

LEARNING FROM SAMPLES OF ONE OR FEWER*

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Organizations learn from experience. Sometimes, however, history is not generous with experience. We explore how organizations convert infrequent events into interpretations of history, and how they balance the need to achieve agreement on interpretations with the need to interpret history correctly. We ask what methods are used, what problems are involved, and what improvements might be made. Although the methods we observe are not guaranteed to lead to consistent agreement on interpretations, valid knowledge, improved organizational performance, or organizational survival, they provide possible insights into the possibilities for and problems of learning from fragments of history.

(ORGANIZATIONAL LEARNING; LEARNING FROM EXPERIENCE; SMALL SAMPLES)

Learning from Samples of One or Fewer

Organizations learn from experience, but learning seems problematic when history offers only meager samples of experience. Historical events are observed, and inferences about historical processes are formed, but the paucity of historical events conspires against effective learning. We consider situations in which organizations seek to learn from history on the basis of very small samples of experience. For example:

Case 1. A military organization has rarely fought in a battle. Yet it wants to learn from its history how to improve its ability to engage in warfare.

Case 2. A business firm has little experience with foreign acquisitions. Yet it wants to learn from its history whether and how to make such investments.

Case 3. An airline rarely has fatal accidents. Yet it wants to learn from its history how to reduce the chances of such disasters.

Case 4. A business firm rarely makes major marketable discoveries. Yet it wants to learn from its history how to increase the chances of such innovations.

Case 5. A power company rarely has nuclear accidents. Yet it wants to learn from its history how to minimize the chances of such catastrophes.

In the next section, we examine how organizations convert meager experience into interpretations of history by experiencing infrequent events richly. In §2, we examine processes for simulating hypothetical histories. In §3, we examine some justifications for these two learning strategies and some of the problems involved.

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1. Experiencing History Richly

Historical events are unique enough to make accumulating knowledge difficult. Each event is a single, unrepeated data point, and accumulation seems to require pooling across diverse contexts. Organizations attempt such pooling, but they also seek to increase the information extracted from their own limited historical experience by treating unique historical incidents as detailed stories rather than single data points. They elaborate experience by discovering more aspects of experience, more interpretations of experience, and more preferences by which to evaluate experience.

Experiencing more aspects of experience. Characterizing history as small samples of unique occurrences overlooks the wealth of experience that is represented in each historical event. The apparent stinginess of history is moderated by attending to more aspects of experience (Campbell 1979). For example, learning about a decision involves monitoring its outcomes. But long before an organization experiences many of the outcomes of a typical decision, it experiences a variety of collateral consequences associated with the making of the decision and its implementation. Learning and evaluation occur through these experiences prior to outcome-based learning. For example, participants appreciate collateral experiences such as "a bold move" or "a good meeting."

When early collateral experiences are positive, organizations, like individuals, are prone to exhibit self-reinforcing decision behavior. Especially when outcome feedback is slow or unclear, an organization is likely to repeat decisions simply because it has made them before. Thus, in a study of decisions about foreign direct investments by Finnish firms, Björkmann (1989) found that, prior to receiving information on the results of their first investments and simply as a result of their experience in making the first decisions, firms increased their propensity to make more investments. This did not appear to be a consequence of any explicit intention to spread risk. Apparently, the organizations extracted lessons from the choice process itself, lessons about the competence and character of relevant actors and the pleasure of deciding to invest. Learning was embedded richly in the taking of action, rather than simply in considering its ultimate consequences.

Making a decision also induces anticipations of its future costs and benefits (Merton 1968). The anticipations are experienced prior to the consequences and are an independent basis for learning. Since expectations for chosen alternatives will generally be positive, they ordinarily reinforce a repetition of the action. On the other hand, negative expectations might be experienced in situations involving coercion or peril, or when learning takes place in an alienated part of the organization, or among opposition groups. In such cases, the effect of making a decision reduces the propensity to repeat it. In general, decision processes in organizations lead to overly optimistic expectations and thus are vulnerable to subsequent disappointment with results (Harrison and March 1984). These optimistic errors in anticipations are likely to make the short-run lessons of experience more reinforcing of action than the long-run lessons. The inconsistency in learning is reduced by the tendency for actual experience to be both delayed and more ambiguous than anticipations, thus allowing optimistic expectations about experience to be confirmed by retrospective sense-making of it (Aronson 1968, Salancik 1977).

