Iranian Journal of Management Studies (IJMS)
Vol. 7, No. 1, January 2014
pp. 67-93

Beyond 'Funnel' and 'Fireworks': 'Water Ribbed Balloon' as a New Metaphorical Approach to Innovation-in-Practice

Hooman Attar*, Seyed Mohammad Reza Shahabi

Assistant Professor of Management Faculty of Management, Science and Technology, Amirkabir University of Technology , Tehran

(Received: 20 November 2012; Revised: 20 August 2013; Accepted: 31 August 2013)

Abstract

Product innovation success has very much to do with the development of models or metaphors that are able to guide actors. One can observe two traditions in this regard: rational and non-rational models. Apparently in the former the model, such as "development funnel", is regarded as a mechanism and rigid applicable, picturing innovation as an orderly, goal-oriented, value-neutral, and systematic process. The latter account offers a few non-rational models that depict product innovation as chaotic, messy, and stressful which involves jagged lines of activity, much like "fireworks". This paper draws on the work of Donald Schön to develop a more socio-politically informed yet pragmatic approach to innovation in organisation i.e. 'ribbed water balloon'. This model outlines product innovation as a non-rational and socio-technical practice, one that not only reveals politics, uncertainty, unsteadiness, setbacks, and reversals with which actors grapple but also considers rituals, norms and organization's behavioral world in its understanding.

Keywords:

fireworks, funnel, innovation models, metaphor, water ribbed balloon.

* Corresponding Author, Tel: +98125936976 Email: hooman@aut.ac.ir

Introduction

In 1983, Donald Schön observed that management and organiational studies tend to split into two camps – artistry vs. applied science. He went on to observe that these groups tend to operate in different worlds, rarely talking to each other. This kind of psychological 'splitting' or intellectual apartheid, is currently observable in studies of innovation in organisations (Lester & Piore, 2004) – polarization around two sets of positions.

One the one hand, we find a large and growing body of work on the economic, orderly, systematic, project-based, risk-reducing aspects of innovation. At the academic level, this view which has close links to the works of Hayes, Wheelwright and Clark (1992), and Cooper *et al*. (1999), prescribes a rational, stage-gate process of innovation in the face of otherwise chaos, conflict, and confusion. At a more consultancy level we find authors who are interested to provide and promote applied theory and technique for harnessing technological innovation with analytic methods so as to marshal and manage its complexities in funnel-like and orderly array. Under this light, the first task is to expand firm's incoming proposals, to make an analysis of the internal and external environment by law-like acquisition, application, and combination of knowledge and promising ideas, designing a set of aggregate projects depending on the share of a given market, and on occasion dominating and colonizing the selected market niche. The next is to position and drive the aggregate as a whole into a development funnel, coordinating 'the project team', 'the product concepts', 'the process materials, means and mechanisms', and 'the projected goals' through a process of funnel implementation. Within this systematic approach practitioners can progressively channel, narrow down, and concretize a constant stream of appropriate project concepts. The last task is to drive the outgoing new products

into the market at a speed that fits with the strategic thrust of the firm's strategy in its attempt to colonize the chosen niche. It demands actors to constantly monitor and provide feedback for organizational learning, the well-being of the firm in long-term, and sustainable competitive advantage.

On the other hand, in contrast to such economic-systematic-applied approaches, we find a variety of theoretical schools of thought examining the complex, socially constructed, and political nature of innovation within organizations. These schools of thought come from a variety of intellectual camps. A recent review of political-process views of innovation, noted three generations of literature within what is only one, albeit broad, school of thought (McLoughlin & Badham, 2005). Adherents to this camp come from the social construction of science and technology (MacKenzie & Wajceman, 1999); symbolic interactionist (Garrety & Badham, 2000), interpretivist (Lester & Piore, 2004) and sense-making views of organizations (Weick, 2000); schools of critical management ranging from Foucauldian (Clegg *et al*, 2006) and discourse theory (Morgan & Sturdy, 2000), through feminist (Wajcman, 1991) to more traditionally Marxist views of organization and innovation (Badham, 2005). According to this group the process of technological innovation is far from rational. It involves open-ended scenarios, ill-defined problems, politics, interpretation and ongoing conversations (Lester & Piore, 2005), fuzzy means and ends (Law & Callon, 1992; Wotherspoon, 2001), navigating uncharted waters (Van de Ven *et al*, 1999), rituals, and above all uncertainty, stress and anxiety (Schön, 1967).

Perhaps the difference between these views and the rational camp can be best exemplified by the works of some scholars (Scudder *et al*., 2000; Schroeder *et al*., 2000; Van de Ven *et al*., 1999) who recently formulated a firework-like model to represent the jagged process of innovation thanks to nonlinear dynamics. The exemplar of fireworks

exemplifies the mismatch between 'firm formal intention together with actors' deliberate navigation' and 'unintended, treacherous, and uncertain aspect of innovation'. It attempts to uncover and describe the non-rational, discontinuous, messy and mysterious dimensions that often make the innovation process take the form of an unmanageable trajectory.

In this paper we shall consider 'funnel' and 'fireworks' which take polar epistemological positions on the relation between theory and practice in innovation. Despite their different positions they hold two assumptions in common. The first is that the process of creativity in organizations can be better captured and coordinated by finding or formulating a family resemblance between our familiar tools, concepts, and images and the mysterious, indeterminate nature of the innovation.

