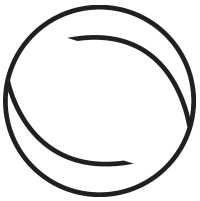

Decision Theory as Practice: Crafting Rationality in Organizations

Laure Cabantous, Jean-Pascal Gond and Michael Johnson-Cramer

Abstract

This paper explores the underlying practices whereby rationality – as defined in rational choice theory – is achieved within organizations. The qualitative coding of 58 case study reports produced by decision analysts, working in a wide range of settings, highlights how organizational actors can make decisions in accord with the axioms of rational choice theory. Our findings describe the emergence of 'decision-analysis' as a field and reveal the complex and fragile socio-technical infrastructure underlying the craft of rationality, the central role of calculability, and the various forms of *bricolage* that decision analysts deploy to make rational decisions happen. Overall, this research explores the social construction of rationality and identifies the practices sustaining the *performativity* of rational choice theory within organizations.

Keywords: bricolage, calculability, decision analysis, performativity, rational decision-making

Laure Cabantous
Nottingham University Business School, UK

Jean-Pascal Gond
HEC Montréal, Canada

Michael Johnson-Cramer
Bucknell University, USA

Economic rationality is not like Newton's laws, which are supposed to be at work everywhere in the universe. It is a fragile property that must be carefully preserved by creating a hospitable environment. (Guala 2007: 147)

The rationality of organizational decision-making processes is a central topic in organization theory (Eisenhardt and Zbaracki 1992; Hodgkinson and Starbuck 2008; March 1978). The rationalistic model, also called the 'synoptic' or 'comprehensive' model (Fredrickson 1984; Hendry 2000), has proven fertile ground for both its proponents and its opponents alike (March 2006). Research based on this model clarified the effects of various external and internal variables on the adoption of comprehensive (or exhaustive) decision-making processes (Bourgeois and Eisenhardt 1988). It also studied the consequences of comprehensive decision-making processes on organizational performance (Dean and Sharfman 1996; Fredrickson 1984).

Yet, this model has drawn its share of critics. The process school valuably complemented the rationalistic approach by uncovering the diversity of decision-making processes that organizations adopt (Mintzberg et al. 1976; Nutt 1984). It highlighted the various rationalities that inhabit organizations, such as the bounded (March and Simon 1958; Simon 1955), political (Allison 1971; Crozier and Friedberg 1980; Pettigrew 1973), and institutional rationalities (Lounsbury 2008; March and Olsen 1989). This approach also unveiled the various uses,

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often symbolic, of formal decision-making tools in organizations (Langley 1989; Laroche 1995; Meyer and Rowan 1977). Lastly, critical perspectives on organizational decision-making challenged the concept of a 'decision' itself and demonstrated the potential irrationality of organizational decisions (Brunsson 2007; Chia 1994; Cohen et al. 1972; Sfez 1973; Starbuck 1983; Tsang 2004).

While they have proven rich with insights, the different paradigms on organizational decision-making have nonetheless neglected crucial aspects of the phenomenon (Hendry 2000; Langley et al. 1995; Laroche 1995). In particular, missing from this research is an analysis of the socio-technical conditions enabling the construction of rational decisions – as defined in rational choice theory – within organizational contexts.[1]

Three main reasons, we argue, explain this lack of interest for the concrete conditions that sustain managers' efforts to make rational decisions. First, rationality – as used in rational choice theory – is treated as a property that organizations have (or do not have) rather than an outcome of a purposive work undertaken by actors inside the organization. This taken-for-granted view on rationality is a common feature of works either advocating (Dean and Sharfman 1996) or challenging (Brunsson 2007) rational forms of decision-making.

Second, decision-making research neglects the potential influence of normative theories of choice on organizational activities through teaching and prescription. Although the economic model of choice remains the benchmark of most teaching exercises on decision-making (Czarniawska 2003; Langley 1989), its potential normative influence on organizations has rarely been evaluated.

Finally, organizational researchers focus on decision-making processes rather than on the concrete practices of organizational decision-makers. Accordingly, they miss the role that material artefacts play in decision-making processes. Yet, some of the artefacts used by organizational actors embody a rational conception of decision-making. Hence, they could act as a 'rationality carrier' and diffuse rationality through organizations. Thus, the 'lost' rationality of organizational decision-making (Laroche 1995) could be simply hidden in the 'missing masses' of organizational life (Latour 1992: 225), that is, its largely neglected materiality (Latour 1994; Orlikowski 2007).

This article seeks to address these blind spots and to develop an organizational theory of the craft of rational decisions in organizations. To uncover the underlying practices that allow making rational decisions, we combine insights from research of the practice perspective (Reckwitz 2002; Whittington 2006) with the economic sociology analyses of perfomativity and calculability (Callon 1998; Callon et al. 2007). This perspective allows analyzing rational decision-making as a social construction that involves a theory (rational choice theory) and a set of tools and artefacts embedding the theory's core assumptions (Cabantous and Gond forthcoming; Cabantous et al. 2008).

Such an empirical exploration of the craft of rationality would not be possible without the existence of a professional body of experts in decision-making prescribing a normative view on rational decision-making within organizations: the so-called *decision analysts*. Instead of abandoning the assumptions of rational choice theory because of their lack of realism, decision analysts intervene in

organizational reality and attempt to make it fit with rational choice theory. Hence, in studying the emergence of this field, we can explore the processes whereby rational choice theory may progressively be turned into social reality. Moreover, a systematic content analysis of 58 case study reports produced by those experts shows the very concrete practices and socio-technical processes that sustain the making of a 'rational decision-maker'.

The article proceeds as follows. Part 1 defines the core concepts – practice, performativity and calculability – that guide our study of the craft of rational decisions in organizations. Part 2 introduces the data and method deployed to investigate the craft of rational decisions within organizations. Parts 3 and 4 present the findings. We conclude with a discussion showing the main implications of this work for future research on rationality, organizational decision-making and performativity.

Conceptual Foundations

Our empirical exploration of the craft of rational decision within organizations is guided by three core concepts: *practice*, *performativity* and *calculability*. These derive from the social practice perspective in organization studies (Reckwitz 2002; Whittington 2006) and the research of economic sociologists Callon and Latour whose anthropology of markets offers a language for describing the material and the social construction of economic activity (Callon 1998; Latour 1996). This part introduces these concepts and explains how they support our investigation of rational decision-making as a socially constructed phenomenon within organizations.

Practice

Rationality is something that people achieve (Garfinkel 1967). It is the product of social interaction and collaboration, not merely an organizational characteristic. As such, rational decision-making, like any form of strategizing, must be conceived as a social practice (Reckwitz 2002; Schatzki et al. 2001). Its existence involves the co-presence of three constitutive elements: actors involved in decision-making (practitioners), tools and models enabling their actions (practice) as well as actors' activities (praxis) (Jarzabkowski et al. 2007; Whittington 2007).

A practice perspective suggests focusing with a 'sociological eye' (Hughes 1971; Whittington 2007) on the thick *processes* whereby rationality is instantiated within organization. It thus moves beyond a variance approach to rationality (Mohr 1982) that considers it as a given 'state' that can be exogenously assessed (Dean and Sharfman 1996). Such an approach allows observing rationality 'in-the-making' within organizations, i.e. the craft or actual *practice* of rational decision-making. It also sees rational decision-making as an organizational actors' performance – in Goffman's (1959) sense of the term.

Performativity

The concept of *performativity* is the second pillar that supports our conceptual framework (Callon 1998). This notion has moved from the laboratory of social studies of sciences (Latour 1987) to the field of economic sociology where it refers to the specific influence of economic theory on actual economic practices (Callon 1998; MacKenzie and Millo 2003). From the performativity perspective, 'economics does not describe an existing external "economy", but brings that economy into being: economics performs the economy, creating the phenomena it describes' (MacKenzie and Millo 2003: 108). Broadly defined, performativity encompasses the whole set of processes whereby a theory influences the reality it describes and thus increases its verisimilitude and ultimately its social success (Callon 2007; Latour 1996). MacKenzie (2006, 2007) distinguishes several types of performativity depending on their degree of influence on economic activities. In the weaker and most common case of 'generic performativity', economic actors use in their practices an aspect of economics (e.g. an assumption, a model, a concept). Performativity becomes 'effective' when the practical use of an aspect of economics has an impact on economic processes themselves (MacKenzie 2007: 55–56). Last, in the less frequent yet stronger case of 'Barnesian performativity', the use of economics over time ('generic performativity') not only alters economic processes ('effective performativity'), but does so in a way that makes them more and more similar to their depiction by economics (MacKenzie 2007: 67).

Performativity research shows that the core principles of economics shape management practices, tools, norms and language, and subsequently frame the business world according to the behavioural assumptions of this theory (Ferraro et al. 2005; MacKenzie 2006). For example, the adoption of market-like relationships between employees and employers in the last 20 years has created outcomes that conform to the economic assumption of self-interested actors. As a result, employers no longer feel any social obligation or moral tie to their employees while, at the same time, employees' loyalty and trust has decreased (Ferraro et al. 2005: 18–19). Hence, performativity draws our attention to the various processes whereby economic theory may influence management practices. Even so, performativity processes do not lead systematically to theory self-realization; they still shape actors' social reality, language, and practices.

Calculability

Finally, the rich body of research on calculative practices provides us with a third complementary lens to investigate the practice of rational decision-making within organizations (Callon and Muniesa 2005; Miller 2001; Porter 1996). *Calculability* is broadly defined as a three step process of 'isolating objects from their context, grouping them in the same frame, establishing original relations between them, classifying them and summing them up' (Callon and Muniesa 2005: 1232). This definition encompasses the qualitative and organizational work that sustains the production of figures ('first order measurement') as well as the narrow view on calculability as the application of calculative techniques to pre-existing figures ('second order measurement') (Power 2004).

Research on how economics shapes ordinary economic activity highlights the central role of tools and practices aiming at making things 'calculable'. Calculability is a necessary condition to the construction of markets (Callon and Muniesa 2005). Calculative practices have also played a crucial role in the processes whereby modern financial theory assumptions have been turned into social reality for actors (MacKenzie 2006). Because the theory decision analysts rely on assumes the existence of strong calculative capacities from actors, we expect calculability to play an important role in the constitution of rational forms of decision-making.

