

Iranian Journal of Management Studies (IJMS)

Vol.5, No.2, July 2012

pp: 9-29

The Rational View of Product Innovation: A Critical Investigation

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(Received: 14 February 2012; Revised: 19 June 2012; Accepted: 26 June 2012)

Abstract

This paper seeks to trace some of the roots and problems of the rational view of innovation. Concentrating primarily upon product innovation, we point out that the eighteenth century notion of social progress in the light of reason has gradually given an enormous impetus to a rational view of product innovation in modern organizations. We summarize several decades of research into management of product innovation from the rational approach, compressing and characterizing the literature by six-key policies, best practices or metaphors. The paper discusses some of the issues and problems concerning the rational approach and finally concludes with proposals for future studies.

Keywords:

Metaphor, Product innovation, Rationality, Scientific reason.

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Introduction

Since the Enlightenment, two contrasting yet complementary approaches to knowledge, the description of reality, and the organization of the society and nature have been in good currency, and during the last hundred years the waves of new social, technological and scientific progress have pushed both traditions into prominence (Burrell & Morgan, 1979; Ashley & Orenstein, 2004; Hatab, 2005). The first approach, exemplified by the work of Bacon and Descartes (2004), prescribes a rational process of augmenting knowledge and world-making with the aim to establish progressive stages of certainty. The opposite approach, exemplified by the work of Nietzsche and Dewey, uncovers and describes the uncertainties in humanity's quest for certainty.

In the first tradition, there has long been a quest for order, proceduralization, stability and certainty, unity and control (Cooley, 1983). This quest seeks to eliminate uncertainty, disorder, contingency, chaos, ambiguity and anxiety, through the systematic regulation of humankind, nature and society, with the hope of establishing a kingdom of order, justice, and beauty (Dewey, 1930; Hegel, 2001). Within this approach, reason and causality, as increasingly exemplified by science and technology, function as humankind's means in the rational march toward a kind of utopia, a steady march through which the mastery of humankind over nature, society and human conduct is possible. For the advocates of this tradition, therefore, comprehensive rationality is the main reality; the order of nature is based on reason that must be explored by humankind; ignorance of causes is powerlessness and the only wisdom is the spread of knowledge about causality and the order necessary in the chain of events; hence, the progressive establishment of certainty and development of methodical knowledge that can promise to reduce humanity's practical activity to an ensemble of rationally-grounded tasks and techniques. In other words, this approach conceives of humanity's practical activity, organizations, values and technological/scientific advancement as consistent, continuing, and to a great extent controllable, endurable, and predictable. It sees concepts of identity, profession, institution, and society not only as resting on the invention of technical and scientific means, but future changes occurring within a predictable, stable, and enduring framework of norms and values. It,

therefore, seeks to create comprehensive rational/law-like procedures for establishing causation between phenomena, and views practical reason as a matter of making rational decisions by subsuming decisions within a well-defined hierarchy of rules (Cassirer, 1968).

Unlike such comprehensive and according to Popper (1971: 425) ‘uncritical’ rationalists, for the latter tradition, represented at least in part by Nietzsche and Dewey, flux, fortune, necessity, non-rationality, indeterminacy, and uncertainty are the main realities. For proponents of this view, reasoning regarding actions to be performed can never attain more than a precarious probability; instead of reason, things change and dance on the feet of chance (Nietzsche, 1976). No ‘eternal will’ orders nature, hence humanity’s full mastery over nature through systematic spread of knowledge about causality is illusory or impossible.

Throughout the development of modern societies and the development of professional activities there has been oscillation and conflict between these two world views ranging from positivism to anti-positivism, from scientism to existentialism, and from functionalism to phenomenology.

The Rational View of Product Innovation

The idea that human progress would be achieved by harnessing natural science to create technology had another profound effect. It was in the light of such doctrines that the professions in the late nineteenth and early twentieth century achieved dramatic success in reliably adjusting scientific means to human ends (Bernstein, 1979; Schön, 1983). Engineering design and methods as well as scientific analysis became the prototypes of the successful use of technical rationality and positivism (Schön, 1983). Perhaps it was in this spirit that, in the early decades of the twentieth century the ideas of ‘scientific management’ and ‘instrumental rationalism’ – the development of law-like methods and rule-following models for the good of social ends – came into good currency (McLuhan, 1964).

As a heritage of social progress in the light of scientific reason, there is a rational view of product innovation which draws on scientific reasoning, fostering a type of proceduralized innovation process guided mostly by applied science-based methods and measures. Corporate growth can be achieved by harnessing technology to create new products for the

fulfillment of organizational ends (Bernstein, 1979; Schön, 1983), and proper application of scientific theories and techniques leads to corporate creativity (Hainer, 1968). Questions such as ‘how to make innovation work’ or ‘how to drive new products into market’ are dealt with economic/business/applied approaches, benchmarking technical proposals and the best means to be selected by the use of science-based tools within a well-defined strategy. Likewise phrases in common use such as ‘innovation as a stage-gate system’ and ‘a road map for creativity’, for example, suggest a rational approach to corporate creativity and innovation. Product innovation is usually pictured as a systematic and sequential process that should lend itself to procedural control, methodological analysis, and scientific management. According to this view, product innovation in organizations should thrive by establishing a close fit between the following best practices or metaphors and the firm’s pattern of action.