Both metaphors of funnel and fireworks are associated with the notion that: 'technological innovation is disruptive, puzzling, and uncertain' but a 'managerial perspective or road-map that indicates how and why the innovation journey unfolds is needed' (Van de Ven & Angle, 2000: 4) – a 'vehicle' or 'theory' for concerted action, and would eventually contribute to the development of 'actionable knowledge' in this area (Argyris, 2006). Even Van de Ven *et al* (2000) acknowledge that innovation managers need a 'process theory' that describe and arrange discrete phenomena, sequences, and performances over time and produce some fundamental laws of innovating useful for influencing the course of events. Yet this has proven to be elusive.

The second shared assumption is the imperative of a behavioral world in which actors can run a productive organizing inquiry to handle uncertainty and problematic situations and constantly contribute to organization's stock of knowledge.

In contrast to these two camps, and those who remain entrenched

within them, the purpose of this paper is to follow up and extend Schön's theoretically informed, pragmatic and integrative 'third way' approach toward organizational inquiry, description of reality, and organization of product innovation. We seek to combine the orderly, economic, productive and prescriptive views of the funnel rationality, with the non-linear, critical, reflective and socio-political insights and perspectives of the fireworks non-rationality. We seek to offer a new kind of marriage between celebrated notions of 'funnel' and 'fireworks'.

Drawing on the strengths and limitations of both metaphors, the particular focus of this paper, therefore, will be to expound the development of an alternative yet overarching metaphor - what we have characterised as the 'third way' to product innovation-in-practice.

As a result, the structure of the paper is as follows. First, an argument is made for the value of Donald Schön's path-breaking work on 'generative metaphors' and the contrast between 'conservative' and 'radical' use of metaphors as methods for description of reality, reflective practice, and organizational studies. A brief exploration is carried out of the 'funnel' and 'fireworks' metaphor, as the key vehicles for creative thought and action to innovation practice and their costs and benefits in particular for informing the management and modelling innovation. Third, an outline and explanation is provided of an alternative 'ribbed water balloon' metaphor, one that, it is argued, provides an integrated vehicle (combining funnel and fireworks) for creative thought and action in innovation practice.

Schön on Generative Metaphors

Schön (1963, 1979) indicates that metaphors, apart from being ornaments of the language, are 'generative' in the sense that they intuitively come and construe uncertain, unfamiliar situations in terms

of our familiar and old images, theories, and concepts. They tacitly invade our feeling, thinking and doing to name and frame our understandings and perceptions. Conceived in this way, 'generative metaphors' can, nevertheless, function as both stimulator and inhibitor for a description of reality, reflective practice, and organizational studies. Generative metaphors however create 'new ways of seeing' if treated as rigid will restrict reflection on 'ways of not-seeing'. Treating 'generative metaphors' as a hypothetical, flexible 'projective model' or as a factual, rigid, 'protective means', this is the core dilemma rooted in this forgotten language, says Schön. We may treat metaphors uncritically when we use them as somewhat rigid 'protective means', when an old concept A comes to conservatively reduce and restrict our experience and conception of B without it being questioned, reflected upon or modified; when we use A to stimulate new ways of seeing B yet do not reflect on the ways of not-seeing which our rigid treatment of A has created. This conservative tendency may inhibit us to effectively inquire about the limits and strength of our metaphorical insight and inference. Metaphors can be a momentum for change, critical reflection, creativity, and inquiry when we use them as flexible 'projective models', when we make sense, interpret, and frame situations of uncertainty, novelty, confusion, uniqueness, and indeterminacy to cast and recast them in new perspectives while inquiring about new possibilities. In the more radical use of metaphors we treat B in the manner of A (or in terms of A), see B in A-like ways which might in turn enable us to question and see A in a new light quite unknown before ongoing and reciprocal reflection to see and inquire about both A and B in fresh lights.

Protective and conservative use of metaphors tends to be preoccupied with the role of metaphors as an instrument for conservatism or techniques of control that of keeping (often unconsciously) as much as possible with our old certainties and

orthodoxies when treating both familiar and unfamiliar situations. The metaphor that often goes underground performs a conservative role of concept formation, problem-setting, and making sense of events. An example of such a metaphor is that of the 'balance scale' which is so much a part of the language of decision making theories and logic. We 'weigh alternatives' in twos (mind/matter, subject/object, 'innovate or die', 'mechanistic vs. organic', 'to be or not to be', 'carrots or sticks', 'capitalism or communism', 'you are with us or against us'), usually without examining the basis of the dualism. In this example, metaphor of scale is literally applied to frame and interpret varied situations.

Strengths and limitations of 'funnel' and 'fireworks' metaphors

We speak of 'innovation funnel' (Schilling, 2005), 'quantum leaps in accelerating new products' (Clark & Wheelwright, 1996), 'innovation as a stage-gate system' (Cooper, 'driving new product to the market' (Cooper, 1994), 'engineering the materials of innovation problem', 'making innovation work' (Davila *et al*., 2005), 'innovation at the speed of information' (Eppinger, 2001), 'channelling the ideas', 'concretizing the product concept' (Clark & Wheelwright, 1996), etc. We literally apply funnelling technique and channelling tools, to concretize seemingly good ideas more rapidly and to drive new products to the market. There is an implicit conservative quest in all of these ideas to control the problematic situations inherent in innovation using familiar, well-formed tools and techniques without changing the tools to convert the messy, the distressing nature of innovation into a mechanistic, disciplined process, perhaps into a family of mass production.

