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Product Innovation and the Games of Uncertainty and Risk

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Abstract: This study investigated how risk is managed in practice at different stages of product innovation-focusing on the practice and process of translating/converting uncertainty into manageable risks. It illustrates how management of risks in innovation treats uncertainty in a restricted and limited way, tacitly accepting a sanitized discourse on risk-one that ignores broader socio-political understandings of uncertainty. In extending our understanding of the role of uncertainty in risk management, this study draws on the theories that range from sense-making to decision making, from reflecting to framing and producing norms; from cognitive-scientific theories of risk and fire-fighting to coping with anxiety. By spanning these literatures, the study advocates a third way which recognises the challenges that have to be faced in developing a broader legitimate socio-political understanding of risk and uncertainty. The outcome is a new conceptual framework for looking at risk and uncertainty in innovation which provides a basis for understanding and reflecting upon how unmanageable uncertainty translates into manageable risks, how risk is managed in practice and how it might be improved.

Key words: Rationality, risk management, risk society, uncertainty, product innovation

INTRODUCTION

Despite its sometime critical edge, organisational studies frequently fails to integrate major sociological treatments of the problematic nature of contemporary society into their routine investigations (Clegg *et al*., 2006). This study outlines how one doctoral thesis (Attar *et al*., 2007), conducted between 2006 and 2009, is attempting to use the idea of risk management in product innovation as a lever for integrating sociological explorations of the risk society and reflexive modernisation into organisational studies.

This study illustrates how narrow rationalistic approaches to risk in product innovation, what Wynne (2002) characterised as the cultural reification of risk, fail to capture the uncertainties of product innovation and the character of attempts to reduce the fateful (Giddens, 1999) workings of the bitch Goddess Fortuna (Machiavelli, 1979) into an acceptable management of risk. Yet, such rationalistic approaches continue to dominate our ritualistic thought and actions concerning risk management practices, techniques and investigations (Wynne, 2002).

The observation of the limitations and restrictions of such rationalistic approaches to not only risk and innovation but also management and organisational dynamics in general is far from new. From Simon and Lindblom to March and Olsen, classical rational models of decision making have long been replaced by more realistic views of bounded rationality and purposive muddling through (March, 1978). In studies of innovation and risk, the inherently uncertain nature of creative improvisation (Leybourne, 2005) and mindful sense-making (Messner *et al*., 2005) is widely recognised and debated. However, what is bracketed out (Latour, 2003) by such traditional rationalistic views is not only uncertainty and ambiguity, the bounded nature of rational approaches to risk-but also the role of emotions (beyond bounded emotionality) (Mumby and Putnam, 1992), the intricate intertwining of sociotechnological imbroglios (Latour, 1993) and both the micro and macro political dimensions that inform and shape rational calculation (bounded politicality). Moreover, this bracketing out is not simply a quirk of academia but is also a central feature of modernism and its concomitant ethos of the progressive rationalisation of the world.

What this creates is a dilemma at the heart of late modern organisations. On the one hand, a dominant ethos of rationality informs idea of progress and how organisations and society, innovation and risk, are effectively managed and controlled. On the other hand, how science and technology advances, how organisations are managed and society controlled, are all riven with uncertainty, emotionality, politics and intrigue. Modernity creates and denies non-rationality that promotes and informs its rationality. For critics such as Latour (2004) and Wynne (2002), this has been an ever present tension within modernity. For Beck *et al*. (1994),

it is a tension that has become particularly paramount in late modern societies, as they increasingly become risk societies-seeking to manage and control in rational ways the problems that their rationality creates-and spawn an increasing degree of reflexive modernisation, as the limitations of modernisation and its rational control become apparent (Power, 2007).

The purpose of this study is to explore the dual character of risk in process of product innovation in late modern societies. On the one hand, it examines its existence as a phenomenon that is understood and analysed in traditional rationalistic terms as a form of regulated uncertainty that is to be managed and controlled through improved techniques and practices. It characterises this as an established risk game. This view of risk is both an intellectual discourse and an embedded cultural phenomenon and set of ritualistic activities (Power, 2007). On the other hand, it explores risk as a phenomenon that is only partially addressed by such rationalistic forms of thought and action, which, in somewhat clichéd terms, are part of the problem rather than the solution. The rationality, or rationalities, of late modern society generate their own non-rationalities-and risks-and a truncated view of the nature of risk and its control fails to capture the fundamental sources of risk or inform thought and activities able to address the technical, economic, social and political problems that it creates (Bauman, 2007).

As Giddens (1999) and Wynne (2002) outline, the narrow technical approaches to managing risk in many organisations, in particular financial institutions, (Bernstein, 1996) exists independently and separately from the *risk society* literature (Beck, 1992, 1999; Beck *et al*., 2003) that explores the social and political causes and consequences of contemporary forms of risk and how we think about and manage it. What this study seeks to do is to span these literatures by advocating a third way which recognises the challenges that have to be faced in developing a broader legitimate socio-political understanding of risk. It explores the role and function of the classical rationalistic accounts of risk and prescriptions for its management in the analysis of product innovation-characterising these as a risk game.

