Decision Sciences
Volume 39 Number 2
May 2008

COMMENTARY

Silver Bullet Junkies and the Codifiers That Love Them: Behavioral Roots Behind a Legacy of Bad Modeling and Use

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ABSTRACT

As research continues to evolve, it is important to look back with a critical eye on its impact on practice and what is guiding its trajectory into the future. In this work we discuss some of the key behavioral drivers that taken as a whole have made for a less than ideal relationship between research, model development, and use/reliance in practice. From a general public-good perspective, there is an obvious need for academics to take on a greater role of responsibility when it comes to both research and curriculum in an effort to avoid some of the failings that our past work has inevitably encouraged to date.

Subject Areas: Cognition and Reasoning, Motivation, and Operations Management–Information Systems Interface.

INTRODUCTION

Many managers have an insatiable thirst to leverage tools that provide quality and expedient decisions. Codification and automation of tactical decision processes, as encapsulated in decision support systems (DSS), often quenches the thirst of these individuals. To this end, information systems-enabled operational systems can both reduce the amount of time individuals allocate to decisions and provide professional coverage should implemented solutions go sour in practice.

Why might such heralded and potentially useful tools result in suboptimal outcomes? Tool developers might argue that managers did not use the system/solutions in the way they were intended. Managers might point the blame squarely on vendors for designing a tool that was flawed, information systems staff or low-level users for allowing the tool to be used on flawed or inaccurate data, or lower-level managers for failing to turn prescriptions into effective practice. The cycle often persists with intentions to fix the broken decision tool, resulting in investments of time and money into systems that continue to fall short of practical reality. Such

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managers are addicted to these decision silver bullets and developers feed this addiction by supplying a diverse array of products, recognizing that these products cannot fully account for all contexts and externalities that reflect the complex business environments in which the tools are used.

Given the potential mismatch between decision tool prescriptions and the effectiveness of these prescriptions, one has to ask why some managers keep going back for more. More importantly, how can the black box underlying the intelligence of these tools be made more transparent so that managers can more fully understand the assumptions and consequences of their decisions? In the discussion to follow, we will speculate on both the demand and supply sides of this problem and outline areas in both teaching and research that require greater diligence on the part of academics.

OF PRESSURE-COOKERS AND BREADCRUMBS: THE DEMAND SIDE OF THE PROBLEM

Why have there been so many cases of information technology (IT) investment devoid of clear and tangible benefit to those adopting it? Is it simply because researchers and practitioners do not know where (or when) to look for such benefits (Hitt & Brynjolffson, 1996)? Can it be chalked up to poor management action associated with use (Partow-Navid, 1987; Rubenfeld, Newstrom, & Duff, 1994; Banerjee, Cronan, & Jones, 1998)? Surely both are likely to explain much of the difficulty capturing the value associated with IT adoption. In focusing on IT tools designed to support decision making, the design and functionality of the technology itself, including the embedded decision models, might be part of the problem (Sanders & Courtney, 1985; Guimaraes, Igbaria, & Lu, 1992; Lawrence, Goodwin, & Fildes, 2002; Guimaraes, Staples, & McKeen, 2003). In dissecting these problems, the fit between decision support and the context to be supported is thought to greatly confound the ability to place blame solely on the tool itself or the management responsible for it. In turn, such confounds make the job of attempting to link tools to benefits an admittedly nontrivial task.

Why do academics and practicing managers struggle to make sense of this decision tool/practice misfit? Many academics view decision making as a highly rational and well-understood process as demonstrated by the interdisciplinary research streams that have been developed over the last 50-plus years. This rational process typically focuses on a reasonably codified decision structure, dynamic completeness, and thoughtful analysis subject to the availability of relevant data. In reality, any number of issues outside of the predictive lens of many academics can interfere with such rational decision processes and result in outcomes very different from those anticipated (Rubenfeld et al., 1994). Similarly, practicing managers understand the complexity and computational processing associated with many of these decisions and, as such, implicitly understand the value in relying on a tool to support such decision making. What is more difficult to assess is the context in which these decisions and actions are taken, something social dynamics and psychology scholars recognize as particularly influential to the decision outcomes: not just the informational context, or the task context, or the industry context, but the entire technosociological environment influenced by organizational hierarchies and power structures, perceptions of explicit and implicit work expectations, peer

pressure, and other common place phenomena that almost all individuals regularly encounter on the job. Although a discussion of the wide array of noneconomic issues that have the potential to drive decisions to adoption is beyond the scope of a single article, one does not need to dive deep into this realm to discover why seemingly well, trained and rational managers repeatedly make fairly ineffective and occasionally harmful decisions regarding the adoption and use of support tools.

