Propositions To Guide Evidence-Based Decision-Making

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ABSTRACT

The methods by which managers make decisions in the face of inaccurate data, changing environments and other pervasive uncertainties, have been studied by researchers and business practitioners for many decades. Much attention is given to highly quantitative decision-theoretic techniques; such methods generally deal with these inherent impediments to rational decisions using mathematical concepts from the theories of probability, stochastic processes, estimation and optimization, fuzzy sets, etc. The very act of quantification itself has great implications for managers' cognitive processes, the impact upon various groups within the organization, and the final outcomes. Indeed, use of formal methods and actual reliance on hard numbers improves decision quality and speed by providing efficient cognitive simplifications and convergent expectations. This paper synthesizes findings from several relevant streams of literature and proposes several simple propositions for further discussion and future research. It applies these ideas to two illustrative examples of major complex business decisions.

Keywords: Management Decisions, quantitative metrics, attribution theory, prospect theory, decision psychology

INTRODUCTION

As advanced economies have largely moved from material production to data driven operations, today's managers have grown increasingly dependent upon formal analyses to compute quantitative metrics from which many management decisions can be made. Their training starts early. Courses in management science, quantitative methods, operations research, operations management and statistics provide sophisticated theories and techniques for analyzing business problems and deriving solutions, which are supportable by "the numbers," that is, by actual data, structured into relevant information. Management students learn a myriad of principles and quantitative procedures to manage the complete value chain represented by the organization and its parent industry, including; probabilistic modeling, decision analysis models, analysis of risk, optimal decision making, optimal estimation and control, and the like.

At the same time, managers utilize multiple techniques in making complex decisions, often integrating formal methodologies into a mix of informal, often intuitive, political, or even emotional processes. Indeed, some managers do distort this amorphous mix of decision variables and manipulate the data to the detriment of organization and its stockholders and to the benefit of the few. The overall process may even be subject to the most blatant fraud. Recent experiences at Enron, WorldCom, Tyco, and LTV Steel, among others, have heightened attention to this question. This has caused many to question the true importance of both formal, quantitative procedures and the resulting numerical outputs.

This paper takes the view that analysis and data really do matter – in many, often subtle, ways. Indeed, the very act of quantification itself has important implications for management decision. "The numbers" thus can refer to both the methods and process of formal analysis, as well as the resultant data outputs that flow later (both temporally and logically later). While there may be self-serving or irrational elements in the overall process, the very nature of modern society, the functioning of organizations, the nature of management work, and several psychological processes insure an important role for formal methods and real data in decisions. Using exact numbers

in discussion clearly reduces ambiguity and apparent uncertainty, but it also enhances various mechanisms of cognitive simplification. It is this latter facet that miscreants exploit. The discussion will first amplify this view and then illustrate key points through detailed analysis of two major decisions of the LTV Corporation of Dallas, Texas: a competitive bid on an Army defense system and the merger with Republic Steel.

MANAGEMENT DECISIONS

Managers seek and use data first to *make* or *ratify* decisions, then to “sell” or *defend* them. They often rely on the release of data to *signal* a decision, or a feint or bluff. Once implementation activities have provided some knowledge of results (KR), or feedback, they may then seek further information, amend the original decision, or change activities: a new round of decision-making has started.

Herbert Simon (1945), the popularizer of automation, emphasized quantitative methods as part of managers' efforts to be “intendedly rational;” yet at most they achieve a “bounded rationality.” Irrespective of the abuses cited above, management scientists continue to develop new theories and procedures for quantitative analysis, along with systems for integrating them with less formal methods. The literature is replete with research, case studies, best practices, general principles, and broad treatises on the managerial decision-making process. This literature suggests that the decision making process may best be described as an amorphous blend of decision-theoretic and intuitive processes.

