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Tame, Messy and Wicked Problems in Risk Management

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Abstract

Heathrow's Terminal Five presents a case study in risk management that shows the importance of understanding and incorporating the behavioural and perception aspects of risk. At the outset of the project, risk was conceived technically, its management was sequentially driven and problems met with linear solutions. The case study follows a change in perspective experienced by the Terminal Five project teams alerting the project to important, but previously ignored, aspects of risk. This change required different ways of conceiving problem, and the paper describes how this can be done using a typology of: 'tame', 'wicked' and 'messy' problems. This requires risk managers to identify project stakeholders and seek resolutions between their varying perspectives, as much as deliver singular, optimal solutions. Typically, because wicked and messy problems cannot be modelled, they have been ignored, so undermining the ability of the project team to control the project effectively. This case study shows how risk management can embrace behavioural and systems complexity without undermining either clarity of information or control of project processes.

Keywords: risk management; Heathrow's Terminal Five

Introduction: Organizational control and strategic risk management

Typically, risk managers determine where uncertainty exists in an organization's activity, and then design preventative and contingency measures. The uncertainties are broken down into stages and, where it exists, information is allocated to each stage in order to identify the cause of the uncertainty and the possible remedial solutions. Placing the stages in sequence builds up an image of the risk that is then weighted according to the likelihood of its occurring and its possible impacts should it occur. By analysing this typical risk management activity on Terminal Five at London's Heathrow Airport, the paper argues that this linear perspective adopted by many existing risk management practices can preclude consideration of the uncertainties arising from the need for systems and knowledge integration and from human behaviour. This is because systems complexity and unpredictable behaviour are not amenable to the rigid classificatory breakdowns and the iterative generation of optimal solutions that risk management theory tends to impose upon problems of uncertainty. It is not so much a question of widening the scope of existing risk analyses, as supplementing them with a different type of analysis that does not rely upon the use quantified proxies. In the Terminal Five case study, the introduction of a wider remit for the risk management team half way through the pre-project feasibility work meant that active consideration was given to the risks associated with project team 'skills' integration, stakeholder involvement and communication channels as well to the 'technical' risks of finance and product function. Because of this, it became apparent to senior management that the severity of the risks associated with poor communication amongst different project experts (from different organizational cultures) were potentially as damaging as those associated with product failure, were more likely to occur, and yet, potentially, were easier to resolve were appropriate structures put in place. One response was to stipulate that project teams should aver from isolating a specific response to a specific component of a problem until the 'last responsible moment', preferring instead to work across a range of possible solutions each argued for from different perspectives. The involvement of many, and often conflicting stakeholders in the consultation process for Terminal Five planning brought to bear such differing norms as to preclude the

possibility of there being any 'right answer' or clear path of resolution to the many ethical, community and perceptual 'conflicts' and confusions.

The paper is asking significant practical questions of risk management. A concern for systems interdependency (such as: different organizations within project teams, infrastructure links, environmental 'footprints') and behavioural influences (such as anxiety, precautionary bias and ethical perceptions), allows projects to use risk management to build up decisional matrices that can identify dynamic efficiencies made possible through the management of knowledge (information linked to employee and customer expectations and enhanced delivery) (Nonaka *et al*, 1998). The realization of these efficiencies relies upon the initiative, skill and commitment of personnel to envisage and exploit risks as new opportunities (Roos, *et al*1997). At the organizational level this requires a strategy of constant and constructively self-critical awareness and evaluation of the structures and often unconscious 'defenses' adopted by managers (Argyris, 1995). At the personnel level it requires a revision of expectations: no longer are employees paid to do what they are told, but encouraged to proffer solutions through an awareness of their contribution to the project's and organization's aims (Ghosal *et al*, 1999) As organizational control is becoming less certain and predictable and increasingly dependent upon external resources (Pfeffer and Salancik, 1978) the management of uncertainties contained as 'risks' is becoming more relevant. It is the potential of risk management to manage the cognitive complexity of interdependent structures constituting organizations in networks of relations along with the cognitive plurality of knowledge, skills and expectations amongst its employees (Glynn, 2000) that this paper investigates.