The Impetus: Pressure-Cooker Effects

The speed of decision making is being continuously accelerated in contemporary business environments, at times creating conflicts between expedient decisions and decisions that provide future operational agility. The increased availability of information upon which to base decisions can have an insidious effect in these settings—executive management may have the expectation that decision-making speed and quality can only be enhanced by the vast wealth of information that managers have access to. While better information sounds good in practice, the literature on information overload highlights the cognitive limitations managers face based on the sheer amount of information they can meaningfully integrate and analyze (Rubenfeld et al., 1994). Such limitations imply trade-offs and errors in information selection and use and, in turn, imply not only decreasing returns to scale with information access but often negative returns (Chervany & Dickson, 1974; Farhoomand & Drury, 2002; Pennington & Tuttle, 2007).

Computers certainly provide the capability of managing much larger volumes of certain kinds of information in a limited amount of time, although the kind of information selected and the type of analysis performed is ultimately an artifact of application design—again something developed by cognitively limited and often not-so-rational humans. Hence, what may be packaged and marketed as a sophisticated support tool for managerial decision making cannot be entirely separated from the perspectives that characterize its developers—who are often external to the firm and devoid of specific context knowledge associated with a given decision application. Diligent managers would of course be wise to view such tools from a relativist perspective, understanding that there are many views of what factors may be relevant in making good decisions and many views of how these factors interact, not all of which are entirely appropriate to all contexts (Guba, 1990). They might do well to consider various solutions derived from a host of tools and perspectives (Meredith, 2001). While this perspective appears obvious, the time-to-decision pressure cooker keeps pressing down upon them. Under pressure to make decisions based on vast amounts of available data, the use and, ultimately, reliance on any one of these black boxes sound fairly inviting. The associated implication is only one fundamental facet of the silver bullet threat.

While the appeal of using decision tools developed by others with potentially biased views of what is appropriate for a highly diverse set of clientele may seem risky, myopic design risks may be insignificant compared to the risk of myopic decision tool use. A critical aspect of the pressure cooker effect is the tendency for high-pressure managerial environments to magnify an existing peripheral impairment that may already naturally characterize certain decision makers. Familiar elements and issues perceived as priorities to managers are likely to get the greatest attention in the use of these systems. System options for analysis that are outside

this realm may be ignored. Most dangerous are features designed as mandatory to system analysis that individual decision makers have no familiarity with. Forced to calibrate the analysis along issues that they lack sufficient knowledge on, yet do not have time to research, managers may in fact fatally confuse the analysis by providing intuition-based yet otherwise unjustified estimates. The result may be the generation of system outputs far less appropriate than those that would have been derived if such mandatory features could have been ignored. Again we might hope and believe that management diligence and responsibility prevent such suboptimal outcomes (or even catastrophes) by ensuring that any blanks are examined and addressed prior to finalizing a decision—but the clock continues to tick. The pressure cooker and lack of transparency into the decision-making black box may lead to a potentially harmful approach. These unknowns, or blanks, may represent a small but critical portion of the issue, to which the support system is calibrated. One needs to question how much of a difference these unknowns can make in our context.

The Release: Breadcrumb Phenomena

Regardless of these threats, managerial perceptions of pressure to quickly make decisions aimed at resolving complex problems is one thing, while acting on these perceived pressures is something else entirely. That is, perceptions of pressure and knowledge of potential shortcuts cannot in itself imply a reduction of rigorous consideration and justification on behalf of the decision maker. There are safeguards against these things. Organizational structures should be designed in large part to ensure mechanisms by which accountability for hasty and irresponsible approaches to decision making is minimized.