DEFINING RISK AND UNCERTAINTY AND INTRODUCTION TO THE APPROACH

Traditionally, the concept of risk is a statistical one and risk management in its most general sense finds its place in the practice of probabilistic reasoning. It is based on an assumption that there is or can be a clear definition of the problems, future events, alternatives, or the objects at stake. It is seen as possible to identify the likely outcomes, estimate the likelihood of their occurrence, assign probabilities and manage the selected risks.

Situations of uncertainty, however, although action is required, resist analysis in such risk management terms (Schön, 1967). In such conditions, the phenomenon or the situation faced-as Dewey (1938) observes-is inherently problematic. It does not easily lend itself to precise quantitative expression because possible outcomes or alternatives are unknown, vaguely defined, unmeasurable or only dimly apparent at the outset (Lester and Piore, 2004; Knight, 2006). Such situations can be both unique and pressing; at times something needs to be done quickly without having a clear definition of the problems because there is too much competing information or too little to make an informed decision (Schön, 1967). In such situations, one must invent and reinvent received wisdom about what to do given that the problems faced are multifaceted, means and ends are fuzzy, alternatives are ill-defined, outcomes are indeterminate and the smallest impulse may generate flaws or happy accidents which alter ones experience of the situation and ultimately the whole course of action (Dewey, 1930; Schön, 1983). There are often mismatches between what one intends (intention), what one can put into practice (implementation) and what emerges and how one perceives (realisation) which block the flow of the kind of systematic and orderly activity and rational problem-solving recommended in standard risk management methodologies. In these situations one usually has to set and reset the problems as well as the likely relevant scenarios again and again and only on occasion (or as an outcome) is one able to tentatively employ a calculus of probabilities.

All purposive human behaviour pursues course of action based on some assessment of the likelihood of achieving desired outcomes and avoiding undesired ones (Kahneman and Slovic, 1982; March, 1978, 2006; Simon, 1982). Insofar as action, decision making and practice inevitably involves a degree of uncertainty and lack of control, such behaviours are intrinsically indeterminate, unpredictable and at times risky i.e., there is a chance that plans will go awry, foreseen situations will not arise and intended outcomes will either not occur or will have unintended consequences (Beck, 1992; Perrow, 1999; Smith, 2003). As Taylor remarks of all practice, there is an inherent phronetic gap between what rules prescribe and situations demand. To this degree, all of us have an understanding, even if implicit or intuitive, of the indeterminate nature of practice. Individuals, groups and cultures do, however, differ over what are seen as desirable and undesirable degrees and types of risk (Douglas, 1966, 1985, 1992; Douglas and Wildavsky, 1982; Lupton, 1999a). Despite this diversity, a desire to avoid

undesirable levels and types of risks can be regarded as part of the human condition.

In contemporary organisations, risk management has become established as a particular method and practice of viewing and attending to such risks (Giddens, 1999; Power, 2004). As a social and cultural phenomenon, in itself, it assumes and prescribes particular views of the nature, forms, degrees and methods of dealing with risky businesses. Many socio-cultural critics of risk management condemn its approach and practice (Power, 2004; Wynne, 2002). It is criticised for employing a restrictive cognitive-rational view of risk-ignoring the social and political dimensions of how risk is characterised and addressed (Lupton, 1999b; Douglas, 1992). For some within this camp, it also adopts a highly restrictive and dangerous approach to risk. It fails to adequately investigate the social and political sources of risk and fails to alleviate them. In a highly complex and interdependent world, risk management, as carried out by many large organisations, ignores the unintended consequences and so-called externalities that they create and which are extremely dangerous for the society in which we live (Beck, 1999; Beck *et al*., 2003; Wynne, 1988, 1996). Risk management is thus condemned as an intellectually moribund and socially blinkered approach to the real nature of risk.

While generally accepting this view and critique, of risk management, the intention here is to extend this analysis in a particular direction. Using the case of risk management in product innovation, this study aims to provide a greater understanding of how risk is actually handled in practice as a basis for informing and supporting a more critical and reflective risk management practice. In so doing, it seeks to extend the discussion of what is commonly characterised as the analysis and management of risk into a broader consideration of how practitioners cope with and address uncertainty (Dewey, 1930; Knight, 2006; Schön, 1967). The study contends that what is commonly taken to be risk management in large organisations is a secondary set of cultural rules, routines and practices. It is a kind of ritual or game that is only made possible by a prior primary process-one that converts the complexity and anxiety of uncertainty into a boundedly manageable set of risks– the uncertainty game. Insofar as this prior uncertainty game is left unacknowledged and unnoticed, risk management neglects a crucial component and phase of how risk is understood and handled. It brackets out from consideration all the intellectual, social and political factors involved in framing how risk is constructed and how restrictive risk management practices are normalised. In viewing risk management, broadly defined, as an intertwined set of uncertainty games and risk games, this study seeks to provide the basis for a constructive and proactive exploration of how to open up, intervene in and redefine the black box of risk.