The typical aspects of risk

By analysing the likelihood of something happening and the array of possible impacts of its happening, organizations are able to translate random uncertainties into probable events, or risks. These can be incorporated into organizational strategy as: the resources an organization has at its disposal and is likely to need, the systems it has in operation to implement decisions and deliver goods and services, and the expectations of its employees, customers and wider stakeholders. Using an example such as Terminal Five, such a risk analysis can take place at a number of different levels and from a number of different perspectives:

Table 1: Potential areas of risk within a project environment

	Organization	**Project**	**Team**	**Personal**
Cultural	*Conflicting strategic aims within joint venture*	*Personnel within organizational 'silos'*	*Multi-tasking team with differing competencies*	*Impact of work upon family*
Social	*Electoral change*	*Protestor and/or security sensitivity*	*Accountability to other teams*	*Aligning activity with personal ethics*
Temporal	*New technology speeding up industry 'clockspeed'*	*Unspecified client need meaning unclear critical path*	*Unrealistic project 'milestones'*	*How activity promotes/hinders career path*
Environmental	*Exhaustion of non-renewable raw material*	*Contaminated site*	*Pollution requires use of unfamiliar protective gear*	*Exposure to hazards*
Financial	*Currency or interest fluctuation*	*Client budget changes*	*Underestimate consumables*	*Salary/benefits*
Physical	*Poor offices weaken public image*	*Untidy site*	*Team split between site and office*	*Health*
Technical	*Errant auditing system*	*Lack of modular, pre-assembly suppliers*	*Faulty machinery*	*Failure to link competencies with tasks*

Facing this complexity, organizations typically use a variety of tools. Engineering estimates are used for property exposures, leading to figures for maximum foreseeable loss and probable maximum loss, coupled to actuarial projections for calculating expected loss levels where sufficient loss data is available. Loss and product/service liability are met using insurance systems linked to policies of risk netting (insuring distinct risks such as product liability and fire with a sole insurer to offset one against the other – a fire in a factory should reduce liability premiums on the products that would have been made there) (Meulbroek, 2001). Scenario analyses and Monte Carlo simulations are used to create predictive models when existing data is thin. For environmental uncertainties such as toxicity and pollution levels, probability tests are used under the aegis of the precaution principle (the onus of proof rests with those advocating change). Political and social risk analysis is dealt with using 'Delphic' analysis whereby experts' opinions are tabulated, cross-referenced and 'stacked'. Financial risks are calculated using probability distributions of net present value linked to policies of risk spreading (minimising exposure to risk by spreading the bearing of risk amongst many investors) and risk pooling (involvement in a series uncorrelated projects and activities) (Klein, 2000)

Being solution lead, these tools err toward the technical and quantifiable risks; the problems are seen as having an optimal solution arrived at through persistent and

careful analysis of the sub-problems from which they are made up, linked to requisite changes in business activity. Such problems can be called 'tame'. Seeing problems as tame helps clarify decision-making. Experts are able to reassure decision takers of any likely consequences using linear, solution driven frameworks with clear modes of appropriate response. By keeping the class of problems tightly defined, risks can be priced using alternative discount rates and tolerability thresholds (Hoffman, 2000). They can then be managed using sequential layers of decision making (hedging, transferring, pooling, transforming) that aim to reduce unmanaged risk to a residual core (Millar and Lessard, 2001).

This selectivity, however, can complicate the risk picture as much as it clarifies it. Firstly, whilst these models do reflect a significant reality (or set of realities), they do not reflect how those significant realities and those presenting them (experts) can be interpreted and perceived by others. For example, whilst an environmental risk can be shown to be almost non-existent, its heightened perception amongst wider stakeholders can have a major influence on project events. Secondly, they do not easily convey the judgmental and structural assumptions influencing the choice of risk focus. A dominating budget structure, for example, may mean funds for risk assessments are only available up to the year-end, meaning risk assessment results are skewed by a contingent factor of annuality. Thirdly, they do not present all possible realities, leaving risks uncovered (Elkington and Smallman, 2002), ignoring, very often, the influence of the cultural, social and temporal aspects of uncertainty because of a failure to consult 'interested' parties. Even in technical and financial areas, where mature modelling techniques allow determined parameters and sequential processes to shape organizational decisions, rapid exogenous changes to resource levels and market and client expectations can make these obsolete. Information, here, as anywhere, is always asymmetric Chacko *et al*, 2001)