Well, wait a second. What are organizational hierarchies if not a set of structured interfaces across which information and accountability must pass? The instrumentality rational, as well as the legitimization of work breakdown, encourages attempts to transmit responsibility for decision making across these interfaces (Weber, 1958), potentially leading to a loss of information regarding the specific issue. In the case of operational decision support tools, the decision responsibility embedded in the tool not only makes it increasingly difficult to determine where specific errors in judgment take place but also increases the risk of such errors occurring in the first place as ambiguity regarding task requirements often increases as additional interfaces are encountered. Some individuals are aware of such organizational nuances and are diligent in addressing them; others may take advantage of such gaps, thus further increasing the risk of degradation to the rigor, for which the use of the work breakdown hierarchy was initially devised (Dillard & Ruchala, 2005). This is not to suggest that hierarchical organizational structures are ineffective, but rather that their weaknesses should be taken into account when anticipating management decision-making behavior (Kraines, 1996).

What is the responsibility of the high-level decision maker who is fully aware of the organizational hierarchy nuances? This manager is charged with the legitimacy of delegating work, ultimately responsible for the final outcome, yet similarly subject to the pressures already discussed. While a number of strategies can be used to increase the transmission of information across interfaces, it is difficult to fully assess the information flow. Tracking the responsibility for complex management

decisions, projects or implementation efforts are often analogous to the children in the Grimm fairy tale finding their way home—a handful of breadcrumbs to record the path of their journey. When problems tend to arise (particularly after some time), it becomes difficult to trace back exactly who owned certain responsibilities, particularly given the uncertainty surrounding many projects and the abstractness of team-based processes.

Given the diffused nature of decision rights and information flow related to management decision making associated with the misuse of decision support tools, how do organizations more appropriately identify misfit problems? Some organizations opt not to focus on the misfit and instead look to assign blame for the poor decisions. IT implementation staff often takes the hit for failed projects originated within the organization (Murray, 2006). After all, it was their job to get it to work. Subordinate users are also fairly convenient scapegoats, particularly if performance is inconsistent (i.e., if the decision tool seems to yield reasonable solutions at least some of the time). Then there is always the developers of the decision tool itself, though, if external to the firm (an issue which again poses its own set of risks) such blame is likely to be volleyed back in the form of reciprocated blame for misappropriation and use, that is, again in the hands of those lower on the organizational totem pole. In any event, this is a rather discouraging set of potential outcomes for a busy decision maker.

Salvation for the Demand Side?

Kopeikina (2006) reiterates: "A clear decision can arise only when someone takes responsibility for it. Only those who are prepared to bear the consequences of a decision have the right to make it." Though given the unavoidable development of competitive work pressures and the cracks posed by instrumental work design and delegation, how can a conscientious firm hope to ensure responsibility among its key decision makers? A natural response might be incentives. Implementing such an incentive plan is not as obvious and poses many questions, such as, what kind of incentives and when should the incentives be given out—upon the first return from the decision is realized (if measurable) or is a longer-term measure required? A more revolutionary approach to incentives might be to consider the formalization of an open market for ideas that transcends organizational hierarchies, while guaranteeing protection for those in lower positions. The theoretical work put forward by Ba, Stallaert, and Whinston (2001) suggests that structures for effective internal knowledge markets can be developed and proposes mechanisms for pricing knowledge. The value of internal markets for knowledge has more recently been examined by Piller and Walcher in new product development contexts (Piller & Walcher, 2006). Perhaps most encouraging is the fact that practitioners and consultants have recently started to dip their toes in the water—at least at a conceptual level (Bryan, 2004). Though a real-world case of such markets still requires documentation, it does appear likely that the appeal of such structures may eventually give rise to formulae for running them effectively.

Critics of such markets might say that they risk undermining the key benefits that effective hierarchical power structures and administered job roles provide to firms. Without empirical evidence either way, such concerns are unlikely to deter experimentation with these market concepts. In any event, regardless

of the trappings of formal mechanisms for engaging all levels in free thought, even less ambitious forms of openness may offer substantial benefits to decision-making processes. Mechanisms to at least ensure transparency of work delegation in decision processes would create accountability and, in turn, due diligence on the part of higher-level decision makers (including due diligence in the appropriate use of decision support applications). Institutionalized check-and-balance systems that require documentation of roles played in decision-making processes would be necessary. This documentation of information and idea-work extends existing frameworks that track routinized work and encapsulated projects—somewhat non-traditional but nevertheless not unprecedented in both practice and research (Reagans & McEvily, 2003). So there is hope for structured approaches to reducing the lure of silver bullets and irresponsible use, but it needs to be engaged, studied, and promoted and, ultimately, championed. The role of academia in leading this initiative should not be underestimated.