This study is important, at least, for two reasons. Firstly, as acknowledged by a number of commentators (Hoffmann and Wynne, 2002), social analyses of risk have often focused on the downstream consequences of already developed products and processes (MacKenzie, 1996). This excludes more reflective questions about the dynamics and visions which shape front-end risk management commitments. Thus the forces shaping these risk management commitments remain as protected as ever from broader accountability. We are, then, more concerned to open up the fuzzy front end of risk management. Secondly, many of the critiques made of the politically dangerous and restrictive nature of risk management by the socio-cultural critics can be understood as a set of critical views on how the process of going from uncertainty to risk is handled. As a result, this analysis here can help to further explore the intertwined micro and macro forces involved in such practices, as well as provide support for critical reflection upon and potential modification of such practices. Thirdly, this analysis does not seek to provide a simple critique of rational views of risk management but, rather, situate such views in a broader understanding of both risk management practice and how it is produced by and intertwined with what I term the uncertainty game: the processes that convert uncertainty into risk. In so doing, this study seeks to address and explore enduring issues and dilemmas in the handling of uncertainty and risk, as well as critically reflect upon how these practices are handled in contemporary large organisations.

The study, of which this study is a part, involves an in depth exploration of how uncertainty and risk are handled in the fuzzy front end of product innovation in a number of inter-organisational innovation projects (Cooperative Research Centres: CRC Programme in Australia). The purpose of the present study is to provide a quick and cursory introduction to the basic framework developed to guide this study.

THE INNOVATION PROCESS AND RISK MANAGEMENT

All innovation is inherently indeterminate and unpredictable, hence risky (Bessant and Tidd, 2009; Christensen, 1999; Smith, 1998). Yet there are multiple perspectives on the nature of product innovation that influence how risk management is understood and prescribed (Smith, 2003). The standard view of product innovation sees it as a linear scientific-technical process, passing through stages from invention to diffusion

(Cooper, 1994; Tidd *et al*., 2005). From our particular focus, on the product innovation arena, one of the most common views of this process views innovation as a funnel, channelling initial vague and generally formed ideas into commercial or commercialised products and processes (Schilling, 2005; Wheelwright and Clark, 1992).

My view of the innovation process is, however, a sociotechnical one (Latour, 1993) and one that is far less linear in its understanding. Rather than viewing product innovation as a scientific-rational and economically driven funnel, I view it more as a socio-cultural and political ribbed balloon (Fig. 1).

The ribbed balloon model is intended to provide a three-dimensional view of innovation as a socio-technical practice (Badham, 2005) that draws on and integrates the work of authors such as Schön (1967), Van de Ven *et al*. (1999), Bucciarelli (1994), Law and Callon (1992) and Wotherspoon (2001). These authors all converge when they assemble their argument to talk about the sociopolitical, messy and unpredictable nature of technological innovation. Bucciarelli (1994) and Schön (1963), in particular, provide a detailed argument on the indeterminate zones of practice; Law and Callon (1992) Van de Ven *et al*. (1999) integrate this with a broad socio-political processual view of the unpredictability and messy indeterminate nature of the innovation process.

Hence, according to the ribbed balloon model, the corporate product innovation is a messy and uncertain process that proceeds iteratively through a series of ideal type phases, from a pre-project fuzzy front-end, through the rite of passage of project approval, before branching out into the project development phase. The process, then, provisionally concludes with the second rite of passage-the decision to adopt or commercialise. At this point, if the innovation is approved and launched it enters the third phase of implementation and/or diffusion, which itself can be seen as culminating in a final decision point of evaluation of success, before proceeding further. The central theme of this model is the notion that innovation is shaped by technical, economic and sociopolitical constructs in an iterative phased process characterised by ongoing uncertainty, anxiety and discontinuity.

While this process may appear to be linear or rational, it is not inevitably or rigidly linear as it may involve iterations, reversals, setbacks, discontinuity and deceptions, repetitions and cycles. In other words, these phases and passage points do not represent a sequence of linear stages 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 change in social and technical interaction around product sub-components and its web of moves as means and ends evolve over time. The process is, also, no simple sequence of moving from more to less uncertainty or concreteness. Finally, it is a process driven by sociological, technical and political dynamics.