A pertinent example of these influences for the case study was a tunnel collapse at Heathrow in 1994 during the extension of a tube line. The subsequent Health and Safety Executive Report (2000) concluded that to fully understand risks "it is essential that organizational and human factors be taken into account". The report stated that in the instance of the tunnel collapse these included: misunderstandings arising from contractual relationships, role ambiguity of personnel, poor

communication between project processes and people, the effects of production pressure on decision making and a cultural commitment to safety. Reading into these conclusions, the tunnelling uncertainties had been reduced to a series of tame problems and tried and tested processes put in place to identify and eliminate and/or control the risks. Whilst there were technical problems such as tunnel wall thickness, where these remained unidentified was less because of a breakdown in tried and tested technical assessments than because of poor interaction between contracting parties. The breakdown was in the information flow between organizations and in the unclear role responsibilities and expectations or project personnel. The implication is that the identification, estimation and evaluation of probabilities of occurrence and the likelihood of impacts is influenced by the risks of management (mis or mal-aligned behaviours, perceptions and systems) as much as it describes the management of risks.

Looking at risk differently

Systems interdependency and 'messes'

Uncertainty tends to be explained by analysing the probability of root causes or sets of root causes (Perrow, 1984). Often, though, it is the isolation of root cause that contributes to, as much alleviates, the uncertainties being explained. Isolating 'operator errors' as a source for system failure on a production line, for example, can serve both as an indication of, and a trigger for, much deeper problems. The response to operator error might be to increasing surveillance. This will ensure workers attend to their tasks with greater concentration, reduce the uncertainty of downtime and so increase productivity (Scarborough and Terry, 1998). It, however, also increases the production system's overall complexity and so dependency upon other systems. Charles Perrow (1994) says this systems' growth can itself become an actual source of risk because systems can develop their own conditions and behaviours that are often impossible to predict. For example, the needs of the surveillance system can predominate over the production process itself, draining resources and eroding profitability, thus exposing a project to the greater financial risk of higher gearing. Moreover, any prediction of failure that the surveillance makes possible can only operate in the very short run, and only at the boundaries to a problem (Thiétart and

Forgues, 1997). The surveillance may correct one form of 'deviant activity', only to displace the deviance elsewhere to re-emerge in another non-surveyed form.

These problems of interdependency can be described as messes (Rittel and Weber, 1973). A mess refers to the coupling of systems components and systems themselves, requiring risk management be aware of far more parameters than just a single component of a processes or series of such.

Human behaviour and wicked problems

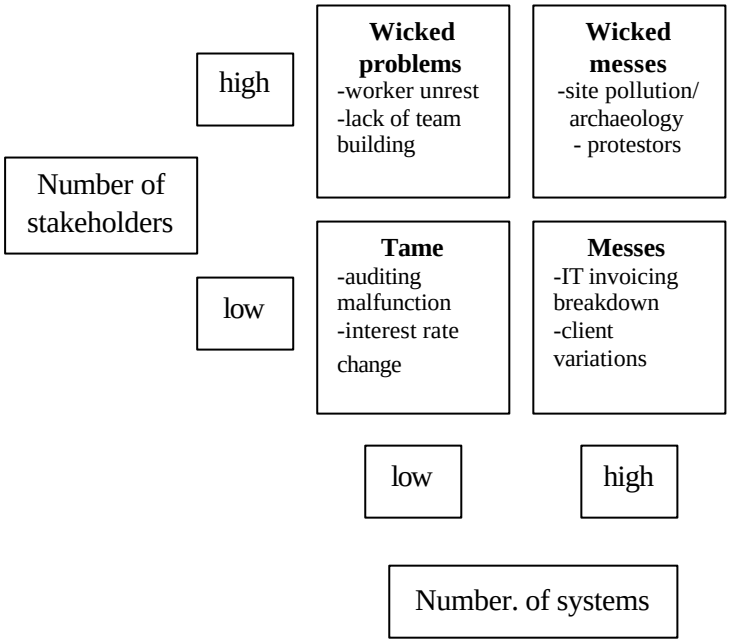
Judgements, perceptions and anxieties all influence uncertainties in organizational decision-making and activity and yet, being difficult to identify in terms of effect and influence, are often excluded from risk management. To continue with the example of increasing surveillance to prevent operator error, but from a behavioural perspective, there are, again, risks consequent upon its adoption. Employees could construe it as a lack of trust in their ability, causing both passive active (absenteeism, day dreaming) or active resistance (withdraw labour, disrupt production) (Storey, 1985). Equally, people often behave in line with the way that they are treated. Using surveillance impresses upon employees the expectation of a rigid, repetitious task structure (Jaques, 1996). This enforced predictability, however, can itself promote uncertainty because changing resource and expectation levels and equipment failures mean more than rigid repetition is sometimes required.