The Process of Product Innovation Should Be Orderly

There are a number of accounts outlining stages and controls using systematic project management methodologies and models (Cooper, 1990; PMBOK, 2004). According to these, the process of product innovation should consist of a series of stages and gates toward a desired goal, each one provides and paves the way for those to come (Cooper, 1990, 1993, 1994, 1999; Griffin, 1997; PDMA, 2004). A study of a thousand of the largest corporate R&D spenders, found that almost 80% of all North American companies adopt a stage-gate process as a conceptual and operational road map for driving a new product project from idea to launch (Booz Allen Hamilton, 2007). According to this report, corporations employ a disciplined stage-gate process combined with regular measurement of everything from time and money spent in product development to the success of new products in the market. A general schematic of the stage-gate system is pictured in Figure 1 (Cooper et al., 2002).



Figure 1. The stage-gate model of product development

In the first stage, ‘scoping’, a quick and inexpensive assessment of the technical merits of the project and its market prospects is set forth. Then comes ‘building business case’ in which a business case is developed and three main components are outlined – product and project definition, project justification, and project plan. Development activities like design manufacturing and operation as well as mapping out marketing strategies and test plans are the components of the third stage. The challenge here is to provide validation of the entire project – the product itself, the production process, customer satisfaction, and the economic outcomes of the project where actors ought to choose and test the most promising idea. Finally there is the route to product commercial launch.

Preceding each stage there is a decision point or gate which serves as a go/kill/hold/recycle judgment point in which decisions regarding further ‘resource allocation’ take place. At gates actors deal with the criteria – usually organized into a scorecard and including both financial as well as qualitative measures – by which projects should be prioritized. Each gate mediates between deliverables and outputs. Deliverables as the outcome of the preceding stage are judged against the criteria and their contribution to the next stage is analyzed according to law-like measures.

The Process of Product Innovation Should Be Funnel-like

Simon coined the term ‘bounded rationality’ to indicate that people are only partly rational and partly emotional/irrational when they are to process, receive, store, retrieve, and transmit information. This holds true for product innovation process during which practitioners deal with too many competing ideas, contradictory views, and conflicting values.

The problem of ‘too much yet competing information’ experienced by organizations apparently has created its own antidote. In answer to these rationally bounded conditions, some theorists (Hayes et al., 1988, 295) tacitly accept the need for the imposition of a lucid frame for thinking and doing, though they have not made this rationale explicit. The frame or the ‘normative template’ (Argyris & Schön, 1974, 28) they put on the practice of innovation draws on the idea of ‘funneling’ as a metaphor which at least in one of its senses points to firms’ obligatory selective inattention to an abundance of conflicting ideas and complex information that helps actors tame and tackle complexity in a purposive

manner (Herrmann, 2004; Hobday, 2005; Mahdi, 2003).

Armed with the funneling metaphor (as a model for intervention), organizations are then able to allocate resources to a specific sequence of projects over time, make their choices less complicated to handle through ongoing narrowing, and on occasion merging the set of alternatives available to them. Each successive stage through the funnel, as it narrows down, should also serve the commercial as well as technical feasibility of all stages (Cooper, 1999; Dunphy et al., 1996; Schilling, 2005; Smith & Reinertsen, 1997; Wheelwright & Clark, 1992). Funneling in fact builds on the view of the sequential stage-gate system so that the combination of the two ideas has become very influential and widely accepted in management of innovation literature (Bessant & Tidd, 2007; Cooper, 1990; Tidd et al., 2006,).

According to the typical schema provided below (Figure 2), an abundance of new ideas needs to be filtered and refined through a series of screening criteria. The aim is to take the most promising ideas from concept, channeling and converging them gradually into a more concrete reality. The work starts with a broad range of information as the input, so the mouth of the funnel needs to be widened as long as actors can handle the complexity in analyzing information. Based on its core competencies, the firm should expand its knowledge and information base so as to take in or generate creative ideas. The firm members look internally and externally to make an interpretation and evaluation within their business context by referring to rational tools and measures, preferably quantitative. New ideas should align with existing technical/human resources, core capabilities, and lines of business so as to ensure a steady flow of good projects within a given time.