Again, the premise of this paper is that “the numbers” really do matter! Briefly, the argument runs as follows. Accepted paradigms (Kuhn, 1980) and received theory inform decision processes throughout an organization. Indeed these have become institutionalized not only into internal programmed activities, but also into the very social milieu in which the organization functions. Most of these paradigms emerge from a positivist research tradition with emphasis on description, measurement and quantification. Consider finance, marketing, operations etc. All of these functional areas rely on disciplines with well accepted paradigms that suggest (even prescribe) the sets of concepts, variables, and methods proper for use in analyses. First, at a macro level, they influence each of the classic five stages of strategic management. Next, paradigms suggest what levels of a variable(s) are to be expected or are desirable as well as how to observe or measure the actual levels. This enables formal identification of problem gaps. Third, problem recognition sets in motion the chain of decision activities. Organization culture, politics, and individual differences form the ambiance around these activities. Lastly, at the individual level, psychological aspects of decision-making combine to reinforce the importance of the numbers. Performance feedback – of the organization or the individual - becomes a central issue. Managerial attributions tend toward promoting cognitive simplification through several routes, including mechanisms well described by prospect theory and expectancy theory. The discussion now expands this thread, addressing each of the above aspects in turn.

Paradigms

How do managers and staff, regardless of personal characteristics, know which specific variables to consider, observe and measure? Which constants to assign, which parameters to estimate? Largely they rely on the established theories and practices of their functional areas. Once learned and accepted, these “paradigms” work within the organizational context to give organization members mental schema to guide thought and action. Practitioners can refer to representative works as the “exemplars” of the underlying paradigm (Kuhn, 1980). Thus paradigm and theory inform the search, giving meaning to the gathered data in terms of time, setting and people; they allow the data to constitute true information.

Formal methods and real data drive activity at all levels; this is especially evident for programmed operational decisions. However, it is through *strategic* activities that the organization orients itself toward the environment around it. Figure 1 presents the familiar, textbook Five Stages model of strategic management (Thompson, et. al., 2008), along with the bodies of paradigmatic knowledge that dominate each stage. Also, law may become influential at any stage. The stages are sequential, allowing feed back; each stage can be considered to represent a particular category of decisions. The impact of personal characteristics: managerial personality, values, specific abilities and insights, and even social outlook are most prominent in the early stages of forming the mission

and the objectives to meet that mission (Andrews, 1971). Decisions at each stage become less ambiguous and usually more programmed and more dependent upon specific indices or organizational rules. Paradigms, by suggesting relevant variables and methodologies, treat problems as solvable "puzzles", with definite solutions (Kuhn, 1980).

Proposition 1.

At the organizational level, paradigms of quantitative disciplines inform each set of strategic decisions.

In management deliberation, it is the plausibility and *credibility* of "the numbers" that is central. To be credible, the numbers should emerge from an accepted paradigm. That is, the variables used should be encouraged within the paradigm, and the substantive inferences should make sense within the paradigm. Hence, when a manager or staff member uses numbers in an assertion, he is signaling or failing to signal credibility through the very choice or variable he uses. Numbers can actually take on a significance that is somewhat independent of their specific values, or their accuracy.

Figure 1. Paradigms inform the five tasks of strategic management.

Problems And Decisions

Figure 2. Managers' values impact the acceptance of both the desired state and the tolerance limit.

Problems may be considered as "gaps" between a desired state of affairs (a goal) and an actual state of affairs (Kepner and Tregoe, 1965). Figure 2 depicts the problem gap. Theory and paradigm provide an idea of desirable levels of referent variables. Experience and organizational context suggest what deviations from these ideal levels are within some tolerance limit. These determine which problems managers recognize and accept (Milutinovich & Mankelwicz, 1983). Similarly, there is a limit to just how closely the actual current state of the variable can be known - the knowledge limit.

Organizations gather much numerical data routinely. The pace and volume of collection intensifies during periods of serious decision. Typically, the decision making process is "triggered" when a manager or trusted staffer perceives some problem or opportunity (Segev, 1977). Indeed most serious analysis occurs as "problemistic search" (Simon, 1945) in response to a specific emergent problem. Figure 3 presents the familiar chain of decision activities, adapted from (Gibson, et. al., 1976).

