Minimal Structures: From Jazz Improvisation to Product Innovation

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Abstract

This paper demonstrates how the art form jazz improvisation can be applied to organizational innovative activities, focusing specifically on product innovation. In the past, the literature on product innovation focused on well-planned approaches which followed a clearly-understood structure based on a rational–functionalist paradigm. However, it is becoming increasingly evident that this model is inappropriate in today's highly competitive business environment. A balance between structure and flexibility seems to be an appropriate way to manage the contradicting demands of control and creativity faced by organizations in highly competitive environments. Jazz improvisation provides this synthesis through the concept of 'minimal structures'. We characterize the minimal structures that allow jazz improvisers to merge composition and performance, and then proceed to apply this approach to new product development.

Descriptors: minimal structures, jazz improvisation, new product development, innovation, synthesis

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Organization Studies
2001, 22/5
733–764

0170–8406/01
0022–0024 $3.00

Introduction

As the business world continues to exhibit higher degrees of uncertainty and an increasing pace of change, there seems to be a strong case for fundamental change in the current forms of *organizing*, particularly in new product development (NDP). The dominant NPD approaches are built on high levels of structure and, in general, are designed to operate in stable environments. An alternative perspective suggests that more attention should be paid to the idea of absorbing the uncertainty inherent in product development today, thus leading to more flexibility and less concern with structure. These stark choices appear to create difficult challenges for organizations. For example, while faster decision making is associated with better performance in high-velocity environments (e.g. Eisenhardt 1989), ignoring important guidelines is potentially disastrous.

Dickson and Gigleriano (1986) characterize these risks in terms of 'missing the boat' (delaying product development by using detailed, time-consuming diagnostic tools) and 'sinking the boat' (when the speed of action leads to inappropriate and failed products). These two critical dimensions entail differing approaches to innovation. According to Thomke and

Reinertsen (1998), high-speed environments demand flexible, expemporaneous, fast (re)actions. On the other hand, the use of structured approaches may lead to superior new product innovations (Cooper 1993) and help to avoid the risks created by the acceleration of lead times (Crawford 1992). We believe the choices do not have to be as dichotomous as that. While the 'flexible model' achieves a shift away from structure to flexibility, we contend that, in the highly uncertain business environment of today, a fine synthesis between the two is what is really needed.

We therefore take a dialectical approach in building an improvisational model which captures the highly organic dimensions of the 'flexible model' but then goes further to achieve such flexibility upon a 'minimal structure'. In a recent paper, Brown and Eisenhardt (1997) found that successful product innovation combined limited structure with freedom to improvize. Similarly, Tatikonda and Rosenthal (2000) have shown that the task of balancing 'firmness' and 'flexibility' can be achieved through project management *formality* and project management *autonomy and resource flexibility,* respectively. Building on these arguments, we go a step further and propose an 'improvisational model' of product innovation which accomplishes this subtle synthesis in turbulent environments. We find further support for this dialectical approach in March's (1991) call for an appropriate balance between 'exploration' (search, variation, experimentation, innovation, etc.) and 'exploitation' (refinement, efficiency, implementation, etc.) in organizational adaptive processes, of which we consider NPD an example. Similarly, in new service development, Edvardsson et al. (1995) have highlighted the need to combine systematic modelling and fortuity — these are analogous to structure and flexibility.

Given the foregoing, we believe it is time for a rethink about the concept of 'structure' upon which the notion of product innovation so heavily relies. We propose to do so through an assessment of jazz improvisation (JI), which we believe has important lessons for innovative action in the organizational context. In the sections that follow, we open the case for improvisation by exploring the manifestations of improvisational activity and the nature of the existing literature on the subject. We then turn to the more extensive literature on NPD in which we identify three established models. We set out their definitive features and critically analyze their suitability. We then proceed to analyze the nature of improvisation as it happens in jazz music. An examination of the emergent literature indicates that JI has not been sufficiently theorized, in spite of recent efforts (see, for example, the forum on the subject in *Organization Science*, edited by Meyer et al., 1998; Moorman and Miner 1998a, 1998b). It is also apparent that many writers drawing from jazz music do not fully appreciate the historical context and performative character of this art form, and may therefore be unaware of its full potential and limitations.

We argue that by effectively combining structure and flexibility, jazz improvisers offer important lessons for such organizational processes as NPD. This includes, for example, the concern for inventiveness and the social component (Bastien and Hostager 1988), as well as the challenge JI poses

to the orthodox conception of structure by basing its *raison d'etre* on a minimalist notion of structure. Thus, we set out the constitutive features of JI and proceed to develop a model of minimal structures in JI which we then apply to NPD in order to formulate an improvisational approach to innovative activities. Improvisation is not offered here as a magic pill: we identify some weaknesses in the concept and some implications for practice, and conclude by suggesting ways in which further research might proceed.

The Concept of Improvisation in Organizations

In this section, we consider the nature of improvisation in organizations and then focus on its application to product innovation. A working definition of improvisation may be taken from jazz music, where it entails composing and performing contemporaneously. Within organizations, it can be described as the conception of action as it unfolds — acting without the benefit of elaborate prior planning (Cunha et al. 1999). It is generally understood in terms of fortuity, serendipity and the unexpected discovery of solutions, often in times of crisis. Some commonly cited examples include: Honda's success in introducing 50cc bikes into the US market (Pascale 1984); the actions of crew members to save a ship whose navigation system had broken down (Hutchins 1991) and the rescue of Appollo XIII by NASA scientists working with unfamiliar concepts (Lovell and Kluger 1995). The populist literature (e.g. Kao 1997) suggests that contemporary organizations need a new kind of worker, one able and willing to improvise like a jazz musician, rather than a talented, but non-creative worker who, like a classical musician, submits to the close supervision and guidance of the conductor.

In the area of strategy, Crossan et al. (1996) and Perry (1991) seek to highlight the benefits of improvisation, because of the flexible, open, and unpredictable nature of the business environment. Similarly, drawing mainly from theatre, with some general reference to jazz, Crossan and Sorrenti (1997) see improvisation as an important part of organizational learning and strategic renewal. Hatch (1997) has drawn more from jazz to highlight the importance of the historical context of improvisational processes. Further contributions include the work of Weick (e.g. 1989, 1993a, 1993b, 1998) who has explored the concept and its consequences for organizing, i.e. organizational design and risk mitigation in interdependent situations such as disasters — as noted above — where decisive and unplanned action is required (see also Bosworth and Kreps 1986; Hutchins 1991; Powers 1981).

Within the NPD literature, improvisation has been largely absent, which reflects the dominant assumption, especially in textbooks, that disciplined action and uncertainty avoidance are the keys to success in innovation. This situation is now beginning to change. Although they do not refer to it as 'improvisation', Imai et al. (1985), for example, show that the NPD process

in Japanese firms can be incremental, iterative, and based on learning by doing. Eisenhardt and Tabrizi (1995) identify the improvisational nature of 'fluid organic processes' in their 'experiential approach' to product development. In a more recent study, Moorman and Miner (1998a) focus specifically on the *incidence* and *effectiveness of improvisation* in new product activities. In an empirical study of two firms, they seek to establish the circumstances under which improvisation is most likely to occur and be effective. They found improvisation to occur when organizational memory (*stored* information) is low but environmental turbulence high; real-time organizational information flows positively influenced the extent to which improvisation produced design and market effectiveness. In an earlier piece, Moorman and Miner (1995) argue that improvisation has three key features: it occurs during action, it is impromptu and deliberate. These three characteristics make it possible to distinguish improvisational from non-improvisational behaviour. We believe improvisation in innovative activities is now ripe for more incisive analysis with a more sophisticated theoretical input. Rather than dwell on situations in which improvisation is deemed to take place, this paper attempts to generate a model of NPD which is by definition improvisational. We now turn to NPD.