In order to enhance the merits of the final products, ideas need to be merged and form the nucleus of a dedicated combination within the bounds of available resources (Wheelwright & Clark, 1995). Selected ideas, therefore, need to be directed into new aggregated development projects, designing a portfolio of projects that will also enhance the corporation's strategic ability to carry out future projects. Managers should ensure that the portfolio deliver on the projected formally-approved objectives.

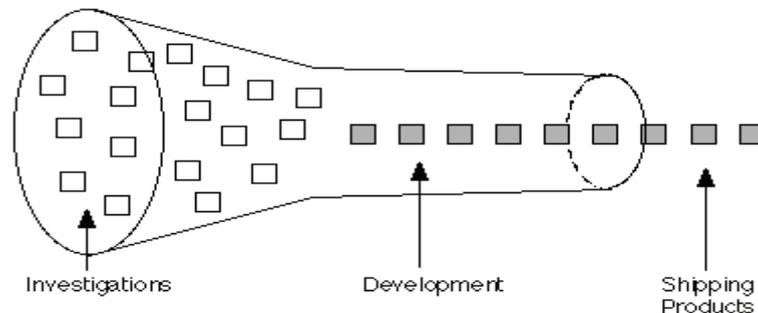


Figure 2. The development funnel

The notion of funnel is treated as the bounds of the available resource and pre-determined direction from which actors should not deviate. Any deviation from corporation's pre-defined strategy is continuously screened, controlled and protected from irrelevant ideas, so bad ideas should be recognized as early as possible, lest they tie up resources and stop the development from moving to the next stage (Hayes et al., 1988, 339; Forrestal, 2008, 46). Another concern is to keep the funnel neck narrowing progressively while transforming promising ideas into reality at a reasonable speed. So the performance of the project should be under continuous monitoring, measurement, and coordination. Finally, as the output new products should be tested and launched at a flow rate in proportion to the size and resources of the corporation as well as the outer environment. Firms should follow a path of continuous analysis, learning from feedbacks, and improving the capabilities that determine and drive their innovation performance (Wheelwright & Clark, 1992).

Product Innovation Is a Goal-oriented Process

There are organization theorists who argue that 'ends justify and determine the means' (Hughes, 1979, 13), that what happens early on to clearly set the objectives before development work gets underway has a powerful impact on both development performance and the outcome. They argue that what goes at the early stages lays the foundation for what follows (Hayes et al., 1988; Gluck & Foster, 1975), so having a coherent strategic direction, consistent choices, and compatible predetermined goals before a project begins gives firms greater leverage over unforeseen issues

and undesired outcomes (Hayes et al., 1988, 279). At the outset, there should be unambiguous and clearly defined ends on which managers and practitioners can base their account and determine the means for achieving those ends (Tidd et al., 2006). Put differently, goals and the approach for achieving them should be made explicit and deliberated prior to taking action to assure their effectiveness in the face of otherwise overwhelming chaos. There are many planning methods such as product portfolio planning, quality function deployment, aggregate project planning, design for manufacturing, critical path analysis, to name a few, that the rational camp constantly develops (Wheelwright & Clark, 1992). Before the project is begun, such a rational process of planning is done in terms of the likely end products definition and objectives that are supposed to emerge from the process (Ulrich & Eppinger, 2004). Therefore, practitioners need to prepare procedures that formulate and evaluate such clearly defined ends. Success and winning at new products consists in grounding these ideal ends within available means, that is within the boundaries of time, budget, quality, etc. (Smith & Reinertsen, 1997). More often the most promising ends emerge from resolving a common riddle: To seek the right product portfolio with the right quality at the right time and at the right cost for the right customer that determine firms' success, survival and sustainability in a competitive environment (Crawford, 1993).

Perceived as such, practitioners are involved in defining a potentially aggregate goal from combination and recombination of many essentially value-conflicting variables including budget, product performance, engineering design parameters, customer behavior and the proper time for the market launch (Krishnan et al., 1997; Smith & Reinertsen, 1997; Wheelwright & Clark, 1992). The outcome of these tradeoffs, if arranged well, may or may not reward the host corporation, similar to gambling.

One notion here is that practitioners ought to plausibly anticipate and list all relevant variables that will function in a project. They must identify in advance what technical specialties are necessary to meet certain needs in a systematic approach toward an ideal finality. Therefore, pre-determined goals determine what type of technology and people should be combined before a corporation launches a new project. As a result, there is little consideration for the likely addition of new problematic situations that can alter or threaten the corporation's pre-defined ends.

