Collective Mind in Organizations: Heedful Interrelating on Flight Decks

Karl E. Weick
University of Michigan
Karlene H. Roberts
University of California, Berkeley

The concept of collective mind is developed to explain organizational performance in situations requiring nearly continuous operational reliability. Collective mind is conceptualized as a pattern of heedful interrelations of actions in a social system. Actors in the system construct their actions (contributions), understanding that the system consists of connected actions by themselves and others (representation), and interrelate their actions within the system (subordination). Ongoing variation in the heed with which individual contributions, representations, and subordinations are interrelated influences comprehension of unfolding events and the incidence of errors. As heedful interrelating and mindful comprehension increase, organizational errors decrease. Flight operations on aircraft carriers exemplify the constructs presented. Implications for organization theory and practice are drawn.

Some organizations require nearly error-free operations all the time because otherwise they are capable of experiencing catastrophes. One such organization is an aircraft carrier, which an informant in Rochlin, LaPorte, and Roberts' (1987: 78) study described as follows:

> . . . imagine that it's a busy day, and you shrink San Francisco Airport to only one short runway and one ramp and one gate. Make planes take off and land at the same time, at half the present time interval, rock the runway from side to side, and require that everyone who leaves in the morning returns that same day. Make sure the equipment is so close to the edge of the envelope that it's fragile. Then turn off the radar to avoid detection, impose strict controls on radios, fuel the aircraft in place with their engines running, put an enemy in the air, and scatter live bombs and rockets around. Now wet the whole thing down with sea water and oil, and man it with 20-year-olds, half of whom have never seen an airplane close-up. Oh and by the way, try not to kill anyone.

Even though carriers represent "a million accidents waiting to happen" (Wilson, 1986: 21), almost none of them do. Here, we examine why not. The explanation we wish to explore is that organizations concerned with reliability enact aggregate mental processes that are more fully developed than those found in organizations concerned with efficiency. By fully developed mental processes, we mean that organizations preoccupied with reliability may spend more time and effort organizing for controlled information processing (Schneider and Schiffrin, 1977), mindful attention (Langer, 1989), and heedful action (Ryle, 1949). These intensified efforts enable people to understand more of the complexity they face, which then enables them to respond with fewer errors. Reliable systems are smart systems.

Before we can test this line of reasoning we need to develop a language of organizational mind that enables us to describe collective mental processes in organizations. In developing it, we move back and forth between concepts of mind and details of reliable performance in flight operations on a modern super carrier.[1] We use flight operations to illustrate organizational mind for a number of reasons: The technology is relatively simple, the coordination among activities is explicit and visible, the socialization is continuous, agents working alone have less grasp of the

0001-8392/93/3803-0357/$1.00.

•

We acknowledge with deep gratitude, generous and extensive help with previous versions of this manuscript from Sue Ashford, Michael Cohen, Dan Denison, Jane Dutton, Les Gasser, Joel Kahn, Rod Kramer, Peter Manning, Dave Meader, Debra Meyerson, Walter Nord, Linda Pike, Joe Porac, Bob Quinn, Lance Sandelands, Paul Schaffner, Howard Schwartz, Kathie Sutcliffe, Bob Sutton, Diane Vaughan, Jim Walsh, Rod White, Mayer Zald, and the anonymous reviewers for *Administrative Science Quarterly*.

1

Unless otherwise cited, aircraft carrier examples are drawn from field observation notes of air operations and interviews aboard Nimitz class carriers made by the second author and others over a five-year period. Researchers spent from four days to three weeks aboard the carriers at any one time. They usually made observations from different vantage points during the evolutions of various events. Observations were entered into computer systems and later compared across observers and across organizational members for clarity of meaning. Examples are also drawn from quarterly workshop discussions with senior officers from those carriers over the two years. The primary observational research methodology was to triangulate observations made by three faculty researchers, as suggested by Glaser and Strauss (1967) and Eisenhardt (1989). The methodology is more fully discussed in Roberts, Stout, and Halpern (1993). Paper-and-pencil data were also collected and are discussed elsewhere (Roberts, Rousseau, and LaPorte, 1993). That research was supported by Office of Naval Research contract ≠N-00014-86-k-0312 and National Science Foundation grant ≠F7-08046.

entire system than they do when working together, the system is constructed of interdependent know-how, teams of people think on their feet and do the "right thing" in novel situations, and the consequences of any lapse in attention are swift and disabling. Because our efforts to understand deck operations got us thinking about the possibility that performance is mediated by collective mental processes, we use these operations to illustrate that thinking, but the processes of mind we discuss are presumed to be inherent in all organizations. What may vary across organizations is the felt need to develop these processes to more advanced levels.