Established Approaches to New Product Development

This section begins by exploring the theoretical and practical aspects of NPD. We outline three established NPD models, and attempt to demonstrate why they are becoming increasingly unsuitable for the rapidly changing environments of today. We note that the co-evolutionary nature of markets and organizations (e.g. Tasaka 1999) provides a framework for understanding why traditional models may be losing their appeal: more and faster product innovations lead to high-velocity environments, which in turn require more flexible product innovation processes.

Three established models are discernible in the NPD literature: the sequential model, the compression model, and the flexible model. To these three models we posit the improvisational model, based on our understanding of jazz improvisation and on previous literature (e.g. Brown and Eisenhardt 1997). The main elements of these models are summarized in Table 1.

We discuss these models in terms of their underlying assumptions, goals, characteristics and shortcomings. These categories, taken together, indicate the existence of a logic of internal consistency that allows us to describe each model as a configuration of elements: assumptions refer to the philosophical foundations of the model; goals are the expected outcomes; characteristics define how the underlying philosophy is translated into a set of practices; while the shortcomings refer to the relative disadvantages characteristic of the model. We also offer a metaphor to capture the structural-performative aspects of each model. The 'processual flow' of each model is captured in Figure 1. There is a clear consistency between the elements characterizing each model, which makes them independent ways of

Table 1
Key Characteristics of Product Innovation Models

Model	Sequential	Compression	Flexible	Improvisational
Underlying assumptions	Purposive rationality and predictability in stable environments.	Activities can be predetermined. Process can be adapted to the environment.	Embracing change. Absorbing uncertainty.	Action through experimentation. Improvisation is based on a template.
Process goals	Achieving efficiency. Reducing uncertainty. Providing operational guidelines.	Increasing speed while keeping low levels of uncertainty. Efficiency in time management.	Achieving flexibility. Responsiveness. Adapting to challenges	Discovery and unrelenting innovation. Balancing between structure and flexibility in dialectical fashion.
Process characteristics	Structured, with discrete phases carried out sequentially.	Predictable series of discrete steps, compressed or removed as need be.	Variation followed by fast convergence. Overlapping procedures.	Progressive convergence within minimal structures. Emergence. Incremental evolution of product features.
Main shortcomings	Rigid Too formal. Time-consuming. Causes glitches. Difficult to achieve in reality.	Possible omission of important steps. Traps of acceleration. Quality may suffer due to shortcuts.	High uncertainty can be counter-productive. Possible delays in concept freezing. Difficult to coordinate.	Can be chaotic and ambiguous. Dialectical logic difficult to sustain. Makes a heavy demand on the appropriate culture and HR systems.
Descriptive metaphor	Relay-race	Accordion	Rugby	Jazz improvisation

approaching the development of new products. The models can be said to fall into a continuum from mechanistic to organic which, in Burns and Stalker's (1961) terms, refer to high *vis à vis* low degrees of formal structure. However, the degree of organicism is not the only differentiating factor. We demonstrate, for example, how the improvisational model goes beyond this continuum and how it differs from the most organic of the established models — the flexible model. The diversity found in the models reflects the emergence of new competitive landscapes (Hitt 2000), casting doubt on the presumed universality of traditional models, and suggesting that there is no such a thing as 'best practice' in NPD (Loch 2000). We now turn to the models.

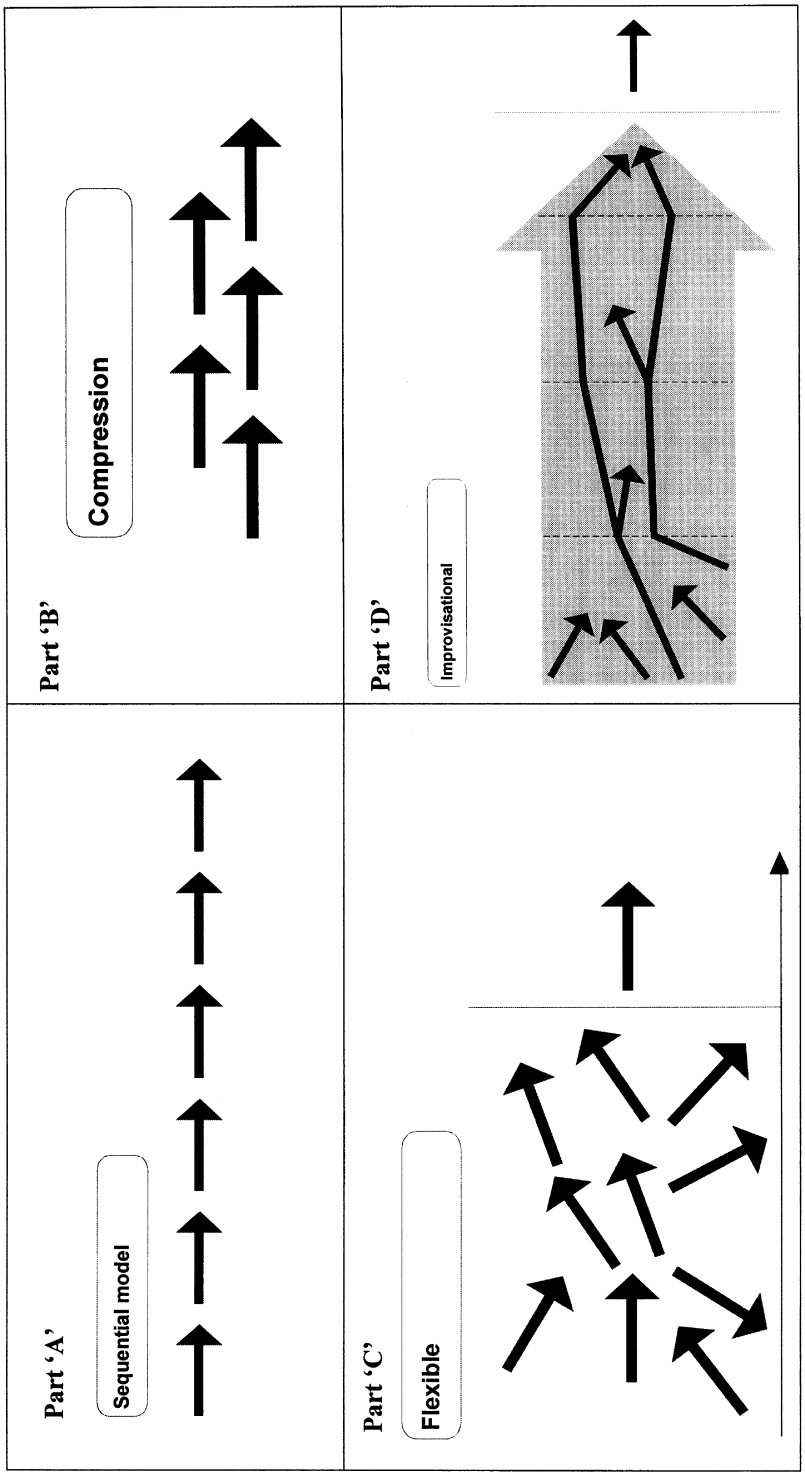

Figure 1. The Processual 'Flow' of the Models

Sequential Model

The sequential, step-by-step model is the most pervasive perspective in the NPD literature. This model relies on systematic planning, based on the assumption that there is a rational logic underpinning the execution of activities, and that major eventualities are predictable. The specific goals of this model are to provide a clear-cut, relatively straightforward, and thorough set of guidelines for product development (Cooper 1988, 1998). To achieve these objectives, it applies mechanistic tools (characterized by the specialized differentiation of functional tasks, clearly defined roles, and centralized decision making; cf. Burns and Stalker 1961) designed to remove uncertainty from the process. It thus seeks to provide rational templates to guide the decisions of product managers across the innovation journey and is expected to reduce the uncertainty inherent in the innovation process (e.g. Dosi 1988) by suggesting a set of discreet phases to be completed sequentially: new product strategy, exploration, screening, business analysis, development, testing, commercialization (see Figure 1, part A). This process is best captured by the metaphor of the relay race in which one stage follows another in predetermined fashion.

