Forecasting and Leader Performance:
Objective Cognition in a Socio-organizational Context

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Abstract

Traditionally, it has been assumed leaders, like other people, are typically poor at forecasting. In the present effort, we argue that people can sometimes prove effective at forecasting and that effective forecasting is particularly important to performance in leadership roles. Subsequently, evidence bearing on how four key variables, mental models, objectivity, time frame, and case content, influence the effectiveness of leader forecasting are examined along with interventions that might contribute to effective forecasting on the part of leaders. The implications of these observations for understanding leader cognition are discussed.

Keywords: leadership, forecasting, mental models, objectivity, proactive orientation, case-based knowledge

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Those who occupy leadership roles in organizations, both for profit and non-profit organizations, are expected to solve, or resolve, many problems (Mumford, Zaccaro, Harding, Jacobs, & Fleishman, 2000) — problems ranging from resolution of strategic crises (Drazin, Glynn, & Kazanjian, 1999) to providing followers with appropriate, effective, feedback (Gaddis, Connelly, & Mumford, 2004). Given the complex nature of the problems leaders must address, a number of cognitive skills have been held to contribute to leader performance—skills such as planning (Marta, Leritz, & Mumford, 2005), intelligence (Hedlund, Forsythe, Horvath, Williams, Snook, & Sternberg, 2003), creativity (Mumford, Connelly, & Gaddis, 2003), critical thinking (Marcy & Mumford, 2010), and wisdom (McKenna, Rooney, & Boal, 2009).

We do not wish to dispute the importance of these, and other, complex cognitive skills as potentially noteworthy influences on leader performance. Indeed, the complex, dynamic, ill-defined, or poorly structured, nature of the problems presented to leaders may well call for a number of distinct cognitive skills. By the same token, in discussions of leader cognition, we often lose sight of one skill of potentially great significance—forecasting (Shipman, Byrne, & Mumford, 2010). Our tendency to discount forecasting is, of course, based on the assumption that most people are poor at forecasting (Pant & Starbuck, 1990). Limited capacity for forecasting, however, says nothing about the relative value in individual differences in forecasting skills.

In the present effort, we will argue that forecasting skills are critical to performance in leadership roles. Subsequently, we will present a model of the critical variables that influence leaders' ability to forecast effectively in complex, dynamic, social situations. Finally, we will

examine some of the practical implications for improving leader performance suggested by our observations concerning the variables influencing leaders' skill in forecasting.

Forecasting

Attributes of Forecasting

Of course, our foregoing statement of intent broaches a rather basic question. What, exactly, is meant by the term forecasting? Forecasting, ultimately, involves prediction—prediction of the effects of actions, or events, on future outcomes for individuals, groups, firms, or social institutions (Mumford, Schultz, & Osburn, 2002; Mumford, Schultz, & Van Doorn 2001). The apparently straightforward definition of forecasting, however, has a number of rather subtle implications with respect to the skill we refer to as forecasting.

To begin, forecasting, as a form of cognition, is not tied to one specific outcome or goal. People may forecast with respect to a single goal, or outcome, when this goal or outcome is salient (Locke & Latham, 1996). However, forecasts may be made with respect to a variety of goals, outcomes, or actions of relevant actors. Thus, forecasting is not tightly bounded but, instead, may consider a range of actions, actors, and outcomes. Along related lines, forecasting is not bound to outcomes, actions, or actors operating at one specific level. Thus, people may forecast actions, actors, and outcomes at the individual, group, firm, or institutional levels. Indeed, forecasts may, at least at times, consider actions, actors, and outcomes operating at multiple levels of analysis (Thomas, Clark, & Gioia, 1993).

Not only does forecasting entail predictions about multiple outcomes, actions, and actors, it is inherently dynamic. In other words, forecasts refer to future events where the events forecasted unfold over time (Dörner & Schaub, 1994). This point is noteworthy because it implies forecasting occurs in a temporal context. Moreover, because the future is inherently

uncertain, forecasts also evidence some degree of uncertainty with uncertainty increasing as the time frame over which forecasts are being made increases (Jaques, 1976). One noteworthy implication of this observation, moreover, is that forecasting is not an “abstract” purely analytic skill. Instead, it requires active monitoring of the environment and environmental change (Xiao, Milgram, & Doyle, 1997) with forecasts being updated as a function of environmental change.

These observations imply that forecasting is a form of situated cognition (Mumford, Friedrich, Caughron, & Antes, 2009). Thus, forecasts are not made with respect to abstract idealized future outcomes or events. Rather, forecasts are made with respect to outcomes more, or less, likely to occur in a particular situation or a situation as it unfolds over time. One implication of this observation is that forecasts involve imagining unfolding actions, events, and outcomes. In other words, forecasting involves the *mental simulation* of the effects of a situation and actions in this situation on relevant outcomes (Mumford, Schultz, & Van Doorn, 2001)—potentially multiple outcomes applying at different levels of analysis. Another implication of this observation is that forecasting will require both ongoing scanning of the environment (Souitaris, 2001) and monitoring of key outcomes (Xiao, Milgram, & Doyle, 1997).

Thus, forecasting is an active, conscious, cognitive activity requiring the investment of resources, potentially substantial resources, over long periods of time. This observation, in turn, broaches a question, why invest substantial resources in forecasting? Ultimately, the answer to this question is pragmatic. Forecasting allows people to project the likely effects of actions. Systematic evaluation of projected actions, in turn, allows people to select those actions most likely to bring about sought after outcomes (Lonergan, Scott, & Mumford, 2004). Thus, forecasting allows for adaptive action within a given context.

Forecasting as a Skill

Our foregoing observations imply that forecasting reflects the identification and prediction of multiple potential outcomes of action in a situation where predictions of the effects of action are based on mental simulation—simulations which provide guidelines for real-time actions (Mumford, Schultz, & Van Doorn, 2001). This observation, however, broaches another question. Can people forecast? In fact, forecasting has been discounted as a viable, potentially useful cognitive skill, in part, because much of the available evidence indicates that when people are asked to forecast, these forecasts are often inaccurate (Buehler, Messervey, & Griffin, 2005; Josephs & Hahn, 1995; Pant & Starbuck, 1990). In other words, people typically produce overly optimistic forecasts which are inaccurate with respect to projected “point” outcomes—actually obtained outcomes. By the same token, however, these findings do not speak to the accuracy of range of forecasts or differences among people in their skill in forecasting.

In fact, a series of studies by Guilford and his colleagues (Berger, Guilford & Christensen, 1957; Kettner, Guilford, & Christensen, 1959; Merrifield, Guilford, Christensen, & Frick, 1962; Wilson, Guilford, Christensen, & Lewis, 1954) have provided some evidence for the existence of meaningful individual differences in forecasting skill. In these studies, a battery of divergent thinking measures (e.g. list the consequences of unlikely change events, list alternative uses of object, provide alternative headlines) were administered and scores on these measures were factored. In addition to traditional divergent and convergent thinking factors, a forecasting factor involving prediction of future outcomes consistently emerged (Mumford, 2001).