The uncertainties arising from human behaviour can be called wicked problems (Rittel and Weber, 1973; Ackoff, 1974). They describe how uncertainties emerge or evolve without ever lending themselves to a definitive description or resolution.

In neither the case of messes nor wicked problems is there a single, correct answer, and when both combine as above to form a 'wicked mess', risk management must look less to solve problems than to resolve tensions and realise satisfactory outcomes, fully cognisant of their being sub-optimal. This is 'satisficing', the acceptance that the problem-solving process ends when you run out of time, money, energy, or some other resource, not when some perfect solution emerges (Simon, 1990). Wicked messes are puzzles; rather than solving them, risk management can *resolve* their complexities by delineating specific time periods and resource

allocations for decisions, or, dissolve them through clearer discourse (Thurow, 1980).

Figure 1: A project risk problem matrix



The matrix provides an overview of how risk management can identify and structure the differing qualities of a range of uncertainties that might be experienced on a project. The further to the top right, the greater the need for 'satisficing strategies' to enable the project to deliver on its aims. For example, the financial risk of rapid changes in interest rates might be considered a tame problem with established sequential responses. The risk of high profile, and possibly violent, protestor activity conducted both on site and through the media might be seen as a wicked mess, requiring the rapid introduction of consultation groups as well as security and safety measures.

The following case study reflects how changing the perspective of risk management from a consideration of just tame problems understood probabilistically, to 'tame', 'messy', and wicked problems, understood as without optimal solutions (Pender, 2001) enables a much more comprehensive and strategically focussed risk management to come to the fore.

Heathrow's Terminal Five

Background

Terminal Five will be built to the western end of Heathrow Airport between the two main runways on land now mostly occupied by the Perry Oaks sludge works within the regional boroughs of Hillingdon, Spelthorne and Hounslow. It was in planning for six years, and is to be followed by a six year capital works programme, due to start in spring 2002, consisting of terminal space, offices, car parks, rail and bus links, accommodation, retail space and service areas. Most of the development site is within the Green Belt, meaning any construction has to be shown to planners to be of an exceptional need. Terminal Five, then, is much more than a building. It is a highly complex transport interchange with two major (BA and BAA) and many minor stakeholders (UK Government, local authorities, Thames Water, Highways Agency, other airlines, Railways Inspectorate, Civil Aviation Authority, Fire Brigade, environmentalists, passengers etc..), all of whom have often conflicting objectives to be satisfied by the facility solution. The programme and construction costs unmanaged, could easily cause either BA or BAA to become 'bankrupt' and

customers (airlines or passengers), unsatisfied with the service provided, could easily shift to other airports.

The risk workshops

The risk workshops took place four years apart, the first beginning in 1996, the second in 2000. The research analyses this change by examining the risk registers, along with the perceptions of the risk facilitators conducting the workshops, one of whom is one of the authors.

The 1996 risk workshop

The workshop brief was to produce a full identification and assessment of project risks with the full backing and commitment of those holding the *'key interests'* and responsibilities to the project i.e. the *key* stakeholders, as well as to comply with risk management legislation. The workshop was designed to identify critical risks and then allocate the requisite and available project competencies to the management of these risks. The participants were based on the considered importance to the project and were chosen largely from the organisational hierarchy within BAA . At this point the project aim was the delivery of a terminal commensurate with its role as an international gateway to the United Kingdom, set within the BAA Board's approved rates of return, and with the minimal possible environmental impact.

The workshop identified a hierarchy of project risk by occurrence and impact into high, medium and low, and from this produced a project risk register, by which those risks affecting project out-turn were to be managed by:

? Describing in qualitative terms giving the risk source, trigger events which could cause it to occur and the impact in term of cost/time/quality/environment and safety.

? Detailing initial risk responses to major risk items.

The mutual commitment of the group was 'ensured' by making participants aware of their equality, the validity of any opinion, and the importance of succinct precision and clarity. Hence the emphasis was upon defining the process and arriving at explicit aims and milestones. The facilitator's role was to create an environment in

which the group utilises its members in terms of their technical knowledge and problem solving abilities.