In sum, we see rationality – as defined in rational choice theory – as a 'fragile product' (Guala 2007: 143) and we seek to highlight its organizational 'conditions of felicity', i.e. the social conditions thanks to which it could be achieved within organizations (Bourdieu 1991). We thus complement research on organizational decision-making by revealing the practices underlying the concrete craft of rationality, and by examining the relationship between rational choice theory, decision-making social processes and tools.

Method and Data

Because previous studies suggest that rationality is seldom enacted in organizations (Langley 1989), we did not follow the traditional method that consists in selecting a representative sample of decisions within a given industrial or cultural context (Dean and Sharfman 1996; Langley 1989). Instead, we focused on a set of decisions that experts of rational choice theory regard as fulfilling the criteria of rationality. This led us to study a community of practitioners of decision-making, the 'decision analysts' (Howard 1966; Raiffa 2002).

For analytical purposes, we study the decision analysis community on two levels. On one level (which we refer to as our first order findings), we offer an account of the emergence of this community. This historical process helps us to understand the process whereby rational choice theory has been translated into organizational contexts. On another level (which we refer to as our second order findings), we study the reports produced by decision analysts within their community of practice. Decision analysts produce reports called 'applications' for the express purpose of sharing experiences of decision-making techniques applications within organizations with their peers.

Though it may appear somewhat indirect and even paradoxical to rely on 'secondary data' for studying 'practice in context', four arguments justify this data set. First, these reports provide rich accounts of decision analysts' experience within organizations and have been produced with the aim of supporting the adoption of decision analysis 'best practices' across a broad range of organizations. Second, the fact that several of the most prominent scholars from the field produced 'applications' demonstrates the value granted to this exercise by decision analysts as well as the legitimacy of this material within the decision analysis field. Third, though these data represent a 'theorized' form of prior practice, it is nevertheless a reflexive exercise produced by the decision analysts on their own practice. Arguably, applications capture an important part of the

'living memory' of this field and open a window on its collective cognition (Walsh 1995). It usefully highlights some of its most famous and valued practices. Fourth and finally, these applications are publicly available and can easily be subject to a systematic content analysis.

Sampling of Decision Analysis Applications

To gather reference and reports of efforts to perform rational choice theory in organizations, we relied on Corner and Kirkwood (1991) and Keefer et al. (2004). These articles provide an exhaustive list of 172 applications published in operational research and management science English-language journals from 1970 to 2001 (e.g. *Operations Research*, *Management Science*, *Interfaces*). These applications are case histories documenting the use of decision analytic methods, defined as 'a set of quantitative methods for analyzing decisions based on the axioms of consistent choice' (Corner and Kirkwood 1991: 206–207).

The present research relies on a sub-sample of 58 applications published in *Interfaces* over the period 1970–2001 (see Table A in appendix for the full list). With 34% of the published applications over the period, *Interfaces* – a bimonthly journal of INFORMS created in 1970 – is the major outlet for publication of decision analysis case studies. By comparison, *Operations Research*, the *Journal of the OR Society* and *Management Science* have published together a total of 59 decision analysis applications over the period (26, 19 and 14 applications respectively).

We selected applications from *Interfaces* because this journal is the application journal of INFORMS. It positions itself at the interface between the academic world and the world of practice, as evidenced by its name and self-presentation: '[*Interfaces* is] dedicated to improving the practical application of operations research and management science (OR/MS) to decisions and policies in today's organizations and industries'. Moreover, this journal appeared as the richer source of information about what decision analysts concretely do to bring their model of choice into being in business contexts, as authors wishing to submit an application are asked to 'provide details of the completed application, along with the results and impacts on the organization'.[2]

The unit of analysis is the decision analysis application. *Interfaces*' applications are short reports (2–20 pages, mean = 10) explaining how some decision analysis techniques – such as utility and value elicitation, probability assessment and sensitivity analysis – have been implemented to help a decision-maker solve a problem. Most applications take place in an organizational context.[3]

Although they are retrospective accounts of attempts to enact the ideal rational decision-maker in organizations, *Interfaces*' applications tell a lot about the concrete practice of construction of rational decisions within organizations. Because these applications were written to help readers to 'learn how to overcome the difficulties and issues encountered in applying OR/MS to real-life situations', they do not hide the concrete efforts that decision analysts deploy to help organizational actors to be rational.[4]

As a text genre, applications are located somewhere between testimonies written by practitioners, and academic papers presenting decision analysis techniques

used in context. *Interfaces*' case studies, contrary to applications published in other academic reviews, describe the techniques used to the extent that this allows readers to better understand the 'art' of decision analysis. *Interfaces'* applications therefore focus on the concrete practices that decision analysts use to discipline decision-makers subjective choices.

Content Analysis of 58 *Interfaces*' Applications

We analyzed the content of *Interfaces*' applications in two steps. The first aimed at highlighting the conceptual stages that unfold during the process of rational decision-making construction. We focused our analysis on the core stages of the process, as our primary interest lies in the understanding of the construction (antecedents) of a rational decision rather than its symbolic effects (consequences). Moreover, the description of the decision-making process appeared to be less subject to authors' creative manipulation than the description of the consequences of the decision.

A first analysis of a sample of applications revealed three main stages in the decision-making process: contextualization, quantification and calculation. Using the software N-Vivo 7.0, we then coded systematically 50 applications along these categories (8 could not be turned into a format readable by the software and were manually analyzed). Systematic analysis of the applications revealed the robustness of the three stages.

Second, we investigated the socio-technical factors that may contribute to rational choice theory performativity. To do so, we loosely relied on a model of rational decision-making as a 'performative praxis' (Cabantous and Gond forthcoming). This model is inspired by the practice and performativity perspectives (Callon 1998; Whittington 2006). It suggests that three underlying dimensions – decision-makers, rational decision-making tools and rational choice theory – contribute to bring rationality within organizations. We coded a second time the whole set of 58 applications along these dimensions. This process led to the stabilization of four categories contributing to the craft of rational decisions: (1) social processes and interactions, (2) tools and techniques, (3) decision analysts' skills and competences, and (4) rational choice theory.

Validating our Analysis: Interviews with Decision Analysts

To complement the analysis of *Interfaces*' applications, we interviewed 10 authors of these reports. All together these 10 decision analysts published 15 of the 58 *Interfaces* applications of our sample.

The interviews lasted between 40 and 140 min and were conducted between August 2008 and February 2009. Two interviews were face-to-face interviews; the remaining eight interviews were conducted over the telephone. The interviews usually started with a brief presentation of the interviewee's career and his/her motives to become a decision analyst. Decision analysts then talked concretely about their practices (e.g. the role of software, the skills required). We asked them to focus on one or two applications to illustrate their practice. This allowed gathering insiders' view on the 'art' of decision analysis and to

collect reflexive insights from decision analysts about their practice within organizational contexts (Bartunek and Louis 1996). These primary data confirmed many conclusions from our analysis of the secondary data and hence the relative robustness of our findings.

Thanks to these interviews, we obtained information about the aim of *Interfaces* applications. This information confirms their role in the decision analysis field as a device capturing its 'collective memory'. We also gathered information about the context of some of the *Interfaces*' applications of our sample. We evaluated the accuracy of our analysis of the applications by confronting primary and secondary data and used this rich material to complete, when possible, our analysis of decision analysts practice.

First Order Findings: How Decision Analysis Emerged

Historically, decision analysis emerged in the 1960s as a discipline distinct from decision theory, system modelling and operations research (Miles 2007). Its corpus of knowledge is built on two main foundations. The first is the subjectivist (or Bayesian) school of probability of Ramsey and De Finetti, which holds (contrary to the frequentist or statistical school) that probabilities are 'degrees of belief' or states of mind rather than states of objects (Savage 1954). The second is the economic approach of utility measurement (Von Neumann and Morgenstern 1947), which holds that a rational decision-maker is someone who makes decisions guided by maximizing his/her subjective expected utility and who is committed to process information through Bayes' theorem (Edwards et al. 2007). This commitment implies that s/he will ensure that his/her preferences respect several axioms (such as the transitivity axiom) and that his/her beliefs follow Kolmogorov axioms for probability (e.g., they are additive) and conform to Bayes' rule. Table 1 gives the full list of rational choice theory axioms.

In Table I, Axiom 1a simply states that the decision problem has to be structured in such a way that the decision-maker sees at least two alternatives. Without at least two alternatives, no decision analysis can be carried out. Coupled with Axiom 1b, Axiom 1a leads the decision-maker to compare the consequence of each plausible alternative.

The remaining axioms discipline the decision-makers' beliefs and preferences and ensure that the subjective expected value of each option can be computed. Axiom 2 ensures that a decision-maker's beliefs have the same properties as statistical probabilities. Imagine a decision-maker who has identified two mutually exclusive events A and B. If she believes that the probability of A is p, then Axiom 2 states that she must believe that the probability of B is 1-p. If she does not, she has to reflect on her beliefs. She might have to reflect on the alternatives as well, because the non-additivity of her beliefs might reveal that the alternatives do not entirely capture her own representation of the decision problem. Axioms 3 and 4 ensure that the decision-maker has transitive preferences and hence cannot be made worse off after a sequence of choices where she systematically chooses her preferred option.

Since its inception, decision analysis has exhibited a strong applied orientation, as evidenced by the title of Howard's paper 'Decision Analysis: Applied

Table 1.
The Axioms of Decision Analysis

Axioms	Description
1a. Generation of alternatives	'At least two alternatives can be specified'.
1b. Identification of consequences	'Possible consequences of each alternative can be identified'.
2. Quantification of judgment	'The relative likelihoods or beliefs (i.e., probabilities) of each possible consequence that could result from each alternative can be specified'.
3. Quantification of preference	'The relative desirability (i.e. utility) for all possible consequences of any alternative can be specified'.
4a. Comparison of alternatives	'If two alternatives would each result in the same two possible consequences, the alternative yielding the higher chance of the preferred consequence is preferred'.
4b. Transitivity of preferences	'If one alternative is preferred to a second alternative and if the second alternative is preferred to a third alternative, then the first alternative is preferred to the third alternative'.
4c. Substitution of consequences	'If an alternative is modified by replacing one of its consequences with a set of consequences and associated probabilities (i.e. a lottery) that is indifferent to the consequence being replaced, then the original and the modified alternatives should be indifferent'.