One tacit yet considerable thing, in these ideas, is that (from conservative view) the instrument or technique here is not itself changed but changes the way we see reality through creating of a new lens, and this privileged character extends to the instrument-user as well (Schön, 1963). The instrument-user wants to control both the tool

and the situation in which s/he employs the tool, rather than being controlled by it – a tacit conservative tendency. So in conservative use of the metaphors one implicitly presumes a kind of 'psychological distance' both from the instrument and the situation. S/he uses the 'tool' as a kind of 'reasoning' or 'logical proof' to see the reality and sets the problems.

Perceived as such, the metaphor of 'Innovation funnels' as a tool is a way of giving management or actors a distance by which they assume as if they can exercise instrumental rationality, manipulate their ideas, assumptions, values, and theories preserving their sense of control upon the problematic situation. When actors 'expand the size and mouth of the funnel' 'screen the incoming proposals and channel the promising ones', 'progressively narrow the neck of the funnel and concretize the seemingly good concepts', 'ensure that a constant stream of appropriate projects flows down', 'drive the outgoing new products into the market at a speed that fits with the strategic thrust of the business' they in fact see the phenomenon mostly as a technical problem, regard tool-using in terms of the adjustment of technical means to unambiguous ends, assume a distance between the tool-users and the problem, and treat certain aspects of the tool (which are carried over) as unchanging.

Hence, innovation funnesl however is a generative metaphor but is also uncritically dealing with innovation in an unchanging funnel-like configuration which suggests actors a protective 'frame' to prematurely impose upon an indeterminate reality, to set the process as an instrumental problem, and to overlook the phenomena that may not fit this frame.

To the extent that certain aspects of the tool (without being changed or mutually adapted) tend to directly or literally locate themselves as unchanging 'protective means' for framing and solving problematic situations, according to Schön and some other metaphor

theorists (in particular Cassirer, 2005; Morgan, 1997), is a conservative way to deal with uncertainty.

In the more radical role of metaphors, by contrast, we treat our old tools as a flexible or elastic instrument, as a projective model to bear on the new situation yet it is somewhat unclear what expectations are to be carried over and how they are to be met or not because the metaphor is subject to an indefinite number of interpretations, inquiry, and re-examination (Schön, 1963: 62).

Seen from this view, dealing with uncertainty in innovation could be categorized into two major groups: conservative vs. radical use of metaphors. In contrast to conservatism, radical use of metaphor in innovation reflects theories that attempt to address questions of uncertainty, non-linearity, anxiety, fuzziness, and value-conflict. We already pointed to theorists that depict innovation analogous to 'fireworks' or as a 'journey in uncharted waters' (Scudder *et al*., 2000; Schroeder *et al*., 2000; Van de Ven *et al*., 1999). But we also find theories who describe innovation as 'rolling a snow ball and following the actors' (Bijker, 1995), as an 'anxiety-producing drama' (Schön, 1967; Salamon & Storey, 2005), as 'fantasy' or 'childlike foolish practice' (March, 1991); as an emergent and loosely connected network of human/nonhuman actors with full of uncertainty (Law & Callon, 1988, 1992; Latour, 2005).

In contrast to conservatism, metaphors of 'uncharted water', 'fireworks', 'rolling a snowball', 'drama', 'childlike fantasy', and 'emergent network' (though some looks non-actionable) provide more radical, reflective, realistic, and critical lenses to scrutinize and study the dynamics of innovation.

In the metaphor of fireworks Van de Ven *et al*. (1999) use a fire-fighting analogy to craft an academic model for the fatalistic process of corporate innovation- a three stage model including initiation, development, and termination/implementation. By this metaphor Van de Ven et al depicts a jagged path that shows how practitioners ought

to maneuvre through three indeterminate stages involving 'divergence' and 'convergence' and full of surprises, serendipities, and setbacks.

Beyond Funnel and Fireworks

This foregoing argument suggests that we must have some attention to the construction of a modified and integrated view of both 'stage-gate funnel' and 'messy fireworks'. In the studies (Bijker, 1995; Wotherspoon, 2001; Van de Ven *et al*., 1999; Schön, 1967; Rogers, 1995) from which the new vision is drawn, several innovation projects (in particular R&D/Advanced development projects) are examined. Despite their uniqueness, we found similarities of which the central theme points to three main periods or intertwined stages/phases. Like them, we also adopt a three stage/phase model and try to understand how such phases, by and large, take shape, but we seek to go further.

We deliberately term three stages/phases as (I) 'fuzzy-front end' and 'project approval passage point' (II) 'development' and 'decision to adopt and commercialize passage point' (III) 'implementation and diffusion' and 'evaluation of success passage point'.

Supplementary bodies of literature, in turn, present 'rite of passage', obligatory points of passage' and 'product development pattern'. The first is Arnold van Gennep's 'rite of passage' (2004 org. 1909), which is associated with rituals and activities that mark a transitional change in social development status. The next is the Law and Callon's (1992) 'obligatory point of passage', the tendency of an actor/s or the demands of a development process so as to impose itself as an obligatory checkpoint for the progress of a project to its next phase. And finally 'product development pattern' builds on three-dimensional view of actors, action, and interaction (Macloughlin & Badham, 2005) whose unit of analysis instead of project/product or a mere combination of 'technical artifact' and 'social institution' is

'socio-technical ensemble' (Bijker, 1995), 'actant' (Latour, 2005), 'cyborgs' (Haraway, 1991).