Organizations also enhance the richness of history by focusing intensively on critical incidents. For example, when a large section of the metal skin of an Aloha Airlines aircraft peeled away in mid-air, the event attracted considerable attention and triggered a major modification in FAA-mandated maintenance programs. Close examination of what happened revealed significant features of aircraft engineering and maintenance that had not been noted earlier. By identifying those features and their implications, the organizations learned. Similarly, when a computer science

graduate student propagated a "virus" among many computer networks, producing breakdowns in hundreds of systems, and considerable publicity, the incident stimulated analyses that identified weaknesses in the underlying computer code and in how people and systems were organized to respond to such events.

Three aspects of an event seem to make it critical. The first is its place in the course of history. Events that change the world are critical incidents. They are branching points of historical development. From such an incident, one learns about changed implications for the future rather than about how to predict or control similar occurrences in the future. A classic example is the invention of the printing press.

The second aspect of an event that makes it critical is its place in the development of belief. Events that change what is believed about the world are critical incidents. In a way consistent with conventional ideas about the relation between surprise and information value (Raiffa 1968), criticality is associated with the surprise an event evokes for current belief. A single incident is typically unsurprising because it can be interpreted as consistent with sampling variation within existing theories (Fischhoff 1975, Fischhoff and Beyth 1975). But sometimes a solitary event provides an unexpected contradiction to our beliefs, as for example in the Aloha Airlines and computer virus cases.

A third aspect that makes an event critical is its metaphorical power. Events that evoke meaning, interest, and attention for organizational participants are critical incidents. Anecdotes and stories are standard features of pedagogical practice. Skill at story telling is a major factor in endowing experience with metaphorical force. But the raw material of experience also affects the development of stories. Critical incidents have a quality of simplicity and representativeness that is not entirely imposed on them. Some historical events are better vehicles for meaning than others.

Experiencing more interpretations. Organizations often augment history by attending to multiple observers or interpretations. The consequences of an action are experienced differently throughout the organization. Conflicts of interest or differences in culture, in particular, stimulate multiple interpretations. Because different individuals and groups experience historical events differently, they learn different lessons from the same experience (Dearborn and Simon 1958, Sproull and Hofmeister 1986). As a result, organizational experience leads to a variety of interpretations, and an organization's repertoire may come to include several different, possibly contradictory, story lines. Differences in perspectives lead to differences in interpretations and create a mosaic of conflicting lessons.

To be sure, efforts to make multiple interpretations consistent are also routine in organizations. Formal proceedings, findings, informal conversations, and the diffusion of stories tend to create a shared, interpretive history. Interpretations of individual or group responsibility for mistakes or failures (or brilliant moves or successes) come to be shared. However, such efforts are not always successful (Brunsson 1989). The structure of internal competition and conflict divides many organizations into advocates and opponents for organizational policies and actions. The contending groups interpret history differently and draw different lessons from it.

Experiencing more preferences. Organizations discover values, aspirations, and identities in the process of experiencing the consequences of their actions. They learn how to distinguish success from failure, and thus affect considerably the other lessons they take from their experience. While the interpretation of a particular outcome as a success or failure is not arbitrary, neither is it always self-evident. The preferences and values in terms of which organizations distinguish successes from failures are themselves transformed in the process of learning. By acting, reflecting, and interpreting, organizations learn what they are. By observing their own actions, they learn

what they want (Weick 1979). Whether these changes are seen as learning new implications of alternative actions for stable preferences, or as transforming preferences, is partly a matter of intellectual taste (Becker and Stigler 1977).

For any given dimension of organizational preferences, aspiration levels change in response to an organization's own experience and to the experience of other organizations to which it compares itself (Cyert and March 1963, Lant and Montgomery 1987), thereby loosening the link between performance and outcomes, on the one hand, and evaluations of success and failure (and thus learning), on the other. Because experiencing an outcome as a success or failure depends on the relation between the outcome and adaptive aspirations for it, what is learned from any particular kind of experience can vary substantially across time and across organizations. Consider, for example, the efforts of a business firm to learn from its marketing experience. Whether a particular marketing strategy is viewed as a success (to be reinforced) or a failure (to be extinguished) will depend as much on the organization's aspirations as on the marketing outcomes. In a similar way, election results are experienced by political parties and movements in terms of a comparison between outcomes and aspirations rather than simply in terms of the former.