The advantages of NPD processes using a sequential flow of activities have been lauded by large, highly influential, survey studies. These include the MIT, SAPPHO, NSF, NewProd, Stanford Innovation Project and PDMA studies (Myers and Marquis 1969; Rothwell et al. 1974; Rubenstein et al. 1976; Cooper 1979; Maidique and Zirger 1984; Griffin 1997b). These studies found that the logical, sequential flow resulted in financial success. While initially developed by NASA in the 1960s, the model was later diffused to firms such as 3M, HP, IBM and Exxon, and many others over the years. The prescriptive appeal of the sequential model and the empirical validation of its qualities led the field to affirm and reaffirm the importance of clear and sequential structuring for NPD success. Although the technical rationality and discipline inherent in the model are notable advantages, the rational-functionalist approach to structure does not necessarily fit the way organizations really work. For example, Cooper (1988) found that less than 1 percent of firms actually used a complete sequential approach; a decade later, Griffin (1997a) revealed that 38.5 percent of firms use no formal process; 93 percent of the firms studied even more recently by Tatikonda and Rosenthal (2000) did not use a system with a high level of formality.

Empirical evidence reveals some additional shortcomings in this model: it can cause glitches (Hoopes and Postrel 1999) or gaps in shared knowledge, provoked by functional specialization; it is too formal, i.e. led by explicit norms that may reduce flexibility (Rosenthal 1992); it is too general to fit the demands of some particular products, and, equally importantly, new services (see Griffin 1997a). The sequential model also seems to be more appropriate for small, incremental innovations, than to breakthrough innovations or to innovations that require the organization to deviate from current courses of action (Wind and Mahajan 1997; Susman and Ray 1996).

Another common criticism is that the sequential model is too laborious for accelerated competitive environments (e.g. Cooper 1994; Imai et al. 1985; Hoopes and Postrel 1999). These shortcomings led to the creation of the compression model.

Compression Model

This model can be thought of as a version of the sequential approach, albeit tailored to high-speed environments. The logic of traditional models (in the original form or in any incremental modification of it; see Hughes and Chafin 1996) is based on the existence of a clear path for development, a logic of planning and control, and a focus on efficiency. These rationales appear adequate for incremental product innovations in mature markets, as demonstrated by Iansiti (1992) and Clark and Fujimoto (1991). The compression model assumes that development activities can be known in advance and that the process can be adapted to the fast-changing environment. The goal therefore is to increase the speed of product development while maintaining low levels of uncertainty.

The basis of developing new products is through a predictable series of steps, as in the sequential model. In essence, the compression model is similar to Cooper's (1994) third generation models, which incorporate 'paralleling' of activities (see Figure 2, part B). By concurrently conducting the several tasks involved in new product development, this model tries to combine the clarity of sequential models with the demands for a faster process, acknowledging the importance of time in competitive situations (Bower and Hout 1988). Thus, it retains the uncertainty-reducing aspects of the sequential model, while pursuing efficiency in time management. This offers some advantages over the previous model, which is why companies like Philips have applied this approach and managed to take appropriate 'shortcuts' in the development process of a new television (Deschamps and Nayak 1995). Development tasks in these instances are carried out simultaneously; they do not follow a relay-race process. The metaphor of an accordion better captures some of the ethos of this model.

Compression may be achieved in several ways: 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 element in the compression strategy is planning: if predevelopment planning is accurate, the entire process can be rationalized, delays eliminated and mistakes avoided. This is because, as Brown and Eisenhardt (1997) have shown, poor planning can be a source of product pathologies, including stop gaps and disruptive re-orientations.

There are some notable shortcomings in this model. For example, important steps may be omitted in attempts to compress the process to fit a predetermined structure. This may create traps of acceleration in which ill-advised shortcuts adversely affect quality. Also, by opting for a high degree of planning and limiting flexibility, as in the sequential model, this

model is ill-equipped to cope with unpredictable and highly unstructured eventualities.

Flexible Model

This model has been necessitated by disturbed-reactive and turbulent environments where high levels of uncertainty are the norm (Iansiti 1995) and the search for flexibility is a major requirement (e.g. Pettigrew et al. 2000). Some of its main proponents include Iansiti (e.g. 1995) and Thomke and Reinertsen (e.g. 1998). The basic assumption of the model is that the speed and degree of change demand radically new perspectives. It is thus consistent with the call for revolutionizing product development (e.g. Wheelwright and Clark 1992). This rationale further holds that uncertainty can be absorbed rather than eliminated. The main goal of the process therefore is to achieve flexibility, a high responsiveness to environmental change and the ability to adapt to emerging challenges. Variation and change thus become core elements of the innovation process that should be incorporated in product development, thus forming the basis for the definitive characteristics of the model. The flexible model therefore considers the importance of market competitiveness to NPD (e.g. Jayaram et al. 1999), assuming that competitive markets require more competitive NPD processes.

This model differs from the previous two in its view of uncertainty and its rejection of the need for a sequential/mechanistic structure. Uncertainty becomes an *opportunity*, rather than a threat, which calls for the adoption of flexible/organic models (Thomke and Reinertsen 1998). As Keegan and Turner (1999) have demonstrated, the organic management of innovation may lead to significant success, but it requires a set of managerial practices, e.g. slack and ambiguity, yet these are more often than not viewed as unorthodox. Departing from the idea of product development as a rigid sequence of phases, the flexible model proposes the use of 'rapid and flexible iterations through system specification, detailed component design, and system testing' (Iansiti 1995: 2). The model therefore adopts a more dynamic perspective, aiming, nevertheless, to keep the concept development stage open as long as possible, in order to avoid launching outdated 'new' products.

Of some relevance to this process is the metaphor of rugby. This may be illustrated in the way the Honda City development team went through the NPD process: 'Like in rugby, every member of the team runs together, tosses the ball left and right, and dashes towards the goal' (Imai et al. 1985: 545). It combines a sense of urgency with variation and overlapping procedures. The proponents of this model argue that new information should be incorporated iteratively to enrich product concept and design, fluid communications created amongst project participants, and problems detected by the use of simulation and prototype-driven experimentation. Thus, the faster a project can integrate new information, the faster it can respond to changes in the product's environment (Iansiti and MacCormack 1997: 112). Flexibility

involves the simultaneous resolution of different functions to promote overlapping phases as well as a certain overlapping of concept development and implementation activities, thus achieving convergence.

The serialized separation of activities (in space and time), characteristic of previous models, gives way, therefore, to a blurring of activities, with phases blending together and being re-initiated when necessary, in expected or unexpected directions (see Figure 3, part C) until the final solution arises, as close as possible to the market launch. This is succinctly described in the case of NEC's SX-2 supercomputer (Iansiti 1995). The permeability of this model makes it adequate for working with real-time information and dealing with problems of environmental disturbance. From the foregoing, we argue that the flexible model works in an organic fashion, eschewing the heavy stress on characteristics such as specialization and standardization (Burns and Stalker 1961) that are crucial to traditional models.

Despite these advantages, the flexible model has some shortcomings. First, by embracing uncertainty in a turbulent environment, it can seriously jeopardize the viability of products. This makes it inadequate for efficiency-seeking organizations. As a 'high velocity–high turbulence model' it is not a mere coincidence that the test of the model has mainly taken place in the computer industry (e.g. Iansiti and MacCormack 1997), whose main features include velocity and a high product innovation rate (Curry and Kenney 1999). There is a risk of possible delays in concept freezing in anticipation of new, though late, 'essential' information, or the possibility that competing product concepts 'might as well' be kept open, thus delaying the final decision on which concept to adopt. There is also the risk of freezing the wrong concept. This model is also more demanding than earlier models in terms of coordination, because linearity has been traded for organicism. Thus the potential failure to manage the resultant 'freedom' effectively can engender a propensity for chaos.