Figure 1 presents these themes in a sketch similar to a 'water ribbed balloon'. The metaphor of 'water ribbed balloon' provides an illustration of how common themes and phases loosely fit together so as to shape a self-transforming web of moves and relations. While this process may appear to be 'linear' or 'rational', we show that it is not inevitable or rigidly linear as it may involve iterations, reversals, setbacks, deceptions, repetitions, and cycles. These phases and passage points do not represent a sequence of linear stage and gates through which all the product sub-components must pass in unison (Wotherspoon, 2001). Nor do they represent predictive factors through which the final shape of a product may be foretold. Rather, they represent the change in social and technical interaction around product sub-components and its web of moves as means and ends evolve over time. It is, also, no simple sequence of moving from more to less uncertainty or concreteness. Finally, it is a non-rational process driven by sociological, technical, and political dynamics.

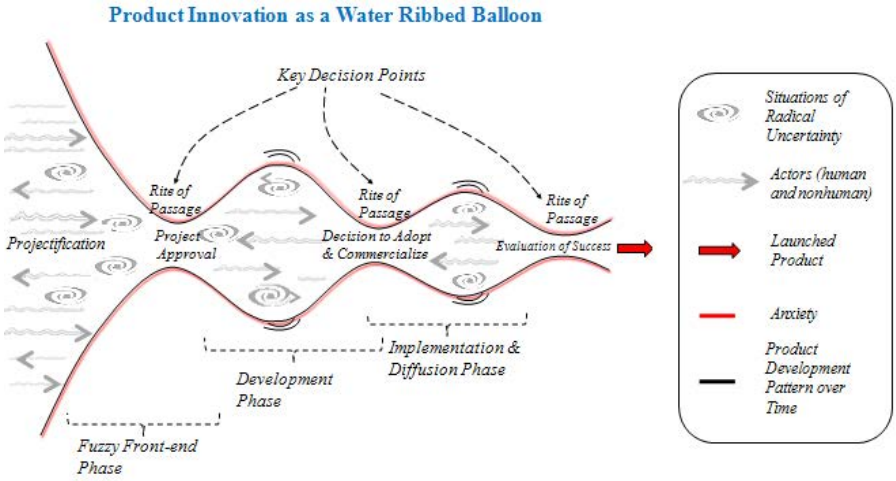

Figure 1. Product Innovation as Water Ribbed Balloon (Attar, 2010)

The purpose of this metaphor is to generate a more creative, socio-politically informed, yet pragmatic and outcome-focused approach to the practice of innovation– a marriage between funnel rationality and fireworks non-rationality. This image is also grounded in what Schön characterised at various times as the 'artistic' approach to practice. Our purpose here is not to simply argue that the 'ribbed water balloon' metaphor is 'correct' but, rather, that it plays a 'generative' and 'projective' role as a creative, elastic metaphor capable of throwing new and important light on how innovation might occur, and can be influenced in practice. The old tools (i.e. Funnel and fireworks), therefore, change to an elastic, evolving yet more actionable tool i.e. water ribbed balloon.

Rite of Passage (*ROP*)

For van Gennep (1909) change in social dynamics can be segmented into several mutually dependent stages and to distinguish several 'passing points' or 'rite of passage' between two different yet overlapping stages. Thus, our notion of passage point rests on a van Gennep's theory of passage which is based on the obvious fact of 'phase change' in the social dynamics of product innovation. In passages, as van Gennep treats them metaphorically, social movement through space takes place. Passages involves a several irrevocable 'turning points' or 'phases' that are driven with intense energy and anxiety, yet rituals or routines help, as the primary means, to navigate safely (Grimes, 2000). In other words, in passing points we benefit from rituals or 'rites of passage' so as to safely move from one stage to another while coping with stress and anxiety. Rite of passage (ROP), therefore, is a phase process of transition, making a movement from one social 'space' to another.

Obligatory point of passage (OPP)

Rite of passage seems to be the equivalent of Actor Network Theorists' 'obligatory point of passage' (Latour, 1987; Law & Callon, 1992). Their analysis of corporate innovation relies heavily on contextual networks of heterogeneous actors (human and nonhuman), interaction between people and things, men and machines. And their discussion of 'heterogeneous actors and networks' introduce a number of concepts among which 'passage points' has proven particularly useful in characterising human/nonhuman interactions when developing a product. They argue that many interactions between 'actors in a web of relationships', between the product and its relevant network of actors and things, is subject to management authorization. They see management and managerial norms in product innovation often as an obligatory point of passage (OPP), who exercises power and permits further transactions among subordinate actors in a network. Hence, an obligatory passage point occurs when certain reinforcing rituals and conditions are created within a project that 'actors and artifacts' must fulfil for management in order to allow the project for continuation (presenting a report, providing scientific evidence, facts, defining and redefining means and ends, etc.). And, in order to progress through the stage actors comply with 'obligatory rites', dear to management, in the format of compulsory checkpoints, similar to van Gennep's ROPs.