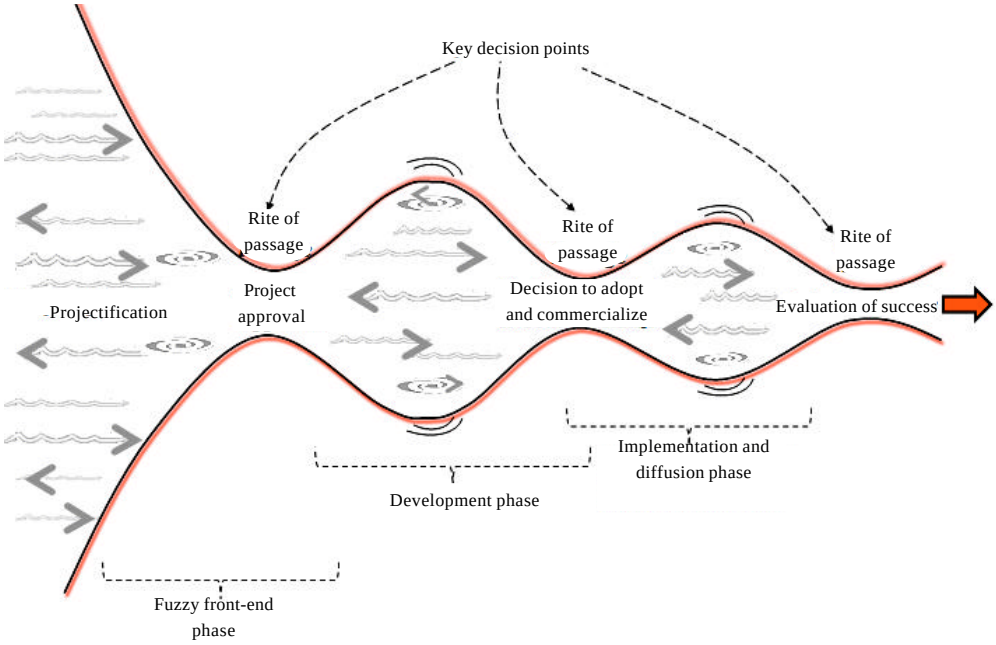

Fig. 1: Product innovation as a socio-technical conversion process: a ribbed balloon

The concept of the ribbed balloon has been introduced in order to capture both the flexibility and the 'lumpy' nature of the innovation process, something not fully captured by the funnel metaphor. In addition, there is always the possibility that innovation does not proceed down the defined path to a successful conclusion. If this is the case, the balloon bursts. While allowing for this possibility of bursting, the ribbed balloon metaphor remains valuable for practitioners as it provides the necessary guidance for the practice of forcing innovation towards a desirable outcome. Therefore, the purpose of this model/metaphor is to generate a more creative, sociopolitically informed, yet pragmatic and outcome-focused approach to the practice of innovation. This image is also grounded in what Schön characterised at various times as the artistic approach to practice. The purpose here is not to simply argue that the ribbed balloon model/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.

In this process, risk management-either broadly or narrowly conceived-can occur at or in all of these different stages, be intertwined with each other and take multiple interlinked technical and social forms. Both innovation and risk management are, in short, complex and messy socio-technical processes-and their understanding is inevitably premised on this point.

THE UNCERTAINTY GAME AND THE RISK GAME

What is commonly taken to be risk management is what, in this study, is characterised as the downstream activities of the routines, rituals and practices of the risk game. This game is premised on the assumption that it is possible to quantify risk, examine measurable outcomes, plan contingencies etc. It usually does not allow for or accept the existence of uncertainty that cannot be fully calculated, judgements and evaluations influenced by socio-cultural and political factors etc (Lupton, 1999b). As a result, it operates, in effect, with material that, I argue, has already been constituted-by a prior uncertainty game-as well as ignoring the social dimension of and uncertainties within its own practice.

What is meant by the uncertainty game is the set of routines, rituals and practices that are involved in identifying and converting uncertainty into risk as part of an innovation process that seeks to address and handle such uncertainty. The risk game is established once these conversions have already been undertaken, once unpredictable and anxious uncertainty has been converted into quantifiable and manageable risk by the prior socio-cultural game or set of practices. It is a process of moving from what Schön (1967) described as the language of invention to the language of investment, with the former grappling with what various theorists of risk-from Knight to Wynne-regard as a frequently unacknowledged yet crucial dimension of risk management: addressing basic and enduring uncertainty. We also use the term risk regulation here in order to cover the activities involved in both the uncertainty game and the risk game i.e., conversion and translation of uncertainty into risk. Risk regulation, therefore, is an inherently socio-political process of converting unmanageable and often anxiety inducing uncertainty into manageable risk, through the iterations of uncertainty and risk games. It must be re-emphasised, however, that this does not involve a real reduction of uncertainty-in the sense that it has been technically brought about or objectively reduced. It is, rather, a process of selective inattention (Sullivan, 1965) to fundamental and enduring uncertainties and a political sociotechnical focusing and channelling of attention and productive effort inevitably involved in all attempts to make innovation happen.