Innovation Is a Gamble of Winning or Losing, Game of Success or Failure

Phrases such as ‘innovate or die’, ‘innovation as the attacker’s advantage’ and ‘winning is everything in innovation so there is no second prize for the runner up’ suggest the view that organizations must engage in product innovation simply in order to keep up with sustainable growth, survival, and competitive advantage (Clark, 1994; Tushman & Anderson, 2004; Davila et al., 2005). As the White Queen says in *Alice through the Looking Glass*: ‘Now, here, you see, it takes all the running you can do, to keep in the same place. If you want to get somewhere else, you must run at least twice as fast as that!’ The explicit use of such analogies and metaphors in innovation literature, in fact has converted the process of product innovation into a game in which there will be winners and losers. Perhaps war as a metaphor could clarify this viewpoint (Dodgson et al., 2008, 95). As Cooper (1993) and Von Braun (1996) spell out, there is a new product war in which firms have to engage for their survival and continuity. Their battlefield and territory is the marketplace and market share, their weapons and counter-weapons are product and process innovations, their troops are the workforce, their generals are senior executives, their plans are strategies and counter-strategies and their enemies are the competitors. Such ‘innovation wars’ implicitly draw on Carl von Clausewitz’s (1976) dictum: War is continuation of politics by other means. According to a more extreme version of this view, new product war is continuation of management and corporate policies to humble the competitors by other means which is outperforming in a different way, as a different kind of war. This point is part of a more general view of innovation, as providing alternatives to allow firms to place their bets that usually top management has participated (Schön, 1967; Nelson, 1994).

Here one can notice an overlooked yet crucial dynamism in rational accounts – the high degree of anxiety due to personal culpability in the event of failure. While uncertainty and indeterminacy are inherent in the process of innovation, rational accounts presume the possibility of a systematic listing of all relevant variables that will operate in a project prior to the fact, and the failure to do so seen as a matter of personal guilt. Whether such systematic denials be a symbol of unwillingness to know (Beck, 1999), mythological justifications, selective perception and

reasoning (Beck, 1999), white-boxing and normalizing abnormality (Wynne, 1988), there is a tacit and undiscussable terror of failure which undermines people's confidence and competence and may stand in the way of innovation. Moreover, this war imagery suggests that the notion of 'practitioner as heroic entrepreneur' could be at odds with the notion of 'practitioner as military mechanic and rational agent'.

The Management of Product Innovation Entails the Management of Risks and Rewards

Many in the rational approach have become increasingly sensitive to the phenomena of risk and uncertainty, and it has become commonplace for them to speak of managing risk and uncertainty inherent in innovation (Cooper, 1993; Hayes et al., 1988, 280). They point to the likelihood of undesired events – or the absence of desired events – that usually disrupt or threaten the order, stability, or performance of the means or ends corporations wish to maintain or achieve.

As a consequence of this, writers have appeared to feel the requirement for the development of a method by which firms can carefully devise a list detailing a future chain of happenings prior to the fact, and proactively mitigate the undesired and manage the selected risks (Smith & Merritt, 2003). Their inquiry about managing and conquering future dilemmas has resulted in developing a number of analytic tools and predictive models – borrowed from other professional and academic disciplines such as insurance and financial engineering – among which risk management is the most influential and important. Phrases such as 'managing the risk of innovation projects' and 'controlling uncertainty in product development' (PMBOK, 2004) suggest that managers and practitioners should and could predict and quantify the likely uncertainties, hence the dangers and benefits of new product projects can be weighed against the likely risks and rewards of alternative scenarios. It is assumed that by selecting those scenarios whose risks and rewards justify their expected cost, time, and quality, practitioners can capture and formulate realities about future uncertainties and keep them within acceptable bounds.

Implicit here is the notion that much of the future uncertainties can be visualized through crystal ball gazing in which risks and rewards about the clear ends are identified, mapped out, and monitored. Much of

the uncertainty in the process of innovation can be foreseen and translated into a set of measurable risks made to systematic control, prior to the fact. Expressed as such, product innovation becomes a process of stage-gate decision-making associated with a process of risk-reduction and reward-maximization. In order to reduce the risks and maximize the rewards of innovation, justification of development effort must always precede the effort itself. Consequently, project proposals in which tradeoffs undergo extensive review are always required. A great deal of time and effort is spent at each crucial gate in order to visualize the future stage, persuade ‘resource controllers’, and legitimize the merits of a project or keep it in motion. During this alchemy process, risks are constantly reviewed, ranked and resolved in a more or less rigid and rational hierarchy. Recognition and evaluation of risks and rewards is determined in an orderly fashion usually by reference to established rigorous measures and mechanisms, preferably quantitative-based. Risk management from this view, then, is a systematic activity together with a series of methodical means, each of which lends itself to effective future visualization and prediction, quantification, and justification.

Uncertainty in Innovation Should Be Translated into a Language of Calculation

It should be noted that the aforementioned methods for dealing with ambiguities and complexities under the name of managing risks and rewards, may change the nature of the product development game from a ‘language of innovation’ to a ‘language of calculation’. This language fosters the establishment of a common and convincing framework for finding measurable tradeoffs between value conflicts. By seeking and justifying a close and clear fit between the risk management plan (means) and the dominant factors that determine future threats to and opportunities for an innovation project (ends), organizations attempt to cultivate a selected market niche. In this way the language of calculation functions as a ritual of verification (Power, 1999), rhetoric and myth, or a recipe to decipher and discipline the future.