We draw on 'Obligatory Point of Passage' to support our notion of 'Rite of Passage'; however, the context of our research differs from that of Van Gennep in one main aspect. We study change in product innovation and not general ceremonial change within a society as a whole. In spite of this difference, our way for identifying the passage points appears to be similar to that of Van Gennep, more specifically, in the sense that ROP refers to social and psychological rituals that help some actors as they move from one stressful obligatory social space to another.

Phases of Water Ribbed Balloon

Fuzzy front-end

In the early stages, what authors understands as 'concept generation' (Bessant & Tidd, 2007), or 'gestation period' (Van de Ven *et al.*, 1999), actors usually begin to propose and probe ideas without knowing exactly where these propositions would lead or what final product/s should look like. By and large, it is also difficult and misleading to technically formulate and anticipate the 'parallel activities', 'multiple coincidental events', 'unintentional confluence of ideas', 'random throw of the dice', 'chance', or 'shocks' that eventually gather enough support and momentum for triggering innovation (Schroeder *et al*., 1989; Wheelwright & Clark, 1992). Meaning that confusion and ambiguity usually reign at the front end and actors have several incompatible and incomplete ideas which make it difficult to proactively predict the nature of the forces that might convince a single champion (Schön, 1963) or potential stakeholders to coalesce some of the promising ideas into a formal project. Yet in a few years or months, depending on the nature of the stimulus, some managers or practitioners who are at the focal points begining to do what they regard as formal progress toward commencing a novel project– what Maylor et al (2006) term as projectification. They seem to have achieved a convergence.

In the course of achieving a convergence actors attempt to familiarize with the problems and early simplistic ideas about the nature of the product/s may be tried and discarded. To make this transition– projectification- actors often initiate a passage point in which a series of early yet crucial decisions must be made. This transition- whether in the form of meetings, letters, informal discussions, etc,- gets serious conversation started and provides the first occasion for, probing, reflection, feedback, which all parties are

very likely to find political and complex. This complexity usually reflects a mismatch between a firm and its members' 'theories-in-use' and their 'espoused theories'– when simply what actors say differs from what they do and such conflicts of power and interest may result in the dominance of one group and submission of others, compromise among actors, or stalemate.

As Argyris and Schön (1996) show some practitioners, for example, propose wrapped best case scenarios with fluffy estimates, what they see as a promising idea and evince their understandings and reasoning to impress management. Resource controllers or managers, in turn, interrogate the practitioners and their proposal in order to dispose and discover what further inquiry, scientific evidence, technical details, and economic resources are required to test or trust the merits of the ideas, to suppress or support the proposals, to kill or commence the project. At times - especially when an idea seems rewarding but very risky to put into practice - practitioners face with management or resource controllers' unwillingness to decide or a tacit willingness to leave much of the responsibility, initiatives, and ambiguities, on the shoulders of the proposers or product champions.

Nevertheless, however confusing, conflictual, and insufficient, the initial moves may be the first passage point that allows parties (i.e. resource controller, managers, and practitioners) to exchange new instructions, information and demonstrations in order to inquire about the likely risks and rewards and distinguish between decision and discussion (Argyris & Schön, 1978). Indeed, passage points are set for convergence of 'conflicting and competing ideas' and confluence of 'diverse and differing activities' and of course continuing conversation and reciprocal inquiry, within which actors probe the situation to determine how the development effort could begin, how the tasks should be assigned, where the activities may branch out, how the components might bunch together, and often who or what might

be the scapegoat for any possible failure (Schön, 1967; Lester & Piore, 2004).

The plunge into the first obligatory passage point, without knowing in advance what a product will exactly look like or what actors need to inquire and learn, or what means they must invent as future events require, provokes anxiety and ambiguity and the sense of vulnerability of being in radical uncertainty. It usually poses financing problems and making crucial decisions that are difficult and distressing to defend in the absence of complete conviction of success. More often the actors' initial sense of vulnerability turns into conservatism and camouflage, hence the search for defensive and self-protective routines or self-deceptive mechanisms to disguise and smooth over undiscussable dilemmas, denying doubt, and suppressing uncertainty or push it off on to others (Hainer *et al*., 1967; Argyris, 2006; Argyris & Schön, 1996). Van de Ven *et al*. (1999: 30), for example, observe such behaviour in product champions who usually attempt to deflect resources suppliers' attention from uncertainties into a set of overly optimistic projections, knowing that a funded project will eventually rescue itself. Not surprisingly such game of 'reciprocal deception' (Argyris & Schön, 1996) is usually accompanied by what Schön (1967) sees as the replacement of 'non-rational language of invention' with 'rational language of investment' to which future failures and errors are easier to attribute.

By and large, these responses may also happen in other stages of product innovation and masked by conventional habits of selective inattention, repression, deception, and myth making. This game may go on until a crisis happen or an error becomes unavoidably visible at which management attempt to play the role of omniscient and the judge and jury of what was good and bad and what shall be done. As Argyris and Schön (1978) observe in a product development project management, for example, conforms to a norm or ritual of denying the

problems revealed in the preceding stages or decision points, and practitioners keep to a norm or ritual of accepting such denials.