The sections above have taken a critical look at the existing models of NPD. Below, we set out our case for exploring improvisation in organizations. The need for an improvisational model of NPD derives from the growing awareness that the innovation process is highly unpredictable and uncontrollable (Van de Ven et al. 1999) and that linearity may be more retrospective reconstruction than fact (Deuten and Rip 2000). Also, most analyses of the NPD process focus on incremental innovations (Veryzer 1998), ignoring some facets of less predictable innovations. Thus, while established models may work in the mature and stable markets (e.g. Iansiti 1992) for which they were originally created (e.g. Chakravarthy 1997), they may not be appropriate for turbulent environments. Managing in turbulent and unpredictable environments requires new forms of organizing through new structures (Ciborra 1996), and through organizational (Orlikowski 1996) and technological (Orlikowski and Hofman 1997) change.

As Eisenhardt and Tabrizi (1995) argue, when unexpected events are an issue, product development in a flexible or improvisational mode may be the answer. NPD models should therefore equip the organization with the capacity for dealing not only with routine and mechanization, but also with

surprise and real-time adaptation, as innovation has to do with both (e.g. Sheremata 2000). While it comes close to meeting the challenges of such environments, the flexible model does not capture the full extent of this complexity, especially since it is concerned with flexibility rather than a synthesis between flexibility and structure. It is in this regard that we offer the improvisational approach. To build our argument, we draw on some useful lessons from jazz improvisation, and then proceed to posit an NPD model which draws from improvisation.

Jazz Improvisation (JI)

In articulating the nature and rationale for an improvisational NPD model we feel it is important to give the reader an introduction to jazz improvisation, the one form of improvisation which has so far had the biggest impact on organizational improvisation, but one which, unfortunately, is not fully understood in the NPD literature. By understanding what actually goes on in jazz improvisation, researchers who make reference to this art form will be better informed about its full potential and limitations with regard to organizational analysis. As noted earlier, improvisation is the merging of composition and performance: improvisers create the music as they go along, without the benefit of prior elaborate planning.

Jazz music emerged as a distinct musical form over a hundred years ago around New Orleans, USA. However, historians generally accept that it represents a synthesis of many cultural influences achieved through four hundred years of slavery (e.g. Megill and Demory 1996) beginning with African rhythms, instruments and spirituality, and gradually absorbing European harmony and instrumentation. Jazz music has continued to grow through phases: from 'dixieland', as epitomized by people like Joe 'King' Oliver, Louis Armstrong, Jelly Roll Morton; big band 'swing' — Benny Goodman, Count Basie, Duke Ellington; 'bebop' — Charlie Parker, Dizzy Gilliespie, Miles Davis; 'free jazz' — Ornette Coleman, John Coltrane; to the modern-day fusion with a wide range of other musical styles, e.g. Sadao Watanabe, Hugh Masekela and many others (see also Berliner 1994; Leonard 1987; Megill and Demory 1996; Williams 1993).

To understand the creation of jazz music, we must appreciate its definitive features, or 'form': melody, harmony, rhythm, theme, timbre, chordal progression, etc. The jazz scale adopts 8 unequal intervals, a departure from the usual 12 equal intervals in the 'chromatic scale'. This creates 'major' or 'minor' scales. The melodic basis of the song is generated by sequential chords, which are combinations of notes. The most common form is the 32-bar chord progression in an *aaba* pattern beginning with a sequence *a,* followed by a repeated *aa*, and the introduction of *aab*, ending on *aaba*. The jazz song is subject to unceasing stylistic transformation, such as the repeated sequence (chorus), the manipulation of a riff — a melodic or harmonic fragment that serves as an underlying theme, the use of individual soloing, and so forth. Within the very wide jazz repertoire, there is a

certain simplicity which exists in the domains of harmony and rhythm: 'a sequence of chords tied to a metric scheme' (Kernfeld 1995: 40), which gives the musicians a sense of direction and allows them to improvise with this 'roadmap' in mind. This roadmap is at the heart of the tacit 'minimal structure' — this is treated more fully below.

It should be noted that jazz is not all about improvisation. Much of the jazz repertoire today is based on annotated compositions by songwriters like Scott Joplin, the Gershwin brothers, Hoagy Carmichael, and others (see Kernfeld 1995). However, no jazz musician worth his salt remains true to the musical score in the way a classical orchestra might play Beethoven — with clinical precision. The more usual approach is 'arrangement', which is largely about re-instrumentation on an existing piece, or the reworking of a riff, etc. *It is this capacity to create so much out of so little that we find so compelling*. Similarly, this capacity for constant renewal and re-invention has important implications for organizational processes like product innovation which this paper seeks to address. Below, we tackle the issue of structure within jazz improvisation and proceed to apply this to NPD.

Improvisation and Minimal Structures

'You can't improvise on nothin', man. You gotta improvise on somethin'. (Charles Mingus, bassist/composer. Cited in Kernfeld 1995)

All music, including jazz, exists within a certain musico-structure which defines such performative basics as harmony, melody, rhythm and tempo, and, more fundamentally, form and composition, as noted above. Unlike other musical forms, which rely on a tight script and/or conductor, jazz contains few if any constraints on performative style and interpretation. As Hatch (1999) has argued, jazz differs from other musical forms 'in the improvisational use it makes of structure', where musicians 'use structure in creative ways to enable them to alter the structural foundations of their playing'. It is important therefore to understand the constitutive elements of this structure and how it actually works in practice. All that jazz needs in terms of structure is a set of consensual guidelines and agreements which we conceptualize as 'minimal structures'. This section seeks to isolate such a structure from our understanding of jazz improvisation. In order to clarify the logic that holds it together, we assess the literature that has so far grappled with this concept.

Weick (1989: 244) suggests that the value of a minimal structure is that 'small structures such as simple melody ... , general assumptions, and incomplete expectations can all lead to large outcomes and effective action'. Eisenberg (1990: 154) has observed that 'improvisational freedom is only possible against a well-defined (and often simple) backdrop of rules and roles'. As such, he sees the process of 'jamming' which jazz musicians engage in, as 'a kind of minimalist's view of organizing, of making do with minimal commonalities and elaborating simple structures in complex ways'.

In a similar vein, Pasmore (1998: 564) notes that 'jazz is designed and intended to allow maximum flexibility within a minimum framework of commonality'. Brown and Eisenhardt (1997) see this minimalism in terms of a 'semistructure'. For Miller (1993), minimalism is about simplicity — focusing more narrowly on a single theme, activity or issue. However, while simplicity, in Miller's terms, ultimately brings about failure, by preventing organizations from adapting to complex changes, our notion of minimal structures is more robust, because it does not serve to constrain action or limit options: JI is, by definition, creative and exploratory.

Drawing from the functional conventions of JI, and from the seminal work of Bastien and Hostager (1988), we see minimal structures as comprising of two elements: social structures and technical structures (see Table 1). Bastien and Hostager (1988) have identified two sets of 'structural conventions' in the jazz process, which they term 'musical structures' and 'social practices'. Drawing from Emery and Trist's (1975) notion of 'turbulence', they view jazz as a *turbulent task environment* whereby the turbulence results from the dynamic process of musical invention and the dynamic process of coordinating invention. This scenario strongly resonates with the product innovation process in which both individual invention and group coordination challenges are at play within a broader context of an uncertain business environment.

From their incisive analysis of an improvised jazz concert, Bastien and Hostager (1988: 586) conclude that 'these structures serve to constrain the turbulence of the jazz process by specifying particular ways of inventing and coordinating musical ideas'. In the sections below, we build upon these conventions and subsequently reconfigure them for our purposes. We suggest that both types of structures are essential for managing the complementary human and performative dynamics by effectively fusing creativity and the mechanisms of realizing it, including the instruments/tools. The application of social and technical structures echoes the tradition of socio-

Table 2
Minimal Structures in Jazz Improvisation

Social Structures	Technical Structures
Behavioural norms	Definition of key, chord progression and repertoire
Communicative codes: call-response, hand signals, eye contact	Use of the template of a song, chorus or riff upon which to improvise
Partnering in an autonomous ensemble	Wide stock of talent and performative competence
Trust within wide zones of manoeuvre and constructive controversy	Knowledge of music technology and instrumentation
Alternate soloing and comping for leadership and personal development	Experimenting with new instruments, styles and textures of sound
Attitudes conducive to risk-taking, 'jamming' and continuous learning; culture supportive of risk-taking	Refashioning performance in response to colleagues and audience

technical systems (e.g. Emery and Trist 1960). There are, of course, other aspects of these processes, such as emotion, a much neglected aspect of structure, according to Hatch (1999). Hatch suggests that in jazz, this is handled through communication; following Bastien and Hostager (1988) communication is treated here as a central component of the social structures. Below, we consider these structures.