Not only is evidence available for the existence of a distinct forecasting skill, but it appears people are not always ineffective in forecasting. In one study along these lines, Dailey and Mumford (2006) asked undergraduates to assume the role of a member of a proposal review committee for a non-profit foundation. Participants were asked to read through three proposals

drawn from either the educational or public policy domains. These proposals were drawn from real-world cases where historic case data allowed actual resource requirements and actual outcomes to be established. Participants were asked, as members of this review panel, to forecast ten outcomes of funding the proposal (e.g. likely acceptance, time to adoption, how many positive outcomes) and ten resource requirements (e.g. how difficult to implement the idea, how many different groups will be involved in idea implementation, how much financial support will be needed). Divergence of forecasted outcomes are resource requirements from actual outcomes and resource requirements were assessed. It was found, although some over optimism was observed, especially with respect to time and money, forecasts were typically within a quarter of a standard deviation of actual case events. Thus peoples' forecasts are not completely inaccurate.

Dailey and Mumford (2006), moreover, manipulated four variables that might influence the accuracy of these forecasts. More specifically, manipulations were made to influence implementation intentions, self-efficacy, evaluation criteria (e.g. funding high quality or funding original ideas) and expertise (e.g. familiarity with the problem domain, educational (high), public policy (low)). It was found that when expertise or familiarity with the problem domain was high, and participants had formulated implementation intentions, the accuracy of forecasts improved – and improved substantially. Thus, experts who intend to act on their forecasts produce reasonably accurate forecasts. Other work by Armor and Taylor (2003), Koole and van't Spijker (2000), and Langholtz, Gettys, and Foote (1995) has produced similar effects. Thus, the forecasts of engaged experts may evidence substantial accuracy.

Not only can forecasts, at least at times, prove reasonably accurate, they also appear to contribute to performance on solving complex problems. In one study along these lines, Byrne, Shipman, and Mumford (2010) asked undergraduates to develop marketing plans for a new high-

energy root beer with the resulting marketing plans being evaluated for quality, originality, and elegance. As they formulated these plans, participants were presented with emails where they were asked to forecast the implications of their ideas, and, after selecting their best idea, to forecast the implications of plans for executing this idea. These written forecasts were appraised with respect to 27 attributes, for example, forecasting negative outcomes, positive outcomes, obstacles that might be encountered, and changes in restrictions. These appraisals of forecast attributes were factored with three factors: forecasting extensiveness, forecasting negative outcomes, and forecasting constraints emerging. More centrally, these factors were found to yield correlations in the .40s with the quality, originality, and elegance of solutions to this marketing problem.

Other studies by Osburn and Mumford (2006), examining performance in planning a secondary school educational curriculum, and Marta, Leritz, and Mumford (2005), examining performance of a managerial consulting task, have also indicated that the quality and extensiveness of peoples' forecasting is strongly related to their problem-solving performance. Thus prediction resulting from forecasting skill is not task specific. Moreover, forecasting skill added to the production obtained from more than traditional differential constraints such as intelligence and divergent thinking. Thus, forecasting skill appears to represent a distinct skill of tangible predictive value when performance on complex problem-solving tasks is examined.

A question likely to arise at this juncture is why forecasting skill is so strongly related to performance in solving complex problems. One reason for the strength of these relationships is that forecasting provides a basis for appraising and refining potential problem solutions (Lonergan, Scott, & Mumford, 2004). Still another reason may be found in peoples' progressive refinement of the mental models and understanding of problems based on their appraisals of

forecasted outcomes (Rouse & Morris, 1986). Yet another reason may be found in the effects of forecasting on the formulation of plans for problem solving (Osburn & Mumford, 2006). A final reason may be found in the effects of forecasting on solution elaboration and opportunistic exploitation of emergent opportunities (Patalano & Seifert, 1997; Xiao, Milgram, & Doyle, 1997).

Forecasting and Leadership

Clearly, through multiple mechanisms, forecasting can have strong, positive, effects on peoples' problem-solving performance. This observation, and the tasks used in many of these studies, of course, suggests that forecasting might also exert strong effects on leader cognition. Indeed both the nature of leadership roles and the demands associated with the problems posed to those occupying these roles suggest that forecasting may, in fact, prove important to both leader cognition and leader performance (Mumford, Friedrich, Caughron, & Byrne, 2007).

We will begin by considering the problems presented to occupants of leadership roles. Jaques (1976) has argued, as leadership level (e.g. supervisors, middle managers, CEOs) increases, the time frame in which problem solutions emerge increases. Although one might debate specific aspects of this argument, the lagged emergence of solutions to leadership problems implies forecasting is likely to prove to be a critical aspect of performance. Along related lines, a variety of evidence (e.g. Howell & Boies, 2004) indicates that effective leader problem solving requires management of contingencies — for example, obtaining requisite resources. What is clear here, however, is that contingencies unfold over time. Accordingly, one would, again, expect that forecasting would prove critical to leader performance.

As contingencies emerge, adaptation, and the formation and implementation of backup plans, often becomes a critical influence on performance. What should be recognized here,

however, is that formation of backup plans and adaptive responses to emergent contingencies has been found to depend on forecasting (Anzai, 1984; Mumford, Schultz, & Van Doorn, 2001; Xiao, Milgram, & Doyle, 1997). Of course, adaptive responses to emergent contingencies imply crises will emerge—resolution of which has proven critical to leader emergence and performance (Hunt, Boal, & Dodge, 1999; Mumford, 2006). What should be recognized here, however, is that effective resolution of crises requires both sensemaking and sensegiving on the part of leaders (Drazin, Glynn, & Kazanjian, 1999; Mumford, 2006; Weick, 1995). Sensemaking and sensegiving require identification, and articulation, of future outcomes and contingencies on outcome attainment. Thus again, it seems plausible to expect forecasting would prove crucial to leader performance.

Of course, leadership problems are not always abstract, isolated entities. Leaders must attempt to solve problems by influencing others (Yukl, 2012). What should be recognized here, however, that people's responses to influence attempts are not guaranteed. As a result, leaders must forecast likely reactions to influence attempts. This observation, of course, points to the importance of leadership roles in shaping the need for forecasting by leaders. Indeed, the importance of leaders forecasting of others' responses to influence attempts was a key consideration underlying Zaccaro, Gilbert, Thor, and Mumford's (1992) argument that leadership requires social intelligence.

In this regard, however, it is important to bear in mind another point. Leadership roles exist in complex social systems (Katz & Kahn, 1978). In complex social systems, performance requires interactions among people — interactions occurring over time (Marks, Mathieu, & Zaccaro, 2001). Thus, leaders must be able to forecast these anticipated patterns of interactions when assessing where and how to exercise influences. Not only must leaders anticipate or

forecast the reactions of teams to the exercise of influence, Mumford, Peterson, and Robledo (2013), have argued, they must also anticipate or forecast the reactions or behaviors of other institutional units to the problems leaders are attempting to resolve as well as their capabilities for understanding, and responding, to these problems. As a result, one would, again, expect forecasting to prove critical to leader performances.