Source: created from Keeney (1982: 830–832).

Decision Theory' (1966) that coined the term 'decision analysis'. This seminal work emerged from a consultancy work that Howard did for General Electrics at that time (Howard 2007). Raiffa, another father of decision analysis, confirms this early orientation in his account of the history of the discipline (Raiffa 2002). He explains his intuition that the decision theory course he was teaching at Columbia was 'largely irrelevant for decisional purpose'. He argues that the course material – rooted in the frequentist interpretation of probability – failed to capture uncertainty and ignored important characteristics of real decision contexts. A couple of years after he was introduced to the subjectivist approach, he joined Harvard Business School. There, he and his colleague Schlaiffer developed an applied version of decision theory specifically tailored *for* business managers and based in the judgemental inputs of knowledgeable organizational actors (Raiffa 2002). In essence, then, decision analysis is an applied discipline; and decision analysts frequently reaffirm that this discipline 'must be applied to be mastered' (Corner 1997: 134).

This applied focus goes hand in hand with a strong prescriptive orientation that shapes the professional identity of the members of this field (Keeney and Raiffa 1976). For decision analysts, the aim of the profession is to help decision-makers to make better decisions by using normative models. It is 'the normative practice of decision-making' and 'consists of a theoretical paradigm for decision making and a body of practical experiences for using this paradigm to illuminate the decision problem for the decision maker' (Howard 1980: 6). At the core of this prescriptive project are the belief that 'although we are not perfect decision makers, we can do better through more structure and guidance' (Clemen and

Reilly 2001: 4), and the conviction that decision analysis provides the right structure for business decisions.

Decision analysis' prescriptive orientation is evidenced by the wide-ranging consultancy work done by the academic leaders of the field. For example, Ralph Keeney served as the head of the decision analysis division of Woodward-Clyde Consultants between 1976 and 1983. Detlof von Winterfeld (University of Southern California) is Associate at Decision Insights Inc., a US consultancy firm specializing in 'quantitative problem solving and decision making'; and Rex Brown (School of Public Policy, George Mason University), a co-founder of the Decision Analysis Society, did some consultancy work on behalf of Decision Science Associates and Management Analysis Centre.[5,6] As Edwards et al. (2007) put it, 'Decision analysis is unabashedly normative in theory and thoroughly prescriptive in practice' (p. 5). Interestingly, such a willingness to 'apply' an abstract normative ideal to actual decision-making in organizational contexts has fuelled the process of theory performativity. This situation contrasts with the case of finance performativity which results primarily from academics' attempts to solve a specific category of pre-existing practical problems such as option pricing (MacKenzie 2006; MacKenzie and Millo 2003).

To speed the institutionalization of their discipline, the self-labelled 'decision analysts' have also, since the 1950s, grouped in trade associations. Among many others: Decision Science Institute was created in 1968 with the mission to 'facilitate the development and dissemination of knowledge in the diverse disciplines of the decision sciences through publication, conferences, and other services' (see also the Decision Analysis Society of the Institute for Operations Research and the Management Sciences, and the Decision Analysis Affinity Group).[7] Other evidence of the institutionalization of the field includes the development of prescriptive decision science programs in numerous US universities (Keeney et al. 2006). These programs enhance the exposure of future managers to decision-analysis principles and facilitate the potential performativity of rational choice theory within organizations.

This close relationship with the world of practice, as well as the multidisciplinary roots of the discipline (economics, psychological research on human judgement, computer science), have made the members of the profession aware of the practical problems of implementing decision theory in the real world. Building on their experience, decision analysts have therefore dedicated most of their effort to the creation of tools (such as decision-trees, influence diagrams and methods for eliciting probability judgements) aimed at supporting rational decision-making and at 'de-biasing' decision-makers.

Though extreme in nature, the historical construction of decision analysis reveals some aspects of the performativity process. The institutional positioning in prestigious academic institutions (Harvard, Stanford) of early academic leaders of the field played some part in the institutionalization of decision analysis. Yet, beyond that, the decision analysis case shows the importance in the performativity process of the entrepreneurial role of early academic promoters who had a clear orientation towards practice. Early academic decision analysts indeed deliberately decided to turn an abstract set of principles (decision theory or rational choice theory) into an 'applied discipline' (decision analysis). They

explicitly acknowledged the normative nature of the theory. They realized that the gap between this normative ideal and what decision-makers naturally do called for an applied and prescriptive version of rational choice theory. The early leaders of the field thus purposively worked at articulating an abstract body of knowledge while simultaneously applying it to a set of practical experiences of implementation within real decision-making contexts.

This practical orientation was a key element to make the move from university to businesses possible. One interviewee, a former Editor of the Practice Abstract column in *Interfaces*, explained that the column was the idea of a leader of the OR/MS field who wanted to incite practitioners to publish short and non-technical descriptions of their projects so as to diffuse OR/MS techniques to non-specialists:

> But in the field in general … there's always been too much of a gap I think between practitioners and theory. And this [the Practice Abstract column of *Interfaces*] is one of many, many attempts by the organizations involved to foster more dialogue between the two and to let people know … You know, basically what's going on in their field who may not be avid readers of things like *Management Science* or *Operations Research* or whatever. So it was kind of designed primarily in *Interfaces*, which is the applications journal of Informs basically.
>
> To give people capsule descriptions of what other people are doing you know, in your industry or in a different industry or whatever. And from an academic standpoint, it was good as well because people could use those in their classes, as illustrations and I know I did that a number of times, real world applications where you know, here's somebody that's using decision-trees and influence diagrams and tornado diagrams and this, that and the other, in a real problem. (Interview with a former editor of the Practice Abstract Column, Autumn 2008)

Due to its specific location bridging business and academia, its prescriptive and practical orientations and its progressive institutionalization into professional associations and within prestigious universities, decision analysis offers itself as an ideal site to observe empirically the potential influence of rational choice theory on the practice of decision-making. The analysis of financial theory performativity by MacKenzie (2006) reveals that the academic institutionalization of mathematical finance in US business schools during the 1970s was deeply intertwined with the rising use of equations, models and theoretical concepts on the trade floor. Similarly, we might expect that the institutionalization of decision analysis might accompany the progressive embodiment of rational choice theory. By analyzing how these decision analysts actually work within organizational contexts and translate their knowledge into practices, we seek to shed light on the process of rational choice theory performativity.

Second Order Findings

How Decision Analysts Perform Rational Choice Theory

Our second order analysis of applications shows how decision analysts craft rational decisions through the construction of a socio-technical infrastructure supporting the calculability of rational decisions. The analysis reveals a three-step

process model of 'contextualization', 'quantification' and 'calculation' that refines and extends previous works on calculability construction (Callon 1998; Callon and Muniesa 2005; Power 2004). Figure 1 depicts graphically our framework. It articulates the process of rational choice theory performativity with the underlying practices that decision analysts undertake to craft rational decisions. Figure 1 also specifies the performativity process by pointing to inputs and outcomes of each stage of decision analysis.

The remainder of this section identifies the practices that underlie the craft of rational decisions and thus may contribute to rational choice theory performativity. We describe the main components of each pattern composing the framework and explain how their succession leads to the performance of rational choice theory. For each component, we show its empirical grounding. Each section demonstrates how the practices that emerged from the coding may contribute to the process of rational choice theory performativity.

Contextualization

Contextualization emerged as the first stage in the work of decision analysts. The aim of this work is to create a fit between the organizational context and decision-analysis principles (see Figure 1, Stage 1). It consists mainly in turning a 'big and messy' situation into a 'decision-analyzable problem'. In other word, it consists in creating a decision context congruent with the first two axioms of rational choice theory and susceptible to management with decision analysis techniques. To phrase it in the terms of decision analysis, it is about 'getting the decision context right' and 'structuring the elements of the decision situation into a logical framework' (Clemen and Reilly 2001: 43). Such a straightforward account of the process should not hide the important socio-technical work that emerged from the data.

The coding of this stage makes clear – as observed by Latour (1987) or Porter (1996) – that the contextualization work relies heavily on social interactions and the construction of a network of allies. Beyond a discussion with key decision-makers, understanding of the problem and gaining access to crucial information both require analysts to establish relationships with many organizational actors, including technicians, managers, and members of the support staff affected by the problem. Slicing the actual decision-making process into tractable units of analysis and selecting the relevant dimensions of the context can require intensive investment into data-collection through interviews, surveys, observations and/or informal meetings.

> When I began my investigation, there were no existing studies on how surgeons made decisions. It was therefore necessary to generate hypotheses for testing. Interviews were conducted with 38 randomly selected surgical specialists. This group represented approximately one out of every 25 surgical specialists in Philadelphia. All surgical disciplines were represented, including obstetrics, ophthalmology, and oral surgery as well as the more obvious subspecialties. ... The hypotheses were also tested using information elicited from observation and critique of 103 unselected surgical decisions made by surgical specialists in our medical school hospital. (Clarke 1987)

This approach can blur organizational boundaries in order to generate the knowledge needed to make sense of the decision-making process:

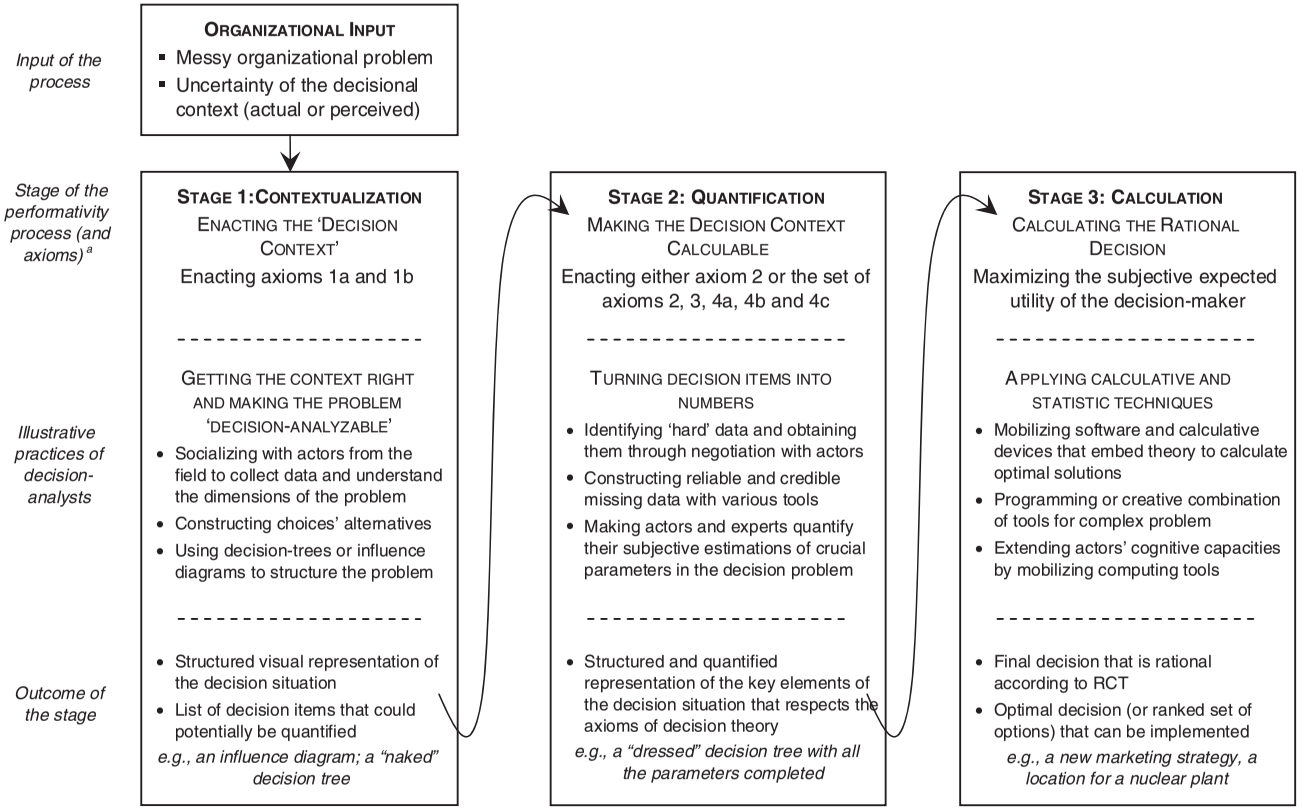

Figure 1. How decision analysts perform rational decision theory through practices: A theoretical model

[a] The stages can be conceptually distinguished even if they may overlap in practice. There is always a possibility, not represented on this graphic, to come back to the previous stage when an important difficulty makes the achievement of one stage impossible. The axioms numbered refer to Table 1.

> We began by forming a cross-functional team consisting of scientists and other staff members from clinical development, finance, marketing, project management, regulatory affairs, and manufacturing. (Beccue 2001)

Moreover, far from being unilaterally decided by the analysts, the representation of the parameters and the structure of the decision are usually negotiated with organizational members during meeting, workshops, or formal interviews.

Decision analysts can rely on specific practices to support this process of collective negotiation over the enactment of a consensual decision context. In virtually all the coded applications, decision analysis artefacts such as decision-trees, influence diagrams and strategy generation tables were mobilized to perform the work of contextualization. These tools derive directly from decision theory and equip analysts with the 'calculative prostheses' of rational economic actors (Callon 1998). They facilitate the enactment of the decision context through the multiple roles they play. Because of their graphical form, they provide a visual aid helping organizational actors to filter the relevant dimensions of the context. They also support the collective discussion over the important parameters of the decision. Lastly, they materialize a consensus over the representation of the decision context. The following quotes illustrate some of these various roles:

> After an issues-raising session, we used strategy tables to narrow some 10,000 possible development options into eight well defined and plausible strategies. We used influence diagrams to help us to identify the important parameters necessary for valuing each strategy and to serve as the road map for the data-collection process. (Beccue 2001)

> As they spoke [during the strategic objective elicitation sessions], I made three lists: one for statements that indicated objectives, one for issues that should be addressed, and one for opportunities that could be taken. After writing down each person's initial thoughts, I guided the discussion into areas that had perhaps been only lightly covered. For instance, I might ask, 'what are Seagate Software's objectives for its customers?' (Keeney 1999)

> The decision-tree display is useful to managers, particularly because it shows the after-tax cost of a dry hole for each option, which was different from the cost to the capital budget. (Walls et al. 1995)

Decision-trees exemplify the pedagogical and structuring roles of tools (see Figure 2). According to one of their more enthusiastic promoters, their purpose was to allow 'bright but mathematically unsophisticated' (Raiffa 2002: 181) business students from Harvard to cope with the statistical foundations of decision theory. This simple tool is a perfect illustration of the work of pedagogical translation of rational choice theory that decision analysts can do. A decision-tree acts as a mediator between the organizational context for decision-making, managers, and the world of rational choice theory within which decision analysts are embedded. Decision-trees play the role of 'immutable and combinable mobiles' (Latour 1987: 227) because they offer a pre-structured decision-making template easily transportable from one context to another and fully coherent with the theory's hypotheses. They force organizational actors: (a) to structure the sequence of future events and actions while respecting the logic of causality, (b) to specify the alternative decisions, (c) to identify their main outcomes, and (d) to decide whether the various dimensions of the environment are given or actionable. In short, decision-trees evoke the very notion of a decision – a concrete choice among knowable options – and by doing so, they may bring the context of rational decision-making into being.

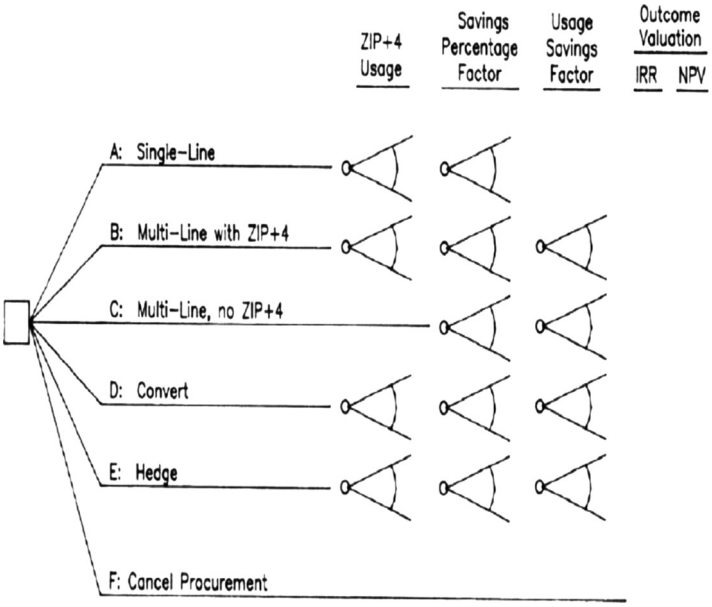

Figure 2.
A 'naked' decision-tree
(Source: Ulvila 1987)

The complexity of the issue, however, can easily threaten the contextualization exercise. A condition as simple as (b), for instance, might appear obvious because the very definition of a decision implies *a minima* the existence of one alternative. In practice, however, managers can face far too many alternatives or simply lack the ability to perceive the existence of any alternatives. Applications reveal how decision-trees are tailored to re-specify these extreme situations into tractable 'decision problems'. A one-branch tree is used to select a project (Hess 1993). A probability tree allows at least structuring the uncertainty in a case where choices are missing (Keefer 1995). A 'Christmas tree' combining simultaneously a high number of decision-trees is used to synthesize the dozen of merchandizing strategies for Amoco (Dyer and Lund 1982). Through these conceptual or material bricolages, analysts recreate the fit between the textbook stylized decision situation and the actual context.

Decision analysis applications therefore suggest that analysts' cognitive and practical flexibilities are crucial competences needed to enact a hospitable environment for rational decision-making. Decision analysis demands the ability to negotiate some compromise between organizational actors who have to adhere to the decision project and the organizational context whose routines may contradict the decision analysis approach. This delicate balance is illustrated by the following quote:

> Initially, the team was overwhelmed by the quantity of information required in a short time frame. For example, some of the information was unavailable or uneconomic to obtain. Reflecting back at the end of the process, the team members agreed that, although such rigorous data collection was not common at Amgen, it was critically important in this instance, and that the decision-analysis approach made it manageable. (Beccue 2001)

Although in many cases the role of theory in contextualization seems to be limited to ritual references, the content analysis suggests that it plays an important role as a normative guide. For instance, prior applications provide ideas for

representing or modelling problems in specific domains of applications such as medical treatment (Hazen et al. 1998). Prior academic knowledge is used to justify the appropriateness of structuring methodologies (Keeney 1999). Theory also structures the process because both tools and analysts are embedded technically and cognitively (respectively) within rational choice theory.

Contextualization is therefore the progressive enactment of the first two axioms of decision theory (see Stage 1 in Figure 1). The decision situation is re-specified by detaching the key elements of the decision situation (i.e. a finite number of parameters, uncertainties and alternative courses of action) from the decision context (Latour 1987). Once detached, these elements are re-arranged logically into a new 'calculative space' (Callon and Muniesa 2005: 1231) fitting the analytical categories of decision theory. In organizing the reconciliation between a messy problem, an organizational context and the notion of decision as understood by decision analysis, contextualization recreates the 'first order measurement' that is needed to realize sophisticated forms of calculation (Power 2004). Once projected into a new common calculative space for decision brought in by analysts (e.g. the graph on which the decision-tree is represented, the paper-board listing the alternatives generated by the generation table), the 'detached' and 'rearranged' dimensions of problems can be reduced to a list of items that can be quantified.

Quantification

As Stage 2 in Figure 1 shows, the quantification of the structured but qualitative representation of the decision situation is the next step in the process leading to rational choice theory performativity. This stage consists mainly in turning decision parameters into numbers and changing the decisional context into 'a [micro] world made safe for numbers' (Porter 1996: 46).