Figure 3 Chain of Decision Activities

Essentially numbers are symbols, and symbols may be powerful. At their best, numbers may accurately represent an actual state of affairs or provide the best projection of one. As outputs from quantitative models, numbers also represent theoretical equilibria, optima, or desired states. The precision in magnitude, location, and time description of variables is the key to problem formulation (Kepner & Tregoe, 1965), the foundation of effective managerial decision-making. As symbols, numbers may even cause dread to managers who fear being "pinned down," made prematurely responsible for a course of action because of the numbers they provide.

Along with diligence and loyalty, a subordinate's past accuracies in relevant analyses form the basis of senior managers' trust in their key subordinates; yet these executives judge their subordinates largely from their own personal frames of reference, influenced in turn by paradigm and experience. Subordinate experts along with the managers themselves practice "uncertainty absorption" (March & Simon, 1958) for the organization. While any subordinate's main task may be to secure the "attention" of superiors (Simon, 1945; Allison, 1971), it is the subordinate's vocal and persistent defense of "the numbers" in his area of expertise which convey confidence, desire, and commitment. These latter factors draw the support of project "champions" and ultimately determine project funding and major decisions (Bower, 1965).

Ideally, managers would begin intensive search for information early, even while the problem is still only partially defined - when the data indicate only a "weak signal," in which only the source and general nature of event(s) are known (Ansoff, 1975). They would then systematically develop the picture until the impacts, courses of response, and final outcomes are known. This requires a diligent mindfulness; decision makers typically attribute greater credibility and importance to numerical data obtained very recently (Boyd, et. al., 1993) or very early in the formal decision activities (Kozielecki, 1972). However, this might truncate information search or distort decision processes. Thus,

Proposition 2.

Paradigms inform problem definition, by prescribing acceptable variables, their desired levels, and methodologies.

Proposition 3.

Subordinates “trigger” the decision making process more successfully, to the extent that they communicate:

- a.) in numbers, using variables from superior’s functional areas,*
- b.) early rather than late, even if data are scarce, and*
- c.) using current data.*

Decisions And Feedback

Philosophers tell us that human experience is continuous, and therefore it is not directly communicated in words. Metaphors allow humans to segment out portions of this experience so that it can be cognitively manipulated and communicated (Langer, 1942). Finding the right metaphor for the situation at hand can be a critical skill for managers or experts to practice their "uncertainty absorption" (March and Simon, 1958). On this note, some assert that the real constituents of human thought are not numbers or quantities at all, but the "labels of fuzzy sets" (Zadeh, 1965).

To Zadeh, these labels distinguish human intelligence from that of the machines. The application of labels and metaphors involve human cognitive (and sometimes physical) activities; in this sense people “socially construct” the environment about them (Berger & Luckmann, 1967). Combining perceived and constructed views of reality, Weick (1969) suggests that individuals “enact” their environments by acting, perceiving and reacting to the results, and then adjusting. In this sense, metaphors, labels, and assigned numbers are all enacted elements. It is when people interact in communication that shared meanings, environments, and reality emerge (Weick, 1969; Smircich & Stubbart, 1985; Prahalad & Bettis, 1986); in this view organization is closely entwined, almost synonymous with organization.

Organizations quickly find that mental pictures, soft fuzz, and even good verbal descriptions don't satisfy creditors, auditors or stockholders, since these things do not enable communicable performance measurement. Virtually every stakeholder group faced by the organization has its preferred (and sometimes unique) metric of organizational performance, which its members have enacted over time. At some point the organization must respond: giving dividends, raises, bonuses, or disciplinary measures. The methods and metrics of determining those responses are subject to increasing scrutiny in a litigious world. More than ever it is top management's duty to identify all stakeholders and prioritize them according to salience (Mitchell, et. al., 1997). All must be satisfied at least minimally. Truly salient stakeholders require much more. The discussion thus leads to the proposition:

Proposition 4.