However, in David Boyle’s (2000) view, when we try to quantify what cannot actually be measured, the non-quantitative character of the phenomena – such as unknown unknowns, anxiety, surprises, intuition,

insights, faith, emotion, and the like – may be drowned in a sea of calculations. We foster an exaggerated trust in the language of calculable risks (Power, 2004, 2007) in spite of a silence about what precisely the calculation of ‘mathematical risk’ is able to do.

Nonetheless the ideology of calculation has a number of advantages to recommend it. It fits with the rational justification of a corporation’s progress, growth and success, and provides a relatively legitimate basis for less conflictual decision-making through the development stages, gates, and funnels. It also stands out as a concrete accomplishment or as a testimony of things (Latour, 1993) that can be identified in no ambiguous terms, as ambiguity is transformed into measurable alternatives and objectives, hence a valid base for concerted action and decision making is justified (Vlaar et al., 2007). Moreover, the rationality of calculation helps an organization to reassure and persuade its members by offering them an illusion of foresight or an illusion of manageability (King & Anderson, 2002) as well as a psychological ritual to reduce anxiety (Hainer et al., 1967; Williamson, 1981; Wynne, 1982).

Discussion

Although the diagrams and discussions presented above may portray a sequence of development in a somewhat rational and orderly fashion, many innovation scholar such as Dodgson et al. (2005, 23) argue that while it is clearly evident, *ex post*, how important innovation is, it is by no means evident, *ex ante*, how and which particular innovations will be successful.

Crawford (1977, 1987), Cooper (1999) and Mahajan et al. (2000) also argue that due to the enormous complexity of many interrelated factors, product innovation failure rates, despite enormous number of techniques and models, are relatively high. Failure rates have variously been reported in the range of 40% to 90% and of the thousand companies in the study of Booz Allen Hamilton – of which 80% adopt the stage-gate funnel – fewer than 10% produced significantly better performance per R&D dollar over a sustained period compared with others in their industry.

In view of what has been discussed, one may ask the question: Why, then, do so many prescriptive accounts deliberately promote rational and

technocratic models of product innovation? Why as seen in Arthur D. Little's (2004) recent studies, is the sequential state-gate system adopted by more than 80% of all North American companies? What lies beneath this overriding commitment to technical rationality?

Reflection on these questions reveals more than one answer. One key to these questions directs us to the legacy of Taylor as the founding father of scientific management. Ironically he was one of the most criticized of all organization theorists but his legacy has proved to be one of the most influential (Morgan, 2006, 23). It is reminiscent of Marx's definition of ideology: That they do not know it but they are doing it (Zizek, 1989). Taylor as a mechanical engineer viewed organization as a kind of 'mechanical machine' that should be designed and treated as a mechanical or technical problem. His rational scientific approach called for detailed monitoring and measurement of tasks and people in order to comply with the requirements of organizational mechanisms because he believed that efficiency and productivity is in the interests of all. His total preoccupation with control, goal setting, repetition, prediction, measurement, standardization and other engineering and machine metaphors has influenced many rational/technocratic analyses of innovation. Phrases such as 'innovation as stage-gate system', 'making innovation-process work', 'flow rate of new products', 'channeling a steady stream of good projects', 'driving new products to the market' and 'concurrent engineering in new products' are a few markers in the proliferation of engineering metaphors for innovation.

Although these kinds of mechanical metaphors, technocratic and analytical demonstrations are decried for paying little attention to the complexity of social and human factors in shaping new technology (Morgan, 2006, 30) and standing at times in the way of innovation (Van de Ven et al., 1999), it should be noted that they are convenient and very attractive. Morgan (2006, 209) declares that such rhetoric helps managers use the rational myths as a legitimate umbrella under which they pursue their political agendas, provide stimulus and purpose for action, and justify vested interests. Seen from this view, the rational model also acts as a myth to overcome the contradictions inherent in corporate innovation, and to justify paradoxes that would otherwise make innovation peculiar and far from possible. Armed with the 'myth of rationality', management presents inherently uncertain innovation subjected to rational control (MacKenzie,

1996) and provides actors with a basis for ‘reciprocal simplification’ of interactions between resource controllers and practitioners in the face of the complexity of the process (Law & Callon, 1992). This offers a powerful tool for persuasion, politics and at times disguise and deception (Aronson, 1973; Van de Ven et al., 1999) that enables players to simplify the project complexities, to exhort each other in the exchange of deliverables, and to mobilize resources.

