process goals	Increasing speed while keeping low levels of uncertainty, incremental innovations for fast moving markets
Major raw material	Product innovation principles, time
Key organizational Functions	Rewarding speed, emphasizing planning, using multi-functional teams
Fundamental assumptions about organizing	Certainty, equilibrium, stability, adaptation, mechanicism
Shortcomings	The traps of acceleration: lack of quality, shortcuts, omission of important steps

models with the demands for a faster process. Thus, the logic is that some development tasks can start simultaneously, instead of following a rigid sequence of developmental steps. This perspective intends to keep the uncertainty-reduction philosophy of sequential models, while recognizing the need to save time. Therefore, it presents the advantages of investing in planning in order to gain speed. Unnecessary tasks should be removed, time spent on each task reduced to the minimum, interactions and responsibilities within teams regulated, and some tasks delegated, namely to suppliers.

The compression model assumes that: (1) development activities can be known in advance, and that (2) product innovation models are expected to reduce uncertainty as much as possible. Recognizing the need to speed up processes, this model's authors envision ways for shortening development phases as much as possible, compressing some activities, overlapping others and obliterating those that are not strictly necessary.

Similarities between the sequential and compression models exist because they both rely on the assumptions of planning and certainty. The compression model can be adequate for developing products that demand the use of familiar technology and are directed towards well understood but fast-changing markets (Eisenhardt and Tabrizi, 1995). Or, in other words, to high-speed routines.

The Flexible Model

The mix of high-speed and uncertainty of a growing number of industries led to the appearance of another model for developing new products: the flexible model. The flexible model introduces an organic approach to the development of new products (Iansiti, 1995). Flexibility, or the capacity to introduce changes in design in response to a changing environment with little or no penalty (Sobek, Ward and Liker, 1999), becomes an important feature of product innovation models when turbulence increases. When flexibility is low, the economic cost of modifying the product is high. The need to do things right the first time, a major challenge when the environment is permanently changing, is also high. A possibility to bridge the gap between planning and execution is to trade a mechanistic approach for an organic one, where the strict succession of changes is no longer the essence of the game. The flexible model, then, substitutes the machine-like process of previous models, with a focus on adaptation through diversity seeking.

Flexibility is influenced by the product development's expense, unit cost, performance, and development schedule, and can be increased via the adoption of flexible technologies, the modification of management processes (e.g. locking requirements progressively, instead of in advance) or of design architectures (e.g. using modular product structures and reducing the coupling between modules).

The speed of change and the high levels of environmental turbulence invite organizations to see innovation not as an organizational disruption to keep under control (as in traditional mechanistic models) but as an engine of renewal. This need for agile product innovation led to the flexible model (see Table 4), a model whose necessity was firstly felt in industries where even 'the ground is in motion' (Emery and Trist, 1965, p. 26). In these industries, instead of encapsulating the process, an organic approach was taken, based on keeping

Table 4. Characteristics of the flexible model

Model	Flexible
Environment	Disturbed reactive, turbulent
Assumptions underlying the model	Embracing change, absorbing uncertainty
Process characteristics	Explicit, with tacit elements; variety is acquired through iteration
Process goals	Flexibility, responsiveness
Major raw materials	Product innovation principles, time, variety
Key organizational functions	Organic structures, unclear timings
Fundamental assumptions about organizing	Uncertainty, surprise, adaptation
Shortcomings	The 'might as wells' syndrome can provoke serious delays, due to unfreezing product concept

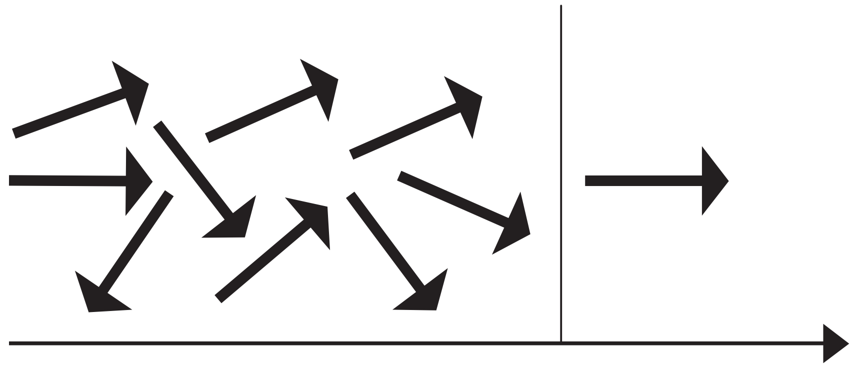

Figure 3. Flexible model

the concept development stage open as long as possible, in order to increase development agility through diversity and fast integration (see Figure 3). This also reduced the negative impact of forecasting errors. Rejecting the idea of product innovation as a rigid and mechanistic sequence of phases, the flexible model proposes the agile utilization of 'rapid and flexible iterations through system specification, detailed component design, and system testing' (Iansiti, 1995, p. 2).