CLIMATE CONTROL FOR MR. OPPORTUNITY AND DORIAN GRAY: THE SUPPLY SIDE

What enables the availability of sophisticated yet misguided, misdesigned, misapplied, and ultimately misleading silver bullets? While a product requires a market (i.e., time-starved decision makers), there is a robust decision tool supply side—the craftsmen and companies that build around them as well as those that provide support (e.g., venture capitalists) and evaluation (e.g., researchers). As such it is important to understand the nature of the silver bullet supply line with an overview of basic market dynamics.

The Distinct Smell of Money

The often overly zealous demand for silver bullets that pervades modern management is one of the strongest feeders for industrial development of these managerial solutions. Particularly with the growth of computing power over the last several decades, the swarm of independent DSS developers has grown in response to niche markets and corporate views of unique management needs. Of course, it helps when higher-level decision makers believe there's an inherent need for automated decision support that can be quickly met by available technology solutions. Further, given documented situations where IT has been effective in supporting decision making, some organizations have scrounged up discretionary IT funding to invest in proprietary decision support solutions with the goal of creating a unique edge within their industry.

Given the breadth of decision tools, it is difficult to fully assess the size of this supply-side opportunity. The size and scope of this opportunity can be seen in looking (and aggregating) the application slices that make it up: Data monitor has estimated total expenditure on workforce optimization systems alone to be in the $1 billion range in 2006 (Webb, 2006) while Gartner places the price-optimization software market at $195 million (Barret, 2006). Other reports confirm post-Y2K growth (and project ongoing growth) in industry specific DSS sales, including those used in healthcare and shipping (Parry, 2002; Raghupathi & Tan, 2002). Of course, one needs to keep in mind that the magnitude of these trends is not due to merely

the emergence of new business problems that need resolution. In reality much of the sustainability of this market is reliant on the pervasive systems restructuring efforts that accompany CIO and other high-level management turnover (Rogow, 2006).

While the size of these markets highlights the corresponding demand, the effectiveness in meeting this demand is in question. Some concerns focus on the breadth of factors incorporated into a specific decision tool. For example, an operations research (OR) 2006 survey of vehicle-routing software shows that only 35% of applications surveyed incorporate real-time traffic information—a necessary capability in fully addressing this problem. Regardless of the understanding that many of the most effective decisions come about through a familiarity with the risks, processes, and networks of particular entities, a 2004 survey suggests only about half of the major decision analysis offerings included codified forms of risk aversion, with similar figures for sequential decision making and multi-stakeholder accounting. The suggested resolution to such deficits is that decision makers may often need to use multiple support tools in making reasonable, fully informed, and analytically supported decisions (Maxwell, 2004). Beyond the breadth of factors associated with one decision area, a second concern focuses on the degree to which the decision tool has incorporated an understanding of the decision context and timing. For example, Gartner suggests that only about a quarter of performance management tools are being developed incorporate cross-enterprise analytics (Beall, 2005). But do developers and their sales representatives make such a suggestion and its rationale absolutely clear to clients? Do they expect clients to act accordingly? If the answer is anything but a strong and unequivocal "Yes," well, then something seems to be amiss here.

Do decision tool suppliers fully contextualize the factors included (and not included) in the decision-making models? Is this a situation of buyer beware as intelligent managers should know that not every factor and context could be incorporated into an automated-decision model? Regardless of what conversations could occur, the message presented to practitioner audiences focuses on "optimizers often replace rather than foster careful thinking" (Gregory & Savage, 2004, p. 67). Gaps and shortcomings, that developers know or even suspect exist in their systems make this replacement of careful thought particularly unfortunate. The fact that many managers are not technically trained to account for, let alone identify, such gaps based on sensitivity information in DSS reports, does not help (Whiting, 2002). Yet, these system gaps clearly exist. What are the economic implications of gap-inherent DSS development for the firm as a whole, given the managerial decision-making dynamics discussed in the last section? Depending on the potential severity of these implications, the socioethical expectations of DSS development should be fairly high. But again, in the absence of any direct and absolute postsale accountability on the part of developers, it is hard to imagine that socioethical issues are at the forefront of developer concerns (Erbschloe, 2003; Frank, 2004).