The antidote is to treat the obligatory rites as both a 'psychological certainty' and an 'intellectual hypothesis' (Argyris & Schön, 1978) - psychological certainty in the sense that rituals, norms, or routines might suggest a basis for action yet must be regarded not as undiscussable but as an intellectual hypothesis as something subject to error, test, scepticism, modification, or entire change.

Thus we represent the ROP or OPP as framing a set of manageable problems out of too many competing alternatives, as a necking in the interaction amongst people and things, between bosses and subordinate, which in any case represents certain conditions and specifications that have been identified by management and product's web of relationships as being imperative for project continuation. But it implies actors to access their tacit assumption, surface the dilemma with which they are struggling, detect errors and incongruities between their words and actual moves, achieve a provisional convergence of meaning, and package uncertainty with valid problems.

Development

If actors in the projectification eventually organize around a champion or a powerful group or gravitate to some appropriate choice of product ideas, then the second phase, development, begins.

When actors approve to launch a full-scale development they still deal with an ill-defined situation in which marketing, engineering design, financial, economic, social and political problems are all mixed up together. Some of these problems are tightly interrelated by a division of labour or a technical component. Some interrelationships show themselves as hidden political games or explicit disputes among actors who hold conflicting viewpoints and use their respective

politics and power to promote their interests (Bijker, 1995). And still many others are loosely linked due to alternative scenarios available for developing product components and sub-components (Van de Ven *et al*., 1999; Bijker, 1995). This all means that shortly after project approval detailed development is launched and activities proliferated into diverse pathways which makes the course again to diverge, and become chaotic and complex to manage. The initial proposals branches out into many loosely related technical sub-components and social activities due to diversity in technical means, development options, and contending groups' multiple goals and interests. Moreover, each technical sub-component may require iterative cycles of linking scientific research with manufacturing and marketing, technical setbacks and testing, prototype development, and not to mention financial justification.

Part of the development phase that we observe in cases involves the visualisation and ultimate realisation of the product and its possible sub-components (Wotherspoon, 2001). The actors appear to use, amongst many other things, both the concept of 'technological frames' and what we have identified as 'obligatory passage points and rites'. Technological frames are used by practitioners to inform and influence the shaping of an artifact, and restrict and influence the range of possible product final shape that actors make an effort to envision or visualize.

As the process begins to climb the slope of the development phase S-curve product details continue to increase and specialized across technological frames and corporate lines of activity. The widening route reaches what appears to be a point of no return, a yielding point that may need management intervention for a go/kill decision or actors themselves have to link overlapping and parallel cycles of the development effort by framing a set of product choices, packaging messes and uncertainty once again with valid assumptions and

information. Depending on the timing of deadlines for completion of the tasks in this irrevocable point the pressures for convergence mount and anxieties about completion run high. These anxieties force actors to some resolution of the problem of multiple amalgamations and possibilities. The project may fragment around its several competing actors and may emerge not with one but with several competing designs. The project may fail altogether to work out the intellectual and socio-political factors involved in resolution and may come up with no optimum design. Or some actors may coalesce around one design tied to one powerful group or figure which emerges as the dominant design (Schön, 1971: 216).

More often, massive and escalating commitments, heavy psychological investment, mounting development costs in man-hours and materials, and above all the fear of admitting failure usually give the project the momentum to stay alive – no matter how contrived (Argyris & Schön, 1996; Van de Ven *et al*., 1999). And of course, people tend to avoid stopping questionable projects once they are under way (Schön, 1967) but such events can shake the actors' confidence particularly resource controllers so that they start paying serious attention.

If enough causes combined to rescue the project, then, some actors attempt to build stronger links by aligning product sub-components, discard the seemingly irrelevant concerns, and again impose a frame, a discipline, or a structure on jagged lines of activity. Out of these usually come amalgam of one or two dominant final form or design of the product while others cease to exist. As part of the same movement, the struggle to achieve a dominant final design helps actors to decrease complexities and confusions by increasing 'stabilisation' (Bijker, 1995). This newly merged, penultimate product continues through a moulding process until completion of the development phase, where a final form of the product emerges or imposed. This

implies that actors from different social groups negotiate and attempt to bring the final form of the product to a close. Whether the stabilisation takes place due to power and political interaction among social groups (Bijker, 1995) or the technical dominance of one design the process concludes with ‘closure’ when involved actors, no matter how reluctant, officially approve the final product form.

It is important to note, these dynamics regarding final amalgamation at times occurs on the basis of insufficient information and still in the face of relative ambiguity and anxiety (Schön, 1967). It is always difficult to find out whether the final design matches market demands, or it could achieve the volume anticipated for it, or it would help organizational growth. There is also ambiguity in how the final form would satisfy all stakeholders or how much engineering trade-offs and heuristics are reliable. After all, tests and quality control have to be completed and despite the likely bugs in the final form marketing strategies have to be settled. Actors observe and evaluate the product with respect to its negotiated final form. If this evaluation proves favourable, and agreement is reached, then the final stage of development is complete. In social constructionist terms, the process concludes with ‘closure’ and ‘stabilisation’ (Bijker, 1995) what we term decision to adopt and commercials.

Similar to front-end, the attempt to mix up sub-components results in another passage point, designed to limit further product modification. Here, decisions regarding the closure and commercialization take effect when the formal agreement is approved. As actors negotiate final forms of the product they squeeze sub-components together so tightly that they effectively limit any further digression of the product. Reaching the end of the development phase is heralded by the emergence of the final product design, and of course setting another environing condition that occasion new problems i.e. implementation and diffusion.