Frequent iteration and testing can work in turbulent environments because these practices favour the creation of more opportunities and probabilities for variety to occur (Eisenhardt and Tabrizi, 1995) and offer frequent feedback, which has two advantages: errors are uncovered earlier and team members can have a perception of progress and improvement, which will be a source of learning and motivation (Eisenhardt and Tabrizi, 1995).

In the flexible model, the idea that sequencing (with or without overlapping) is the most appropriate way of handling new product development is abandoned, and a more dynamic perspective is adopted, based on learning-while-doing and on the emergent nature of the innovation journey under turbulent conditions. Considering that less that 5 per cent of the developing products are completely specified before beginning product design (Thomke and Reinertsen, 1998), the flexible model may benefit from the realistic premises it is based upon.

This model is best suited to business environments that are unpredictable, rapid and populated by aggressive competitors (e.g. computers and software, multimedia and the fashion industry). Here, companies with a flexible approach may continue to incorporate market information in the new product concept until late, neutralizing competitor moves or taking advantage of surprise (Cunha, 2003).

A flexible approach to NPD is also an action-biased one: instead of investing in careful pre-specification of design details, the model rests upon the creation of alternative and non-definitive (i.e. reversible) designs. The use of prototypes, for example, may generate early knowledge of real product attributes and immediate customer feedback. A distinguishing feature of the model is that the generation of diversity should be accompanied by quick integration when a satisfying solution is achieved.

The flexible model is not immune to criticism. One major criticism is the 'might as well' syndrome, or the propensity to keep on waiting for information to come, which can lead to delays due to late concept freezing.

The Integrative Model

Integration is a concept initially proposed in organization theory by Lawrence and Lorsch (1967) and has gained widespread acceptance in the NPD and innovation literature in recent years. Initially referring to the quality of collaboration between team members in an NPD project, integration now refers to the quality of coordination and collaborative work amongst all entities involved in NPD (Jassahalla and Sashittal, 2000).

The integrative model acknowledges that NPD is a complex activity that requires the capability to obtain, transform and interpret large amounts of market, technical, financial and other internal and external information, in order to develop product ideas and evaluate their technical soundness, manufacturability and economic feasibility (Ancona and Caldwell, 1990). This usually requires the efforts of various individuals from a number of functional areas, and increasingly from external entities (Mintzberg et al., 1996), hence turning NPD into a highly-complex collective achievement, more than an individual activity (Emmanuelides, 1993) (see Table 5 and Figure 4).

Table 5. Characteristics of the integrative model

Model	Integrative
Environment	Disturbed reactive, turbulent, complex
Assumptions underlying the model	Structure defined by teams, decisions are structured
Process characteristics	Half tacit and half explicit
Process goals	Trade-off between long-term and short-term, responsiveness
Major raw materials	Knowledge, competencies, information
Key organizational functions	Teams, teamwork, internal and external collaborative networks
Fundamental assumptions about organizing	Uncertainty, surprise, adaptation, emergence
Shortcomings	Conflict, time-delays if marketers are not included in the team