Peripheral Impairment (Strikes Again): The "OR Crisis"

While we can step back and acknowledge the complexity and integrated nature of decision making within organizations, our research on and training of decision-support developers often focuses on solving fairly narrowly defined problems

within this complex, messy decision space. Model developers regularly exclude variables and dynamics that they recognize as potentially relevant to research contexts in order to focus on factors and dynamics that they are interested in studying in greater depth. And there is some sense behind such a line of logic—as long as people are willing to embrace the fact that the results are simply relative to the framework investigated, and not absolute or even widely robust laws that suggest prescription when viewed in isolation. Unfortunately, the quest for tractability among model developers is hardly unbiased. In fact, in operational model development, there is a particular tendency to continue to ignore a particular field of phenomena: Notably the noneconomically codifiable social and behavioral factors and dynamics characteristic of the workers involved in the work systems modeled (Powell & Johnson, 1980; Ackoff, 1987).

In Ackoff's classical argument against the direction of the operations research field he states "OR does not incorporate the arts and humanities largely because its distorted belief that doing so would reduce its objectivity, a misconception it shares with much of science." As a result, he asserts that the interdisciplinarity of OR is "a pretention, not a reality" (Ackoff, 1979, p. 84). He goes on to suggest that the exclusion of behavioral dynamics and its implied lack of empirical insight into their roles in the contexts modeled and prescribed for is a value judgment that might be viewed as immoral from the perspective of intellectual responsibility. That's not to say that modelers have not been increasingly active in the generally interdisciplinary flavor of their models over the last two decades—though one needs to seriously question how much is honestly being integrated when only surface acknowledgements of social and psychological theory are used as springboards to the reduction of such theory to otherwise simple mathematical extensions of existing models. What tends to be absent in such work is empirical validation of these reductions or follow-ups as to the practicality of the added utility of such reductions. So even if an honest attempt to pick up the banner of relativism in lieu of absolute realism, the battery of studies required for consistently practical use of these models will continue to fall short of the mark (Meredith, 2001).

Regardless of these criticisms, Corbett and Van Wassenhove (1993) claim that the "OR Crisis" might be viewed as little more than a "natural drift" that has increased the scope of operations management practice and OR theory, which has, in turn, attenuated communication between representatives of the two sides of the operations spectrum. Appropriately, they draw a line between math-theory-driven OR/MS purists and those interested in applying new research to management practice (whom they label "management engineers") with the aid of management consultants. As a result of growth at the extremes of this spectrum, the field suffers from an increasingly limited supply of individuals able to facilitate much needed communications between OR/MS purists and practitioners.

Yet, apart from this somewhat awkward labeling scheme, there is an underlying problem in the assumptions of the "natural drift" hypothesis. In particular, it assumes that the "tools" to be applied by such researchers are appropriately crafted by the OR/MS purists. Therein resides a major problem. The mere fact that these purists are so detached from practice and real-world dynamics makes it impractical to put them in charge of tool development—a lesson demonstrated repeatedly in the information system design literature, bringing us again to Ackoff's original

criticisms. Reliance on such a model for interaction almost certainly ensures the irrelevancy of purist roles, a point corroborated by Corbett and Van Wassenhove (1993) and more recently, by Guide and Van Wassenhove (2007). This helps explain the evidence they find that suggests significant declines in managerial confidence and interest in the most abstract facets of OR/MS (Meredith, 2001). It appears that not much has changed in OR as a field, continuing the pattern of detachment from practice (Guide & Van Wassenhove, 2007).

Yet, should the retention of the OR/MS traditions emblematic of the 1970s really come as any surprise to management academics? The 1970s served as a major hiring period for OR faculty, many of which came directly out of highly industrial engineering orientations, many of which eventually attained highly influential positions in editorials boards and universities, and many of which still remain in those positions. Many leaders in purist OR approaches have been uninterested, unwilling, or, frankly, unable to adjust to the growing awareness of needs in practical managerial decision making that extend beyond their realm of experience. Rather than adjust, many purposely maintain their philosophical perspectives through doctoral training, selective recruitment, and editorial staffing. Unfortunately, the result is that such academics are able to maintain a veneer of modernity and vigor within their ivory tower communities while, much like the portrait of Dorian Gray, their image in the eyes of competent real-world managers may be, well, less than appealing.