The nature of leadership roles, and the problems presented to people occupying these roles, implies that forecasting will be a critical influence on leader performance. In fact, Shipman, Byrne, and Mumford (2010) have provided some rather powerful support for this argument. In this study, participants were asked to assume the role of principal, the leader of a new experimental secondary school, and prepare a speech to be given to students' parents and teachers describing their vision for this school. In accordance with the findings obtained in earlier studies (Strange & Mumford, 2005), the resulting vision statements were appraised by judges for quality, originality, elegance, perceived utility and emotional impact.

As participants worked on this task, they were presented with a series of emails from a consulting firm, a firm hired to help them formulate their vision, which asked, or did not ask, participants to engage in various activities. More specifically, emails asked participants to 1) consider implications or facts, 2) key causes or key goals, 3) reflect or not reflect on prior educational experiences, and 4) deliberate (think) or implement (act). The final email presented prior to speech preparation asked all participants to forecast the implications of plan execution. The resulting written forecasts were appraised by judges with respect to 21 potential attributes — forecasts of outcomes, forecasts of resources, time frame of forecast, forecasts of interdependences and forecasts of likely errors among other variables. A factoring of these

ratings of forecasted attributes yielded four dimensions: 1) forecasting resources, 2) forecasting extensiveness, 3) forecasting time frame, and 4) forecasting the relevant outcomes.

When those attributes of participants' forecasts were correlated with appraisals of leader vision statements, it was found that forecasting was strongly, positively related to the desirable attributes in the resulting vision statements embedded in the speeches to be given. More specifically, the extensiveness of forecasts (r between .30 and .40) and the time frame of forecasts (r between .15 and .30) were positively related to the quality, originality, elegance, perceived utility, and emotional impact of the resulting vision statements. In addition, it was found that forecasts and the resulting vision statements improved when people thought about causes, as opposed to goals, and implications as opposed to facts. More critically, it was found that forecasting skill was a better predictor of vision strength than intelligence (Zaccaro, Mumford, Connelly, Marks, & Gilbert, 2000), divergent thinking (Mumford, Connelly, & Gaddis, 2003), and leadership style (Mumford, Antes, Caughron, & Friedrich, 2008). Thus, forecasting appears to be an especially powerful variable shaping leader performance

Forecasting Model

If it is granted that forecasting is a critical leadership skill, then a new question comes to fore. How do people forecast? Any attempt to answer this question must bear in mind two critical cognitive capacities: 1) the nature of the knowledge people use in making forecasts and 2) the ways people work with this knowledge to produce forecasts. In this section, we will examine how knowledge and processing activities give rise to forecasts.

Knowledge

Forecasts provide a basis for anticipating the effect of alternative actions within a certain environment. As a result, it seems plausible to argue that forecasts are based on experience —

experiences which reflect the effects of action in similar environments. Although multiple types of knowledge, conceptual (schematic), associational, and spatial have been identified (Hunter, Bedell-Avers, Hunsicker, Mumford & Ligon, 2008) environmentally situated knowledge is typically held to be embedded in case-based, or experiential, knowledge (Kolodner, 1997).

Case-based knowledge structures are held to be complex entities (Scott, Lonergan, & Mumford, 2005). More specifically, cases are held to include information bearing on causes, outcomes, restrictions, contingencies, actors, affect, and systems (Hammond, 1990; Mumford, Schultz, & Osborn, 2002). Typically, these cases have attached diagnostics, diagnostics marking key situational cues, which serve to activate relevant cases when encountered (Patalano & Seifert, 1997). Use of activated cases, in turn, provides a basis for guiding actions, and appraisal of the effects of actions, forecasting, when people are presented with complex action-oriented, social problems (Berger & Jordan, 1992; Hershey, Walsh, Read, & Chulef, 1990; Xiao, Milgram & Doyle, 1997).

Case-based knowledge, however, appears to be organized in a library system. More specifically, people appear to abstract case prototypes from prior experiences (Mumford, Barrett, & Hester, 2012). These case prototypes typically summarize a number of cases with respect to critical aspects of performance in the situation at hand. These case prototypes are also associated with a set of commonly encountered exceptions to the case prototype with exceptions being tagged, or linked, to key diagnostics (Hershey, Walsh, Read, & Chulef, 1990). Prototypic cases, typically, albeit not always, reflect “positive” cases with respect to attained outcomes.

Case prototypes, and case exceptions, are linked to a set of real-world, actual, cases which reflect prior experiences. These cases are indexed with respect to the key attributes of the knowledge embedded in cases. Thus, cases may be indexed with respect to goals, or outcomes,

causes, actors, affect, etc. Different indices may be applied to organize different types of cases of experience in different domains based on the criticality and salience of the attributes with respect to case outcomes. Typically, however, cases are indexed with respect to outcomes, or goals, and causes of these outcomes (Mumford, Schultz, & Osburn 2002; Mumford, Schultz, & Van Doorn 2001). Appraisal of outcomes sought and the key causes of these outcomes, in turn, allows people to manipulate cases in such a way as to produce forecasts and action plans as people consider other relevant case attributes such as contingencies, actions, and actor affect (Scott, Lonergan, & Mumford, 2005).

Case prototypes, however, are themselves organized in terms of a higher-level structure. More specifically, case prototypes appear to be accessed and organized, with respect to broader mental models (Rouse & Morris, 1986). Mental models are based on assumptions about cause-outcome linkages (Goldvarg & Johnson-Laird, 2001). Accordingly, cases are typically activated and indexed, with respect to key causes and key outcomes embedded in broader mental models.

Processes

The overarching organization of cases with respect to mental models provides a basis for formulating a model of how people work with case-based knowledge in forecasting. Figure 1 provides an illustration of these processing activities. This model assumes that people scan their environment with environmental scanning, leading to the identification of significant situational cues which activate a relevant mental model. One implication of this statement is, of course, that attentional resources will influence both mental model activation and subsequent forecasting. With activation of a mental model, however, key causes and key outcomes embedded in this model are then activated. Those key causes and key outcomes, in turn, provide a basis for activating case prototypes and exceptions to this case prototype.

INSERT FIGURE 1

In the case of leaders, however, activation of a mental model will also give rise to activation of a prescriptive mental model (Strange & Mumford, 2005). Strange and Mumford (2002; 2005) have provided evidence indicating that prescriptive mental models provide a basis for the formation of leaders' vision. More centrally, leaders' vision, their idealized image of how a social system should operate (Mumford, 2006), in turn, can be expected to influence activation of key causes and key outcomes. Thus, the key causes and key outcomes activated are held to depend on both leaders understanding of the situation at hand and the leader's vision.