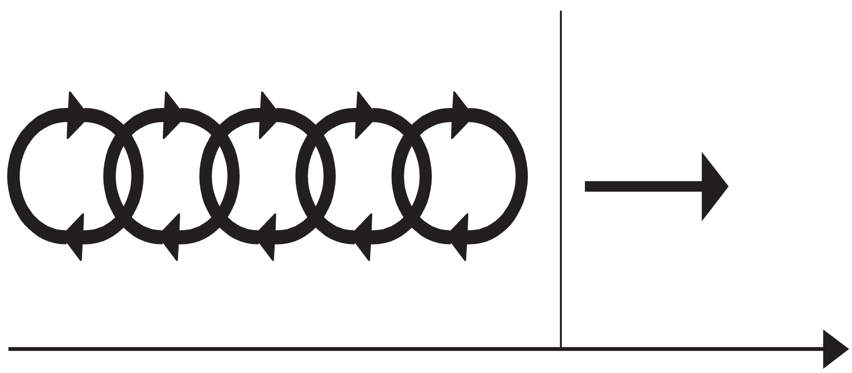

Figure 4. Integrative model

The integrative model reinforces some of the major shifts between previous and recent NPD models, and introduces new paradigmatic changes in the way the NPD process is conceived. First, it reinforces the shift from structure to processes. Processes are collections of tasks and activities that together transform inputs into outputs (Garvin, 1998). Many modern organizations do not operate on a process-basis, rather they are functional and hierarchical, suffer from isolated departments, poor co-ordination and limited lateral communication. All too often, work is fragmented and compartmentalized, and managers find it difficult to get things done. Managing and describing organizations in terms of processes instead of structures helps to go beyond a static view of innovation and NPD, thus permitting to address in a more direct way the issues of fragmentation and lack of cross-functional integration. The Japanese recognize this when they define cross function as:

> a management process designed to encourage and support interdepartmental communication and cooperation throughout a company – as opposed to command and control through narrow departments or divisions. The purpose is to attain such company-wide targets as quality, cost, and delivery of products and services by optimising the sharing of work' (Japan Union of Scientists and Engineers, in Dimancescu, 1992, p. 14).

Second, the shift is also from functions to knowledge. Instead of thinking in terms of distinct departments that come together to take an idea from inception to launch the rational of the integrative model is to think in terms of the pool of knowledge required to deliver a new product. One implication of this shift is to extend NPD solutions beyond structural systems, such as the *stage-gate* process (Cooper, 1988), into more emergent ways of organizing, such as team empowerment. In other words, managing NPD is about managing not only the technical but also the human systems involved in innovation. A second implication is that the concept of integration now extends to integration of product innovation in other organizational systems such as the business system.

Finally, NPD is a collective task, which means that teams and teamwork are crucial. NPD teams are groups of individuals reciprocally interdependent and directly involved with a project (Ancona and Caldwell, 1990). These teams are created to work in a particular project and they are dissolved at the end of it. They usually include people from different functional areas or departments in the organization, or multi-functional teams. Multi-functional teams can potentially improve integration in NPD by reducing hierarchical and functional barriers, facilitating lateral communication and promoting co-ordination of efforts. Teams can be given autonomy and responsibility for deciding how an NPD project unfolds, therefore project stages are highly ill-structured as they are defined by teams themselves. Structured points in the process consist of the decision-gates only, when the project team and the board team meet to take strategic decisions.

In line with these views, NPD can be conceived as a knowledge-creation process, in which new ideas and concepts are transformed into new or improved products. In the process, knowledge is used and new knowledge is created, which can be used for generating more ideas and concepts (Mendes, Gomes and Bátiz-Lazo, 2003).

The Improvisational Model

Improvisation refers to the temporal convergence of planning and execution, which means that an action is improvised when it constitutes a deliberate, real-time response to a problem or opportunity, and is executed with the available resources (Cunha, Cunha and Kamoche, 1999; Miner, Bassoff and Moorman, 2001).

The improvisational approach to NPD (see Table 6) tries to facilitate innovation under relentlessly shifting and fluid conditions. This model may be best suited to disturbed or turbulent environments. It combines elements of the flexible model (e.g. exploratory learning) with elements of traditional approaches including the need to use developmental models as control devices. However, control is executed through the use of minimal structures, which makes a significant difference.

Clear roles, no-exceptions milestones, experimentation and gradual convergence are on the basis of the improvisational model, an approach that synthesises order and disorder (see Figure 5). Improvisational NPD teams are allowed to work autonomously inside the limits prescribed by a small set of ‘big rules’ (i.e. within the confines of a minimal structure). If the synthesis of freedom and control constitutes a major challenge for product innovation in today’s firms (Clark and Fujimoto, 1991), the improvisational model suggests a pragmatic way of operating this paradoxical need, via the utilization of minimal structures. Minimal structures basically consist of a simple and well-defined set of rules, where some features are formalized while others are not (Kamoche and Cunha, 2001). In the case of product innovation, minimal structures may consist of clear roles and responsibilities (for product definition and financial performance, project schedules, portfolio priorities and time intervals between projects; Brown and Eisenhardt, 1997), action-based communication and

Table 6. Characteristics of the improvisational model

Model	**Improvisational**
Environment	Disturbed-reactive, turbulent
Assumptions underlying the model	Trading structure for minimal structure
Process characteristics	Mainly tacit, with explicit elements
Process goals	Coping with turbulent environments, adaptiveness
Major raw material	Product innovation principles, ideas
Key organizational functions	Minimal structures, learning-while-doing
Fundamental assumptions about organizing	Complexity, emergence
Shortcomings	Fuzzy, unclear, ambiguous process; vulnerable to disintegration/centrifugal forces, risk of ‘sinking the boat’