Reliance on actual numbers is not limited to a hard Positivist world view. It is indeed a prime modality by which actors “enact” their environment.

Numerical data are collected largely to measure and compare performances: of individuals, groups, or the organization as a whole. Performance feedback thus becomes a cardinal issue for discussion. In Weick's (1969) terms, managers first act, and then perceive and interpret the results of their own activity and others' responses (feedback), and then adjust their actions and perceptions. These steps of “enactment” are guided by paradigm, accepted theory, and their own experience which provides the desiderata from prior enactments. Attribution theory (Heider, 1944), Expectancy theory (Vroom, 1964), and Prospect theory (Kahnemann & Tversky, 1979) suggest important points about how managers utilize the numbers.

Both managers and their external stakeholders accept the financial and accounting metrics above as clear performance feedback for the company. Within the organization - at the level of groups, individuals, and resource pools - the situation becomes more complex. Then analysis must also consider both political and psychological factors, and there is often less reliance on “objective” methods of measurement (Castrogiovanni, 1991) or the paradigms underlying those methods. The accurate measurement of individual or group performances is not so simple. Feedback, or “knowledge of results,” is a cardinal concept for this discussion. Ilgen, et. al. (1979) provides the classic, voluminous literature synthesis and model for individual level performance feedback, adapted here as Figure 4.

Figure 4. Effects of feedback on the recipient (Ilgen, et. al., 1979).

Individuals must perceive, accept, and determine to act on feedback regarding their job performance. They do these cognitive acts more readily when the feedback is clear, precise, and timely. However, each cognitive act is also influenced by the individual's frame of reference, based largely on their experience. As a consequence, much valuable feedback goes unperceived and unaccepted because some individual cannot separate the source of the feedback from its message content. Human sources of feedback (usually supervisors), by virtue of humanity, also have a personal frame of reference. Feedback to them is also filtered; this feedback may come not only from higher management, but from subordinates as well.

Yet what do employees and managers actually consider feedback to be? Herold & Greller (1977), using a large sample of employees from many job categories, performed the classic construct validation for job performance feedback. While employees recognize several discrete dimensions of feedback, it is negative feedbacks - first from objective standards (numbers evaluating performance) and then social (from supervisors and coworkers) - that are most highly weighted by individuals in guiding their actions toward approaching performance goals. Disaffected or alienated employees have greater difficulties in the source-message discrimination; hence, they get little benefit from the negative feedback provided. The discussion thus far suggests:

Proposition 5.

Feedback to employees is more effective when it includes clear numbers of variables within her/his frame of reference.

Those at every hierarchical level provide as well as receive feedback (Ilgen, et. al., 1993), and make attributions about those both above and below them. Hence the issue of performance feedback must be understood within the broad issues of enactment, communication and attribution. Based on the seminal work of Heider (1944), attribution theory suggests much of relevance to this discussion. Individuals reason backwards from the knowledge of results of past episodes, through actions and processes, to make attributions of the ability, motivation and character of others. Behaviors that are unexpected and chosen freely are considered especially revealing of these things (Jones & Davis, 1965). These attributions impact the level of Instrumentality (Vroom, 1964; House, 1971), or the perceived probability that their performance will be rewarded, as well as the Valence, or perceived value of the

rewards offered. Faced with feedback concerning their own performance, employees and managers may raise (or lower) self-attributed ability, with concomitant effect on the motivational Expectancy (Vroom, 1964) that their efforts will lead to performance.

However, there may not be repeated episodes; indeed, critical events may occur unexpectedly, in unique situations, and without "the numbers" available from organizational programs in more ordinary episodes. At these times the perceiver must fall back to make attributions based on the causal schemata from their own frame of reference, which most commonly leads to a "fundamental attribution error" (Kelley, 1967), in which the perceiver will attribute poor performance by others to poor motives, motivation, or lack of ability. They continue to attribute their own poor performances to situational factors and to bad luck.