With identification of key causes and key outcomes to be sought, relevant cases will be activated. Based on our foregoing observations concerning the structures of case-based knowledge, it can be expected the most strongly activated case will be the case prototype. However, major case exceptions with respect to this prototype will also be activated to some extent. Analysis of case prototypes and exceptions to this case prototype in relation to situational monitoring will, in turn, allow people to abstract critical attributes to be considered in forecasting. Although, in principle, people might work with multiple cases in abstracting key forecasting attributes, prior studies indicate that people have difficulty working with multiple cases due to their complexity (Scott, Lonergan, & Mumford, 2005). As a result, people prefer to use a few cases and work through cases sequentially in identifying key forecasting attributes. Moreover, the case attributes selected for use in forecasting will, in part, depend on perceived, critical, situational contingencies identified through ongoing monitoring of the situation at hand (Xiao, Milgram, & Doyle, 1997).

With identification of the critical attributes to be considered in forecasting, it becomes possible for people to produce forecasts. Typically, forecasting is held to occur by the person envisioning the effects of changes in a forecasting attribute, for example, a cause or a contingency, with respect to certain case outcomes. Thus, in forecasting, attributes are cognitively manipulated with respect to an available case. Typically, those manipulations of case attributes will be made with respect to the case prototype activated earlier. However, attributes drawn from case exceptions may be used in forecasting if they are more closely matched to key situational contingencies. The number and nature of the attributes considered in forecasting give rise to more, or less, extensive forecasting with forecasting performance being tied to the extensiveness of forecasting (Shipman, Byrne, & Mumford, 2010). Based on these forecasts, action plans are then formulated, typically, action plans intended to bring about goal attainment (Latham & Arshoff, in press).

Support for Model

The model of forecasting performance presented above is rather complex. As a result, no single study can be devised which would provide a comprehensive test of this model. Rather, a series of studies is needed to test key propositions arising from the model. Accordingly, a series of studies was initiated to test four key propositions arising from this model. These tests focused on 1) the use of key causes in leader forecasting, 2) the objectives of forecasting, 3) the timeframe of concern in formulating forecasts, and 4) the use of cases in forecasting. In this section, we will review the findings emerging from various studies of forecasting with respect to each of these themes.

Mental Models

The model of forecasting presented above holds that forecasts are, in part, based on leaders' mental models, including their prescriptive mental model or vision. A key characteristic of mental models, however, is that they allow people to identify the causal operatives to be considered in forecasting. Indeed, our model of forecasting holds that manipulation of causes in the context of prototypic cases provides the basis for generating forecasts. Thus, one would expect that better analysis of critical causes operating in a situation would result in better leader performance and better forecasting.

The impact of causal analysis on leader performance has been examined in a study by Marcy and Mumford (2010). In this study, 159 undergraduates were asked to work on a complex simulation task. In working on this complex simulation, participants were asked to assume the role of president of a university where, as university president, they were to make a number of leadership decisions bearing on issues such as resource allocation, faculty hiring, enrollment management, athletics, and finances among other issues. Performance on this simulation exercise was assessed based on aggregate indices of performance.

Prior to starting work on this simulation, participants either were, or were not, given instruction in viable strategies for analyzing causes — more specifically, identification of critical causes. In a series of seven self-paced instructional modules, participants were provided with instruction that taught them to work with causes that 1) can be manipulated, 2) influence multiple outcomes, 3) have large effects, 4) can be controlled, 5) have synergistic effects, 6) work together, and 7) have direct effects. It was found that better performance was observed among people working on the educational, leadership simulation when training in causal analysis was provided as compared to when such training was not provided.

Although the Marcy and Mumford (2010) study indicates causal analysis contributes to leader performance, it does not directly address the impact of causal analysis on forecasting. This issue, however, has been addressed by Beehler et al. (2010) and Stenmark et al. (2011). In these studies, participants, some 100 undergraduates, were asked to assume the role of a middle manager working in an electronics firm. Following the presentation of a description of the firm and their role in the firm, participants were presented with a set of eight emails sent by followers indicating challenges, or problems, being encountered. Participants, in responding to each email, were asked to describe: 1) potential actions that might be taken to resolve the problem, 2) forecast the potential outcomes of these actions, and 3) provide, and justify, a final decision. Judges, four in all, were asked to appraise the forecasts provided with respect to three variables: 1) amount of detail in forecast, 2) complexity of the forecast, and 3) inclusion of critical aspects of the problem scenario in the forecasts provided. In both studies, adequate ($r_{tt} \geq .70$) interrater agreement coefficients were obtained in evaluating the forecasts.

In the Beehler et al. (2010) study, participants were also asked to indicate critical causes operating in the problem scenarios. Judges, four in all, evaluated the number of causes identified and the extent to which participants identified critical causes. In addition, the organizational scenario was manipulated to induce greater or lesser time pressure and a deliberative or implementation (Gollwitzer, 1994) mindset. Although time pressure and mindset had little effect on forecast quality, it was found that the identification of critical causes was strongly, positively related ($r = .43$) to the quality of the forecasts provided. Moreover, identification of critical causes exerted stronger effects on forecasting than either intelligence or general planning skills. Thus, identification of critical causes does apparently contribute to the production of better forecasts.

Some support for this conclusion was provided in a second study conducted by Stenmark et al. (2011). This study followed the same procedures as the Beehler et al. (2010) study. Here, however, manipulations were made in the organizational scenario to induce either greater or lesser firm performance pressure and greater or lesser within-firm conflict. Again it was found that identification of critical causes was strongly, positively related ($r = .60$) to the quality of the obtained forecasts. However, performance pressure and environmental conflict had no noteworthy effects on forecast quality.

Apparently, forecast quality is not strongly influenced by performance pressure, conflict, time pressure, and deliberation. However, in leadership roles, forecast quality is apparently strongly influenced by identification of critical causes. Moreover, identification of critical causes influences leader performance as well as forecasting perhaps because forecasting conditions subsequent leader performance (Shipman, Byrne, & Mumford, 2010). Although these findings are of some interest in their own right, they indicate, in keeping with the model presented earlier, that people work with causes, causes derived from their underlying mental models, in forecasting.

Objects of Forecasts

Although the findings obtained in the Beehler et al. (2010), Marcy and Mumford (2010), and Stenmark et al. (2011) studies point to the importance of mental models and causal analysis for forecasting, these studies have little to say about the content of forecasts. This issue, however, has been addressed in studies conducted by Caughron and colleagues (2011, 2013).

Caughron et al. (2011) asked some 160 undergraduates to assume the role of a manager, a leader, working in a pharmaceutical company producing a new drug. After reading through a description of the firm and their role in this firm, they were presented with a series of emails

requiring a leadership decision. Four judges, producing adequate interrater agreement coefficients, were asked to code written responses to these emails with respect to the viability of forecasts — anticipating consequences. Manipulations were made vis-à-vis the description of the firm and their role in this firm. Manipulations focused on personal control versus situational control of the events and sought either personal (e.g., promotion) or organizational (e.g., increased profits) outcomes.

It was found that forecasting improved when participants forecasted with respect to organizational, as opposed to personal, outcomes. These effects, in fact, hold even when covariates such as intelligence, planning skills, and need for cognition were taken into account. Thus, a depersonalized, more objective, approach apparently contributes to forecasting. Moreover, in a supplemental set of analyses, it was found that forecasting resulted in identification of more critical issues relevant to the problem at hand and better information organization.