Implementation and diffusion phase

When actors respond to the demands of the second obligatory passage point, the implementation and diffusion phase has already begun. This phase, as its title suggests, includes market introduction, mass production and implementation, and diffusion of innovation. If the product is developed elsewhere, the implementation centres on the conditions necessary to adopt and commercialize the innovation.

What is of great importance in the third phase as well as the earlier ones is the unit of diffusion. While the unit of diffusion in both 'funnel' and 'fireworks' is usually a product or project, that of 'water ribbed balloon' is more nearly a self-transforming 'socio-technical web' that resists to be managed by a single actor. Actors along with their techniques, interests, and understandings intervene at various times to influence and forward the product diffusion. Each step, therefore, in the diffusion of innovation represent a relatively reconfiguration not merely in a product but within its associated web of moves.

Given the unintended as well as intended change in products' entire process of use, diffusion does not evolve systematically or sequentially. Many emerging sources of interrelated and reinforcing web of relationships are most likely to be involved, that stem from a cluster of decentralized actors and technologies that cause unexpected reorientation in a production application. YouTube, for example, permits simultaneous international witnessing of events and its application may change from political elections to music shows and information. Therefore, diffusion process must be seen as an improvising (Orlikowski, 1995), shifting and evolving whole in which decision making is widely shared (Rogers, 1995), with new adopters.

Evaluation of success and failure (the third obligatory passage point) may occur according to a corporate specific demands,

objectives and measures. With respect to a product application, there are differing interpretations in terms of project success or failure. And like other socially construed themes (Berger and Luckmann, 2009) success or failure, too, are socially constructed realities rather than fixed objectives. Success or failure is not usually explained impartially and symmetrically. Besides of this, in asymmetrical explanation, 'working' and 'nonworking' are contingent properties and cannot stand for a product success or failure (Bijker, 1995: 15). A product may work from the technical viewpoint but not acceptable from marketing or sociological perspectives. Rate of acceleration, for example, as a criterion from marketing, on the dashboard of six and eight cylinder cars during the 70s and 80s begun to be displaced by rate of fuel consumption and frugal driving since late 90s. To this we should add that as new social groups and technological frames from unexpected quarters mesh with diffusion stage, new product meanings and applications are about to emerge and take shape. Introducing platform products such as operating systems with bugs to the market by dominant and powerful institutions, for example, has given birth to a new generation of products - a fertile soil for gap-filling products such as those of anti-virus companies (Tabrizi & Walleigh, 1997).

Conclusion

Effective product innovation is an enterprise that has very much to do with the development of actionable knowledge that is able to acknowledge and handle situations of uncertainty and anxiety (Attar, 2010). Actionable knowledge or models are 'normative theories', 'normative templates', 'theories for intervention' or 'actionable metaphors' that purport to define the activities through which intended consequences can be produced and achieved in such a way that these consequences persist despite unanticipated effects (Argyris, 2006). Because unstable and uncertain world of product innovation demands

interventionists to put a template or metaphor on its reality development of such template offers a basis for concerted action, yet they must be treated as intellectual hypotheses rather than psychological certainties or rigidities.

It seems that in many rationalistic accounts such as funnel the template is regarded as a psychological certainty, as a rigid applicable knowledge than elastic actionable knowledge between which as Argyris and Schön (1996) assert there is a profound gap. While the former tells us what should be regarded as relevant the latter tells what 'normative template' to implement and how to treat it as both psychological certainty and intellectual hypothesis given the complexities of everyday practice.

Conceived as such, it is not surprising to see that the inquiry in rational accounts usually represents a search for appropriate mechanisms mostly based on the conservative use of metaphors as instruments of control, coordination, and rigidity uncritically treating the tool, concept, or image as unquestionable technologies of reason. So it is not surprising that the majority of innovation models tend to picture innovation as an orderly, goal-oriented, value-neutral, and systematic process; thereby the need for developing best technical-rational means that can tame future uncertainties and tailor complexities into clear-cut tools and recipes. Although there are few models that depict product innovation as chaotic, conflictual process, which involves jagged lines of activity, setbacks, mess, stress, chance, and uncertainty that block systematic thinking or sequential doing, they do not bridge the academic chasm between rational and non-rational accounts.

In other words, neither the 'funnel' nor 'fireworks' theorists of innovation have been critical and coherent enough about the metaphor they bring about and they take to be essential for modelling and management of innovation. Neither side gives much emphasis to the

nature of the instrument they suggest, the form and fashion of the ensuing problems and restrictions, and its position on the relation between thinking and doing in innovation. They display a particular selective inattention. Within the first view there is *gap of attention* to the mismatch between 'funnel rationality' and the emerging problems and non-rational processes. Within the second view there is a *gap of explanation* about firms' failure to notice the mismatch between actors' public discussions and assumptions and their private puzzling action, between actors' espoused-theories and their theories-in-use which kept undiscussible until flaws and fires (non-rationality in the process) become unavoidably visible. Neither view has much to say about how managers/practitioners intuitively make decisions under uncertainty and what they actually do in their encounter with problematic situations, value conflict, and discontinuity.