A key component of this model concerns the nature and characteristics of the uncertainty and risk games-games which are characterised not by the rational strategic logic of the chess game but the context based situational logics of Wittgenstein (1953) language games. These are the games, as characterised by Clegg and MacIntyre as the type of game in which not only is pawn to king 4 replied to by a knight turning into a queen, but a chess move is responded to by a lob over the net.

As outlined here, the purpose of the uncertainty game, like the risk game, is to provide symbolic forms (Douglas and Wildavsky, 1982), rituals (Wynne, 1982), disciplines (Goffman, 1961), norms (Clegg *et al*., 2006) and in short valid bases of concerted action (Vlaar *et al*., 2007). The rules of the game, like the rules of all social games, are multiple, fluid, contentious and shifting. Also, the way such rules are followed is a contextual, meaning driven and complex practical process. If such conditions are taken into account, however, then it is useful and meaningful to try and identify-as Bourdieu (1977) does in his discussion of fields of practice-what the general rules of the game look like.

The rules that have been identified are drawn from a specific source. They are what are described as the types of behaviours, actions, practices, routines or rituals identified by broader approaches to risk as those involved in the handling of fundamental and basic uncertainties and insecurities in the broadly defined risk management process (Lupton, 1999a, b). As can be seen, the characters of these rules are not specific to the area of managing risk. In many ways, they represent a risk version of general views of the nature of sensemaking (Weick, 2000), the operation of bounded rationality (Simon, 1982), the dynamics of social and technological framing (Bijker, 1995; Koestler, 1964; Schön and Rein, 1995) and the

nature of reflective practice (Schön, 1983, 1987). Insofar as each of these perspectives identifies uncertainty and the handling of uncertainty, as a key component of social and organisational life, they can be seen as useful contributors to an understanding of the uncertainty game.

I have encapsulated and presented academic reflection on such matters as a set of rules in order to assist academic understanding and, ultimately, as an aid for reflective practice. These are, however, presented more in the form of an inevitably schematic map (Fig. 2, 3)