The work started by deconstructing the project into a series of five sub projects and focused on the technical and financial issues using quantified measures covering cost, programme, environment, quality and safety. The majority of the participants had an accounting or engineering background. By deconstructing the project into 'manageable' parts and dealing with those parts independently, the focus assumed the uncertainties to be faced were of a tame nature. This was akin to treating the problems as a game of roulette rather than a game of poker; absolutely rather than relationally. The analysis of the registers showed more discussion time was spent deliberating over the magnitude of probability and consequence than was spent considering possible response plans or the possibility that not all risks had been identified. The predominating assumption was that risk information was most readily available from historic data. The facilitator adopted the role of summariser; consolidating opinions to points of solution whereby agreement was reached as to who was responsible for which risk. The risks themselves were described by each expert, and went largely unchallenged in discussion, and the workshops adopted the role of compiling these different risks into a workable schedule. The output was the compilation of an extensive risk schedule assessing the nature, occurrence, impact and 'risk owner' for over 350 risk descriptions. Table 2 shows the fifteen uncertainties from which T5 was considered most at risk.

Table 2: Top 15 risks from the earlier Project Risk Registers ranked in order of potential severity

Late wish list from BA
Impractical design causes problems with buildability
Contractors go bust
Delays with internal approval process
Overheating of construction labour market
Unforeseen ground conditions
Vandalism to construction site buildings
Failure of co-ordination between teams and with BAA
Budget drives a reduction in design standards
Inadequate site supervision e.g. Safety risk
Container delivery to head of stand and between buildings
Weather dependency of construction
Lack of consultation with contractor on buildability issues
Supplier under performance - Critical items being delivered late
Off site rail head – Not possible
No decision on rivers diversion

Of the top fifteen identified risks, eleven could be described as tame (technical, financial or economic), with only the risk of variations, co-ordination problems, approval delays and vandalism touching upon complexities of behavioural or systems interdependency. Of these, 'variations from 'British Airways' was cited as being the greatest risk facing the project, yet BA itself was not consulted nor became party to the workshop. So even where a wicked mess was acknowledged, no attempt was made to evaluate it. Such a high proportion of 'tame' problem identification was all the more telling considering the capital works elements of the project had not even started, and so the emphasis was still upon strategy and planning rather than operations.

The 2000 risk workshop

During the intervening period, the project aims had been considerably simplified to a single sentence: "To develop the world's most refreshing interchange delivered within cost and programme parameters, maximising shareholder value and respecting

last responsible moment to realise exceptional project performance". The last responsible moment is defined as "the latest moment a decision can be made to finish the project to budget and programme without any compensating factors" (Lane and Woodward, 2000). Defining the last responsible moment forces project teams to reflect upon the limits of their understanding, and how what they do understand relates to the understandings of other teams The inclusion of last responsible moment meant the framing of the risk workshop changed from an emphasis upon delivering problem-solution coefficients to articulating those practices that afforded the project team the greatest space for reflection upon the nature of the problems they faced, before having to take a decision. This emphasis upon reflection and conversation meant it was considered *critical* to choose the participants based on their influence and ability to explore prevailing and emerging business issues. This meant that a considerable amount of time was spent with BAA and BA to ensure the 'right' people were present, along with general insurance and legal advisors, project suppliers and rail transport stakeholders. One of the problems with this approach is that the number of participants was more than would be considered ideal (10-12) and to help manage this successfully two assistants were employed.

The workshop aims reflected this broader scope by looking to:

? Link risk with opportunity and awareness of the associated tools and procedures; including secondary opportunity and risk identification

? Be aware of team building criteria and competency gaps

? Establish common ground within and between project teams

A framework for the discussion had been designed using a questionnaire sent out before discussions, asking the participants to identify the five most significant risks and opportunities facing Terminal Five. This was used not only to identify areas of synergy or possible conflict, but also to indicate preconceptions brought to the discussion. Ground rules were again established, but there was a subtle change toward promoting conversation and critical reflection where people were of equal status, to regard feelings as important as fact, and to speculate rather than focus on precision. The more fluid aims meant the facilitator's role required far greater

attention, and became a much more pro-active role of challenging received opinions and consensus as opposed to consolidating opinion and compiling conclusions. Specifically, the facilitator was to introduce different ways of looking at problems and to provide discourse structures leaving participants free to think.

Where the previous conclusions had emphasized the need for a clear presentation of specific risks, now the participants were asked to consider devising enough space within project activity for teams to reflect upon the uncertainties they face, to consider possible innovations in the light of that space, and so to understand how risks could be converted into opportunities. Risk management became, in effect, a mode of project and team learning and knowledge management. The process aimed to replace the identification of reactive, fire-fighting activities with pro-active approaches by improving project team confidence, knowledge awareness and clear activity responsibility communicated through the life of the project.