Social Structures

Social structures in JI are conceptualized largely in terms of behavioural norms and communicative codes (e.g. Bastien and Hostager 1988). Behavioural norms include: the nominal leader, who decides which songs to play and in what key; the soloist, who determines the style and embellishment; and the use of a chorus, which restates the basic theme. Band members use a combination of hand signals and eye contact to communicate change in tempo, the beginning and ending of soloing, call-and-response exchanges, and so forth. There is an unspoken understanding of the need to respect and comply with these basic guidelines for action, for without them, the improvisational process would degenerate into chaos. These basic guidelines, and the behavioural norms, help to determine performance standards. A high quality of performance is achieved if musicians apply their full competence and creativity, while respecting these minimal guidelines as to when to solo, for how long, what key and tempo to adopt, and so forth. Thus, as Bastien and Hostager (1988: 586) note, the social structures 'paradoxically enable collective musical innovation by constraining the range of musical and behavioural choices available to the players'.

A third important element of social structures is 'partnering' which refers to the collaborative creation of a collective mind (Weick and Roberts 1993). Partnering highlights the strength of relationships established over time and the mutual commitment arising from sharing in the intense process of creativity. For our purposes, this intensity, risk-taking and mutual commitment go beyond the group concept of 'cohesiveness'. Creative collaboration demands a climate of 'constructive controversy' (West 1995) which fosters trust and cooperation, and builds on dialogue and inquiry, in turn leading to the systematic remodelling of the song. Creative collaboration, as a process of discovery, works if there is total commitment to the project, in this case the improvised performance. A high degree of commitment is achievable since jazz musicians see themselves as members of a highly autonomous, interdependent and mutually enriching unit — their commitment is predicated on their inherent stake in the success of the performance, upon which their reputation and integrity depends. Trust is an important part of this process, as a fundamental ingredient in sustaining performative interdependence and social cohesion. This special form of trust comes partly from the possession of adequate and comparable skills amongst the band members, and partly from the need to create a psychological buffer against errors arising from the experimental nature of improvisation.

We next consider leadership. In addition to the formal band leader, improvisation offers a special form of leadership through the act of soloing. At any one time, anyone can solo and in the process restate his/her competence for the appreciation of colleagues and audience, as well as to offer a distinct and personal interpretation of the song. Allowing an individual to determine the direction and flavour of the performance attests to the ensemble's trust in the soloist. The legitimacy of the soloists' 'authority' thus derives from their expert skill and ability to blend their competence with that of the other members. There is often no prior agreement as to the order in which members will solo, or the length of the solo; it all depends on how the ensemble interpret the song as they proceed, how this is received by the audience, and how the members themselves react to the soloist's definitional contribution, i.e. temporary leadership. Finally, under social structures, we include attitudes, in particular, risk-taking and a predilection to experiment, singly or collectively. Barrett (1998: 606) notes that 'improvisation involves exploring, continual experimentation, tinkering with possibilities without knowing where one's queries will lead or how action will unfold'. This aesthetics of imperfection (Weick 1995) requires musicians to treat errors as a source of learning.

Technical Structures

This refers to the techno-structural and performative conventions of jazz music as well as the variety and combination of talents, skills and capabilities that members bring to the ensemble. Bastien and Hostager (1988) refer to the former as 'musical structures'. They consider two elements: cognitively held rules for generating and building upon new musical ideas, including rules for 'musical grammar'. More specifically, this refers to the basic procedures in jazz theory for defining and selecting the basic form of the music: the key, chords, chordal relationships and chordal progression (see also Berliner 1994).

The second element is the *template*, a song, chorus or riff. Bastien and Hostager (1988: 587) argue that 'songs are a more concrete and limiting musical structure than jazz theory in that they embody particular patterns of chords and chordal progressions'. The song is a basic template upon which musicians can generate innovative variation. To do so, and to sustain a high level of competent performance, jazz musicians must be thoroughly knowledgeable about jazz music theory and jazz history which includes the different jazz forms and key contributors. This constitutes a definitive feature of technical structures. They should also possess a wide repertoire (of well-known jazz standards) acquired over a long period of learning and performing, thus highlighting the role of memory (e.g. Weick 1998).

Fourthly, technical structures are about music technology and instrumentation, where instrumentation might range from an unaccompanied pianist to a big band orchestra. Technology and instrumentation have been changing constantly in the last hundred years, from the earliest ensembles, in

the 1890s, comprising cornet-trumpet-clarinet-trombone-tuba-banjo-drums combinations, to the adoption of new instruments (e.g. piano, string bass, vibraphone, saxophone, violin, guitar, electric keyboards, etc.), and the modification of instruments or playing styles, for example by using mutes on trumpets or trombones to produce voice-like effects, and by using synthesizers to manipulate and create new sounds and inflections, and so forth. This inventiveness and constant modification of musical 'tools' resembles the art of bricolage.

Technical ability also implies an understanding of the role and contribution of other instruments, other than one's preferred one(s). Accomplished jazz musicians are competent across different ranges of an instrument — e.g. soprano, alto, tenor and baritone saxophone or across a number of instruments, usually in the same section — e.g. horns (trumpet, clarinet, trombone, etc.). The more talented and innovative ones progress across a wider range — e.g. from piano to trumpet and banjo. Edward 'Kid' Ory, one of the definitive forces behind the 'dixieland' sound was proficient in no less than eight instruments. Such multi-skilling or versatility is a central feature of improvisation; it also plays a crucial role in facilitating experimentation with new instruments, styles and textures of sound. Finally, technical structures involve a constant refashioning and re-interpretation of the performance in response to colleagues and the audience. In Hatch's (1999) terms, this is possible because musicians make structure implicit, play around it and thus fill the 'empty spaces' from which new structures are inferred.

Towards Minimal Structures

The definitive aspect of these structures is that they are largely implicit and tacit. Band members will appreciate the importance of competence, trust, soloist leadership, a wide repertoire and so forth, yet these may never be explicitly stated. Incompetent players weed themselves out or are simply not invited to a 'gig'. The absence of explicit rules does not lead to chaos or confusion; if anything, it frees up the musicians' creative capabilities and thus accords jazz improvisation the unique ability to manage the paradox of flexibility and structure. According to Hatch (1999), structure in jazz supports, but does not specify. For Brown and Eisenhardt (1997) what is needed is a 'semistructure' which combines specific guidelines and a high degree of flexibility.

The above paradox can be viewed alternatively with reference to Meyer and Rowan's (1977) institutional theory in which organizations such as hospitals and schools have highly specific and rigid rules of administration and yet the professionals working in them may have a high degree of freedom in how they approach their work. These authors argue that such institutions resolve this paradox through the 'logic of confidence' invested in professionals. For our purposes, this 'logic of confidence' amounts to the trust which accords jazz improvisers wide *zones of manoeuvre* (Kamoche and Cunha 1999; cf. Clark 2000) within which to experiment and create. The

challenge for managers is to establish what is the right amount of structure. Weick (1999: 545) suggests that 'either there is too little structure or the wrong kind of structure in organizations, and that is what makes it hard for them to innovate'. Below, we demonstrate how this model can be applied to NPD.