The dimensions of preferences also change. As we have noted above, a rich examination of an individual case uncovers a variety of features and consequences of action. These experiences become bases for organizational interpretations not only of the world and its rewards but also of the organization, particularly its preferences, values, and character (Zald and Denton 1963). For example, when the Coca-Cola Company reinstated old coke as Coca-Cola Classic (after having first withdrawn it from the market in favor of a replacement), it learned from its behavior that it was a "flexible company that listened to its customers" (Oliver 1986). Anything that predisposes parts of an organization to find pleasure in consequences, for example, an upbeat mood (Isen, Schalker, Clark and Karp 1978) or a sense of responsibility for action (March and Olsen 1975), tends to increase the likelihood of identifying positive aspects of unanticipated consequences, thus of transforming preferences.

2. Simulating Experience

In trying to understand unique experiences, organizations make implicit choices between two alternative perspectives on history. In the first perspective, realized events are seen as necessary consequences of antecedent historical conditions. In the second perspective, realized events are seen as *draws* from a distribution of possible events. If historical events are (possibly unlikely) draws from a wealth of possibilities, an understanding of history requires attention to the whole distribution of possible events, including those that did not occur (Fischhoff 1980, Hogarth 1983). The organizational problem is to infer an underlying distribution of possible events from a series of realized events having varying, but possibly quite low, probabilities. The merging of empirical and theoretical knowledge required to understand these underlying distributions raises some complicated problems of inference and method.

We consider two closely-related techniques for organizational simulation of hypothetical events: the first technique is to define and elaborate a class of historical non-events that can be called near-histories—events that almost happened. The second technique is to define and elaborate a class of historical non-events that can be called hypothetical histories—events that might have happened under certain unrealized but plausible conditions.

Near-histories. If a basketball game is decided by one point, one team wins and the other team loses, with consequences that may be vital for a championship. But the outcome will normally be interpreted by experts as a draw from some probability

distribution over possible outcomes rather than simply as a "win" by one team and a "loss" by the other. In general, if a relatively small change in some conditions would have transformed one outcome into another, the former will be experienced to some degree as having been the latter. In such a spirit, the National Research Council (1980) has defined a safety "incident" as an event that, under slightly different circumstances, could have been an accident.

Air traffic systems illustrate how organizations learn from near-histories or "incidents" (Tamuz 1987). By collecting information about near-accidents from pilots and air traffic controllers, air safety reporting systems considerably enlarge the sample of events that can be treated as relevant to understanding aviation safety. Information on near-accidents augments the relatively sparse history of real accidents and has been used to redesign aircraft, air traffic control systems, airports, cockpit routines, and pilot training procedures.

Near-histories are useful antidotes to a tendency to over generalize from the drama of great disasters or victories (Fischhoff 1982). For example, students of the Battle of Midway have suggested a number of quite likely alternative scenarios for that battle that would have led to notably different outcomes (Prange 1982). Future admirals learn not only from the battle but also from its near-histories. Standard folkloric observations that great failures often are the consequence of bad luck or timing and great successes the consequence of good luck or timing suggest an implicit distribution of possible outcomes around the observed outliers. They emphasize that the near-histories of genius and foolishness are more similar than their realized histories.

Hypothetical histories. Near-histories are a special case of a more general approach—the construction of hypothetical histories. Hypothetical histories play a role in organizational learning similar to that of mental models or simulations in studies of individual learning (Kahneman and Tversky 1982a, Johnson-Laird 1983). Organizations use small samples of specific historical events to construct theories about events, and then simulate hypothetical histories that can be treated as having interpretive significance comparable to, or even greater than, the history actually experienced. In this process, the analysis of unique historical outcomes emphasizes identifying the underlying distribution from which that realization was drawn rather than explaining the particular draw (Stinchcombe 1978).