The most significant decisions, and those with the greatest long run consequences, are those made by the top management, especially the CEO and those closest to her/him. Stockholders, the financial press, and the board - that can directly ratify the CEO's rewards or administer her/his dismissal - define the performance of the CEO by the performance of the organization. Again, at this level performances are largely defined by formal, quantitative, and especially financial criteria. Given the magnitude of the loss possible from poor strategic decisions, it becomes important to know what stimuli, events, or data CEO's actually do recognize as feedback. Mankelwicz, et. al. (1987) repeated the Herold and Greller (1977) study with a sample of 53 US financial services CEO's to validate the feedback construct at the uppermost level. Results indicated a greater number of significant dimensions of feedback than for employees in general. There was, however, a more startling difference: positive feedback - again first from objective *numbers*, and then from social sources - accounted for most explained variance. By personality, the more masculine CEO's especially tended to downplay negative feedback, whether objective or social. The CEO's were thus truly attentive to the numerically based measures used by outside stakeholders, while remaining oriented more toward opportunity grasping rather than problem seeking and solving. Hence,

Proposition 6.

At any organizational level, personal factors may override the guidance of "the numbers."

Even CEO's may ignore or rationalize away negative feedback. They may even escalate commitment to failing projects when it was clearly possible to frame initial setbacks as unpredictable (Staw & Ross, 1978). Prospect theory (Kahneman & Tversky, 1979) holds a further explanation: individuals and groups initially "frame" a situation in terms of gains and losses, with a definite zero or neutral point. When confronted with apparent "loss" situations, people engage in risky behaviors to avoid these losses. That is, they seek to avoid the eminent loss at the risk of a possibly greater loss later. Risk aversion may at times be a mixed blessing. It is interesting to combine these finding with those of the CEO cited above. Thus,

Proposition 7.

Even risk averse and sophisticated people may ignore the guidance of "the numbers."

Together, these findings from general and managerial psychology provide at least a partial explanation for recent corporate boondoggles. The need for extraordinary executive diligence, wisdom and courage will never vanish. Yet these same findings also underscore the utility of formal methodologies and their outputs for responsible managers in preventing and alleviating such tragedies.

Numbers, Ethics, Organization Failures

Ethical problems are similar to practical ones, as individuals become aware of a moral gap between actual behaviors and those presumed under an accepted code. They then pass through stages of moral judgment, intentions to act, and finally actions (Rest, 1986). The greater the "moral intensity" (Jones, 1991) of an issue or problem, the more likely this process will continue through the steps, resulting in actual moral behaviors. The moral intensity concept encompasses six measurable dimensions: magnitude of effect, probability of effect, concentration of effect

on a specific group(s), social consensus on the issues, immediacy in time, and proximity in space. However, it is obvious that the quantification of ethical matters is still relatively new and naïve.

Empirically, the magnitude of effect and a general social consensus greatly facilitate initial moral awareness in competitive environments when the discussion contains explicit moral language (Butterfield, et. al., 2000). Indeed, many aspects of organizational context may act to facilitate or impede intention ever becoming behaviors (Jones, 1991), good or bad. Individuals' differences also interact with the characteristics of the issue, as defined by moral intensity (Trevino, et. al. 2006); in particular, "Utilitarians" become aware of fewer moral issues than "Formalists" (Reynolds, 2006).

At the organizational and societal levels, very familiar, long enacted numerical, monetized metrics predominate. Stock price, reported profit, ROA, risk adjusted measures, quick ratio, market share and other indices are the bases for many decisions. Ironically, corporate miscreants must initially appeal to the very respect accorded these measures to perform a successful distortion of fact. The distortion itself is possible usually through *over aggregation* of data or the unrecognized *lack of real correspondence* between the actual aspect of the situation (concept or construct) and the accepted measure (Boyd, et. al., 1993). However, it is finally the very quality of the procedures and measures that insures such fraudulent success is temporary.