To some extent decision analysts can rely on the calculative infrastructure that exists within the organization. As the quotes below illustrate, databases and figures produced by management accounting systems and/or organizational routines usually provide some of the decision parameters:

> It is important to emphasize that this approach does not ignore 'hard' objective data when it is available. Rather, the model provides the logic for combining data and judgements in an explicit, consistent manner. In our case, profit margin data for the various products and cost data for the alternate merchandising strategies were processed according to the specifications of a judgemental model. (Dyer 1982: 42)

> Given the short time period of the project, we knew from the beginning that we would have to make the best use of data that were already developed and to use judgement where data were lacking. A lot of data were developed by the Postal Service, GAO, manufacturers, OTA's technical consultant, and others. The data available were not exactly the data required to address the task, and some had to be judgementally adjusted. This is the usual situation for a decision analysis. (Ulvila 1988: 75–76)

Decision analysis however does not exclusively rely on the numbers routinely produced by organizations. As the Amgen quotes above (p. 15) illustrate, the data needed are likely to go beyond the existing figures available in the organization, requiring information that is either 'unavailable or uneconomic to obtain' (Beccue 2001).

Yet, a key feature of decision analysis is that it extensively relies on judgemental inputs that are not commonly available in a quantified format in organizations. Generally, many of the entities common to decision theory textbooks and crucial to performing rational choice theory (e.g. utility functions, subjective probabilities) do not exist as such in organizations. As with the case of statistical categories (Desrosières 1990) or scientific experimentation (Hacking 1983; Latour 1987), measuring actually entails 'making things', that is, creating new entities (Porter 1996).

Even more than contextualization, quantification builds on an intensive deployment of social interactions by analysts. To put numbers corresponding to these new entities (the nodes and squares of the decision-tree for instance), analysts spend a lot of time gathering 'soft' subjective or qualitative information from organizational actors. They have to identify and enlist 'experts', i.e. actors having a good knowledge of the situation and context, so that the data they provide fulfil the essential condition of credibility and reliability. Through expert panels, meetings, face-to-face interviews, focus groups or quantitative surveys, they assess subjective beliefs about the likelihood of outcomes and/or subjective evaluations of the values of the outcomes of the decision.

> To assess the schedule uncertainties, we convened three panels of schedule specialists, with about 10 technical staff members of the DOE Office of Reconfiguration, its contractors and consultants in each panel. We selected the participants for their knowledge of tritium-supply alternatives and their understanding of schedule uncertainties. (Von Winterfeld and Schweitzer 1998)

> To get an objective and credible analysis, we based our evaluation on the judgements of five teams of Air Force officers. (Burk and Parnell 1997)

> How did you choose the values for the USPS estimate adjustment factors that you used? How did you convince your sponsors that those were the best numbers to use? U: The values were based on discussions with the OTA, GAO, and the technical consultant, and on information in various documents. Fred Wood was involved in all of the discussions, and he reviewed. (Ulvila 1988: 76)

Constructing these figures necessitates making trade-offs between conflicting assessments of experts, managing actors' anxieties, and overcoming their reluctance to provide quantified information. It is a process of permanent negotiation with actors and context that balances the level of accuracy of the information and the possibility to quantify it.

> More important, management was uncomfortable estimating probabilities, let alone expressing levels of uncertainty about them. Monte Carlo simulation would likely raise management anxieties about probabilities even further. We elected instead to explore the optimistic and pessimistic parameter values rather than do a simulation. (Hess 1993)

> In the OPC study, we had too little time for in-depth assessments. Instead, we conducted probability assessments quickly with the expectation that extensive probabilistic sensitivity analysis later would reveal where refinement was necessary. For each chance event, the appropriate experts joined the analytic team to discuss the formulation and provide the needed inputs. (Borrison 1995)

Analysts depend heavily on organizational actors, who are providers of subjective judgements, of any information that can serve as an input in the quantification process. Without mobilizing them, decision analysis cannot be conducted. Numerous tools and techniques, such as utility elicitation methods that allow the

construction of the decision-maker's utility function, or methods for eliciting probability judgements, assist analysts in their work of quantification. Actors use these tools to quantify their qualitative knowledge and to turn non-observable entities such a 'utilities' into figures.

> This may be done by introducing two additional pieces of information into the analysis. The first is an assessment of the user's subjective probabilities of all relevant future events (the seven techno economic uncertainties plus the two proliferation/diversion uncertainties in this case); for instance, each user would be asked for his probability assessments that the uranium resource base would be high, medium, or low. (Peck 1980)

Whatever the method at hand, the decision analysis axioms play a key role in the process. In the case of probability elicitation judgements for instance, decision-makers' beliefs pass through a measurement discipline constraining his/her subjective beliefs about the likelihood of future events such that they conform to the axioms of decision theory. Other methods such as assessment of multi-attribute functions require fulfilling specific conditions.

> We assumed that the value model was linear. Our assessments showed that the required additive independence conditions [Keeney and Raiffa 1976] were approximately met. (Burk 1997)

> The new strategies were evaluated by direct assessment of the multiattribute utility function Equation (2). The fundamental assumption required for the existence of an additive multi-attribute utility function under conditions of certainty, as we have here, is called difference independence [Dyer and Sarin 1980]. Our own understanding of the problem coupled with responses from interviews suggested that this assumption was valid except for four cases. (Dyer and Lund 1982)

The exigencies of both quantification and decision theory axiomatic make the task complex and put at stake the technical skills and the creativity of the analyst. Dyer and Lund's application of decision analysis at Amoco (1982) provides the most striking illustration of socio-technical bricolage at the quantification stage:

> The methodology used in the study is a novel combination of judgemental modelling and multi-attribute utility theory. We defined a hierarchic multi-attribute utility function to evaluate the impact of a merchandising strategy on full-facility service stations, and then used judgemental modelling to determine the weights for the objectives of the utility function. (Dyer and Lund 1982)

To enable managers to understand and to assess the abstract weights of the objective of the utility function, the authors built a 'Tinker Toy model' representing spatially this function and the manner it links various decision options (reproduced in Figure 3).

During an interview, Dyer remembered how Lund theatrically used this model:

> He [Lund] had told me that when he made his presentation internally in the company, he walked in and actually had the Tinker Toy model covered with a … like a towel, a piece of cloth. And so he would make his initial comments about the issues associated with choosing what products to emphasise and what kinds of marketing strategies to emphasise and the difficulty of making those decisions in isolation because the sales of one product can influence the sales of another. And after he'd made those general comments, then he would unveil his Tinker Toy model then ask the people to come and look at it and then he would try to point out that you know, one of those circles or wooden balls represented one product, another represented another product. (Interview with Dyer, Autumn 2008)

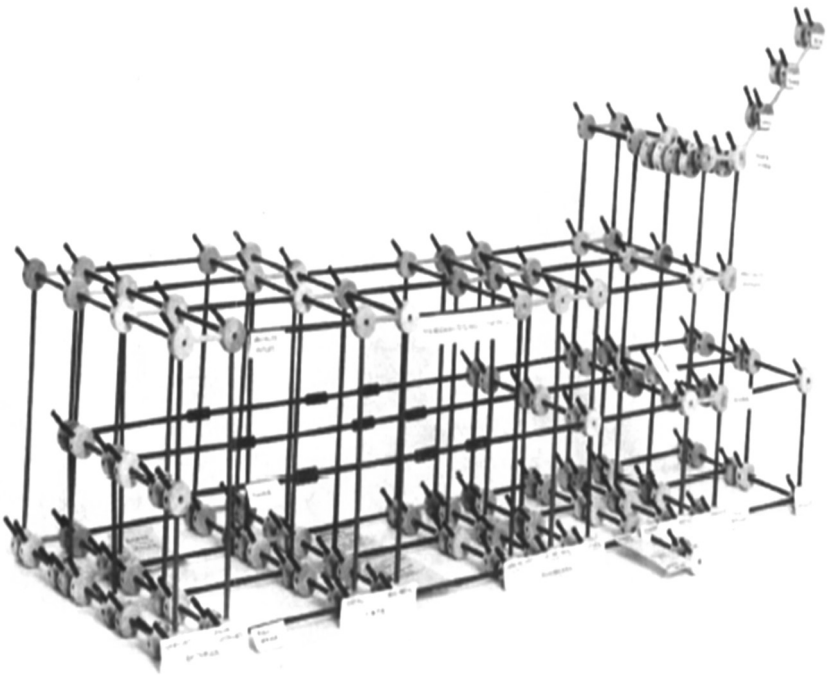

Figure 3.
The 'Tinker Toy'
(Source: Dyer and
Lund 1982)

Managers stood around the model as they worked to put a number on each node.

Several applications exhibit less spectacular but similar attempts to build artefacts. These artefacts allow analysts to negotiate with actors the quantitative values of the parameters while sticking to rational choice theory constraining axioms. They help analysts to co-construct with organization members preferences and quantitative knowledge that may not have previously existed. They also ensure that these quantities and preferences are similarly and conveniently structured. Thus, organizational members come to see the world through the decision analyst's lens with evidence carefully constructed to make them provide the data needed to make decision theory function.

Theory embedded in a material artefact becomes a tool for bounding the reality analysts hope to construct. Analysts refer often to theory in the sections dedicated to quantification. This suggests that rational choice theory axioms deeply shape their practice. Moreover, theory is directly referred to as a solution to very practical problem such as probability assessment. It sets the standards that the quantification process has to achieve in order to ensure conformity with the axioms. Theory plays, here, a role both as normative guide for action and as a toolbox to address an issue during quantification. Once quantified, the various entities and parameters needed are now ready for the next and ultimate stage, calculation. Decision-trees are now 'dressed' (Figure 4). Once contextualization and calculability have put in place the infrastructure that allows calculability, more sophisticated techniques of 'second order measurement' (Power 2004) can be mobilized to build the rational decision.