A pervasive contemporary version of hypothetical histories is found in the use of spread sheets to explore the implications of alternative assumptions or shifts in variables in a system of equations that portrays organizational relations. More generally, many modern techniques of planning in organizations involve the simulation of hypothetical future scenarios, which in the present terms are indistinguishable from hypothetical histories (Hax and Majluf 1984). The logic is simple: small pieces of experience are used to construct a theory of history from which a variety of unrealized, but possible, additional scenarios are generated. In this way, ideas about historical processes drawn from detailed case studies are used to develop distributions of possible futures.

Organizations expand their comprehension of history by making experience richer, by considering multiple interpretations of experience, by using experience to discover and modify their preferences, and by simulating near-events and hypothetical histories. They try to learn from samples of one or fewer. Many of the techniques organizations use to learn from small samples of history, however, are clearly suspect. They can lead to learning false lessons, to superstitious learning, to exaggerated confidence in historical understandings. As a result, discussions of organizational learning from small samples tend to be framed by a mood of despair over the futility of the effort. In §3, we turn to an examination of how such learning might be understood, evaluated, and improved.

3. Assessing and Improving Learning from Small Histories

In §1 and 2, we have described some of the ways organizations learn from fragments of history. In this section, we assess their effectiveness in terms of two common criteria: reliability and validity. A reliable learning process is one by which an organization develops common understandings of its experience and makes its interpretations public, stable, and shared. A valid learning process is one by which an organization is able to understand, predict, and control its environment. Neither reliability nor validity is assured. Because different people and groups in an organization approach historical experience with different expectations and beliefs, shared understandings cannot be assumed. And because historical events are produced by particular (and often complicated) combinations of factors occurring in non-repetitive contexts, learning validly from small samples of historical experience is difficult (Brehmer 1980, Kiesler and Sproull 1982).

If individual beliefs converge to an accurate understanding of reality, then they become simultaneously shared and valid. Such a convergence might be expected in worlds of stable knowledge and cumulative discovery. Alternatively, if socially constructed beliefs are enacted into reality (Weick 1979), the enactment brings high levels of both reliability and validity. For example, organizational beliefs about power, legitimacy, competence, and responsibility are based upon interpretations of shared experiences that are themselves considerably affected by the beliefs.

The more general situation, however, is one of partial conflict between the dual requirements of reliability and validity. Stable, shared knowledge interferes with the discovery of contrary experience from which valid learning arises, and the exploration of novel ideas interferes with the reliable maintenance and sharing of interpretations (March 1990). As a result, organizational learning involves balancing the two. The trade-offs between reliability and validity made by the learning procedures we observe are less a result of conscious choice than a collection of evolving practices, imperfectly justified and incompletely comprehended. For example, the extent and character of subgroup differentiation in organizations and the mechanisms by which they are sustained or changed are important means by which the trade-off between reliability and validity is made.

The reliability of learning: The construction and sharing of belief. Stability in shared understandings is important for organizational effectiveness and survival (Beyer 1981, March and Olsen 1989), as it is for social systems (Durkheim 1973) and knowledge in general (Rorty 1985). However, the ambiguities of history make common understandings of organizational experience difficult to sustain. Meaning is not self-evident but must be constructed and shared. Many different interpretations are both supportable and refutable.

Some standard mechanisms of individual sense-making contribute to reliability. The retrieval of history from memory exaggerates the consistency of experience with prior conceptions (Fischhoff 1975; Pearson, Ross and Dawes 1990). Incorrect predictions are not noticed or are interpreted as irrelevant anomalies or measurement errors (Einhorn and Hogarth 1978; Lord, Lepper and Ross 1979). Missing data are experienced as consistent with the model and are remembered as real (Cohen and Ebbesen 1979, Loftus 1979).

The apparatus of organizational information processing and decision-making supplements these individual and social cognitive processes. Information is gathered and distributed more to interpret decisions than to inform them (Feldman and March 1981, March and Sevón 1984). Meetings are organized more to share stories and explanations than to take action (Brunsson 1985, 1989). Organizations develop robust understandings that are resilient to contradictory information (Sproull, Weiner and

Wolf 1978; Starbuck 1983). Conceptions of identity in organizations tend also to be conserved by interpretations of experience. Decision makers in organizations discover what they are and how they should behave by taking actions (Weick 1979). Making a decision leads to defining a personal and organizational identity consistent with that decision. Similarly, the social construction of aspirations tends to be conservative, to reinforce shared behavioral preferences.