There is a further ironic twist to this discussion. Recall that accounting, the economics underlying it, and the Utilitarian philosophic roots of economics all stress "the numbers," and certainly when contrasted with other frameworks of thought. Top managers run large and diversified organizations, at least officially, largely on the basis of reported numbers; this is for the ostensible purpose of maximizing their own and stockholders utility. Everyone seems to attach moral significance to unjustified and clear-cut instances of physical or financial harm. Yet Reynold's (2006) utilitarians, presumably more quantitatively oriented, seem to have less moral awareness, especially in issues that violated social norms. It may be that, at least in the short run, a person's reliance on numbers oriented paradigms may actually hamper the ethical sphere of decision. For instance, partners in CPA firms generally showed lower moral reasoning than lower level employees (Ponemon, 1992); accountants and accounting students similarly scored lower than comparison groups from other fields (Lampe & Finn, 1992). The discussion thus suggests:

Proposition 8.

Close attention to "the numbers" still cannot prevent all frauds, thefts, ethical mishaps, or blunders.

Proposition 9.

Use of quantitative methodologies and close attention to "the numbers" allow more rapid detection of frauds, thefts, and ethical mishaps.

Why then are there so many scandals, boondoggles and oversights? The fault is not with "the numbers," nor even with the process of quantification itself. Part of it is looking at the wrong numbers, or an incomplete set. Monetization allows numerical comparisons across an organization, industry, or economy. Yet conversion to monetary units distorts some quantities, while other variables are notoriously difficult to quantify (e.g., the value of your life). Further distortion is produced by the very nature of modern organization (Mintzberg, 1983), with its hierarchically upward flow of reported numbers (aggregated at each level) and downward flow of instructions and authorizations. Aggregation makes it easy to hide errors or misdeeds; even more fundamental, it renders the information less specific and less timely. Hence, top managers often respond on the basis poor quality information. If the findings of Reynolds (2006), Trevino, et. al. (2006) and others can be generalized, then those at the top are both hampered in detecting practical problems and personally less aware of ethical ones. Even with rather good intentions, managers may begin problemistic search rather late.

The next section will apply arguments above in analysis of two short cases, concerning specific decisions faced by the LTV Corporation. These situations illustrate the both difficulty the advantages of relying on quantitative analysis, as well as possible consequences when it is neglected.

THE ARDEC SOLICITATION – A BID/NO-BID DECISION

In the late 1980's the US Army issued a Request for Proposal for a new state-of-the-art weapon system to replace a highly successful, but outdated system. The program was to be managed by the Army Research Development and Engineering Center (ARDEC), within their advanced development laboratories located at the Picatinny Arsenal in New Jersey. The new system would support troops in the field using an autonomous "fire and forget" strategy. The winning system should incorporate new technologies capable of stretched the envelopes for system manufacturability, reliability, maintainability, and supportability. The Army also desired large improvements in lethality, precision, autonomy and targeting. Finally, the system should be affordable, as defined by specific cost exchange ratios stated in the RFP.

The Army anticipated responses from many domestic and foreign contractor teams that had hardware, software and manufacturing technologies already well into development phases. The Army's aggressive implementation and fielding plans called for rapid transition to full scale engineering development (FSED) and then to production.

LTV was organized in a Matrix fashion, merging both project and functional elements. The project area included major programs and advanced programs. The functional area consisted of all relevant elements, including engineering, manufacturing, all the various "ilities" (reliability, maintainability, etc.), software, quality, finance, and marketing. The procedure for obtaining a "bid" or "no bid" decision on any program involved the joint decision of a body of executives (The Pricing Board) consisting of 8 vice presidents representing various elements and interests of the company and led by a senior vice president as illustrated in Figure 1.

Figure 2 illustrates the various elements and analyses, which were assimilated to support the request for a bid decision.

Figures 3 and 4 illustrate the types of analyses conducted. The support rationale included all relevant engineering technical analyses, financial analyses, quantitative and qualitative management analyses, and a marketing analysis (typically qualitative), which collectively explained how an investment in the ARDEC program was beneficial to the company both in terms of the short term project and also in terms of long term business and follow-on derivative business.