To these ends, discussions considered as much of what was not known as compiling what was. In addition, they subjected what was 'known' to thorough analysis, testing the presumptions brought to the table by the respective experts, and limiting the claims for this knowledge by refusing to elevate quantified risks above qualitative risks. The discussion was also concerned with enhancing the role of risk owners, considering them as risk 'custodians', responsible for the delivery of both work and the management of the risks attached to it.

The results compiled in a register of the top risks facing the project represented a significant change in emphasis. Table 3 identifies the top fifteen.

Table 3: Top fifteen risks from the later Project Risk Registers in order of potential severity

Not having clear lines of accountability/ responsibility, and clearly defined role of the client.
Lack of Integration of IT/IM systems (Ownership, BA/BAA boundaries, timing, complexity of system, etc)
Impact of adverse Foreign Currency Exchange rates on construction costs (approximately 40% of £500m opportunity)
Continuing "Business as usual" behaviour
Skills shortages and labour shortages during construction
Lack of integration of teams and people "kicking" against the use of integrated teams
Inability to manage project changes (change control)
Major 3rd party pieces of infrastructure on critical path for project not delivered on time (e.g. Iver South, M25 Spur, Highways Agency, Piccex LUL, Southern Electric
Project disrupted through IR dispute
Failure to integrate baggage into the project (and the project into baggage)
Failure to secure regulatory regime to support viable T5
Onerous conditions imposed by Public Inquiry Decision e.g.. Timing of Spur Road, Twin Rivers Diversions
Risk management strategy fails due to inadequate or nil incentive fund
Implications of Iver South not receiving planning consent resulting in need to maintain centrifuges at Perry Oaks for longer period (e.g. beyond commencement of Construction)
Protestors action disrupts project

Of these eleven can be considered as focussing upon issues of behavioural and systems interdependence (messes, wicked problems and wicked messes), and only four as 'tame'. The hierarchy used in the register was not numerical, but colour coded, flattening the risk identification to red for high; amber for medium and green for low. This allowed participants' judgements to be included without having them reduced to an algorithmic proxy. Where major disagreement occurred on the nature and importance of a risk, a discussion was held concerning the different perceptions of the risk. Using information from the questionnaire, as well as issues arising from the dialogue, the facilitator focussed the participants upon the relative positions and assumptions being adopted. Once these were stated clearly and understood, a satisfactory resolution of the differences could be worked on.

The emphasis upon conversation and questioning meant that where in the fist workshops the tendency was to 'dump' into the risk register all the risks the experts could imagine, in the second the focus was upon how their experience related to the particulars of the Terminal Five project. Moreover, where the first workshops saw

responsibility as merely listing and ranking the risks, the second worked up risk 'custodian' schedules that actively required individuals to be held accountable for their management throughout the project life.

Conclusions

The differences in the risk register workshop outcomes shows the influence that risk tools, techniques and presumptions have over the configuration of risk. By introducing the core rubric of tame, wicked and messy problems, risk management is far better placed to allow organizations to understand fully the gamut of risks they face, irrespective of their technical nature or otherwise. The investigation of the workshops has shown that risk management systems can underplay the importance of behavioural and system complexity considerations. The first workshops focussed upon technical aspects because of the makeup, the determining aims and the adoption of habitual risk perspectives. Using the experience of one of the authors within the second series, the research shows how by re-orienting workshop parameters to a less prescriptive level, and allowing greater scope in discourse, other aspects of risk will surface, and even come to predominate. Where the first emphasized a regimented, ordered structure toward conceptualising the exact components of risk, the second adopted more flexible patterns of determination, emphasising conversational exchange above tight structures. The difference in the outcomes arising from these differing emphases is stark. The emphasis of the first was upon attaching detailed solutions to specific largely technical problems. Each risk was linked to an identified risk owner whose responsibility was to find solutions to minimise exposure. In the second series, the participants were less formalized in the delivery of expert opinion, were more sensitive to how risk management could influence strategic decisions of the project directorate, and more focused upon using conversation to break down received opinions. This allowed an exploration of differing accounts of uncertainties arising from different sets of stakeholder perceptions, systems complexities and normative influence, enabling the risk schedules to reflect an awareness of the non-technical aspects of risk definition. The evidence from that the second workshop approaching risk management as an activity of 'satisficing' suggests the search for optimal solutions can often be counterproductive, if it means excluding the perspectives and needs of others.