For these and related reasons the calls for reform continue. A clear example is that of Hopp's article on the 50th anniversary of *Management Science*, in which he emphasizes that understanding the nature of a firm's operational dynamics "does not just require a theory of human motivation and a theory of material flow; it also requires a means for describing the interaction between the two" (Hopp, 2004, pg.19). Still more recently, Bennis and O'Toole's HBR discussion reiterates that "the things routinely ignored by academics on the grounds that they cannot be measured—most human factors and all matters relating to judgment, ethics and morality—are exactly what make the difference between good business decisions and bad ones. . .The greatest risks [leaders] run are the by-products of their trained tendency to define problems in terms of what they know and then to fall back on past behavior when faced with a new challenge" (Bennis & O'Toole, 2005, p. 97). These "leaders" are not just managerial decision makers, but also the decision- support developers that they rely on. Who better to influence these "trained tendencies" but those who "train" them? And how more influential such reformed "training," if taught by individuals, who regularly make it their concern to research and develop a greater understanding of the very issues that have been brushed aside by traditional math-modeling tactics.

Interfacing with Blinders On

Even when developers are diligent and socially responsible in the crafting of their engines, there is still room for managerial abuse and scapegoating a la "how was I supposed to know it worked that way?" Transparency in the developed product is key here and it takes many forms (Lee, 1989). Transparency into the model structures (i.e., variables, agents, relationships assumed), mechanisms (i.e., nature

of interaction, simulation dynamics, solution approaches, etc.), and data sources are all absolutely critical to ensure thorough and rigorous understanding of tools that claim to provide managerial guidance. At least such transparency will reduce the ability of managers to excuse themselves of errors in DSS use simply due to their own ignorance of the system. Yet developers can take still additional steps to build in transparency in an attempt to reduce such risks. In particular, developers should embed within their designs commentaries that justify the inclusion of specific features (in lieu of others). For example, why was each rule, association, and constraint provided in their specific mathematical form (as opposed to another perhaps equally reasonable form)? Why were the behaviors of specific agents codified as they were? Are they really thought to be sufficiently realistic? Are they really stable and not contingent on changes in the operating climate that might arise from prescribed changes suggested by the DSS? Why were specific statistical assumptions (e.g., normality) made? Yes, the complexity of this information transmission is significant, but it creates the opportunity for shared understanding and offers checks and balances into decision processes and ultimately decision outcomes.

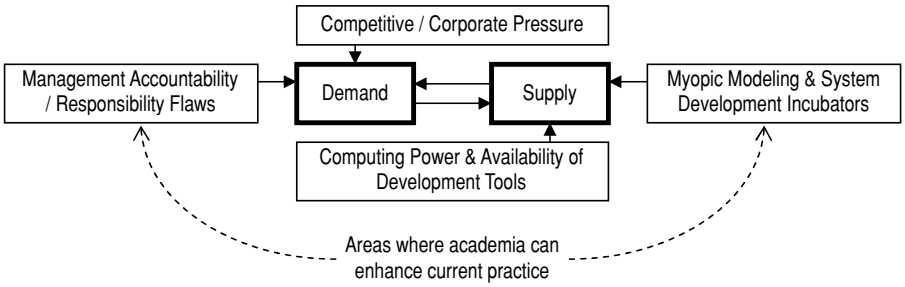
Such justification naturally feeds into another requirement for DSS development that should be embedded into these applications: sensitivity reports. How do changes, not only in the data used, but in the very nature of the assumptions questioned above, impact the suggestions provided by the system? Sufficient warnings and caveats regarding such sensitivity need to be clearly provided with every output report. If this seems like excessive documentation—remember it's the job of decision supports systems to support, not replace, managerial decision making. Firms still need to expect managers to use their heads in making sense out of what they see, even (and especially) if they get a little computational assistance along the way. And along those same lines, firms also need to expect managers to get their hands a little dirty in ensuring that computational assistance is appropriate. Developers necessarily must help pave the way for such activity, making sure that assumptions, and so on that set off alarms in the minds of managers and users can be modified or extended to incorporate the true and often changing nature of the business context in which decisions are to be made.