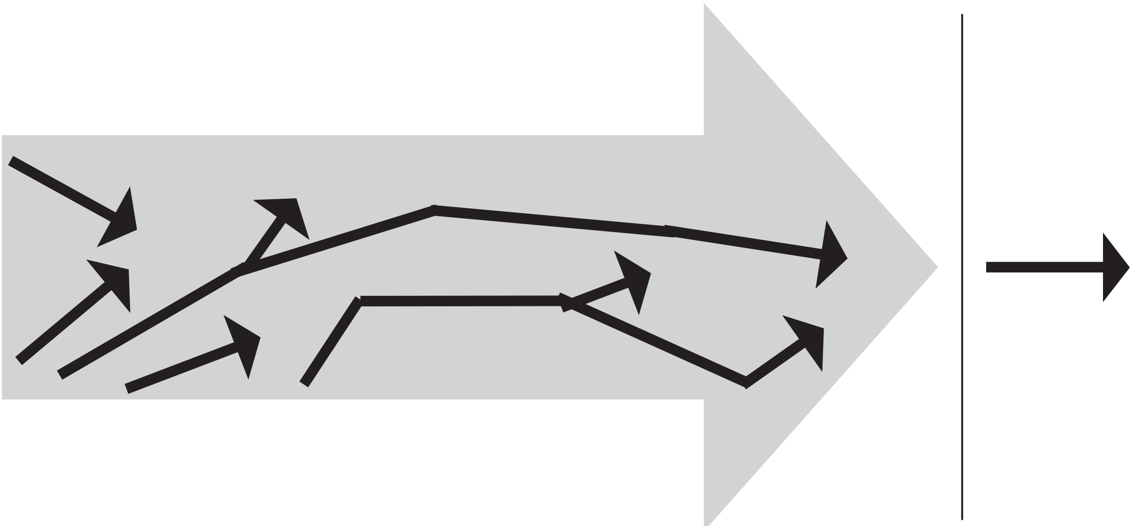

Figure 5. Improvisational model

freedom to act inside existing limits. Minimal structures collapse the traditional notion of structure, substituting a serial, step-following process, by the freedom to act and to build a unique process, contained within a set of technical and social rules that must be known and accepted by those working in an improvisational mode. The case of the Honda City model provides a good illustration of the use of NPD with minimal structuring. Honda's top-management provided the NPD team with only two instructions: (1) to come up with a product concept fundamentally different from any previous concept developed at Honda; (2) to make an inexpensive but not cheap car (Nonaka, 1991).

Minimal social structures should coexist with minimal technical structures. NPD in an improvisational mode may proceed through gradual convergence or the progressive narrowing of an initially larger range of acceptable solutions. Gradual convergence means that each group involved in the development of a new product works autonomously, but has to meet regularly with the other groups to coordinate efforts and eliminate flawed solutions. The search for variation is then limited, from the very beginning of the project, by the structural constraints introduced by the improvisational *modus operandi*. Because of the improvisational model's search for flexibility *and* efficiency (Adler, Goldoftas and Levine, 1999), it seems to be especially suited to organizations competing in industries where high levels of efficiency can be considered critical, and for which the purely organic functioning of the flexible model is not suitable (e.g. the automobile and computing industries).

The improvisational model, as depicted in Figure 5, synthesizes order and emergence: like the more traditional models, it implies the existence of a strong, although minimal, structure that gives direction and facilitates coordination (Kamoche and Cunha, 2001); emergence is embraced because the new product concept is achieved gradually, while action unfolds. As pointed out by Sobek, Ward and Liker (1999), gradual convergence provides the group with the possibility of collective learning based on real-time information, not forcing the choice of early and potentially misleading convergence points.

Innovating in an improvised mode entails some risks, including high levels of stress and ambiguity, and the possibility of strategic drift. These risks are increased if improvisational processes are not clearly embedded in organizational goals.

Table 7 summarizes the main features of both organization and NPD models, and establishes a link between theoretical characteristics of the former with views of organizing for NPD.

Conclusion

It was argued in this article that organization theories and product innovation models are co-evolving in the planning to emergence direction, a conceptual move that has been triggered by changes in business landscapes: new landscapes require new product innovation models. From the previous discussion, it is possible to derive six propositions (see Table 8 for an overview).