Although the Caughron et al. (2011) study points to the value of objectivity in forecasting, in organizations, a host of variables operate to inhibit objectivity. Leaders are often not objective about competitors, and they are often not objective about others' motives. Thus, Caughron et al. (2013) conducted another study. In this study, participants were asked to assume the role of a manager, a leader, working in a firm maintaining social websites. Subsequently, participants, some 200 undergraduates, were asked to provide written responses to a series of emails. These written responses were coded by judges, again judges evidencing adequate agreement, with respect to attributes of viable forecasts: 1) anticipating consequences for self and others, 2) considering best- and worst-case scenarios, 3) thinking about short- and long-term outcomes, and 4) thinking about potential costs and benefits.

Manipulations were made in the description of the firm to induce appraisals of closeness to versus distance from competitors, competitor motives (i.e., pro-relationship versus selfish), and corroboration versus non-corroboration of information provided by competitors. It was found that forecasting was best with respect to close competitors when information was confirmed and competitors were motivated to maintain the relationship. The worst forecasts emerged when competitors were distant, information was not corroborated, and competitors acted in their own interest. Put differently, intense competition and high turbulence, by undermining objectivity, may hurt leader forecasting.

Time Frame

Taken as a whole, the findings described above indicate that forecasting improves when people objectively seek to manipulate critical causes embedded in mental models with respect to situational contingencies. Effective forecasting, moreover, results in better identification of key issues and better integration of information on the part of those working in leadership roles. Although these findings are consistent with the model presented earlier, this model is based on an apparently anomalous assumption. Forecasts of the future are based on the past in the sense that forecasts are held to be based on experiential, case-based, knowledge.

Although this proposition may appear counterintuitive, support for this proposition has been provided in a study by Martin et al. (2011). In this study, some 130 undergraduate business students were asked to assume the role of manager, the leader, of a retail store. After reading through background information describing the industry and their store, participants were asked to provide written solutions to four problems being encountered in operating this store. Prior to starting work on these problems, participants were asked to complete a series of exercises. Manipulations occurred through these exercises with participants being asked 1) to reflect on

past cases of success or past cases of failure relevant to the problem and 2) to think about these cases with respect to processes, outcomes, or both processes and outcomes. It was found that the best decisions with respect to the problems presented, and the most effective forecasting, occurred when people reflected on positively framed past experience and considered both process and outcomes in their reflection on past experience. These findings, of course, point to the value of a thorough analysis of available cases in forecasting. More centrally, however, they suggest that the use of positive case prototypes may provide particularly appropriate content for forecasting. Thus, the past does appear to provide the basis for forecasting the future.

This observation, however, should not be taken to imply that the future should not be taken into account in forecasting. Rather, prior experiences must be considered in the context of the future. This point is underscored in a study conducted by Martin et al. (2011). In this study, participants, some 120 undergraduates, were again asked to assume the role of the manager, the leader, of a small retail store. After reading through a description of the industry and the store, they were asked to provide written answers to four problems. Written answers to these problems were appraised by four judges, judges evidencing adequate agreement, with respect to forecasting or anticipating consequences. Manipulations were made to encourage participants to consider the past, the future, or both past and future, and to think about either positive or negative future events. It was found that forecasting was best when people thought about positive future events as they worked on these leadership problems. Thus, positive past experiences must be framed in terms of positive future outcomes to encourage effective forecasting.

Cases

The Martin et al. (2011) study, of course, is also of interest because it provides some evidence pointing to the use of case-based, or experiential, knowledge in forecasting. More direct

evidence bearing on this point, a key proposition underlying the model of forecasting presented earlier, has been provided in a series of studies by Bagdasarov et al. (2013), Harkrider et al. (2013), Johnson et al. (2012), Peacock et al. (2013), and Thiel et al. (2013).

In all these studies, some 100 to 120 doctoral students enrolled in a professional ethics education course were recruited to participate in a study embedded in one module of instruction. In this module of instruction, participants were presented with one- to two-page, instructional case. All manipulations occurring in all studies were made by varying the content presented in this instructional case. Subsequently, participants were presented with a transfer case (e.g., assuming the role of a city council member involved in a faulty bid and contract process), and they were asked to provide written answers to a series of probe questions before describing their final course of action. These probe questions asked participants to identify critical issues involved in the case, key challenges broached by the case, and likely outcomes of the case. Three judges, judges evidencing adequate agreement, were asked to review answers provided to those probe questions and rate overall forecast quality with respect to specificity, complexity, and criticality of the forecasts provided.

Across all five studies, a central, clear conclusion emerged. Variation in the content of the case material presented in instruction resulted in shifts, substantial shifts, in the quality of the forecasts observed on the transfer task. Thus, instruction focused on case content influenced subsequent forecasting. As a result, it seems reasonable to conclude that case-based knowledge does, in fact, provide a basis for forecasting.

The manipulations made in case content, however, are also noteworthy with respect to five key conclusions. First, Johnson et al. (2012) found that forecasts improved when people sought to identify a limited number of key causes and avoid negative outcomes through

manipulation of these causes. Second, Bagdasarov et al. (2013) found that the quality of forecasts improved when participants believed they had autonomy. Third, Thiel et al. (2013) found that the quality in forecasts improved when participants actively considered the affective implications of the cases. Fourth, Harkrider et al. (2013) found that the quality of forecasts improved when mastery models, models that illustrated procedures for case analysis, were presented during training. Fifth, and finally, Peacock et al. (2013) found that the quality of forecasts decreased as instructional interventions became too complex due to the increased processing load induced by complex instruction.

Of course, these findings are also consistent with the findings of Partlow, Medeiros, and Mumford (this volume) indicating that leaders, in vision formation, prefer simple to complex mental models. These findings, however, are also noteworthy because they suggest that people in forecasting will prove most effective when they are allowed to think autonomously about potential negative outcomes including negative affective outcomes. Thus, while people must think about downstream negatives in forecasting, they must maintain a positive, proactive orientation. And, more centrally, this balanced analysis in forecasting is based on the analysis of extant experiences, or cases, as they inform future action in subsequent situations people encounter in leadership roles.

Discussion

Before turning to the broader conclusions flowing from the present effort, certain limitations should be noted. To begin, the model of forecasting presented in the present effort is a rather complex model. As a result, it should be clear that many, perhaps most, of the propositions which might potentially flow from this model have not been tested in the studies conducted thus far. This point is of some importance because further studies may require changes in the structure

of this model. By the same token, the studies conducted to date do suggest this model provides a plausible description of the forecasting process. And, at a minimum, this model might provide some useful guidelines for further efforts intended to understand the nature, and significance, of leader forecasting (Shipman, Byrne, & Mumford, 2010).

Another limitation relevant to the present effort pertains to the measures used to assess forecasting. With a few exceptions (e.g., Dailey & Mumford, 2006), the measures employed to assess forecasting performance have been based on expert judgment. Although these judgmental appraisals of forecasting still evidence good interrater agreement (e.g., Thiel et al., 2013) and adequate construct validity (e.g., Beehler et al., 2010), the question remains as to whether similar findings would be obtained if other, more objective, performance measures were used.