Lastly, all DSS documentation and implementation processes should require a reiteration that a reliance on *any* single automated solution is likely to be a risky proposition. Documentation should provide references to alternative methodologies, notably nonmodeling alternatives, such as policy-piloting programs and microdelphi panels. Developers need not view these as strict competitors for their market. In fact developers would do well to partner with consulting groups that are well versed in methods that are not entirely automated in order to benefit from their experience with human decision makers and real-world practice. Joint branding benefits may even be an appealing side effect, if pursued faithfully.

WHAT NEEDS TO BE TAUGHT

Before proposing what needs to be taught, it is worthwhile to give an overview of how the various elements of the market for silver bullets, as discussed interact. Although many other issues may come into play (we readily admit to this being exactly the kind of statement that has been used to write-off critical issues in past

Figure 1: Overview of elements driving supply and demand for "silver bullets."



research), the dominant features discussed thus far are depicted in Figure 1. (*Note: We strongly encourage others to build on and modify this framework, as well as using other perspectives in future discussions on DSS abuse*.)

Management Accountability/Responsibility Flaws

Our management colleagues have broad ownership of organizational design and behavior practices that should be included in all undergraduate and graduate curricula to address decision-making/organizational structure issues and incentive approaches discussed earlier. An understanding of practices, effective management of these practices, and inherent gaps that a given practice generates should be the basis for more fully understanding sociotechnical system effectiveness. Further, significant information system undertakings are truly change management events—while information systems academics focus on change management (typically at the project level), management faculty should address the broader leadership and change management issues that are critical to more fully understanding the behavioral components of technology acceptance and its effective use. Students need to learn to be critical, not just accepting, of existing models and their implementations—and instructors in OR courses, for example, need to encourage such critical questions and be courageous enough themselves to allow their discussion.

From an information systems curriculum standpoint, continuing efforts to foster basic information system understanding in all managers is critical. This basic understanding is not intended to open the black box per se, but to define what the black box contains. If a manager understands the basic building blocks of information systems (inputs, process, output, feedback), he or she is better positioned to pose the questions "what is included as input?" or "how does this automated process actually work?" and so on. In addition, the curriculum should help general managers develop basic conceptual categorization schema of information systems types (e.g., functional information technology, network information technology, enterprise information technology (McAfee, 2006). Such schema allow future managers to more fully understand the potential challenges (adoption, implementation, execution, exploitation) and benefits associated with each category type. These challenges have direct implications for what they, as general managers, must do to successfully exploit the capabilities inherent in any information system.

Myopic Modeling and System Development Incubators

In looking at curricula focusing on the development of information systems (IS) professionals, continued efforts at developing skilled systems analysts who provide the boundary-spanning role between development and managerial users are critical. These system analysts can play a critical role in shaping developer understanding of critical facets and assumptions associated with decision models. In addition, these individuals can help shape users' understanding of why all potentially relevant factors are not included in the model and are therefore able to shape the fallacy of the silver bullet fix with the user community.

Increasingly, software across all information systems categories (including decision support tools) is purchased from outside vendors. The IS curriculum should ensure that sufficient development is given not just to a make versus buy decision process, but to fully explore the stages and activities needed to make effective buy decisions (the IS community has a variety of models and processes for make decisions). Developing such skills will ensure that organizations have internal capabilities to objectively assess/compare software alternatives.

Finally, as noted earlier, information systems implementations are increasingly significant change management projects. There has been a tendency for information systems curriculum to focus heavily on technical skill development and less on the human dynamics of systems implementation and exploitation (Lippert & Anandarajan, 2004). As organizations increasingly look to automate and leverage information technology effectively, it is critical that increased attention is given to ensuring that information technology investments are designed and implemented in ways that create organizational value.

From an operations research/decision science perspective, our curriculum still needs to ensure that our students have the technical skills to develop and implement decision models. However, while these lessons provide the theoretical and technical development, necessary to be an effective developer/practitioner, curricula should be enhanced to make developers aware of decision tool misunderstanding or misuse that can occur within a specific decision application, when integrating a tool across functions, or by applying tools in contexts for which they may not have been developed. This type of understanding will help create deeper awareness of the ethical responsibility developers have in building and communicating the capabilities inherent in decision support system tools.