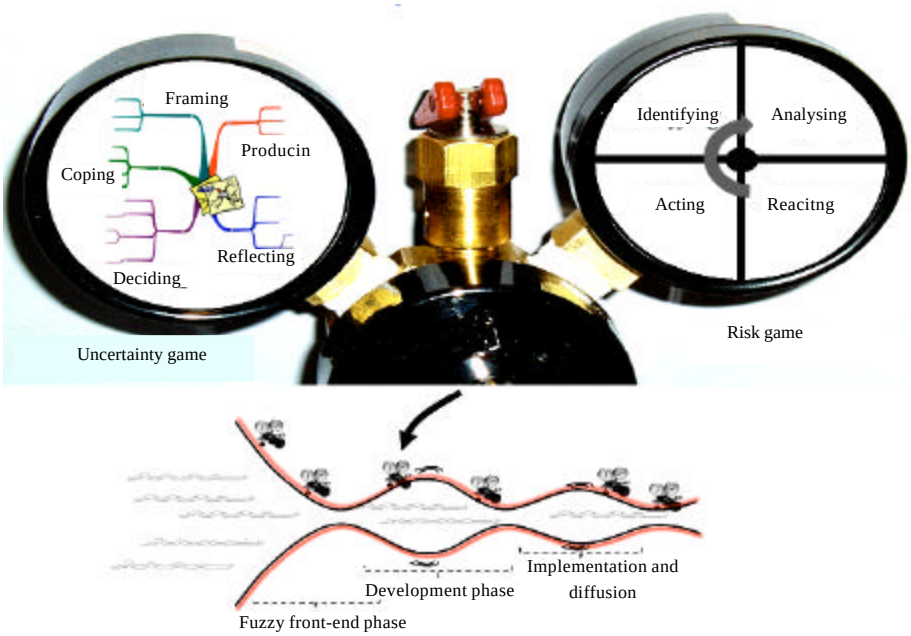

Fig. 2: Uncertainty game and risk game

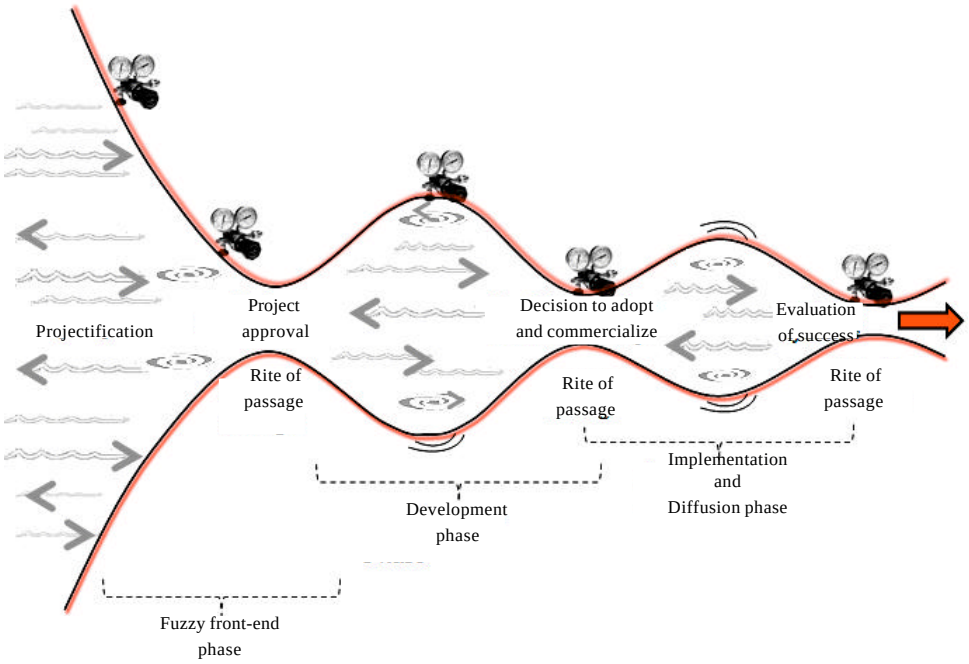

Fig. 3: Converting uncertainty to risk in the innovation process

rather than an inclusive description and are intended, at present, as themes and hypotheses to be further analysed, explored and detailed through empirical investigation.

THE UNCERTAINTY GAME

Rule 1 reflection: Knowing in action, reflection in action and reflection on action: At the heart of attempting to handle uncertainty in a deliberate manner is a process of reflection on knowing-in-action i.e., those coping with uncertainty in practice will be addressing and resolving actual and possible uncertainties as part of their actions and decisions-although this may be done implicitly as tacit awareness in knowing-in-action (Schön, 1983). Reflection-in-action involves a standing back, within action and reflecting on the ideas and assumptions, to then be quickly addressed and resolved in the action process (Schön, 1983, 1987). Reflection-on-action involves a more distanced, retrospective look at the assumptions and issues and may also involve reflection on reflection-in-action, both in terms of the validity of decisions made and the adequacy of the process (Arendt, 1971; Dewey, 1933, 1938). What sparks off and inspires reflection, the source of the surprises that make this happen, may be many.

Rule 2 coping: Controlling complexity, coping with anxiety: While uncertainty is ever-present in human existence, it is a continuing source of worry and anxiety (Dewey, 1930). As individuals, groups and organisations, we seek to relieve ourselves of this anxiety by, in some way, controlling experienced uncertainties (Sullivan, 1965). In many cases, however, the fear and anxiety generated by uncertainty pushes people and organisations into a managerial command and control mindset more appropriate for simple rather than complex situations. As outlined by complexity and chaos theories, it is possible to adopt a weaker idea of controlling, involving identifying and using patterns in the chaos to guide action in complex environments or within complex systems (Stacey, 2002). It is a strategy that is mindful of uncertainty and complexity, generates rich pictures, adopts an experimental attitude and so on. However, such an approach is at odds with knee jerk, what Beck terms reflex, individual and organisational responses to the threat of complexity and uncertainty. A common response, that occurs, at more superficial and deeper levels, is to practice what Sullivan (1965) describes as selective inattention i.e., to ignore, avoid or repress evidence or awareness of uncertainty. As argued by many observers, from Knights classic studies of uncertainty in economic life to Staceys application of chaos theory to strategic leadership, an ability to cope with the anxiety of uncertainty and respond proactively and creatively, is a key leadership capability, mindset or behavioural repertoire.

Rule 3 framing: Unframing and reframing: In the face of uncertainty and complexity, actors are inevitably selective in the information that they receive and pay attention to, the criteria and values that they consider and apply and the bases upon which they make their judgements. The processes through which such selection occurs are variously studied, amongst others, by analysts of metaphor (Schön, 1963; Cassirer, 1953), language (Wittgenstein, 1953), scientific paradigms (Kuhn, 1996) and Gestalt psychology. In its political form, it is the topic of ideology-critique and the documentation of governmentality and the forces of knowledge-power and the discursive practices that they embody and create. A recognition of complexity and these processes of selectivity, lies at the heart of Weicks injunction for managers to complicate themselves and the description that Weick and Sutcliffe (2001) provide the rich pictures collected by high-reliability organisations and their mindful inhabitants. In prescriptive advice attached to such perspectives, actors are encouraged to be aware of and reflective about the metaphors, paradigms and perspectives that frame their thought and, through such awareness, explore the possibility of alternative frames (Koestler, 1964) and orientations. In its social and political forms, such advice involves consideration of the kinds of practice fields, reflective spaces, or regions of open and undistorted communication that could be created to achieve such ends.