Finally, it should be recognized that virtually all of the studies examined in the present effort were based on an experimental paradigm. As a result, forecasting performance, and influences on forecasting, were examined with respect to students — either undergraduate or graduate students. As a result, the question arises as to whether similar findings would emerge in studies of “real world” samples of organizational leaders. Although this question is not illegitimate, it should be recognized that the use of undergraduate or graduate student samples is not atypical in cognitive studies. More centrally, virtually all of the studies conducted to examine forecasting were based on low-fidelity simulation exercises (Motowidlo, Dunnette, & Carter, 1990) where participants were asked to work in leadership roles. As a result, with regard to these studies, there is at least an initial basis for drawing some general conclusions with respect to forecasting and its influence on leader performance.

Perhaps one of the most noteworthy conclusions emerging from the present effort concerns people’s ability to forecast. Traditionally, it has been assumed that people are simply

bad at forecasting (Pant & Starbuck, 1990). People's poor performance on forecasting tasks has lead to the *assumption* that forecasting was simply not worth studying. Of course, typically poor performance has little to say about the value of differential performance. More centrally, the findings obtained in the Dailey and Mumford (2006) study indicate that people might be good, at least reasonably good, at forecasting when they possess requisite expertise and intend to act on their forecasts.

If people can, at least under some conditions, forecast effectively, a new question comes to fore. Is effective forecasting of value for leaders? In fact, available theories of leader performance (e.g., Jaques, 1976) suggest forecasting performance might prove critical to leader performance. The results obtained in the studies examined in the present effort provide some compelling support for this proposition. Multiple studies, studies by Byrne, Shipman, and Mumford (2010), Shipman, Byrne, and Mumford (2010), and Stenmark et al. (2011), all indicate the skill in forecasting is very strongly related to performance differences observed on leadership tasks. Not only is forecasting strongly related to leader performance, measures of forecasting skill add to the prediction obtained from more traditional measures of individual differences — intelligence, divergent thinking, planning, and need for cognition. Not only does forecasting skill add to the prediction of performance in leadership roles, forecasting skill was found to be a stronger, far stronger, predictor than other traditional predictors of leader performance. Thus, forecasting does, in fact, appear to be critical to leadership.

Because leaders must act, and act effectively, in a complex, dynamic, social system, it is not surprising that forecasting would prove critical to performance (Yukl, 2011). Although it is clear why forecasting would be critical to leader performance, forecasting appears to have a number of more subtle effects, effects on human cognition which might also prove beneficial to

those asked to assume leadership roles. Forecasting appears to improve the integration of information and help leaders identify critical issues that must be addressed (Caughron et al., 2011). Forecasting, moreover, has been found to contribute to the development of stronger mental models which, in turn, should result in the production of stronger leader visions (Strange & Mumford, 2005) and better leader sensemaking and sensegiving (Drazin, Glynn, & Kazanjian, 1999; Weick, 1995).

The many potential benefits of leader forecasting, of course, broaches a new question. How do leaders forecast? In fact, in the present effort, we have presented an initial model describing the key cognitive operations underlying forecasting. This model holds that scanning serves to activate relevant mental models used to organize experience or case-based knowledge. Analysis of the causes of action and the outcomes sought, information embedded in these case-based knowledge structures, in turn, provides a basis for forecasting the downstream effects of action with respect to the situation at hand.

This thumbnail sketch of the forecasting model provides a framework which allowed us to test a number of key propositions. For example, Beehler et al. (2010) showed, in keeping with this model, that analysis of causes and causal relationships was critical to forecasting. Johnson et al. (2012) showed that case-based knowledge is used in forecasting. Martin et al. (2011) showed that reflection on case-based knowledge, knowledge acquired through past experience, contributes to forecasting. Caughron et al. (2011) have shown that forecasting improves when people maintain an objective approach to the situation at hand. Taken together, these, and other, studies suggest this model of forecasting performance is, at least, plausible.

This model of forecasting performance is not only of interest for academic reasons. It also provides guidelines for the development of new interventions that might improve leader

performance. For example, the findings of Beehler et al. (2011) and Marcy and Mumford (2010) indicate that providing leaders with training in causal analysis skills will improve forecasting and leader performance. The findings of Martin et al. (2011) and Strange and Mumford (2005) suggest that encouraging leaders to reflect on past experiences will result in better forecasting and better performance in leadership roles. The findings of Caughron et al. (2013) and Partlow, Medeiros, and Mumford (this volume), indicate that getting leaders to boil things down to their essentials will also result in better forecasting and better performance in leadership roles.

These and other potential practical implications — for example, considering forecasting skill in leader assessment (Yukl, 2011) — of our studies of forecasting point to a broader conclusion. A more in-depth understanding of key aspects of leader cognition reveals not only how leaders think, it also provides the basis for new interventions that will improve how they think and subsequent leader performance (Mumford, Marks, Connelly, Zaccaro, & Reiter-Palmon, 2000; Mumford, Zaccaro, Harding, Jacobs, & Fleishman, 2000). We hope the present effort provides an impetus for further research on leader cognition, in general, and leader forecasting skills, in particular.

References

- Anzai, Y. (1984). Cognitive control of real-time event-driven systems. *Cognitive Science*, 8(3), 221-254.
- Armor, D. A., & Taylor, S. E. (2003). The effects of mindset on behavior: Self-regulation in deliberative and implemental frames of mind. *Personality and Social Psychology Bulletin*, 29(1), 86-95.
- Bagdasarov, Z., Thiel, C. E., Johnson, J. F., Connelly, S., Harkrider, L. N., Devenport, L. D., & Mumford, M. D. (2013). Case-based ethics instruction: The influence of contextual and individual factors in case content on ethical decision-making. *Science and Engineering Ethics*, 19, 1305-1322.
- Beehler, C.K., Antes, A.L., Wang, X., Caughron, J.J., Theil, C.L., & Mumford, M.D. (2010). Causal analysis in forecasting and ethical decision-making. *Ethics and Behavior*, 20, 110-127.
- Berger, R. M., Guilford, J. P., & Christensen, P. R. (1957). A factor-analytic study of planning abilities. *Psychological Monographs: General and Applied*, 71(6), 1-31.
- Berger, C. R., & Jordan, J. M. (1992). Planning sources, planning difficulty and verbal fluency. *Communications Monographs*, 59(2), 130-149.
- Buehler, R., Messervey, D., & Griffin, D. (2005). Collaborative planning and prediction: Does group discussion affect optimistic biases in time estimation? *Organizational Behavior and Human Decision Processes*, 97(1), 47-63.
- Byrne, C. L., Shipman, A. S., & Mumford, M. D. (2010). The effects of forecasting on creative problem-solving: An experimental study. *Creativity Research Journal*, 22(2), 119-138.
- Caughron, J. J., Antes, A. L., Stenmark, C. K., Thiel, C. E., Wang, X., & Mumford, M. D. (2011). Sensemaking strategies for ethical decision making. *Ethics & Behavior*, 21(5), 351-366.
- Caughron, J. J., Antes, A. L., Stenmark, C. K., Thiel, C. E., Wang, X., & Mumford, M. D. (2013). Competition and sensemaking in ethical situations. *Journal of Applied Social Psychology*, 43(7), 1491-1507.
- Dailey, L., & Mumford, M. D. (2006). Evaluative aspects of creative thought: Errors in appraising the implications of new ideas. *Creativity Research Journal*, 18(3), 385-390.
- Dörner, D., & Schaub, H. (1994). Errors in Planning and Decision-making and the Nature of Human Information Processing. *Applied Psychology*, 43(4), 433-453.