Drawing on the common assumptions between both competing camps (i.e. the need of vehicle road-maps, models, or metaphors to put on the complex reality of innovation) we have developed the model of water ribbed balloon which is not simply a critique of the other two. The model outlines product innovation as a non-rational and socio-technical practice, one that not only reveals politics, uncertainty, unsteadiness, setbacks, and reversals with which actors grapple but also considers rituals, norms and organization's behavioural world in its understanding.

References

Argyris, C. (2006), Reasons and Rationalizations: The Limits to Organizational Knowledge, Oxford University Press

Argyris, C. and Schön, D.A. (1996), Organizational Learning II: Theory, Learning and Practice, Reading, Mass.: Addison-Wesley Publishing Co.

Attar H. (2010), The Dance on the Feet of Chance: Handling Uncertainty and Managing Risk in the Fuzzy Front-end of Innovation, IN: Xlibris.

Badham R.J. (2005), Technology and the Transformation of Work, The Oxford Handbook of Work and Organization, Ackroyd S., Batt R., Thompson P., & Tolbert P.S., Oxford: Oxford University Press

Berger P. & Luckerman T. (2009), The Social Construction of Reality, Anchor.

Bijker, W. (1995), Of Bicycle, Bakelites, and Bulbs: Toward a Theory of Sociotechnical Change, Cambridge, MA: MIT Press.

Bohn R. (2000), Stop Fighting Fires, Harvard Business Review, 78 (4): 82-91.

Cassirer E. (2005), Language and Myth, NY: Dover Publications.

Christensen C.M., (1999), The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail, MA: Harvard Business School Press.

Clegg, S., Courpasson, D. and Phillips N., (2006), Power and Organizations, Sage

Cooper R.G. (1994), Third-Generation New Product Processes, Journal of Product Innovation Management, 11 (1): 3-14.

Davila, T., Epstein, M.J., and Shelton R. (2005), Making Innovation Work: How to Manage It, Measure It, and Profit from it, Wharton School publishing

Dewey, J. (1930), The Quest for Certainty. A study of the relation of knowledge and action, IL: Southern Illinois University Press.

Grimes, R.L. (2000), Deeply Into the Bone: Reinventing Rites of Passage, University of California Press

Haraway, D. (1991), Simians, cyborgs, and women: The reinvention of nature. London: Routledge,

Knight, F. H. (2006), Risk, Uncertainty and Profit., NY: Dover Publications.

Kuhn T. (1996), The Structure of Scientific Revolutions, IL: University Of Chicago Press.

Latour, B. (2005), Reassembling the Social: An Introduction to Actor-Network-Theory, Oxford: Oxford University Press.

Law J., & Callon M., (1992), The Life and Death of an Artifact: A network Analysis of Technical Change, Shaping Technology/Building Society: Studies in Sociotechnical Change, Edited by Bijker W., Law J., Cambridge: MIT Press

Lester, R.K. and Piore M.J. (2004), Innovation: The Missing Dimension. Cambridge, Mass.: Harvard University Press

Leybourne, S. (2005), 'Improvisation within management: Oxymoron, paradox or legitimate way of achieving', Paper presented to the Academy of Management, Hawaii.

MacKenzie D. (1996), Knowing Machines: Essays on Technical Change, Cambridge: MIT Press.

MacKenzie, D. and Wajcman, J. (1999) The social shaping of technology, 2nd edn. Milton Keynes: Open University Press

March, J. (1991), Decision and Organizations, NY: Wiley.

McLoughlin, I. and Badham R. (2005b), Political process perspectives on organization and technological change, Human Relations, Vol. 58, No.7, pp. 827–843

Reopenning N.P. (2001), Understanding fire fighting in new product development, The Journal of Product Innovation Management, 18, 285-300

Rogers, E.M. (1995), Diffusion of Innovation, (4th Edition) New York, Free Press

Schilling M.A. (2005), Strategic Management of Technological Innovation, NY: McGraw Hill/Irvin

Schön, D. A. (2003), Displacement of Concepts, London: Tavistock Publications.

Schön, D. A. (1967), Technology and Change. The new Heraclitus, Oxford: Pergamon Press.

Schön, D. A. (1987), Educating the Reflective Practitioner. San Francisco, CA: Jossey-Bass.

Schön, D. A. (1983), The Reflective Practitioner: How Professionals Think in Action. New York: Basic Books.

Smith P. (1998), Developing the Products in Half the Time: New Rules, New Tools, NY: John Wiley and Sons.

Smith P., & Merritt G., (2003), Proactive Risk Management: Controlling Uncertainties in Product Development, NY: Productivity Press.

Tabrizi, B. and Walleigh, (1997), Defining Next Generation of Products, Harvard Business Review, Dec

Tidd J., Bessant J., & Pavitt K.,(2005) Managing Innovation: Integrating Technological Market and Organizational Change, NY: John Wiley and Sons.

Van de Ven A.H., Polley D.E., Garud R., & Venkataraman S., (1999), Innovation Journey, Oxford: Oxford University Press.

Weick K., (2000), Making Sense of the Organization, Wiley

Wheelwright S.C., & Clark K.B., (1992), Revolutionizing Product Development: Quantum Leaps in Speed, Efficiency, and Quality, NY: Free Press.

Wotherspoon R. (2001), The Multiple Faces of Engineering Design, PhD Dissertation, University of Wollongong, Australia