Towards an 'Improvisational Model' of NPD

One of the earlier efforts by highly bureaucratic firms to respond to smaller, nimbler competitors was through 'skunkworks' (e.g. Gwynne 1997) — smaller, highly autonomous departments/plants that worked on specific problems, *outside* central control, with the aim of commercializing their solutions. These forms enjoyed minimal success: the best known example is the failure of Xerox in the 1970s to commercially develop their advanced computer technology, which was later appropriated by Apple. The challenge for the improvisational model is to achieve a synthesis between control and flexibility through multidisciplinary teams working autonomously *within* the company's product strategy. Various authors have argued that striking this balance is the main challenge in product development today (e.g. Adler et al. 1999; Clark and Fujimoto 1991; Tatikonda and Rosenthal (2000). Our minimally-structured improvisational model takes on this challenge and serves as a framework to re-examine product innovation.

Given the emergent, albeit patchy, evidence on the prevalence of improvisation in organizational settings (e.g. Ciborra 1999; Faia-Correia et al. 1999) as well as in NPD activities (Brown and Eisenhardt 1995; Eisenhardt and Tabrizi 1995; Moorman and Miner 1998a; Nonaka 1991), there seems to be a need for a fine-grained analysis of an improvisational approach to modelling NPD. The evolving nature of NPD practices, as illustrated, for example, by Sobek et al. (1999) and Griffin (1997b), suggests that an improvisational approach would be appropriate for fast-changing environments (see also Brown and Eisenhardt 1997) and for the complex processes involved in new service development (Edvardsson et al. 1995).

A thorough comparison between this model and the flexible model may be helpful for clarifying the rationale for the former. As in jazz improvisation, the improvisational model of NPD would be aiming to achieve planning and execution contemporaneously. The need for this has been accentuated by the fact that the co-evolution of markets and technologies today has increased the difficulty of forecasting (e.g. Makridakis 1990). The need to constantly rework product design in the light of new knowledge or changing circumstances (Hart 1995) implicitly recognizes that old prescriptive models may not be adequate under conditions of high market volatility. This volatility has been amply demonstrated in the internet-related sector.

The flexible and the improvisational models are both change-driven models. Both are closer to 'exploration' than to 'exploitation', in March's (1991) terms, and place emphasis on discovery and handling surprise. Nevertheless, the differences between them are not merely a matter of degree, as

Table 1 illustrates. The flexible model stimulates variation and tries to push flexibility to the maximum, while blending functions, thus aiming to be as 'organic' as possible. In contrast, the improvisational model is unconstrained by the imperatives of function or sets of activities and lays more emphasis on combining the need for structure with that of freedom (see Figure 4, part D).

This implies being both flexible and efficient (Adler et al. 1999) or striking a balance between the organic and mechanistic structures (Burns and Stalker 1961). The realization of such a dialectical approach is facilitated by the minimal structure, where appropriate levels of responsibilities, priorities and procedures are clearly defined and combined with wide *zones of manoeuvre*. By combining structure and flexibility, the improvisational model introduces scholars and managers to a kind of synthesis that has not been sufficiently developed in the past but that must now be addressed (e.g. Nadler and Tushman 1999). This is best articulated in Brown and Eisenhardt (1997). In this approach, open definitions of the product concept (Nonaka 1991) merge with clear, although not necessarily explicit, modes of coordination. Other examples include the gradual narrowing, converging logic of Toyota (Sobek et al. 1999), the frequent milestones combined with regular testing of the successful companies in Eisenhardt and Tabrizi's (1995) sample, Brown and Eisenhardt's (1997) priorities combined with extensive interaction and freedom to improvise, and the 'flexibility within a structure mode' of effective product development execution (Tatikonda and Rosenthal 2000). These examples provide ample evidence of the emergent improvisational model of NPD. Clearly, there is scope for further research to determine the prevalence and viability of this model over time — the limited studies in this embryonic literature have only been published in the last few years.

While the flexible model is rooted in the creation of variation (e.g. alternative solutions) followed by fast convergence, the improvisational model generates innovativeness on the basis of minimal structures. The minimal structure serves as a *template* upon which improvisation can take place — *you cannot improvise on nothing*. If there is agreement about the basic aspects of the process, e.g. behavioural norms, leadership, deadlines, product concept, etc., product designers have unfettered scope for creativity (see the sections below). Thus, while the flexible model seeks operational flexibility between functions in order to adapt to challenges, the improvisational model is characterized by an unrelenting quest for discovery and innovation along the social and technical dimensions — ranging from revolving leadership to experimenting with unusual tools and procedures.

Similarly, controls are used to facilitate rather than to constrain participation and knowledge creation (Lindkvist et al. 1998); this echoes the role of structure, as noted by Hatch (1999). For example, at previously established milestones or points of intersection (e.g. Brown and Eisenhardt 1997; Sobek et al. 1999), gradual convergence is achieved through the elimination of unfeasible ideas. The design emerges as the development process goes along (Orlikowski 1996; see also Figure 4). These practices are similar

to the synch-and-stabilize approach observed by Cusumano (1997) at Microsoft, where the synchronization of the work of individuals and teams was followed by periodic stabilizations of the incrementally evolving product features.

Brown and Eisenhardt's (1997) analysis of how firms engage in continuous change in the high-velocity computer industry is an excellent illustration of the dialectical ethos of the improvisational model. Without necessarily referring to it as an 'improvisational NPD model', these writers found that successful firms engaged in the following: they combined 'limited structure' (e.g. priorities, clear responsibilities, meetings) with extensive interaction to improvise new products, constantly explored the future through experimentation, and linked products over time through 'rhythmic transition processes'. Noting that while conventional wisdom

Table 3
An Improvisational Model for NPD

Social Structures		Technical Structures	
NPD	Jazz Improvisation		NPD
Team's objectives specified priorities, members' responsibilities. Regular meetings	Behavioural norms	Definition of key, chord progression and repertoire	Identification of critical quality standards and performance criteria
Cross-functional and cross-project communication; networking	Communicative codes: call-response, hand signals, eye contact	Template of a song, chorus or riff upon which to improvise	Template of a product concept, process, prototype, vision, milestone, etc upon which to improvise
Intense interaction in (semi) autonomous workteams; information sharing	Partnering in an autonomous ensemble	Wide stock of talent and performative competence	Broad range of cross-functional skills; frequent training and rotation
Trust in a climate of trial-and-error experimentation. Mutual faith in performance integrity	Trust within wide zones of manoeuvre and constructive controversy	Knowledge of music technology and instrumentation	Extensive knowledge of available technology and how it leads to collective action
Revolving leadership in product design and development; mentoring and empowerment	Alternate soloing and comping for leadership and personal development	Experimenting with new instruments, styles and textures of sound	Application of unusual tools, methods and technologies; creating experimental products; Bricolage; multiple iterations and testing
Attitudes conducive to experimentation with new product ideas; continuous learning; supporting and rewarding risk-taking	Attitudes conducive to risk-taking, 'jamming' and continuous learning; culture supportive of risk-taking	Refashioning performance in response to colleagues and audience	Constant systematic remodelling; use of real-time information flows; involvement of customers in testing prototypes

going back to Burns and Stalker's (1961) seminal study suggests that 'organic' structures are the answer to successful product innovation, Brown and Eisenhardt (1997: 7) found that managers of successful firms 'balanced between mechanistic and organic by combining clear responsibilities and priorities with extensive communication'. They propose the term *semi-structures* to define this organizational process in which some aspects (e.g. meetings) are predetermined and others (e.g. the actual design process) are not. This notion is consistent with our concept of minimal structures. A minimally structured improvisational model is presented in Table 3, which shows how both the social and technical dimensions derived from minimal structures in JI (Table 2) relate directly to specific aspects of NPD. In the sections below, we explain what this minimal structure actually means in the process of product innovation. We draw from the emergent literature to demonstrate how specific aspects of the minimal structure are likely to operate, and the extent to which they are likely to contribute to improved product innovation.

The Social Structure in NPD

The first 'layer' of the social structure is behavioural norms — shared expectations about appropriate behaviour (Bastien and Hostager 1988). In the context of innovation, behavioural norms evolve around the team's objectives and the expectations directed at each member to work towards realizing the product concept or the assigned task. As in Brown and Eisenhardt's (1997) study, members in successful product innovation projects work with specified priorities, have clear-cut responsibilities and hold meetings on a regular basis. The design process itself is not tightly structured. There is a need for information about specifications and goals, division of responsibilities, systematic reporting, documentation and feedback (Edvardsson et al. 1995).