Pressures toward reliability are easily orchestrated within an emphasis on critical incidents. Defining an event as critical focuses attention on interpreting and responding to the event. Because of the ambiguities associated with any single incident, responses and interpretations tend to be adopted more as a result of their temporal proximity, cognitive availability, or political convenience than by virtue of their obvious validity (Cyert, Dill and March 1958; Cohen, March and Olsen 1972).

The learning process is generally conservative, sustaining existing structures of belief, including existing differences, while coping with surprises in the unfolding of history. Organizations create the same kinds of coherent systems of belief that in science are called knowledge, in religion are called morality, and in other people's societies are called myths. Experience is used to strengthen and elaborate previously believed theories of life.

Such a description is, however, incomplete. There are limits to the conservation of belief (Martin and Siehl 1983, Higgins and Bargh 1987). Both success and failure contain the seeds of change. A persistent subjective sense of success leads to a sense of competence and a willingness to experiment (March and Shapira 1987). A persistent subjective sense of failure produces instability in beliefs and disagreement among organizational participants with respect to both preferences and action (Sproull, Weiner and Wolf 1978). In addition, pressures toward subgroup homogeneity lead to internal differentiation and limit organizational homogeneity (Cangelosi and Dill 1965, Lawrence and Lorsch 1967).

The validity of learning: The construction of causal belief. The confusions of history often obscure what happened, why it happened, and how we should learn from it. The general problem is not simply one of eliminating known biases in historical interpretation by organizations. The experimental design and sample sizes of history are inadequate for making inferences about it (Lounamaa and March 1987, Levitt and March 1988). Estimation from historical events is subject to two major kinds of variability. The first stems from the fact that some of the processes by which history is produced may be genuinely stochastic. Understanding those processes requires approximating the underlying distributions from which a realized event is drawn. The expected error in estimation can be decreased by aggregating over several events, but history limits the number of comparable events. Lacking multiple events, organizations use whatever information they can extract from single cases to discern the historical processes that determine those underlying distributions.

The second kind of variability in estimation stems from the measurement and interpretation of historical events by observers. Measurement error, model misspecification, and system complexity introduce substantial noise into observations and interpretations. With large samples of events, organizations can tolerate a relatively large amount of noise, aggregating over events to extract a signal. With small samples, however, aggregation is a less powerful procedure. Two organizational responses are common. First, since variability in interpretation with respect to any information is partly a function of the effort expended in examining it, the expected error can be decreased through a more intense examination of the individual case. Second, since the processes of measurement and interpretation yield a distribution of possible observations, the expected error can be decreased by aggregating over multiple observers.

Most of the ways organizations increase the validity of learning from historical experience can be seen as reflecting such considerations. Organizations attempt to overcome the limitations in the experimental design and sample sizes of history by enhancing the knowledge they have. They attempt to experience history more richly, to formulate more interpretations of that experience, and to supplement history by experiencing more of the events that did not occur but could have.

Consider, first, efforts to experience history more richly. Every unique historical event is a collection of micro events, each of which can be experienced. In this sense, the learning potential of any historical event is indeterminate. Because both the scope of an event and the depth of its decomposition into elements are arbitrary, so also is the richness of experience. By considering additional aspects of experience and new dimensions of preferences, an organization expands the information gained from a particular case. The pursuit of rich experience, however, requires a method for absorbing detail without molding it. Great organizational histories, like great novels, are written, not by first constructing interpretations of events and then filling in the details, but by first identifying the details and allowing the interpretations to emerge from them. As a result, openness to a variety of (possibly irrelevant) dimensions of experience and preference is often more valuable than a clear prior model and unambiguous objectives (Maier 1963; March 1978, 1987).

Moving from rich experiences of history to valid inferences about history involves a logic that is not very well-defined but is different from the logic of classical statistical inference. It assumes that the various micro events associated with an event are in some way interconnected. They are clearly not independent samples of some universe in the standard statistical sense. But they provide scraps of information about an underlying reality that cumulate, much the way various elements of a portrait cumulate to provide information about its subject.