In a similar vein, Williamson (1989) argues that organizational proposals regarding the future are always incomplete in the sense that it is impossible in the real world to anticipate all contingencies. People have to focus their attention on post-project opportunism as a fundamental concern in the design of structures for transactions. This opens the door for bounded rationality, specifically in terms of ‘plausible farsightedness’ instead of ‘hyper-rationality’ (Williamson, 1981, 174). Likewise, Brunsson (2006) argues that maintaining the dream of rationality in fact prevents us from relinquishing our Platonic notion of ideals. Rational models are ‘mechanisms of hope’ that protect and encourage ‘homeostatic and conservative systems’ to continue and to avoid looking absurd in spite of the experiences that befall to them and contradict their sense of stability and security as well as their pre-defined ideals.

Although there is always uncertainty in innovation projects, some uncertainty may be amenable to the rational approach. So there is another sense in which belief in the rational view can be justified. There is utility in rational and technocratic models when organizations deal with marginal, incremental or derivative innovation projects. As Wheelwright and Clark (1992, 92) argue, the more radical the innovation the more its development process involves significant change in product and process technology, hence it is more uncertain, less rational and less predictable; and more creativity, insight and initiative are required at the outset (Wheelwright & Clark, 1992, 97). The more incremental the project the more its process tends to be sequential, straightforward, unambiguous, orderly and predictable. Wheelwright and Clark (1992, 95) state that incremental innovation ranges from cost-reduction in versions of existing products to add-ons or enhancements to an existing production process. Such projects usually require substantially fewer resources than more radical innovations and their acceptance requires a smaller amount of

change both in product and process technology. A summary of what has been discussed is as follows:

Table 1: The Rational View of Product Innovation: Pros and Cons

Belief about Product Innovation	Pros	Cons
Should be orderly	Systematic Management	Selective Attention to Uncertainty
Should be goal-oriented	Ambiguity Avoidance	Selective Attention to Change
Should Funnel-like	A Template for Intervention	Linear Model for a Messy Phenomenon
Game of success and failure	Provocative	Fear of Failure
Manage risk and rewards	Gamble Handling	Underestimating Uncertainty
Uncertainty Elimination	Quantifying the Process	Measuring the Immeasurable

Conclusion

Corporations have problems dealing with the indeterminate aspects of product innovation. They have difficulty in reflecting upon and handling uncertainties of product innovation. They prefer, and are better equipped to operate within the ‘language of investment’ than the ‘language of invention’. In the language of investment, corporations select an environmental niche, and attempt to program and fabricate its future according to rational, stable assumptions and formulations. Consequently, corporations often attempt to develop rule-following models, metaphors, and mechanisms to direct and describe the phenomenon of technological innovation. These models are assumed to objectively map, measure, and monitor future uncertainties that govern the behavior of the chosen niche. By seeking a close and clear fit between such models (means) and the dominant factors that determine future threats and opportunities to the niche environment (ends), corporations attempt to manage and master the phenomenon of innovation through an orderly process.

This paper explores the use of such rational models and metaphors in handling the uncertain, unruly nature of the innovation process that has created its own dilemma which centers on the conservative use of metaphors.

On one hand, there is a managerial quest to rationalize and control the complex and nonlinear nature of innovation, making its process as an orderly, goal oriented, risk-reducing, measurable, paradigmatic and mostly funnel-like activity.

Although models such as ‘stage-gate model’ and ‘development funnel’

are stimulating, suggestive and technically informative for practitioners, they fail to acknowledge that innovation and technical change affront the continuing effort of social systems to remain as they are. Corporate members often respond to the uncertainties of innovation in a variety of defensive ways such as 'pushing off uncertainty onto others', 'escaping from the anxiety and embarrassment' and 'hiding in tall grasses'.

It is the argument of this paper that such an approach is more adequate when targeting and 'solving' well-defined problems in the process innovation. It fails to systematically recognize, reflect upon, and improve the effectiveness of the complex and creative task undertaken in the prior stage of 'problem setting' necessary in situations of uncertainty. In other words, in ill-defined, unique, and uncertain situations, 'problem setting' is the key primary activity and 'problem solving' only secondary which is constructing a well-defined problem. Yet organizations frequently have problems admitting, or utilizing, this insight, often having great difficulty in handling the non-linear language of innovation appropriately. They tacitly accept the need for putting a normative template on the complex reality of innovation yet intuitively treat such templates as a recipe or an instruction manual, and as an unchanging and undiscussable tool. There is a tendency to see the recipe or the model in all its concreteness rather than as illustration of an elastic concept.