Figure 4 Typical Financial Analyses

- . Accounting Ratios
- . Investment
- . Return on Investment
- . “Spending Curve”

- . Phase by Phase Analyses
 - Research/Development
 - FSED
 - Production
 - Follow-on Products

- . Synergy with Company Products
- . Re-engineering
- . Product Evolution

Although all the members of the Pricing Board generally concurred with the results of the analyses, somewhat surprisingly, the lead executive requested a *quantitative analysis* of the competition before a final decision would be rendered. In response to the Pricing Board’s request, the program team mimicked the process to be used by the government’s Source Selection Evaluation Board in awarding the contract. Using the detailed program breakdown and scoring criteria derived from the RFP, the likely approach from each competing team was assigned a score for each element of the RFP requirements. Subjective weights were assigned to each team to include intangible elements like; experience with ARDEC and the ability to invest in pre-proposal and complementary efforts. The process is illustrated in Figure 5.

Figure 5 Computations for Each Team

Issues	Value to Win (Derived from RFP)	Team Weights	Score
Technology (Performance)			
Quality			
Reliability			
Maintainability			
Producibility			
Software			
SW Quality			
Cost			
....			
INTANGIBLES:			
“Gun Club”			
ARDEC Experience			
Ability to Invest			
... ..			
			Weighted Score

. Mimicked Source Selection Evaluation Board

This analysis again demonstrated that the LTV team led the competition and supported the decision to bid the program. When these results were presented to the Pricing Board, most members concurred with the analysis but the lead executive responded with the desire for “at least a 2 to 1 advantage” over the competition. The program team decided on the analytical approach illustrated in Figure 6. A list of pre-proposal tasks that would enhance the company’s win probability was assembled and grouped into desirable sets with varying affordability. Using Delphi techniques the judgments of all parties relevant to the program, including all members of the Pricing Board were solicited, to determine a win-probability utility for each level of pre-proposal investment. The results showed that for a generally acceptable level of investment, the probability of win for LTV was 0.7 and, hence, the probability of win for all other competitors combined was 0.3. The third visit to the Pricing Board resulted in the coveted “Bid” decision as well as funding of the selected pre-proposal tasks. The chosen expenditures consisted of both technical and customer-development efforts. Although the bid was not the absolute lowest among the competing teams, it was nonetheless successful. The program was executed on time and within budget.

LTV STEEL: DECISION TO MERGE

In 1984 with much public fanfare and intense government scrutiny, the LTV Corporation, Dallas, Texas announced the merger of its Jones and Laughlin steel operation with Republic Steel and renamed the combined organization LTV Steel, thereby creating the nation’s second largest steel company (OhioCitizen.com, 2006). At the time of the merger both steel companies were losing hundreds of millions of dollars annually. Citing substantial economies of scale and an improving economic climate, LTV’s CEO argued that each organization would benefit from complementary products and leaner operations. The argument was that the “projected numbers” suggested the combined, streamlined companies could show a profit within five years. Two short years after the merger, the newly created steel giant declared bankruptcy. Although subsequent to this first filing LTV Steel reorganized and successfully emerged from bankruptcy in 1994, in the face of strong competitive pressures from foreign firms, the company filed for Chapter 11 bankruptcy in 2000. In 2001, while incurring losses of \$2 million each day, LTV Corporation ended its participation in the steel industry with the closing of its Cleveland Works steel plant (Rice, 2006). The bankruptcy and closings idled tens of thousands of workers, devastated many communities dependent upon the local steel operations, eliminated the health care benefits for more tens of thousands of retired workers and put in jeopardy the existing and future pension benefits of all LTV steel workers (Paulsen, 2001). These actions

marked the end of a way of life for many who had no means of maintaining their livelihood outside of the steel industry. Much of the blame for these consequences has been placed upon the price structures and anti-competitive practices of foreign companies (Hoff, 2002). This example seems at odds with the premise that sound quantitative analyses are often crucial to making successful business decisions. Equally disturbing is the reality that concurrent with these plant closures many LTV steel executives ended their lucrative relationships with the Corporation with golden parachutes, substantial severance packages, and large personal fortunes. These circumstances lead many to question the methods LTV executives used to justify the merger. Even without fraud or abuse there are instances when “gut feel” and intuition play large roles in the decision making process.