Consider, second, efforts to interpret experience in more ways. Imagination in generating alternatives of interpretation reduces the standard confirmatory bias of experience, at the cost of also reducing the speed at which a correct interpretation is recognized and confirmed. Janis and Mann (1977) and George (1980) have each pointed out the advantages of pooling perceptions and judgments across individuals who interpret history differently. A similar argument is made into a methodological point by Allison (1971) and Neustadt and May (1986). Such observations suggest an important trade-off in attempts to improve the precision of estimates: an organization can opt to increase the number of events to be observed and interpreted or, alternatively, to increase the number and diversity of observers for a single event. Whether it is better to invest in additional events or in additional observers depends both on the relative cost of the two and on the relative magnitudes of the two sources of variability. But in pursuing an understanding of organizational history, greater reduction in uncertainty can often be achieved by pooling observers than by pooling events, particularly if the observers are relatively independent.

Consider, third, efforts to experience more of the events that did not happen. The presumption is that the processes of history are both more stable than their realized outcomes and more susceptible to understanding through rich descriptions. Near-histories and hypothetical histories produce distributions of unrealized, possible events. By treating events that did not occur as having significance similar to those that did occur, hypothetical histories exploit the information contained in rich descriptions of historical processes to provide a more judicious assessment of the probability distribution of future events.

In addition to providing a wider range of experience from which to draw, near-histories may be more easily interpreted than realized history. Tamuz (1988) suggests that understanding actual aviation accidents is heavily compromised by the legal and

financial contexts which provide individual and organizational incentives for discovering particular self-interested interpretations. She argues that although the reporting of near-accidents is affected by publicity, politics, and perceived reporting incentives, the analysis of these near-accidents often introduces fewer biases than those of accidents, thus producing understandings that are more consistent with broader social constructions and theories of evidence.

Although near-histories make useful contributions to learning, supplementing realized events with hypothetical ones introduces certain complications. First, constructing hypothetical histories can be expensive. Sometimes the substantial costs of such activities are shared by professional associations and governmental agencies, as they are in the air transportation industry. But often the ordinary branchings of history make it difficult to gather and interpret information on consequences of hypothetical histories that are not immediate. Imagine an organization that wanted to compare the ultimate careers and productivity of its employees with those job applicants it almost hired, or of applicants to whom it offered employment but who chose to work elsewhere. Assembling information on such a collection of historical branches involving outsiders, and interpreting the information, are substantial tasks.

Second, the impact of hypothetical histories ordinarily cannot compare with the dramatic power of realized history (Fischhoff and Beyth 1975, Kiesler and Sproull 1982). It is difficult to match the powerful effect of actual events (for example, the 1987 Challenger explosion) on beliefs. As a result, a vital part of the telling of history is the evocation of imagination (Tolstoy 1869). The probable dependence of imagination on vividness (Shedler and Manis 1986) and rich detail (Krieger 1983) provides at least a partial reason for emphasizing such stories in organizations (Clark 1972, Martin 1982). In the stories of Three-Mile Island, the Aloha Airlines flight, and the Cornell computer virus, vivid historical events were used to dramatize a hypothetical story of even greater potential disaster. The drama mobilized attention and learning across a wide spectrum of groups.

Third, hypothetical histories may be ambiguous and thus unpersuasive. Where organizations face possible events of great consequence but small likelihood, the use of near-histories to augment simple experience is sometimes controversial. If the probability of disaster is very low, near-histories will tend to picture greater risk than will be experienced directly by most organizations or individuals in a reasonable length of time. In such case, near-histories are likely to be treated as generating too pessimistic a picture. For example, long before the fatal Challenger flight, the spacecraft flew a series of successful missions despite its faulty O-rings. Some engineers interpreted the indications of O-ring problems during these early flights as symptoms that past successes had been relatively lucky draws from a distribution in which the probability of disaster was relatively high (Bell and Esch 1987, Boisjoly 1987). Others, including some key personnel in NASA, considered these estimates of danger as exaggerated because, in the realized history, the system had been robust enough to tolerate such problems (Starbuck and Milliken 1988).