The appeals for initial unframing are, consequently, accompanied by advice about reframing situations and events (Schön and Rein, 1995). At the heart of numerous explorations of creativity lies an appeal for more open, reflective and multi-dimensional thinking, informed by conscious recognition of the limited constraints that we inevitably impose on our perception of complex situations and reflection on how we might generate and apply multiple frames to break out of restrictive forms of thought and practice that bracket out so much information and so many avenues for action.

Rule 4 decision-making: Consolidation, bounded rationality and choice: It is one thing to reframe a situation, another to estimate the consequences regarding the preferences, deciding what to do about it. It has been the province of decision making theory following the classic contributions of Simon (1982), to explore how

decisions are and can be made in situations of inevitably bounded rationality. As for March (2006), decision making in a state of bounded rationality inevitably involves a guess about uncertain future consequences in regard to preferences. In terms of prescriptive responses to such situations, two types of recommendations have been provided. Firstly, advocacy of the kind of experimental, open, hypothesis-testing ethos promoted by Popper (2002) in his revisionist model of science and advocacy of liberal piecemeal social engineering. It is this kind of ethos that has been taken up by policy analysts such as Lindblom (1979) in their advocacy of disjointed incrementalism and strategy analysts such as Quinn (1980) in their recommendations for logical incrementalism. Secondly, more radical, open and creative approaches to dealing with the non-rationality of real-world decision making in organisations is what March (2006) advocates as a technology of foolishness.

In the specific area of risk analysis, Knight addresses a number of these issues in his recommendation for achieving consolidation through objective and subjective probability in regard to the uncertainty surrounding situations.

Rule 5 producing: Diffusion and implementation: Finally, once reflection has been sparked, anxiety reduced to satisfied bounds, unframing and reframing occurred and decision making carried out, decisions still remain to be implemented. As is the case with the other rules, both technical and social factors need to be enrolled in order to bring about the planned effects. It is this need to mobilise sociotechnical powers in order to get things done, that underlie the focus of actor-network theories upon processes of translation and enrolment, the concentration of cultural theories upon the active application of blame and taboos and governmentality theories on the use of normalisation and other techniques of monitoring and control to create responsible subjects and provide them and other authorities with the detailed measures and measurements essential to controlling things, actions, events and populations.

All of these rules are descriptions and associated prescriptions, about how we think and act in situations of uncertainty and also, how we manage to cope with and channel this uncertainty into another kind of game-the game of detailed calculative action planning that is the main topic of most analyses of risk management. It is, however, the prior uncertainty game that transforms a buzzing, complex and unmanageable reality into something with a relatively ordered character, with boundaries, trends and probabilities. Insofar as risk analysis operates on the risk game produced by the prior workings of the uncertainty game, it fails to grasp the complex dynamics of how individuals, organisations and society construct risk-and then work elaborately on their already elaborated constructions. Insofar as it succeeds in capturing the ideas, patterns and practices of the uncertainty game, however, it can provide the basis for a more in depth and realistic analysis of how risk is actually dealt with. As we shall see, many of the critiques of the limited cognitive-rational views of risk are based on a recognition of the cultural and political nature and dynamics of the uncertainty game and the form that it takes in modern societies. Rather than simply condemning restrictive risk analysis for its ignorance and pointing to the crucial issues in the uncertainty game that they ignore and the benefits of a more sociological, cultural or radical analysis that captures these elements, our approach here aims to do more. The recognition of the uncertainty game does not provide any simple solutions but, what it does do, is to integrate the insights of these various critics in a way that they can be incorporated into a more reflective. It further tends to open a comprehensive view of what occurs and what should occur, in addressing uncertainty and risk. In this sense, it provides the basis for exploring and reflecting upon an uncertainty game that many ignore-yet does so in a way that recognises, rather than avoids or restricts, the fundamental challenges that this imposes.

THE RISK GAME

At the core of the risk game is the risk management process (PMI, 2004), a systematic approach to making rational choices in which the actor seeks to master identified risks. Most of the literature on innovation project risk management suggests this kind of process. The approach in this study differs, however, in two ways: firstly, it adds a new step to the whole process. The new step is re-action, including response to the effects of initial actions-responses that may result in further iterative risk identification or open up fundamental uncertainties and insecurities that throw the project back into the uncertainty game; secondly, the process, as played out in practice, is inevitably more contingent, contextual and situational than the rational models understand or prescribe. Moreover, it is inevitably circumscribed by and interacts with, ongoing operations (albeit to varying degrees) of the uncertainty game. The view of the risk game presented here is not as detailed as the analysis of the uncertainty game, which is a more prominent focus of this study. It is, however, presented in the form of the four

rules drawn from four step consecutive process of the rational models: (1) identification, (2) analysis, (3) action and (4) reaction in regard to risks are taken place.

Rule 1 identification: This step seeks to delineate the possible sources of risk; in so doing it focuses on where to look for likely sources of negative outcomes (e.g., in the market, in the business macro environment, in the innovation process, in the actions of competitors, etc.). Identifying is essentially an, inevitably bracketed, brainstorming process by which actors uncover any risks that could potentially afflict the innovation process. Depending on the nature of the project, a variety of thought starters can prompt risk discovery, yet it remains framed and channelled by the boundaries set by the initial uncertainty game.