- Drazin, R., Glynn, M. A., & Kazanjian, R. K. (1999). Multilevel theorizing about creativity in organizations: A sensemaking perspective. *Academy of Management Review*, 24(2), 286-307.
- Gaddis, B., Connelly, S., & Mumford, M. D. (2004). Failure feedback as an affective event: Influences of leader affect on subordinate attitudes and performance. *The Leadership Quarterly*, 15(5), 663-686.
- Goldvarg, E., & Johnson-Laird, P. N. (2001). Naive causality: A mental model theory of causal meaning and reasoning. *Cognitive Science*, 25(4), 565-610.
- Gollwitzer, P. M. (1999). Implementation intentions: strong effects of simple plans. *American Psychologist*, 54(7), 493.
- Hammond, K. J. (1990). Case-based planning: A framework for planning from experience. *Cognitive Science*, 14(3), 385-443.
- Harkrider, L., MacDougall, A. E., Bagdasarov, Z., Johnson, J. F., Thiel, C. E., Mumford, M. D., Connelly, S. & Devenport, L. D. (2013). Structuring case-based ethics training: How comparing cases and structured prompts influence training effectiveness. *Ethics & Behavior*, 23, 179-198.
- Hedlund, J., Forsythe, G. B., Horvath, J. A., Williams, W. M., Snook, S., & Sternberg, R. J. (2003). Identifying and assessing tacit knowledge: Understanding the practical intelligence of military leaders. *The Leadership Quarterly*, 14(2), 117-140.
- Hershey, D. A., Walsh, D. A., Read, S. J., & Chulef, A. S. (1990). The effects of expertise on financial problem solving: Evidence for goal-directed, problem-solving scripts. *Organizational Behavior and Human Decision Processes*, 46(1), 77-101.
- Howell, J. M., & Boies, K. (2004). Champions of technological innovation: The influence of contextual knowledge, role orientation, idea generation, and idea promotion on champion emergence. *The Leadership Quarterly*, 15(1), 123-143.
- Hunt, J. G., Boal, K. B., & Dodge, G. E. (1999). The effects of visionary and crisis-responsive charisma on followers: An experimental examination of two kinds of charismatic leadership. *The Leadership Quarterly*, 10(3), 423-448.
- Hunter, S. T., Bedell-Avers, K. E., Hunsicker, C. M., Mumford, M. D., & Ligon, G. S. (2008). Applying multiple knowledge structures in creative thought: Effects on idea generation and problem-solving. *Creativity Research Journal*, 20(2), 137-154.
- Johnson, J. F., Bagdasarov, Z., Connelly, S., Harkrider, L., Devenport, L. D., Mumford, M. D., & Thiel, C. E. (2012). Case-based ethics education: The impact of cause complexity and outcome favorability on ethicality. *Journal of Empirical Research on Human Research Ethics: An International Journal*, 7(3), 63-77.

- Jaques, E. (1976). *A General Theory of Bureaucracy*. London: Heinemann.
- Josephs, R. A., & Hahn, E. D. (1995). Bias and accuracy in estimates of task duration. *Organizational Behavior and Human Decision Processes*, 61(2), 202-213.
- Katz, D., & Kahn, R. L. (1978). *The Social Psychology of Organizations*. Hoboken, NJ: Wiley.
- Kettner, N. W., Guilford, J. P., & Christensen, P. R. (1959). A factor-analytic study across the domains of reasoning, creativity, and evaluation. *Psychological Monographs: General and Applied*, 73(9), 1-31.
- Kolodner, J. L. (1997). Educational implications of analogy: A view from case-based reasoning. *American Psychologist*, 52(1), 57.
- Koole, S., & van't Spijker, M. (2000). Overcoming the planning fallacy through willpower: effects of implementation intentions on actual and predicted task-completion times. *European Journal of Social Psychology*, 30(6), 873-888.
- Langholtz, H., Gettys, C., & Foote, B. (1995). Are resource fluctuations anticipated in resource allocation tasks?. *Organizational Behavior and Human Decision Processes*, 64(3), 274-282.
- Latham, G. P., & Arshoff, A. S. (in press). Planning: A mediator in goal-setting theory. In M. D. Mumford & M. Frese (Eds.), *Planning in organizations: The Psychology of Performance*. New York, NY: Taylor & Francis.
- Locke, E. A., & Latham, G. P. (1996). Goal setting theory: An introduction. In R. M. Steers, L. W. Porter, & G. A. Bigley (Eds.), *Motivation and Leadership at Work* (95-121). New York, NY: McGraw-Hill.
- Lonergan, D. C., Scott, G. M., & Mumford, M. D. (2004). Evaluative aspects of creative thought: Effects of appraisal and revision standards. *Creativity Research Journal*, 16(2-3), 231-246.
- Marcy, R. T., & Mumford, M. D. (2010). Leader cognition: Improving leader performance through causal analysis. *The Leadership Quarterly*, 21(1), 1-19.
- Marks, M. A., Mathieu, J. E., & Zaccaro, S. J. (2001). A temporally based framework and taxonomy of team processes. *Academy of Management Review*, 26(3), 356-376.
- Marta, S., Leritz, L. E., & Mumford, M. D. (2005). Leadership skills and the group performance: Situational demands, behavioral requirements, and planning. *The Leadership Quarterly*, 16(1), 97-120.