Conversely, if the probability of success is very low, most short sequences of realized experience will contain no successes. The direct experience of most organizations and individuals with projects offering very low probability of very high return will be less favorable than will an analysis of near-successes. In such cases, near-histories are likely to be treated as providing too optimistic a picture. One such case involves organizations searching unsuccessfully for major innovations and treating assertions of "near-discoveries" as an unduly optimistic basis for sustaining investment in research.

As these examples suggest, the most obvious learning problem with near-histories is the necessary ambiguity of their interpretation. If an organization is concerned with

product quality and uses an inspection system to reject items that do not meet standards, every rejected item provides information on two things—the likelihood of substandard production and the likelihood of discovering the inadequacy. Each event, therefore, is both a failure and a success. Similarly, every time a pilot avoids a collision, the event provides evidence both for the threat and for its irrelevance. It is not clear whether the learning should emphasize how close the organization came to a disaster, thus the reality of danger in the guise of safety, or the fact that disaster was avoided, thus the reality of safety in the guise of danger.

4. Four Questions

Organizational efforts to learn reliably and validly from small histories are marked by two conspicuous things: first, we try to learn from them, often believing that we do so (Allison 1971, George and McKeown 1985), or can do so (Fischhoff 1982, Kahneman and Tversky 1982b), and often believing that we do not and cannot (Fischhoff 1980; Dawes, Faust and Meehl 1989). Second, we do not have a shared conception of how we learn from small histories or what distinguishes single cases that are informative from those that are not (Herbst 1970, Mohr 1985).

We have not invented a general logic for learning from history that can fully rationalize what we have described, nor do we imagine that such a total rationalization is possible. Many of the ways in which organizations treat small histories are difficult to justify as either leading to shared beliefs, exhibiting intelligence, or producing competitive advantage. Learning processes sometimes result in confusion and mistakes.

Nevertheless, we are disposed to see elements of intelligence in organizational efforts to organize, construct, and interpret experience, so as to move toward a shared understanding of it. We think organizations learn from their histories in ways that are, at times, remarkably subtle adaptations to the inferential inadequacies of historical experience. We recognize some advantages in having stable, shared beliefs about experience even if misinterpretations are embedded in those beliefs. We see possibilities for expanding and enhancing unique, ambiguous events, so as to learn more richly and validly from them. We believe that usable knowledge can be extracted from fragments of history and that intensive examinations of individual cases can be used imaginatively to construct meaningful hypothetical histories.

Such beliefs depend ultimately on confidence in being able to resolve some fundamental issues in historical inference. These include four critical questions:

(1) What is the evidential standing of imagination? Organizations use near-histories and hypothetical histories to learn from samples of one or fewer. The procedures seem to have elements of intelligence in them, but they mix theoretical and empirical knowledge in ways that are not considered comprehensively in our theories of inference.

(2) What is a proper process for combining prior expectations and interrelated, cumulated aspects of a rich description into an interpretation of history? Organizations develop and modify stories about history on the basis of detailed examinations of individual cases. It is clear that radically different stories may be told about the same history. But it also seems clear that the evaluation of stories is not arbitrary, that there are criteria for differentiating between good and bad stories.

(3) What is the proper trade-off between reliability and validity in historical interpretation? As organizations develop theories of their experiences, they balance gains and losses in validity against gains and losses in reliability. The metric and the procedures for the trade-off are ill-defined, but there seems little doubt that an

intelligent organization will sometimes sacrifice conventional notions of validity in order to achieve or sustain reliability in interpretation.

(4) What are the relative values of multiple observations of events and multiple interpretations of them? Improving precision in estimates involves pooling over observations and over observers. Theories of historical inference tend to emphasize pooling over observations. Pooling over observers appears to have advantages in some common situations, but in the absence of a clearer formulation of the gains and losses involved, it is hard to specify the precise conditions favoring one strategy or the other.

These questions invite heroic philosophical and methodological efforts to clarify and extend the uses of historical experience in the construction and sharing of meaning. The problems involved are not trivial. Nevertheless, we think modest progress can be made without waiting for a revolution in epistemology and within reasonably conventional modes of thinking about historical inference and learning from experience. The present paper is in that spirit. By examining the ways organizations actually seek to learn from small histories, and by trying to make sense of some of the things they do, we have tried to suggest some possible directions for understanding how meaning is extracted from sample sizes of one or fewer.

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