Rule 2 analysis: Questions are generated and answered about which risks should we pay attention to, i.e., of all possible risks that we can identify which ones should we address in formulating a plan of action? Conventionally, risks are assessed in terms of probability of occurrence and likely severity if realised (i.e., likely size of impact). On the basis of such an assessment, risks can be ranked in terms of priority for action. As a result the objective of risk analysis is to estimate the likelihood of the risk and its overall magnitude. In common sense, this step forms the basis for determining how serious the identified risks are with the aim of prioritising them. And prioritising the risks is done according to the time and resources available, hence some difficult decisions must be made here.

Rule 3 action: This involves the formulation of a risk management strategy. Four possible courses of action can be drawn on when addressing identified risks: (a) accept the risk and live with it (e.g., because the probability of occurrence or the likely impact is very low); (b) accept the risk but monitor the situation so that the acceptance decision can be re-visited if necessary (e.g., due to a change in circumstances which alters the probability of occurrence and/or likely size of impact); (c) take action to mitigate the impact if the risk is realised (e.g., take out insurance or otherwise pass on the risk to another party, reduce dependence on the risk-prone element of action, establish parallel activities, etc.) and (d) take action to minimise or prevent the risk from being realised (e.g., remove a risk-prone element in the plan of action).

Rule 4 re-action: In spite of careful identification, analysis and detailed action the practice of risk under the pressure of uncertainty not only proves difficult to follow (Repenning, 2001) but also insufficient to avoid or identify all potential threats and crises that might threaten the project performance. Therefore, the capability to be reactive to emergent risks and crises is required. This I term reaction-which includes all those reflective, firefighting (Bohn, 2000) and mindful (Weick and Sutcliffe, 2001) activities involved in monitoring, intervening in and reassessing how well the risk management strategy is doing. This may involve organisations in an ongoing fashion seeking to make sense of events, anticipating problems in advance and responding promptly to undesirable events in a flexible rather than rigid way. And when things do go wrong, this may involve applying more or less standardised solutions, identifying and empowering those with the expertise to contain or minimise the risk of the situation and rely upon organisational resilience to bounce back quickly after emergence of an error. Or create surprises, controversies and political confrontations surrounding the explicit resurgence of a more fundamental uncertainty game.

CONCLUSIONS

As Schön (1967) has argued, contemporary organisations are not designed for uncertainty, where there are no clear ends and where it is not clear what to try to control and organise. So while they cannot deal effectively with situations of uncertainty, organisations are able to identify, analyse, evaluate and manage risks. Accordingly the innovative work of organisations consists of framing, packaging and translating uncertainty at various stages of innovation into something manageable, thereby converting it into manageable risk. This study explores this phenomenon while seeks to address the inadequacy of existing theories of risk management for dealing with the uncertainty of innovation as well. It is, however, a preliminary research which tries to introduce and institutionalise a new conceptual framework for looking at risk management in innovation.

The primary purpose of the framework is to integrate the insights of the broader and more critical social and political perspectives on risk management with those of the narrower and more restricted cognitive-science views, in such a way that they provide a basis for understanding and reflecting upon how risk is managed in practice and how it might be improved.

In so doing, the intertwining of the uncertainty and risk games reflects and, hopefully, further illuminates some of the themes addressed by such literatures as those on risk as fire-fighting, accident analysis and prevention and mindfulness in high-reliability systems. The uncertainty game addresses many of the dimensions

of fire-fighting as well as normal accidents and complex sensemaking existing in complex systems. However, as many prescriptive risk management theories advocate, more manageable risk games are established by channelling these uncertainties into more programmed forms of institutionalised mindfulness, situational organisational design and failure mode and effectiveness analyses. These translations or conversions are examples of the intertwining of the uncertainty and risk games in the broader regulation of risk.

To put it another way, risk management and dealing with uncertainty are, by and large, parallel universes with their own solar systems, time zones and laws of gravity. Yet organisations make an effort to convert uncertainty into frameworks of risk when facing problematic situations. The process of converting uncertainty into risk is at the heart of dealing with problematic situations which are indeterminate, unpredictable and ambiguous.

The identification of uncertainty and risk games provides us with the foundations necessary to explore the practice of converting uncertainty to risk in product innovation in more detail. It allows the analysis to address all the issues raised by broader and more critical theories of risk in a pragmatically focused analysis of how actors deal with issues of risk and uncertainty in practice.

As indicated earlier, this framework is preliminary and suggestive in character and requires further elaboration, support, data collection and testing and illustration before it can in any way be regarded as sufficiently well-clarified or authoritative. I have, however, elaborated it here in order to stimulate discussion and receive feedback on an ongoing research initiative.

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