References

- Ackoff, R. L. (1979). The future of operational research is past. *The Journal of the Operational Research Society*, 30(2), 93-104.
- Argyris, C. & Schön, D. A. (1974). *Theory in practice: Increasing professional effectiveness*. San Francisco: Jossey-Bass Publishers.
- Aronson, E. (1973). The rationalizing animal, *Psychology Today*, 6(5), 46-52
- Arthur, D. (2005). Innovation as strategic lever to drive profitability and growth. *Little Global Innovation Excellence Study*, Retrieved from http://www.adl.com/uploads/tx_extthoughtleadership/ADL_Global_Innovation_Excellence_Survey_2005.pdf
- Ashley, D., & Orenstein, D. M. (2004). *Sociological theory: Classical statements* (6th ed.). Philadelphia, PA: Pennsylvania State University Press, Allyn & Bacon.
- Badham, R. (1986). *Theories of industrial society*. New York: St. Martin's Press.
- Beck, U. (1999). *World Risk Society*. Cambridge, UK: Polity Press.
- Bernstein, P. L. (1996). *Against the gods: The remarkable story of risk*. New York, NY: John Wiley and Sons.
- Bernstein, R. J. (1979). *The restructuring of social and political theory*. London: Routledge.
- Bessant, J., & Tidd, J. (2007). *Innovation and entrepreneurship*. New York, NY: John Wiley and Sons.
- Bijker, W. (1995). *Of bicycle, bakelites, and bulbs: Toward a theory of sociotechnical change*. Cambridge, MA: MIT Press.
- Boyle, D. (2001). *The tyranny of numbers: Why counting can't make us happy*. London: Harper Collins.
- Booz Allen Hamilton. (2007). *The Global Innovation 1000 Special Report*. 49, Retrieved from http://www.booz.com/me/home/what_we_think/40007409/40007869/42008337.
- Brunsson, N. (2006). *Mechanisms of hope: Maintaining the dream of the rational organization*. Copenhagen, Denmark: Copenhagen Business School Press.
- Burrell, G., & Morgan, G. (1979). *Sociological paradigms and organizational*

- analysis: Elements of the sociology of corporate life.* London, UK: Heinemann.
- Cassirer, E. (1968). *The philosophy of the enlightenment.* Princeton, NJ: Princeton University Press.
- Cooley, C. H. (1983). *Human nature and the social order.* Edison, NJ: Transaction Publishers.
- Cooper, R. G. (1990). Stage-gate systems: A new tool for managing new products. *Journal of Business Horizons*, 33(3), 44-54
- Cooper, R. G. (1993). *Wining at new products: Accelerating the process from idea to launch.* Reading, MA: Addison-Wesley.
- Cooper, R. G. (1994). Third-generation new product processes. *Journal of Product Innovation Management*, 11(1), 3-14.
- Cooper, R. G. (1999). From experience, the invisible success factors in product development. *Journal of Product Innovation and Management*, 16(2), 115-133.
- Cooper, R. G., Edgett, S. J., & Kleinschmidt, E. J. (2002). Optimizing the stage-gate process product innovation best practices series what best practice companies are doing. *Research Technology Management*, 45(6), 43-49.
- Crawford, C. M. (1977). Marketing research and the new product failure rate. *Journal of Marketing*, 41(2), 51-61.
- Crawford, C. M. (1987). New product failure rates: a reprise. *Research Management*, 30(4), 20-24.
- Crawford, C. M. (1993). The hidden cost of APD. *Journal of Product Innovation Management*, 9(3), 188-199.
- Davila, T., Epstein, M. J., & Shelton, R. (2005). *Making innovation work: How to manage it, measure it, and profit from it.* Pennsylvania: Wharton School publishing.
- Descartes, R. (2004a). *Discourse on the method of rightly conducting the reason and seeking truth in the sciences.* Whitefish, MT: Kessinger Publishing.
- Dewey, J. (1930). *The quest for certainty: A study of the relation of knowledge and action.* Carbondale, IL: Southern Illinois University Press.

- Dewey, J. (1938). *Logic: The theory of inquiry*. New York, NY: Rinehart and Winston.
- Dodgson, M., Gann, D., & Salter, A. (2005). *Think, play, do: Technology, innovation, and organization*. UK: Oxford University Press.
- Dodgson, M., Gann, D., & Salter, A. (2008). *The management of technological innovation: Strategy and practice* (2nd ed.). UK: Oxford University Press.
- Dunphy, S. M., Herbig, P. R., & Howes, M. E. (1996). The innovation funnel. *Technological Forecasting and Social Change*, 53(3), 279-292.
- Forrestal, L. (2008). Change in context. *Business Review Weekly*, 30(9), 46.
- Gluck, F., & Foster, R. (1975). Managing technological change: A box of cigars for Brad. *Harvard Business Review*, 53(5), 139-150.
- Griffin, A. (1997). Modelling and measuring product development cycle time across industries. *Journal of Engineering and Technology Management*, 14(1), 1-24.
- Hainer, R. M., Kingsbury, S., & Gleicher, D. (1967). *Uncertainty in research, management, and new product development*. New York, NY: Reinhold Publishing Corporation.
- Hatab, L. J. (2005). *Nietzsche's life sentence: Coming to terms with eternal recurrence*. London: Routledge.
- Hayes, R. H., & Pisano, G. (1988). *Manufacturing renaissance*. Cambridge, MA: Harvard University Press.
- Hegel, G. W. F. (2001). *The philosophy of history*. Kitchener: Batoche Books.
- Herrmann, J. W. (2004). *Decomposition in product development*. Working Paper, University of Maryland. Retrieved from <http://www.isr.umd.edu>
- Hobday, M. (2005). Firm-level innovation models: Perspectives on research in developed and developing countries. *Technology Analysis & Strategic Management*, 17(2), 121-146
- Hughes, C. (1979). *Goal setting*. New York: Amacom.
- King, N., & Anderson, N. (2002). *Managing innovation and change: A critical guide for organizations*. London: Thomson
- Krishnan, V., Eppinger, S., Whitney, D. (1997). A model-based framework to overlap product development activities. *Management Science*43(4).