WHAT NEEDS TO BE RESEARCHED

Despite its many virtues, relativist perspectives applied to business modeling for management support are likely to take longer to develop and ultimately get published. Avoiding such a perspective certainly would permit a cleaner and faster modeling and decision-making process, in part, because it completely bypasses real-world validation. This approach encourages academic isolationism and sustains the disconnect with practice that continues to plague the applicability of the majority of math-theoretic research developments (Meredith, 2001). Without a doubt, empiricism needs to be reembraced in the context of decision support model development and its feeder system (i.e., math-model construction)

(Bendoly, Schultz, & Donohue, 2006). Greater appreciation for the role of such work needs to be embraced at top universities, some of which are currently dominated by model tweaking. This change will not be made from within established math-modeling departments that have been allowed comfortable protection among the laurels of top business school rankings, nor is it likely to take place within the editorial ranks of OR flagship journals, but rather by (i) the strong leadership of broad-minded and inspirational deans and (ii) a recognition by ranking outlets that top schools often do not represent the most respected, practice-informed, and impactful researchers in all fields. Only through such mechanisms can change in the orientation of certain elite academic ranks take place.

What kind of change are we talking about? Specifically what kind of research needs to be pursued? For one, research needs to challenge some of the well-established beliefs regarding the linkages between the mere availability of information supported by technology and the operational gains obtainable through better decision making. Both the articles included in this special issue focus on this current gap in our understanding. The article "The Effects of Process and Outcome Similarity on Users' Evaluations of Decision Aids" opens the decision-making black box by examining how users' evaluations of a decision aid change when the user understands the inherent decision process and decision outcome logic inherent in the tool. Decision aids having decision processes that are more consistent with users engender greater trust and perceptions of system usefulness. The authors examine populations with limited and more significant task domain knowledge and determine that process similarity is particularly important for novices. Clearly, not just the decision context, but the capabilities of a decision support system user matters leading to the suggestion that developers may want to deliver differing capabilities (and process information) depending on the characteristics of the potential tool users.

Similarly, the article "Judgmental Adjustments of Previously Adjusted Forecasts" also attempts to reveal the often hidden nature of information use in decision making. When decision makers are provided explanations behind any prior forecasting adjustments the explanations change the nature of their understanding of the forecast and any subsequent behavior. More specifically, the more informative (and appropriate from the decision maker's standpoint) an explanation, the less likely a decision maker would be forced to make additional adjustments (or the adjustments were minor). If the explanation was contradictory or misleading, the decision maker was more likely to make significant and more sizable adjustments.

Beyond providing explanation facilities and more robust information within decision support systems, other research directed toward the following topics would be valuable:

- What information to include/disregard when making specific decisions,
- Outcomes when using process analysis recommendations,
- Underlying reasons behind the misinterpretation and misuse of DSS tools,
- System circumvention in yield management and other settings,
- Bias in scheduling constraint specification and performance sensitivity,

- Customer relationship management overloads and assumption-making in new service development,
- Organizational information system characteristics and the resulting effects on decision making,
- The role of information integration on work sharing and behavioral outcomes, and
- The ability of decision makers to identify invalid or inappropriate data in operational decision-making systems.

CONCLUSIONS

A decade ago, Corbett and Van Wassenhove (1993) demonstrated how trends in the sales of software containing OR tools showed a very different picture from that of the decline of interest in OR by such high-ranking academically driven and practice-oriented journals as HBR. They cited Geoffrion's 1992 note that by the end of 1991 "over a million copies of a linear and nonlinear optimization code, modified to work with the leading spreadsheet packages, had been shipped (of course no evidence of effective use is presented)" (p. 432). A similar contrast can be made today. Yet, given the discussion outlined to this point, such seemingly contrary results should not be viewed as surprising to academics in any sense. Yes, there is an understanding by leading managers that many purist OR models have little practical value, but there are a lot of less experienced and less competent managers out there. The market for silver bullets should and will survive. The battle is not to eliminate such a market, but rather to enhance the capabilities delivered by this market and to temper the unrealistic perceptions of what can be delivered by this market through conscious efforts in researching the elements that foster decision support development and educating our students to become effective contributors and users of such systems. [Received: January 2008. Accepted: February 2008.]

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