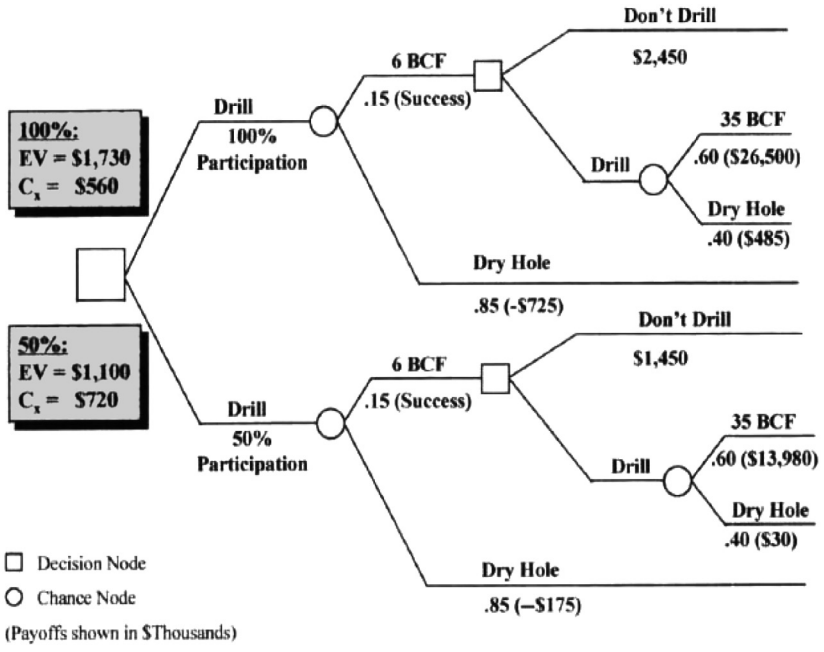

Figure 4.
A 'dressed' decision-tree (Source: Walls, Morahan, and Dyer 1995: 45)

Calculation

At this point, the decision context fits with the required conditions prescribed by the axioms of rational choice theory (outcomes of Stage 2 in Figure 1), and organizational members are sufficiently prepared for finding a solution to their problems through decision analysis (Stage 3 in Figure 1). Now, the final stage of calculation occurs.

This stage consists in applying to the now quantified entities that constitute the decision problem some statistical and arithmetic techniques. Contrary to the previous stages, calculation does not imply the development of new social interactions. Rather, it is perhaps the absence of interaction – the seclusion of the decision analyst prior to the revealing of the problem's solution – that may enhance the performance of rationality, the sense among organizational actors that something different, something ordinarily not present in the organizational context, is under way.

On the surface, the calculation stage involves the effective mobilization of entities previously quantified and the coordination of actants such as spreadsheets, computers and algorithms (MacKenzie 2006). Except in a few cases where analyses reveal the need for data adjustment implying some interactions, applications suggest that calculation is more about desk research:

> This program involves a forward-looking simulation that shows the distribution of outcomes over an extended time period into the future, say 20 to 30 years (Figure 6). Investors would take a look at the distribution of returns – in the short run and the longer run – and then decide either to reduce or to increase their risks based on the pattern of contributions and the associated probabilities I would change the risk-aversion parameter as a consequence and rerun the models to generate new results. (Mulvey 1994)

In that step, the coding reveals the crucial importance of tools such as statistical techniques and computers. The extension of actors' cognitive capacities through computer software suggests that actors' rational capabilities may be artificially increased so that the decision-maker is able to maximize his/her utility function. The technology creates a situation enabling the equipped decision-maker to behave according to economics' hypotheses (Callon 1998). Applications demonstrate the diversity of use of computers in this phase and show the improvement in calculation of rational decision due to technologies across time. Recent applications mobilize, quasi systematically, software to solve the decision problem and/or to perform a sensitivity analysis.

> We implemented the model in a spreadsheet and then solved it using a popular Monte Carlo simulation add-in package. (Perdue et al. 1999)

> Levelized revenue requirements were calculated using computer models developed for that purpose. (Madden et al. 1983)

> A simulation model was constructed to estimate the expected net present value of buying and operating each of the four ship options. (Bell 1984)

This stage also reveals the technical skills and know-how that are needed to solve the decision problem: analysts indeed often develop their own program (or combine existing software) to perform the calculations.

> I initially developed the WPRS in a spreadsheet using macros from Kirkwood [1997]. Since calculation of the evaluation measure scores for each WP required access to several databases used by EM project managers, we subsequently reprogrammed the WPRS into a database to reduce the time required to score the WPs. (Parnell 2001)

> The program is written in BASIC and has been run on a Control Data mainframe and on IBM and Radio Shack personal computers. BASIC allows a simple questioning interaction between negotiator and computer and allows the program to be run on most microcomputers. (Winter 1985)

> I developed a second program to assist in the calibration effort. (Mulvey 1994)

In this stage, theory is more sparingly mobilized as such than in the previous stages and hence is less visible and explicitly present. The whole stage, nonetheless, is framed according to the core principle of rational choice theory. Theory is converted into and embodied within the various artefacts mobilized by decision analysts in their practices (Callon 1998; Latour 1994), as rationality itself is made real in practice. Statistical and theoretical assumptions about calculated entities and parameters are embedded within the various algorithms used to perform the calculations. As shown on Stage 3 in Figure 1, the final outcome of this stage is either an optimal 'rational' decision or a ranked set of options.

Rational Choice Theory Performativity

Overall, our three stage model describes how rational decisions have been progressively constructed and enacted. From an empirical viewpoint, it suggests endowing rational choice theory with some forms of performativity. First, our analysis uncovers the presence of 'generic performativity', as decision analysts mobilize in their practice – and over the various stages of contextualization, quantification, and calculation – certain concepts, models, and calculation

techniques from economics. For instance, data shows that in their practice, decision analysts mobilize the notion of 'subjective probability', build 'decision-trees' and can even turn managers' 'utility functions' into social reality through elicitation techniques (e.g. Keeney and McDaniels 1992). Economic concepts and categories are thus brought into beings and populate decision-making processes.

Second, our data reveal 'effective performativity' by showing that through the works of decision analysts, rational choice theory 'makes a difference'. Decision analysts' tools and engineering activities enact processes of decision-making that depart significantly from those previously observed within organization studies (Minzberg et al. 1976; Nutt 1984). For instance, Skaf (1999) contrasts the company portfolio management process before and after his intervention as follows:

> In the past, the ad hoc process favored the asset-team leader with either the strongest arguments or the most optimistic asset plan. Now the organization has a process that engages asset teams and senior management from day one in identifying the best portfolio strategy for the business unit. (Skaf 1999)

Generally, applications demonstrate that performing decision-analysis involves a work of data-collection and analysis that is far more systematic and rigorous than the in-use modes of decision-making in the studied organizations (e.g. Beccue 2001; Dyer and Lund 1982). Endorsement letters produced by managers and executives that accompany many applications (e.g. Dunning et al. 2001; Keeney 1999; Paté-Cornell and Fischbeck 1994; Islei et al. 1991) provide further evidence of organizational changes and confirm the presence of 'effective performativity', as illustrated below.

> As General Manager, New Businesses, VP Health Imaging, Eastman Kodak, I encourage all of the business planners to use the decision and risk principles and processes as part of evaluating new business opportunities. The processes have clearly led to better decisions about entry and exit of businesses. (Clemen et al. 2001)

Third, the enactment of rational decision within organizations may support the more lasting form of 'Barnesian performativity' because the processes designed by decision analysts are sometimes 'built-in'. Such an organizational embeddedness of decision-analysis enhances the verisimilitude of rational choice theory. Although our research design does not allow the systematic assessment of this fact, some applications report a lasting impact of decision-analysis, for instance through the development of software packages and techniques that becomes integral parts of organizational decision-making routines (e.g. Islei et al. 1991; Parnel 2001; Paté-Cornell and Fischbeck 1994; Skaf 1999). This suggests that the existence of rational choice theory 'Barnesian performativity' cannot be excluded. Yet, this strong form of performativity remains empirically rare.

Discussion and Implications

Crafting Rationality: Revealing Decision Analysts' Practices

A first key contribution of our analysis is to specify the complex bundle of practices that sustains the craft of rationality. As shown in Figure I, social and

technical dimensions are intimately intertwined in a three stages process of contextualization, quantification and calculability that may lead to the enactment of a rational decision. Our study thus demonstrates that rationality is not solely a mode of social intelligence (March 2006) but also a crafted product of organizational intelligence. Crafting rationality requires a careful and patient work from well-trained analysts-engineers, and partially lies on the collective mobilization of social actors, theory and material artefacts.

For instance, in the first two stages of the performativity process (see Figure I), practices that necessitate social competences and creativity, such as the practices deployed to collect judgemental inputs, are as crucial as technologies and formal analysis. In the third stage of the performativity process, machines, algorithms, and other 'immutable mobiles' (Latour 1987: 227) are the object of an intensive work of 'bricolage' from decision analysts. Yet, calculating the optimal decision frequently involves programming or combining creatively various software applications. In some rare applications, the software produced by decision analysts became part of organizational routines, facilitating the consolidation of routines to sustain rationality.

In the three stages, decision analysts are much closer to the creative sociotechnical 'bricoleurs' that Latour describes in his study of Aramis (Latour 1996) than to the cold engineers acting like machines (Morgan 1980), or the allies of conventionality and status quo that organizational critique of rationality often portrays (March 2006: 207–211). Their set of practices grants rationality its 'sociomateriality' in creating 'assemblages' of artefacts embedding a rational approach to decision-making (Orlikowski and Scott 2008).

This paper thus calls for empirical studies approaching 'rationality-as-practice'. Looking at rational decision-making as a social practice contributes to move organizational studies on decision-making beyond the lasting debate on the inherent rationality vs irrationality of organizations and their decisions. In this perspective rationality becomes something that organizations can acquire if they wish and devote their efforts to it. This perspective is not so much an alternative to the rationalistic paradigm (Hendry 2000) than a new way of understanding it 'from inside' with a different lens.

Moreover, our findings can nurture future research adopting the rationalistic paradigm. The present study stresses the role of actors' reflexive mobilization of rational choice theory and the reliance upon tools embedding this theory's hypotheses as important features of rational decision-making processes. These factors could complement the criteria of exhaustive data collection that the construct of comprehensiveness suggests (Fredrickson 1984). Hence, our results points to more appropriate proxies for assessing the degree of comprehensiveness in decision-making processes.

Finally, in line with prior studies on strategy making (Samra-Fredericks 2005), future research could explore ethnographically the work of decision analysts within organizational contexts. Such empirical studies will complement our analysis by allowing an in-depth understanding of the daily combination of rational decision-making practices within the flow of actions in context. In so doing, these studies could contribute to an ethnomethodological understanding of how rationality 'works' in social and organizational life (Garfinkel 1967). They

could reveal, for instance, the investments needed to sustain the rational part of strategy-making and show the role played by theory in structuring the work of a specific community of practice (Brown and Duguid 1991).