- Latour, B. (1993). *We have never been modern*. Brighton: Harvester Wheatsheaf
- Law, J., & Callon, M. (1992). *The life and death of an aircraft: A network analysis of technical change*. In W. Bijker and J. Law (Eds.), *Shaping Technology, Building Society: Studies in Sociotechnical Change*. Cambridge, Mass, MIT Press: 205-224.
- MacKenzie, D. (1996). *Knowing machines: Essays on technical change*. Cambridge, Mass: MIT Press.
- Mahajan, V., Muller, E., & Wind Y. (2000). *New-product diffusion models*. Wien - New York: Springer.
- Mahdi, S. (2003). Search strategy in product innovation process. *Industrial and Corporate Change*, 12(2), 235-270.
- March, J. (1978). Bounded rationality, ambiguity, and the engineering of choice. *The Bell Journal of Economics*, 9(2), 587-608
- McLuhan, M. (1964). *Understanding media: The extensions of man*. London: Routledge.
- Morgan, G. (1997). *Images of organization* (3rd ed.). London: Sage.
- Nietzsche, F. (1873-1875). Thus spoke Zarathustra. In W. Kaufmann, *The Portable Nietzsche* (1976), Penguin Press
- Nelson, R. (1994). The co-evolution of technology, industrial structure, and supporting institutions. *Industrial and Corporate Change*, 3(1), 47-63.
- PMBOK. (2004). *A Guide to the Project Management Body of Knowledge* (3rd ed.). Project Management Institute.
- Popper, K. (1968). *Conjectures and refutations*. New York: Harper and Row.
- Popper, K. (1971). *The open society and its enemies*. Princeton, NJ: Princeton University Press.
- Schilling M.A. (2005). *Strategic management of technological innovation*. Irvin, USA: McGraw Hill.
- Schön, D. A. (1967). *Technology and change: The new Heraclitus*. Oxford: Pergamon Press.
- Schön, D. A. (1983). *The reflective practitioner: How professionals think in action*. New York: Basic Books.
- Simon, H. A. (1957). *A behavioral model of rational choice*. In H. A. Simon

- (Ed.), *Models of man: Social and rational: Mathematical essays on rational human behavior in a social setting*, New York: Wiley.
- Smith, P., & Reinertsen D. G. (1997). *Developing the products in half the time: New rules, new tools*. New York: John Wiley and Sons.
- Tushman, M, & Anderson P. (2004). *Managing strategic innovation and change: A collection of readings*. New York: Oxford University Press.
- Ulrich, K. T., & Eppinger, S. D. (2004). *Product design and development* (3rd ed.). New York, NY: McGraw Hill.
- Van de Ven, A. H., Poole, M. S., & Angle, H. A. (2000). *Research on the management of innovation: The Minnesota studies*. USA: Oxford University Press.
- Von Braun, C. F. (1996). *The innovation war*. Englewood Cliffs, NJ: Prentice Hall.
- Von Clausewitz, C. (1976). *On war*. Princeton, NJ: Princeton University Press.
- Wheelwright, S. C., & Clark, K. B. (1992). *Revolutionizing product development: Quantum leaps in speed, efficiency, and quality*. New York: Free Press.
- Wheelwright, S. C., Clark, K. B. (1995). *Leading product development*. New York: Free Press.
- Williamson, O. E. (1981). The economies of organization: The transaction cost approach. *American Journal of Sociology*, 87(3), 548-577.
- Williamson, O. E. (1989). *Transaction cost economics*. In R. Schmalensee & R. D. Willig (Eds.), *Handbook of industrial organization*, 1, New York: Elsevier Science.
- Wynne, B. (1982). *Rationality and ritual: The windscale inquiry and nuclear decision in Britain*. Chalfont St Giles: British Society for the History of Science Ltd.
- Wynne, B. (1988). Unruly technology: Practical rules, impractical discourses and public understanding. *Journal of Social Studies of Science*, 18(1), 147-167.
- Zizek, S. (1989). *The sublime object of ideology*. London and New York: Verso.