Table 7. Linking organization theory and product innovation

	Organizing as order	→			Organizing as disorder
Role of the environment	Should be under control	→			Complex relationships with organization
Essence of organizing	Stability, control, rationality, predictability	→			Disorder, ambiguity, improvisation, random
Main goal	Achieving equilibrium and stability	→			Achieving dynamical equilibrium
Organizational structures	Mechanistic, hierarchical, functional	→			Organic, flat, horizontal
Product innovation model	**Sequential**	**Compression**	**Flexible**	**Integrative**	**Improvisational**
Assumptions	Certainty, equilibrium, stability, predictability, mechanicism	Certainty, equilibrium, stability, adaptation, mechanicism	Uncertainty, surprise, adaptation	Uncertainty, surprise, adaptation, emergence	Complexity, emergence
Main goal	To standardize innovation	To optimize the sequential model	To adapt to the project needs	To integrate multiple PD components	To manage efficiency and flexibility at the same time
PS structures	Universal: all products; all organizations; all industries	Universal: all products; all organizations; adaptable to industries	Adaptable to product types and industries; universal: all organizations	Adaptable to product types, organizations and industries	Dependent on the particular project

First, the discussion shows that the principle of contingency seems to be valid to NPD. Traditional, sequential models were context-free and presumed to fit every case in any context. The 'one size fits all' assumption is no longer tenable. As Gomes et al. (2003) have concluded, different cases require diverse approaches. Future research will need to refine a contingency approach to product innovation. Such an approach will need to find types of products, structures and technologies that recommend the use of a certain product innovation model.

Second, the evolution of product innovation models is also due to the growing recognition that there is an element of emergence in organizational life that cannot be removed and that encourages the adoption of flexible NPD practices. Innovation researchers have paid attention to the planned side of the process, but treated emergent actions and particularly improvisational actions as less functional if not harmful (Lewin, 1998). Recently, however, a growing body of work is placing a significant focus on the emergent side of product innovation. Thus, it was suggested

Table 8. Innovations in product innovation models

Proposition 1: From universal to contingent models	◆ There is not a one best model ◆ The innovation process should be adapted to the type of product ◆ The process should be adapted to the type of environment
Proposition 2: From invariant to flexible practices	◆ Introduce freedom if necessary ◆ Consider the possibility of making use of more emergent models
Proposition 3: From avoiding risks to taking advantage of opportunities	◆ Product innovation is not only risk avoidance but also building on opportunity ◆ Long-range plans should be complemented with short- term, real-time plans
Proposition 4: From planning to learning	◆ The product innovation process is a technical but also a social one ◆ The process should include planning, but infuse it with real-time learning (while doing) ◆ To prevent errors of forecasting, product flexibility should be high
Proposition 5: From exclusive teams to inclusive networks	◆ NPD teams are networks of inclusion, not cells of exclusion ◆ Transfer of knowledge between projects should be systematic ◆ Customers and suppliers should be included in the team for contribution
Proposition 6: From structure to structured chaos	◆ Over-engineering may be constraining ◆ Process focus (control vs innovativeness; principles vs ideas) should be diagnosed

that if the traditional mechanical approach may aptly describe what happens in some product innovation efforts, it is not adequate for other processes. That is why it was argued that developments in product innovation models are moving from planning to emergence.

The third proposition states that new NPD models understand the intrinsic novelty of innovation processes as an opportunity for learning and discovery, and not as an uncertainty to be removed. Students and practitioners of management have been taught that deviations from order are generally bad (Abrahamson, 2002), but recent theorizing is pointing in a different direction: novelty may be part of the fabric of social organizations (Fonseca, 2002) and therefore should not be 'combated'.

This is closely related with the fourth observation: innovation processes are technical endeavours that need to be planned, but are also social processes that will bring diversity to the organization. As forecasts are condemned to failure, learning-while-doing should be facilitated. Learning is stimulated in communities of practice (Brown and Duguid, 1991). These communities enrich their repertoires of knowledge, engaging in communication with other communities.

This leads to a fifth observation: NPD teams need to be understood as inclusive networks instead of exclusive, self-focused teams.

All the above propositions result in a final one: NPD practices are evolving from structure to structured chaos, as Brown and Eisenhardt (1998) have put it. This means that the traditional engineering roots of management processes (Shenhav, 1999), including NPD, should be complemented with a more organic and adaptive view. In summary: order may not be as good as it seemed and the challenge may reside in the identification of the appropriate combination of structure and disorder.

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