As for communication, the emphasis here is information sharing and the mechanisms for doing so. Information is shared across functions and project teams and through extensive networking. Nonaka and Takeuchi (1995) illustrate this 'fluidity' with regard to Kao's 'free access to information' policy which provides integrated computer systems across the organization, 'open floor allocation', 'open meetings' and 'fluid personnel change'. These forms of communication have now become institutionalized in the high-tech industry. In such contexts, frequent discussions and e-mail become analogous to hand signals and eye contact in jazz. Similarly, extensive communication in multi-functional teams, information sharing and the involvement of workers in idea generation were found to be associated with successful product innovation (e.g. Brown and Eisenhardt 1997) and model changes which constitute new products (e.g. Adler et al. 1999).

Related to communication is the existence of intense interaction within the semi-autonomous project teams. According to Weick and Roberts (1993) this characteristic defines and facilitates the cohesiveness of collaboration and further strengthens operational 'fluidity' (Nonaka and Takeuchi 1995).

The importance of communicating and sharing information has been noted in crisis situations, for example in Hutchin's (1991) analysis of the way crew members repeatedly communicated partial information as they calculated coordinates to guide their ship to harbour after its navigation system failed. In jazz improvisation this intense partnering ultimately leads to a feeling of 'transcendence' (Eisenberg 1990). The critical role of autonomy in determining product success has been noted in many instances (e.g. Imai et al. 1985; Moorman and Miner 1998a; Tatikonda and Rosenthal 2000).

The significance of trust is exemplified, in particular, in Adler et al. (1999), along three dimensions: 'consistency trust' (people will do what they said they would); 'competence trust' (having faith in other's abilities) — both these forms of trust are particularly vital when there is high uncertainty and hence a need for reliable colleagues both in JI and NPD; 'goodwill trust' — this refers to openness and goal congruence. Trust has also been found to be an important determinant of the success of collaborative product development projects (e.g. Littler et al. 1995), and is associated with superior performance (e.g. Thwaites 1992). Trust is further evidenced in terms of mutual faith in performance integrity, especially where evaluation parameters are vague, indeterminate or constantly changing, and where members have wide *zones of manoeuvre* (Kamoche and Cunha 1999) designed to facilitate autonomy, hence reasonable margins of error in product or concept design.

Eisenhardt and Tabrizi (1995) and Clark and Fujimoto (1991) found that 'strong leadership' motivates and focuses product development teams. As such, at the idea-generation and operational levels, it may be helpful to allow individuals to assume temporary, evolving leadership (to play solo) in order to help them develop leadership skills and for confidence-building and empowerment of team members. Accompanying the soloist ('comping') serves both to support and constrain the soloist. It also serves the important purpose of facilitating learning by eliminating such obstacles as excessive competition and failure to appreciate others' input (e.g. Argyris 1993).

Zien and Buckler (1997) and Perry (1995) have noted the importance of having a culture supportive of innovation. This appears crucial insofar as improvisation is about experimentation and exploration. This played a crucial role in Honda's success, in particular through the choice of management style and the unique blend of strategy, structure and 'shared values' (Pascale 1984). The experimental nature of improvisation implies a high potential for error and misjudgement. Zien and Buckler (1997) found that, among highly innovative companies, a hundred investigations for every market success was a common rule of thumb. In successful, highly innovative companies, mistakes are treated as an opportunity for organizational learning (e.g. Harryson 1997), failure resulting from risk-taking is rewarded (e.g. Sasaki 1991), and managers accept and encourage 'rule-breaking' (Brown and Eisenhardt 1997). It seems necessary, therefore, to develop risk-taking attitudes which are supported by a sympathetic culture, in order

to facilitate continuous learning. Inquisitive attitudes have been found to reduce psychological over-attachment to projects, which in turn may avoid escalating commitment to a chosen course of action when change is required (Staw and Ross 1987).

The Technical Structure in NPD

Drawing from our technical structure in JI, we see the equivalent of key, chordal progression and repertoire as the specification of quality and performance standards in innovation. These parameters offer very clear guidelines on vital issues such as 'product scheduling for time to market' and 'product performance', which, in turn, is predicated on predetermined quality standards. These elements constitute the required level of 'formality' (Tatikonda and Rosenthal 2000) that provides a sense of purpose and direction. It is important that these criteria include allowable margins of error within which experimentation can be accommodated.

In the same way that jazz musicians might improvise on the basis of a song, riff, or chord, etc., templates upon which to improvise in NPD can be drawn from such aspects of the innovation process as the product concept, an existing design, blueprint, or experimentation with new tools/technology. Other templates include broad product visions and slogans (Nonaka 1991) or a product prototype upon which engineers can model and create variations (e.g. Barrett 1998; Weick 1999). Such a template has the added capacity to create a shared orientation of the task in hand as well as galvanizing action. Barrett (1998: 612) describes how Kodak developed the Funsaver camera: designers made changes and creative contributions iteratively, made these public through computer technology, thus allowing everyone 'to tune themselves to possible direction, like changing the root movement of the chord'. Others include the delineation of project milestones (e.g. Eisenhardt and Tabrizi 1995), priorities, responsibilities and 'rhythmic transition processes' (Brown and Eisenhardt 1997), as well as periodic reviews for project control, i.e. 'phase gates' (e.g. Tatikonda and Rosenthal 2000).

A high degree of individual competence is central to the technical structures in innovation: our third element in Table 3. This is analogous to the performative competence required of jazz improvisers. In innovative activities, cross-functional skills are necessitated by the interdependency inherent in teamworking. For example, Adler et al. (1999) found extensive training and rotation accorded a very high priority to the extent that workers attained sufficient competence to rotate around four jobs. This plays the additional role of reinforcing 'competence trust'.

Coupled with extensive competence is knowledge about tools/technology through which this expertise is accomplished. This parallels musicians' ability to effectively use a wide range of instruments and their knowledge of music technology and instrumentation. Although project team members cannot be expected to be expert in all the technology available, an extensive knowledge of the available technology and how this helps to coordinate collective action is essential for bringing multiple perspectives to bear on

the distributed task (Seifert and Hutchins 1992). This is particularly helpful in realizing the product's technical performance as measured in terms of technical functionality, quality, product unit cost and time-to-market (e.g. Rosenthal 1992).

Knowledge of the productive process is helpful in creating an ability to use whatever materials/tools are on hand and to apply them to the task in a manner similar to the art of bricolage (e.g. Weick 1993a). This could also be illustrated in the case of NASA scientists who had to experiment with novel physics and mathematical concepts to guide Apollo XIII back to earth (Lovell and Kluger 1995). Constant experimentation and trial-and-error have the potential to achieve individual and organizational learning. In NPD, this manifests itself in multiple iterations (design alterations), the generation of multiple ideas and the search for alternative methods which ultimately speeds up development time and improves product quality (see, e.g., Eisenhardt and Tabrizi 1995). Brown and Eisenhardt (1997) also found that managers of successful product portfolios looked to the future through a high degree of experimentation and by constantly probing the future with experimental products, futurists and strategic partnerships. This has some implications for organizational learning both within the improvisational model and in some forms of the 'flexible model' (e.g. Sitkin 1992; Sobek et al. 1999). Frequent experimentation and testing have also been found to uncover inappropriate aspects of design (Staw and Ross 1987).

Finally, improvisation in jazz involves the constant systematic remodelling instigated by the simultaneous reaction from colleagues and the audience. Musicians are able to utilize these reactions as they become available and reformulate their performance almost instantaneously. This use of real-time information flows is pivotal to successful product innovation, particularly as regards the use of market intelligence. As various observers have argued, market information keeps the project team focused on customer needs and wants throughout the design and development effort (e.g. Veryzer 1998: O'Connor 1998). Similarly, the involvement of prospective customers in idea generation and the use of prototypes helps uncover customer wants and market opportunities, thus improving the product development process (e.g. Mullins and Sutherland 1998).