Decision Analysis: A Fragile Performativity?

A second contribution of the present study is to examine critically the performativity thesis by assessing the influence on organizational decision-making practices of the core axioms of economics. Moving performativity studies from the financial marketplace to intra-organizational processes provides empirical evidence to Ferraro et al.'s claim (2005) that the 'rational man' can be brought into being within organizations. It contradicts the received wisdom in organization theory that the 'textbook' form of rational decision-making is not relevant and/or unrealistic. The analysis of this organizational achievement, however, points to the limitations of the work of decision analysts and the fragility of rational choice theory's performativity. Our study therefore contributes to consolidate the growing bodies of performativity studies by highlighting some conditions for the performance of the core axioms of economics.

Studies of finance theory performativity demonstrate that theoretical abstraction and complexity are not necessarily obstacles to performativity (MacKenzie 2006). They show that complex theories can be used to reframe the social reality and then lead to behaviours validating their premises (Merton 1948; Ferraro et al. 2005). However, financial markets are places where the performativity process is facilitated because traders, financial analysts and portfolio managers can count on a socio-technical and institutional market infrastructure. This infrastructure supports their calculation, crystallizes previous theory into practices and allows the progressive diffusion of sophisticated indicators (e.g. measures of volatility or beta) (MacKenzie 2006; MacKenzie and Millo 2003).

By contrast, decision analysts are like Sisyphus. They have to reconstruct part of the calculability infrastructure needed to perform rational choice theory in order to fit every single organizational context. Though they are equipped with portable devices such as software or tools and can sometimes rely on pre-existing data produced by accountability or engineering systems in organizational contexts, they also have to devote important efforts to finding the judgemental inputs necessary for decision analysis. The need for such data has led to the development of specific practices (e.g. elicitation techniques as part of interviews or focus groups). Thus, if sociological studies of finance suggest that the performance of financial assumptions by traders on financial markets could be compared to an actor performance of a play (the theory) in a real concrete theatre, with its stage (trading floor), its lights (on the computers and screens) and its seats (back office) already materialized (Callon 2007), our study of decision analysis applications rather suggests that the performance of the rational choice theory play is similar to 'street theatre'. A rough-and-ready stage has to be found (pre-existing quantified data), the present pedestrians (organizational actors) have to be mobilized and interested. External events keep threatening the overall

performance, and require from the decision analysts good improvisation skills (creative bricolage).

Moreover, beyond revealing the conditions of the performance of the core axioms of economics, our study clarifies important boundaries of the performativity process directly related to the nature of the theory performed. In the finance theory case of MacKenzie (2006, 2007) what is performed is a simple version of the expected utility model, called the 'variance-mean model' (2006: 45–67). The 'variance-mean' version of expected utility theory allows bypassing the modelling of investors' subjective utility and subjective beliefs. In most of *Interfaces*' applications, however, subjective beliefs have been elicited, and in some cases the utility function of the main decision-maker has been constructed. This feature of rational choice theory delineates the boundaries of its performativity: the 'conditions of felicity' (Bourdieu, 1991) can be achieved only by relying on parameters that reflect the subjectivity of actors within each given organizational context.

This comment also points to an important notion of the interplay of various dimensions in the potential performativity of rational theories. Building on research on organizational design (Hatchuel 2001; Simon 1996), performativity scholars could study the interplay in the process of economics performativity, of three dimensions: theoretical design (the internal features of a theoretical framework), organizational design (the capacity to create the social context within which a theory can be performed), and the engineering design (the materialization of assumptions through an assemblage of artefacts). To empirically document the respective contribution of each dimension in the performativity process, future research could compare the degree of performativity of different rationalistic frameworks. For instance, the performativity of decision theory could be compared to the peformativity of Taylor's scientific management or agency theory.

Making Decisions Calculable

A third core finding of our study is that making decisions rational implies enacting inside organizations an 'infrastructure for calculability'. Our study thus contributes to the analysis of the somewhat neglected role played by calculability in the craft of rational decision-making within organizations. In studying decision analysts' practices, we revealed that rational decisions are not only performed because they are discursive tools and conventional categories within which actors are embedded (Hendry 2000; Laroche 1995) but also because these categories have been made 'calculable' (Callon 1998; Callon and Muniesa 2005). To make decision theory entities and categories 'calculable', decision analysts build on calculative tools and practices already in place. At the core of their practice, however, is a work of creative bricolage that allows constructing new material and theoretical devices.

Rational choice theory represents the rare case where measurement is dependent 'on when, where, and by whom it is done' (Power 2004: 769). This theory indeed explicitly acknowledges that it rests on subjective inputs (see Raiffa 2002: 181, for

instance). This subtle positioning – between a 'pure' measurement work expurgating numbers from subjectivity and a 'pure' subjective judgement – might impede it from fully benefiting from the properties of quantification. Proponents of a purely 'objective' approach to decisions will criticize its subjectivist roots. This was one of the main lessons of Pollock and Chen (1986) when they discovered their unsuccessful application of decision analysis in China could result from the fact that Chinese decision-makers were expecting 'the computer program that would provide the optimal decision'. On the other hand, proponents of a subjectivist perspective on decision will coin the quantification process as an 'objectification' process, and argue that constraining subjective judgements and values by a set of axioms expurgate them from their subjectivity.

The decision analysis case lays out an interesting middle ground between these two extreme views. It shows how decision engineers' creativity sustains a form of 'judgement mechanization' (Porter 1996) that structures but yet facilitates the expression of decision-makers' subjectivity. Future research on rational decision-making could study the organizational practices sustaining the whole spectrum of calculability situations located between a 'purely objective' calculability and a 'purely subjective' judgement. Such analysis would benefit from the research stream exploring calculability in the context of market functioning (Callon and Muniesa 2005). In particular, recent concepts from the sociological analysis of decision-making such as 'qualculability' (Cochoy 2002), 'qualification' (Musselin and Paradeise 2005), or 'judgement devices' (Karpik 1996) could provide useful lenses to account for the various forms of calculability that enable organizational actors to make decisions.

Acknowledgements

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Notes

1 As highlighed above, there is no consensus on what rationality is. Garfinkel (1967), for instance, identified up to 14 forms of rationality. In this paper, we use the terms 'rationality' and 'rational decision-making' to refer to a specific view on rationality, that of rational choice theory (also called decision theory). From this perspective, a rational behaviour consists in evaluating the consequences of one's actions and choosing the actions that are consistent with one's preferences and beliefs so as to maximize one's expected utility. We adopt this specific view on rationality not due to any normative stance of our own but rather because it is how the decision analysts, whom we are studying, define the term.

2 Quote from the journal's website: http://interfaces.pubs.informs.org/index.htm.

3 See Dalkey (1981) and; Smith and Winkler (1999) in the Appendix for two exceptions.

4 http://interfaces.pubs.informs.org/index.htm.

5 This quote is extracted from the website of this consultancy: http://www.diiusa.com

6 For a detailed presentation of this organization, see: http://www.mainet.com/index.html

7 Quote extracted from the decision science association website: http://www.decisionsciences.org/

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Laure Cabantous Laure Cabantous is Assistant Professor at Nottingham University Business School. Her research agenda reflects her interdisciplinary background in economics (PhD), management and psychology of decision-making. It is organized around three interrelated areas: performativity and calculative practices, cognition and strategy-making, and behavioural decision-making. Her research has been published in the *Journal of Behavioral Decision-Making*, *Theory and Decision* and the *Oxford Handbook of Organizational Decision-Making*.
Address: Nottingham University Business School, Jubilee Campus, Wollaton Road, Nottingham NG8 1BB, UK.
Email: laure.cabantous@nottingham.ac.uk

Jean-Pascal Gond Dr Jean-Pascal Gond is Adjunct Professor at HEC Montréal. His research investigates the social construction and performativity of Corporate Social Responsibility (CSR), CSR across cultures, and the role of social rating agencies in the development of socially responsible investment. His research has been published in *Human Relations*, *Journal of Business Ethics*, *Business and Society*, *Business Ethics Quarterly*, *Finance Contrôle Stratégie* and *Revue Française de Gestion*.
Address: HEC Montréal, 3000 Chemin de la Côte-Sainte-Catherine, Montreal, QC H3T 2A7, Canada.
Email: jean-pascal.gond@hec.ca

Michael Johnson-Cramer Michael Johnson-Cramer is an Associate Professor of Management at Bucknell University. His most recent research examines the nature of organizational decision-making and explores the sources of conflict in firm-stakeholder relationships. He is currently an associate editor at *Business & Society*.
Address: Taylor Hall 307, Bucknell University, Lewisburg, PA 17837, USA.
Email: mjohncra@bucknell.edu

Appendix. List of the 58 DA applications published in Interfaces (1970–2001)

Date	Authors	Title (PA if Practice Abstract)	Application Area	Company	DA Tools	Vol	Iss.	p.
1980	Digman	A decision analysis of the airline coupon strategy.	Manufacturing and Service (Strategy)	United Airlines	Decision Tree (DT)	10	2	97–101
1980	Peck	Communicating model based information for energy debates: two case studies.	Public policy (Miscellaneous)	US Govt.	DT. Communication/ Facilitation (Com.)	10	5	42–48
1981	Dalkey	A case study of a decision analysis: Hamlet's soliloquy.	General	*None*	Probability assessment (PA)	11	5	45–49
1982	Ozernoy, Smith & Sicherman	Evaluating computerized geographic information systems using decision analysis.	Manufacturing and Service (Budget Allocation)	Woodward-Clyde Consultants (WCC)	Pb structuring/ Formulation (Pb Struct)	11	5	92–99
1982	Dyer & Lund	Tinker toys and Christmas trees: opening a new merchandising package for Amoco Oil Company.	Manufacturing and Service (Strategy)	Amoco Oil	Pb Struct.; Utility assessment (UA); Com.	12	6	38–52
1983	Madden, Hynick & Hodde	Decision analysis used to evaluate air quality control equipment for Ohio Edison Company.	Energy (Product and Project Selection)	Ohio Edisson	DT; PA; Com.	13	1	66–75
1984	Bell	Bidding for the S.S. Kuniang.	Energy (Bidding)	New England Electric	DT	14	2	17–23
1984	Cohan, Haas, Radloff &Yancik	Using fire in forest management: decision making under uncertainty.	Public Policy (Miscellaneous)	3 US National Forests	DT	14	5	8-19
1985	Winter	An application of computerized decision tree models in management-union bargaining.	Manufacturing and Service (Miscellaneous)	Large manufacturer of heavy industrial goods	DT	15	2	74–80
1986	Hosseini	Decision analysis and its applications in the choice between two wildcat oil venture.	Energy (Site selection)	Tomco Oil Corp.	Com.	16	2	75–85
1986	Luna & Reid	Mortgage selection using a decision-tree approach.	General		DT	16	3	73–81
1986	Pollock & Chen	Strive to conquer the black stink: decision analysis in the People's Republic of China.	General	Chinese Govt.	Com.	16	2	31–37