- Martin, L. E., Stenmark, C. K., Thiel, C. E., Antes, A. L., Mumford, M. D., Connelly, S., & Devenport, L. D. (2011). The influence of temporal orientation and affective frame on use of ethical decision-making strategies. *Ethics & Behavior*, 21(2), 127-146.
- McKenna, B., Rooney, D., & Boal, K. B. (2009). Wisdom principles as a meta-theoretical basis for evaluating leadership. *The Leadership Quarterly*, 20(2), 177-190.
- Merrifield, P. R., Guilford, J. P., Christensen, P. R., & Frick, J. W. (1962). The role of intellectual factors in problem solving. *Psychological Monographs: General and Applied*, 76(10), 1-21.
- Motowidlo, S. J., Dunnette, M. D., & Carter, G. W. (1990). An alternative selection procedure: The low-fidelity simulation. *Journal of Applied Psychology*, 75(6), 640-647.
- Mumford, M. D. (2001). Something old, something new: Revisiting Guilford's conception of creative problem solving. *Creativity Research Journal*, 13(3-4), 267-276.
- Mumford, M. D. (2006). *Pathways to outstanding leadership: A comparative analysis of charismatic, ideological, and pragmatic leaders*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Mumford, M. D., Antes, A. L., Caughron, J. J., & Friedrich, T. L. (2008). Charismatic, ideological, and pragmatic leadership: Multi-level influences on emergence and performance. *The Leadership Quarterly*, 19(2), 144-160.
- Mumford, M. D., Barrett, J. D., & Hester, K. S. (2012). Background data: Use of experiential knowledge in personnel selection. In N. Schmidt (Ed.), *The Oxford Handbook of Personnel Assessment and Selection* (353-382). Oxford, England: Oxford University Press.
- Mumford, M. D., Connelly, S., & Gaddis, B. (2003). How creative leaders think: Experimental findings and cases. *The Leadership Quarterly*, 14(4), 411-432.
- Mumford, M. D., Friedrich, T. L., Caughron, J. J., & Antes, A. L. (2009). Leadership research: traditions, developments, and current directions. In D. Buchanan & A. Bryman (Eds.), *The Sage Handbook of Organizational Research Methods* (111-127). Thousand Oaks, CA: Sage.
- Mumford, M. D., Friedrich, T. L., Caughron, J. J., & Byrne, C. L. (2007). Leader cognition in real-world settings: How do leaders think about crises?. *The Leadership Quarterly*, 18(6), 515-543.
- Mumford, M. D., Marks, M. A., Connelly, M. S., Zaccaro, S. J., & Reiter-Palmon, R. (2000). Development of leadership skills: Experience and timing. *The Leadership Quarterly*, 11(1), 87-114.

- Mumford, M. D., Peterson, D., & Robledo, I. (2013). Leading scientists and engineers: Cognition in a socio-technical context. In S. Hemlin, C. M. Allwood, B. Martin, & M. D. Mumford (Eds.), *Leadership in science, technology, and innovation*. London, England: Rutledge.
- Mumford, M. D., Schultz, R. A., & Osburn, H. K. (2002). Planning in organizations: Performance as a multi-level phenomenon. *Research in Multi Level Issues, 1*, 3-65.
- Mumford, M. D., Schultz, R. A., & Van Doorn, J. R. (2001). Performance in planning: Processes, requirements, and errors. *Review of General Psychology, 5*(3), 213.
- Mumford, M. D., Zaccaro, S. J., Harding, F. D., Jacobs, T. O., & Fleishman, E. A. (2000). Leadership skills for a changing world: Solving complex social problems. *The Leadership Quarterly, 11*(1), 11-35.
- Osburn, H. K., & Mumford, M. D. (2006). Creativity and planning: Training interventions to develop creative problem-solving skills. *Creativity Research Journal, 18*(2), 173-190.
- Pant, P. N., & Starbuck, W. H. (1990). Innocents in the forest: Forecasting and research methods. *Journal of Management, 16*(2), 433-460.
- Partlow, P. J., Medeiros, K. E., & Mumford, M. D. (this volume). Leader cognition and vision formation: Simplicity and negativity. *The Leadership Quarterly*.
- Patalano, A. L., & Seifert, C. M. (1997). Opportunistic planning: Being reminded of pending goals. *Cognitive Psychology, 34*, 1-36.
- Peacock, J., Harkrider, L. N., Bagdasarov, Z., Connelly, S., Johnson, J. F., Thiel, C. E., ... & Devenport, L. D. (2012). Effects of alternative outcome scenarios and structured outcome evaluation on case-based ethics instruction. *Science and Engineering Ethics, 1-21*.
- Rouse, W. B., & Morris, N. M. (1986). On looking into the black box: Prospects and limits in the search for mental models. *Psychological Bulletin, 100*(3), 349-363.
- Scott, G. M., Lonergan, D. C., & Mumford, M. D. (2005). Conceptual combination: Alternative knowledge structures, alternative heuristics. *Creativity Research Journal, 17*(1), 79-98.
- Shipman, A. S., Byrne, C. L., & Mumford, M. D. (2010). Leader vision formation and forecasting: The effects of forecasting extent, resources, and timeframe. *The Leadership Quarterly, 21*(3), 439-456.
- Stenmark, C. K., Antes, A. L., Wang, X., Caughron, J. J., Thiel, C. E., & Mumford, M. D. (2010). Strategies in forecasting outcomes in ethical decision-making: Identifying and analyzing the causes of the problem. *Ethics & behavior, 20*(2), 110-127.

- Strange, J. M., & Mumford, M. D. (2002). The origins of vision: Charismatic versus ideological leadership. *The Leadership Quarterly*, 13(4), 343-377.
- Strange, J. M., & Mumford, M. D. (2005). The origins of vision: Effects of reflection, models, and analysis. *The Leadership Quarterly*, 16(1), 121-148.
- Souitaris, V. (2001). Strategic influences of technological innovation in Greece. *British Journal of Management*, 12(2), 131-147.
- Thiel, C. E., Connelly, S., Harkrider, L., Devenport, L. D., Bagdasarov, Z., Johnson, J. F., & Mumford, M. D. (2013). Case-based knowledge and ethics education: Improving learning and transfer through emotionally rich cases. *Science and engineering ethics*, 19(1), 265-286.
- Thomas, J. B., Clark, S. M., & Gioia, D. A. (1993). Strategic sensemaking and organizational performance: Linkages among scanning, interpretation, action, and outcomes. *Academy of Management Journal*, 36(2), 239-270.
- Weick, K. E. (1995). *Sensemaking in organizations*. Thousand Oaks, CA: Sage.
- Wilson, R. C., Guilford, J. P., Christensen, P. R., & Lewis, D. J. (1954). A factor-analytic study of creative-thinking abilities. *Psychometrika*, 19(4), 297-311.
- Xiao, Y., Milgram, P., & Doyle, D. J. (1997). Planning behavior and its functional role in interactions with complex systems. *Systems, Man and Cybernetics, Part A: Systems and Humans, IEEE Transactions on*, 27(3), 313-324.
- Yukl, G. (2011). Contingency theories of effective leadership. In A. Bryman, D. Collinson, K. Grint, B. Jackson, & M. Uhl-Bien (Eds.), *The Sage Handbook of Leadership* (286-298). Thousand Oaks, CA: Sage.
- Yukl, G. (2012). Effective Leadership Behavior: What We Know and What Questions Need More Attention. *The Academy of Management Perspectives*, 26(4), 66-85.
- Zaccaro, S. J., Gilbert, J. A., Thor, K. K., & Mumford, M. D. (1992). Leadership and social intelligence: Linking social perspectiveness and behavioral flexibility to leader effectiveness. *The Leadership Quarterly*, 2(4), 317-342.
- Zaccaro, S. J., Mumford, M. D., Connelly, M. S., Marks, M. A., & Gilbert, J. A. (2000). Assessment of leader problem-solving capabilities. *The Leadership Quarterly*, 11(1), 37-64.

Figure 1: Model of Forecasting

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