Terminal Five underwent an entire identity shift, from a technically constructed asset owned by a single company to a transport interchange invested in by many stakeholders. The effort and resources required to effect this change are significant. Organizationally, there has to be willingness to structure risk workshops with space sufficient to exploit the opportunities thrown up by risk whilst recognising the last responsible moment; the point at which a decision is taken. The challenge is to ensure participants have sufficient time to become aware of the nature of non-tame problems, and the competency and responsibility to operate with the persisting uncertainties that these entail. This requires involvement from different levels and cultures (executive culture, engineering culture, operational or administrative culture) (Schein, 1996) within the project environment, meaning risk workshops operate at a strategic level in close proximity to the project directorate. Without this project rapport, the benefits of understanding the risks associated with systems integration and human behaviour will be sidelined as a subset of technical constraints, and be left to configure themselves as potentially harmful events. Configuring where upon the matrix of tame, wicked and messy a problem lies is only a valid investment if the resultant register is then integrated fully into overall project strategy.

Bibliography

Ackoff, R (1974) Redesigning the future: A systems approach to societal problems New York: John Wiley & Sons

Argyris, C (1995) 'Action Science and Organizational Learning', Journal of Managerial Psychology, 10 (6): 20-26

Chacko,G., Terano, V., Verto, G. (2001) 'Cephalon, Inc. Taking Risk Management Theory Seriously', Journal of Financial Economics, 60: 449-485

Dragonetti, N., Edvinsson, L. (1997) Intellectual Capital, London: MacMillan

Glynn, M (2000) 'Pluralism and the Problem of Variety', Academy of Management Review 25 (4): 726-734

Elkington, P; Smallman (2002) 'Managing Project Risks', International Journal of Project Management, 20: 49-57

Ghosal, S, Bartlett, C, Moran, P (1999) 'A new manifesto for management', Sloan Management Review, 40 (3) 9-34

Health and Safety Executive (HSE) (2000) The collapse of NATM tunnels at Heathrow Airport, London: HSE Reports

Hoffman, D (2000), 'Operational Risk Management ', Bank, Accounting and Finance, 14 (2): 21-29

Jacques, R (1996) Manufacturing the Employee, London: Sage

Klein, M (2000) 'The Risk premium for Evaluating Public Projects', Oxford Review of Economic Policy, 13 (4): 29-42

Lane, R, Woodward, G (2000) 'Wicked problems, righteous solutions', Proceedings of the Eighth Conference of the International group for Lean Construction

Meulbroek, L (2001) 'A better Way to Manage Risk', Harvard Business Review, 79 (2): 22-24

Millar, R; Lessard, D (2001) 'Understanding and Managing Risks in Large Engineering Projects', International Journal of Project Management, 19: 437-443

Nonanka, I., Reinmoeller, P., Senoo, D (1998) 'The Art of Knowledge: Systems to Capitalize on Market Knowledge', European Management Journal, 16 (4): 673-684

Pender, S (2001) 'Managing Incomplete Knowledge', International Journal of Project Management, 19: 79-97

Perrow, C (1984) Normal accidents: living with high risk technologies, New York: Basic Books

Perrow, C (1994) 'Accidents in high-risk systems', Technology Studies, 1 (1): 1-20

Pfeffer, J, Salancik, G (1978) The external control of organizations: a resource perspective, New York: Harper and Row

Rittel H and Weber M (1973) 'Dilemmas in a General Theory of Planning', Policy Sciences 4: 155-169

Roos, J., Roos, G., Draonetti, N., Edvinsson, L. (1997) Intellectual Capital, London: MacMillan

Scarborough, H., Terry, M. (1998) 'Forget Japan: The Very British Response to Lean Practice', Employee Relations, 20 (3): 224-236

Schein, E. (1996) 'Three Cultures of Management: The Key to Organizational Learning in the 21st Century' Sloan Management Review, 38 (1): 9-21

Storey, J (1985) 'The means of management control', Sociology 19 (2): 193-211

Simon, H (1990) 'Invariants of Human Behaviour', Annual Review of Psychology, 41

Thiétart, R, Forgues, B (1997) 'Action, Structure and Chaos', Organization Studies, 18 (1): 119-143

Thurow, L (1980) The Zero-Sum Society: Distribution and the Possibilities for Economic Change New York: Basic Books