Appendix. (Continued)

Date	Authors	Title (PA if Practice Abstract)	Application Area	Company	DA Tools	Vol	Iss.	p.
1987	Clarke	The application of decision analysis to clinical medicine.	Medical		DT	17	2	27–34
1987	Ulvila	Postal automatic (ZIP+4) technology: a decision analysis	Medical	US Postal Service	DT; PA	17	2	1–12
1988	Heian & Gale	Mortgage selection using a decision-tree approach: an extension.	General			18	4	72–83
1988	Ulvila	Hindsight: the automatic zipper.	Public Policy (Miscellaneous)	US Postal Service	Com.	18	1	74–77
1988	Wenstop & Carlsen	Ranking hydroelectric power projects with multicriteria decision analysis.	Public Policy (Miscellaneous)	Norwegian Gov.	Pb Struct; Com.	18	4	36–48
1989	Alemi & Agliato	Restricting patients' choices of physicians: a decision analytic evaluation of costs.	Medical		DT; Com.	19	2	20–28
1990	Feinstein	Decision whether to test student athletes for drug use.	Medical	Santa Clara University	Pb Struct; Com.; PA	20	3	80–87
1991	Islei, Lockett, Cox & Gisbourne	Modelling strategic decision making and performance measurements at ICI Pharmaceuticals.	M&S (R&D project selection)	ICI Pharmaceutical	Strategy and/or objectives generation (Strat. Gen); Implementation (I)	21	6	4–22
1991	Reagan-Cirincione, et al.	Decision modeling: tools for strategic thinking.	Public Policy	New York State Insurance Department	Strat. Gen; Com.; Group issues	**21**	**6**	**52–65**
1992	Balson, Welsh & Wilson	Using decision analysis and risk analysis to manage utility environmental risk.	Energy (Environmental risk)	Utility companies	Pb Struct. PA	**22**	**6**	**126–139**
1992	Buede & Bresnick	Applications of decision analysis to the military systems acquisition process.	Military	US Marine Corps.	Strat. Gen	**22**	**6**	**110–125**
1992	Engemann & Miller	Operations risk management at a major bank.	M&S (Finance)	Bank	Pb Struct.; I.	**22**	**6**	**140–149**

(Continued)

Appendix. (Continued)

Date	Authors	Title (PA if Practice Abstract)	Application Area	Company	DA Tools	Vol	Iss.	p.
1992	Keeney & McDaniels	Value-focused thinking about strategic decisions at BC Hydro.	Energy (Strategy)	BC Hydro	Strat. Gen; UA; Com.; I.	**22**	**6**	**94–109**
1992	Krumm & Rolle	Management and application of decision and risk analysis in Du Pont.	M&S (Strategy)	Du Pont	Strat. Gen; Pb Struct. ; Com.	**22**	**6**	**84–93**
1992	Kusnic & Owen	The unifying vision process: value beyond traditional decision analysis in multiple-decision-maker-environment.	M&S (Strategy)		Strat. Gen; Com.; Group issues; I.	**22**	**6**	**150–166**
1992	Quaddus, Atkinson & Levy	An application of decision conferencing to strategic planning for a voluntary organization.	M&S (Strategy)		Pb Struct. ; Com.; Group issues	**22**	**6**	**61–71**
1992	Vari &Vecsenyi	Experiences with decision conferencing in Hungary.	General		Com. ; Group issues; I.	**22**	**6**	**72–83**
1993	Hess	Swinging on the branch of a tree: project selection applications.	M&S (Project selection)	ICI Americas	Pb Struct. ; SA	**23**	**6**	**5–12**
1994	Millet	A novena to Saint Anthony, or how to find inventory by not looking.	M&S (Product planning)	A nameless organization with a large logistical operation	SA	**24**	**2**	**69–75**
1994	Mulvey	An asset-liability investment system.	M&S (Finance)	Pacific Financial Asset Management Company		**24**	**3**	**22–33**
1994	Paté-Cornell & Fischbeck	Risk management for the tiles of the space shuttle	General	National Aeronautics and Space Administration	PA; I.	**24**	**1**	**64–86**
1995	Borison	Oglethorpe Power Corporation decides about investing in a major transmission system.	Energy (Product and project selection)	Oglethorpe Power Corp.	Pb Struct. ; Com.	**25**	**2**	**25–36**
1995	Keefer	Facilities evaluation under uncertainty: pricing a refinery.	Energy (Bidding and pricing)	Oil company		**25**	**6**	**57–66**

Appendix. (Continued)

Date	Authors	Title (PA if Practice Abstract)	Application Area	Company	DA Tools	Vol	Iss.	p.
1995	Walls, Morahan & Dyer	Decision analysis of exploration opportunities in the offshore US at Phillips Petroleum Company.	Energy (Product and project selection)	Phillips Petroleum Cy	Pb Struct. ; UA; SA; I.	**25**	**6**	**39–56**
1996	Taha & Wolf	Evaluation of generator maintenance schedules at Entergy Electric System.	Energy (Miscellaneous)	Entergy Electric System		**26**	**4**	**56–65**
1997	Brown	Evaluation of vision correction alternatives for myopic adults.	Medical	*None*	Strat. Gen; Pb Struct. ; SA	**27**	**2**	**66–84**
1997	Burk & Parnell	Evaluating future military space technologies.	Military	Air Force	Strat. Gen; UA; I.	**27**	**3**	60–73
1997	Bruggink	The contribution of project analysis to an R&D project at an industrial R&D center.	M&S (R&D project selection)	Alcoa	Pb Struct.	**27**		**107–109**
1997	Stonebraker, Sage & Leak	The contribution of project analysis to an R&D project at an industrial R&D centre (PA).	M&S (R&D project selection)	Ford Microelectronics Inc. (FMI)	Pb Struct.	**27**	**2**	**109–111**
1998	Hazen, Pellissier & Sounderpandian	Stochastic-tree models in medical decision making.	Medical		Pb Struct.; UA	**28**	**4**	**64–80**
1998	Hurley	Optimal sequential decisions and the content of the fourth-and-goal conference.	General			**28**	**6**	**19–22**
1998	Toland, Kloeber & Jackson	A comparative analysis of hazardous waste remediation alternatives.	Energy (Technology choice)			**28**	**5**	**70–85**
1998	von Winterfeld & Schweitzer	An assessment of tritium supply alternatives in support of the US nuclear weapons stockpile.	Energy (Technology choice)	The Department Energy (DOE)	Strat. Gen; Pb Struct.; PA; Com.	**28**	**1**	**92–112**
1999	Bodily & Allen	A dialogue process for choosing value-creating strategies.	M&S (Strategy)	A composite pharmaceutical firm	Strat. Gen; Pb Struct. ;SA; Com.; I.	**29**	**6**	**16–28**
1999	Keeney	Developing a foundation for strategy at Seagate Software.	M&S (Strategy)	Seagate Software	Com.	**29**	**6**	**4–15**
1999	D. Matheson & J. Matheson	Outside-in strategic modeling.	M&S (Strategy)	Major oil Company	Pb Struct.	**29**	**6**	**29–41**

(Continued)

Appendix. (Continued)

Date	Authors	Title (PA if Practice Abstract)	Application Area	Company	DA Tools	Vol	Iss.	p.
1999	Perdue, McAllister, King & Berkey	Valuation of R and D projects using options pricing and decision analysis models.	M&S (R&D project selection)	West Valley Nuclear Services Cy, Westinghouse Science & Techn. Center	Pb Struct. ; PA; SA	**29**	**6**	**57–74**
1999	Perdue & Kumar	Decision analysis of high-level radioactive waste cleanup end points at the West Valley Demonstration Project Waste Tank Farm (PA).	Energy (Strategy)	Westinghouse Science & Technology Center	Strat. Gen	**29**	**4**	**96–98**
1999	Skaf	Portfolio management of an upstream oil and gas organization.	Energy (Strategy)	Upstream oil & gas industry	Strat. Gen; Com. I.	**29**	**6**	**84–104**
1999	Smith &Winkler	Casey's problem: interpreting and evaluating a new test.	Medical	*None*	Pb Struct. ; SA; I.	**29**	**3**	**63–76**
2000	Keeney & Lin	Evaluating customer acquisition at American Express Using multiple objectives (PA).	M&S (Product planning)	American Express		**30**	**5**	**31–33**
2001	Beccue	Choosing a development strategy for a new product at Amgen (PA).	M&S (Product planning)	Amgen		**31**	**5**	**62–64**
2001	Clemen & Kwit	The value of decision analysis at Eastman Kodak Cie.	M&S (Strategy)	Eastman Kodak Company		**31**	**5**	**74–92**
2001	Dunning, et al.	New York Power Authority uses decision analysis to schedule refueling of its Indian point 3 nuclear power plant.	Energy (Miscellaneous)	New York Power Authority	Pb Struct. ; PA.	**31**	**5**	**121–135**
2001	Parnell	Work-package-ranking system for the Department of Energy's Office of Science and Technology. (PA)	Energy (Product and Project selection)	Dpt. of Energy's Office of Science and Technology		**31**	**4**	**109–111**
2003	Johnson & Petty	Analyzing the development strategy for Apimoxin PA		Pharmaceutical industry		**33**	**3**	**57–59**