To conclude this section, we note that the strength of the improvisational model lies in the unique way in which this model achieves a balance between control/structure and flexibility/autonomy. The dialectical approach to integrating tensions between these two 'opposites' is an important logic of this model. The firms that succeed in realizing this synthesis seem to be effective in the management of NPD projects in turbulent environments, as demonstrated, for example, by Brown and Eisenhardt (1997) and Tatikonda and Rosenthal (2000). Though the minimal structure is, by definition, parsimonious and concise, we have endeavoured to elaborate its constitutive elements in order to demonstrate the logic that holds it together.

While developing a conceptual framework to make sense of the fragmented knowledge of the nature of improvisation in product innovation, we caution that managers who opt to implement this model may encounter some

difficulties which might affect the achievement of performance standards. The shortcomings of this model are summarized in Table 1. For example, failure to achieve an appropriate synthesis between structure and flexibility may result in teams becoming chaotic or regressing to control-based models (Brown and Eisenhardt 1997). This may happen because managers are unable or unwilling to implement autonomy (e.g. Gerwin and Moffat 1997); they may also resort to the comfort zones of formality, while under pressure. Similarly, not everyone is willing or *can* improvise. As Weick (1995) suggests, how people react to failure can affect their subsequent willingness to improvise, hence the need for an 'aesthetics of imperfection' in which errors are treated as opportunities rather than threats. Similarly, in their 'experiential' strategy, Eisenhardt and Tabrizi (1995) note that fast pace and uncertainty entail cognitive and emotional issues.

We also see a special challenge in sustaining the dialectical logic central to the improvisational model, as many organizations may lack the capacity to be both flexible *and* structured. The absence of teamwork, appropriate training and reward strategies, and a supportive culture, may stall the process. The improvisational model may also run against the practice of many Western organizations, where clear, second-order controls (Perrow 1986) are the norm. In Japanese companies, the tacit, third-order controls required by improvisation are more ingrained (see Nonaka 1991; Adler et al. 1999; Sobek et al. 1999). As a consequence, the improvisational process may look ambiguous or unrealistic (Brown and Eisenhardt 1995). Below, we summarize our argument and then consider some implications.

Conclusions and Implications

In this paper, we have examined the concept of improvisation and attempted to demonstrate how it can be applied to innovative activities. The paper seeks to take the NPD debate to a higher level of sophistication — this research area has often been described as lacking theoretical development (e.g. Jayaram et al. 1999). As noted in our analysis, improvisation has been receiving some attention in recent years. Jazz has provided the main inspiration. Whichever field of the performative arts one turns to for inspiration, the main point is that there appear to be important lessons to be learned from the way improvisation in the arts redefines the concept of structure to permit creativity, innovation and continuous learning. While building on some of the existing literature on jazz improvisation, this paper has gone further to contextualize improvisation within the history of jazz music, and isolate a minimal structure which is relevant for NPD.

We are aware of some limitations in this study. For example, given our focus on jazz music, we have not analyzed other manifestations of improvisation, such as emergencies, public speaking (including 'loosely structured' lectures), theatre, or even sports. In our quest for parsimony that permits maximum flexibility, we offered a two-dimensional model of minimal structures. There are of course other aspects such as cognition,

emotions and spirituality which are at play in both performance and in innovative activity; these are potential avenues for further research. It should also be recognized that JI is not a faultless activity — experimentation within a context of uncertainty may result in 'wrong' notes, miscommunication, soloing that verges on self-gratification, excessive brinkmanship on stage, strategic drift or the degeneration of a jamming session into a 'cutting session', with musicians striving to outdo each other. There is also a danger that fashioning organizational innovation along the lines of JI might cause one to lose sight of the essence of product innovation. It is therefore worth reiterating that we are not advocating jazz improvisation, but rather are seeking lessons from this complex art form.

The improvisational model is not offered here as a *fait accompli*. Instead, it should be seen as a mechanism to improve innovation in *certain* organizational contexts. In 'high reliability organizations', where errors are intolerable (Barrett 1998), an improvisational approach is probably inappropriate. We recognize the need for further research to identify other circumstances within which improvisation is appropriate, in addition to the ones discussed here. Such research would require observation of actual innovation processes. So far, improvisation has been studied at a high level of abstraction, e.g. as a metaphor (e.g. Hatch 1999) or mindset (Weick 1998). The literature has not fully addressed the operationalization of the concept for elaborating and empirically testing its manifestations, and for establishing valid and accurate measurement tools — with the possible exception of Moorman and Miner (1998a) and Brown and Eisenhardt (1997). Some authors take a prescriptive (e.g. Crossan et al. 1996), or an anecdotal and journalistic approach (as in some pieces in Meyer et al. 1998).

A relevant research area is organizational renewal. The capacity for individuals/teams to constantly re-invent products and processes enriches the notion of systematic remodelling to embrace organizational learning and renewal. According to Chakravarthy (1982), strategic renewal through 'internal experimentation' and selection offers the possibility of remaining adaptive in different environments. We suggest, therefore, that there is scope for further research in how team-level improvisational activities foster organizational learning and renewal. In this regard, our model is consistent with the growing interest in emergent and self-organizing views of organizations (e.g. Mintzberg and McHugh 1985; Stacey 1991).

The improvisational model may therefore be interpreted as an adaptive response to changes needed when organizations redesign from efficiency-oriented hierarchic bureaucracies to flexibly-structured learning entities, aiming to solve problems through connected self-organizing processes (Daft and Lewin 1993). Our concept of minimal structures also hopefully paves the way for empirical work on the feasibility of improvisation in other aspects of organizational endeavour. This might reveal other pertinent dimensions, in addition to the two we propose — social and technical, while retaining the 'minimalist' character of such a schema. Finally, we contend that the improvisational approach offers a new opportunity to re-examine the concepts of structure and innovation, in addition to proposing a more

critical rapprochement between organization science and other forms of human endeavour — the arts. By delving incisively into the essence of jazz improvisation, we hope to give researchers who are currently drawing selectively, and in some cases superficially, from this art form, a better understanding of how it can contribute to organization science.

These research implications also have important consequences for the practical management of innovation; however, the absence of a mature research tradition requires caution in recommending improvisation to managers. Nevertheless, Tatikonda and Rosenthal (2000: 418) conclude from their empirical study that 'balancing firmness and flexibility, by having flexibility within a structure, is both achievable and desirable'. In a similar vein, Moorman and Miner's (1998a: 16) findings strongly suggest that 'there are conditions in which improvisation might be not only what organizations do practice, but what they should practice to flourish'. For them, these conditions involve the careful deployment and management of organizational resources. To this debate, we have proposed the concept of minimal structures that might serve as a template for improvisational activities, and have shown how the emergent literature demonstrates the relevance of improvisation to product innovation.

Although we see the minimal structures in terms of basic prerequisites and guidelines upon which larger consequences can be anticipated, managers may well interpret it in terms of the levels of control they wish to maintain over the innovation process, how much autonomy to allow the design team, and at what stages they might allow individual members to take the lead in the development process. If they choose to delineate 'phases' of innovation with reference to specific products, for administrative and budgetary purposes, they may decide to keep lower degrees of structure, for example, for an exploratory/research design phase, and higher degrees of structure for implementation. Managers can also treat improvisation as a source of actionable ideas (e.g. rotating leadership, networking, controlled freedom) that may allow a synthesis between the 'traditional' opposites of firmness and flexibility. It is also likely to engender idea generation and a propensity for experimentation. Managers wishing to introduce minimally structured NPD approaches should be aware of the risks involved in what is essentially an imperfect art, and should provide organizational structures, human resource strategies and cultures that nurture such ventures.

Note

* We are grateful to the Editor and anonymous *O.S.* reviewers, and to Kwaku Atuahene-Gima, João Vieira da Cunha and Muammer Ozer for useful comments on earlier versions of this paper.

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