DISCUSSION

The case examples illustrate management decision making in the real business world. They demonstrate the importance (and necessity) of quantitative analyses yielding exact metrics. While each metric pertained to a specific aspect of the situation, each metric was also an important consideration of some stakeholder(s). Yet, beyond the detailed analyses of “the numbers” the ultimate decision making was made incrementally with increased dependence upon the intuition, experience and trust in those involved in the decision making process at all organizational levels.

The LTV/ARDEC case was especially illustrative of the interplay of quantitative analysis and people factors such as confidence and trust in key staff, personal frames of reference, and appropriate feedback. It is suggested here that the fundamentals of attribution theory and prospect theory may provide insights into these decision practices. Indeed in the ARDEC example it was found as the program team was informally debriefed by the Pricing Board that:

- The Pricing Board members did in fact pay close attention to all the engineering and financial information presented.
- All this data met their expectations and guidelines for justifying a research and development pursuit of this nature.
- The Board was in general agreement with “the numbers”, i.e. the detailed technical and financial analyses.
- The Board felt that, despite the fact that ARDEC was a very new customer to LTV; the program team had developed credibility and rapport with its technical staff and key decision makers.
- The program team displayed sufficient expertise and confidence to successfully execute the program from all perspectives, technical and financial.
- The lead Board member had requested those rather unusual exercises to ensure that the program team had considered all critical factors and all relevant perspectives in developing its approach to winning and executing the program, and positioning the company for follow-on derivative and spin-off business, as well as to test the commitment and creativity of the program team..

This case and the literature suggest that:

- Sound quantitative and qualitative analyses are often the basis for rational decisions
- Such analyses are commonplace and well-accepted
- Top level decision are made on a multi-faceted basis
 - Firm fundamentals
 - Individual “comfort zone”
- In any decision you must know your (external) customer
- Likewise in any decision you must know your (internal) customer
- Decision analyses are often “tuned” to the customers’ comfort zone
- Other factors, such as business acumen, managerial intuition, and trust, may be important
- These issues are consistent with classical paradigms, concepts and theories

The LTV steel example on the other hand seems a bit contradictory to these principles. If LTV executive management had carefully scrutinized “the numbers” in a manner analogous to the ARDEC example, how could the

decision to merge with Republic Steel have gone so terrible wrong so quickly? Many of the substantive issues pertinent to the merger, such as the downturn of the American steel industry and the dumping of heavily-subsidized steel on US markets by foreign competitors, were well known prior to the decision to merge of the two floundering companies. It is suggested that the decision in this case might in part be explained by attribution theory and by examining the decision makers' personal frames of reference. Many managers, driven by the direct link between the perception of their performance and the performance of the organization may more likely to rationalize away negative feedback and avoid perceptions of eminent loss at the risk of more severe penalties in the future.

FUTURE RESEARCH

Just as there is a need for developing meaningful, quantitative performance metrics and appropriate analysis methodologies, there is also a need for further research into the interplay among quantitative analyses, qualitative assessments, intuition and the issues of confidence, trust and rational behavior. It is desirable to identify appropriate databases and to conduct statistical studies which test hypotheses concerning the degree to which modern organizations base key management decisions on metrics which are actually supported by specific quantitative analyses, as well as the degree to which executives simultaneously rely on overall business acumen and confidence in the management team. Future research will strive to identify the most common key metrics of management decisions, some generalized parameters to describe these metrics, the antecedent conditions promoting their use, and the derivation of a generalized model which may serve as a descriptor or even predictor in certain circumstances.

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