THE IDEA OF GROUP MIND

Discussions of collective mental processes have been rare, despite the fact that people claim to be studying "social" cognition (e.g., Schneider, 1991). The preoccupation with individual cognition has left organizational theorists ill-equipped to do much more with the so-called cognitive revolution than apply it to organizational concerns, one brain at a time. There are a few exceptions, however, and we introduce our own discussion of collective mind with a brief review of three recent attempts to engage the topic of group mind.

Wegner and his associates (Wegner, Giuliano, and Hertel, 1985; Wegner, 1987; Wegner, Erber, and Raymond, 1991) suggested that group mind may take the form of cognitive interdependence focused around memory processes. They argued that people in close relationships enact a single transactive memory system, complete with differentiated responsibility for remembering different portions of common experience. People know the locations rather than the details of common events and rely on one another to contribute missing details that cue their own retrieval. Transactive memory systems are integrated and differentiated structures in the sense that connected individuals often hold related information in different locations. When people trade lower-order, detailed, disparate information, they often discover higher-order themes, generalizations, and ideas that subsume these details. It is these integrations of disparate inputs that seem to embody the "magical transformation" that group mind theorists sought to understand (Wegner, Giuliano, and Hertel, 1985: 268). The important point Wegner contributes to our understanding of collective mental processes is that group mind is *not* indexed by within-group similarity of attitudes, understanding, or language, nor can it be understood without close attention to communications processes among group members (Wegner, Giuliano, and Hertel, 1985: 254–255). Both of these lessons will be evident in our reformulation.

Work in artificial intelligence provides the backdrop for two additional attempts to conceptualize group mind: Sandelands and Stablein's (1987) description of organizations as mental entities capable of thought and Hutchins' (1990, 1991) description of organizations as distributed information-processing systems. The relevant ideas are associated with theories of "connectionism," embodied in so-called "neural networks." Despite claims that their work is grounded in the

brain's microanatomy, connectionists repeatedly refer to "neurological plausibility" (Quinlan, 1991: 41), "neuron-like units" (Churchland, 1992: 32), "brain-style processing" (Rumelhart, 1992: 69), or "neural inspiration" (Boden, 1990: 18). This qualification is warranted because the "neural" networks examined by connectionists are simply computational models that involve synchronous parallel processing among many interrelated unreliable and/or simple processing units (Quinlan, 1991: 40). The basic idea is that knowledge in very large networks of very simple processing units resides in patterns of connections, not in individuated local symbols. As Boden (1990: 14) explained, any "unit's activity is regulated by the activity of neighboring units, connected to it by inhibitory or excitatory links whose strength can vary according to design and/or learning." Thus, any one unit can represent several different concepts, and the same concept in a different context may activate a slightly different network of units.

Connectionism by itself, however, is a shaky basis on which to erect a theory of organizational mind. The framework remains grounded in a device that models a single, relatively tightly coupled actor as opposed to a loosely coupled system of multiple actors, such as an organization. Connectionists have difficulty simulating emotion and motivation (Dreyfus and Dreyfus, 1990), as well as everyday thought and reasoning (Rumelhart, 1992). In computational models there is no turnover of units akin to that found in organizations, where units are replaced or moved to other locations. And the inputs connectionists investigate are relatively simple items such as numerals, words, or phrases, with the outputs being more or less accurate renderings of these inputs (e.g., Elman, 1992). This contrasts with organizational researchers who pay more attention to complex inputs, such as traditional competitors who make overtures to cooperate, and to outputs that consist of action as well as thought.

What connectionism contributes to organizational theory is the insight that complex patterns can be encoded by patterns of activation and inhibition among simple units, if those units are richly connected. This means that relatively simple actors may be able to apprehend complex inputs if they are organized in ways that resemble neural networks. Connectionists also raise the possibility that mind is "located" in connections and the weights put on them rather than in entities. Thus, to understand mind is to be attentive to process, relating, and method, as well as to structures and content.

Sandelands and Stablein (1987: 139–141) found parallels between the organization of neurons in the brain and the organization of activities in organizations. They used this parallel to argue that connected activities encode concepts and ideas in organizations much like connected neurons encode concepts and ideas in brains. Ideas encoded in behaviors appear to interact in ways that suggest operations of intelligent processing. These parallels are consistent with the idea that organizations are minds. The important lessons from Sandelands and Stablein's analysis are that connections between behaviors, rather than people, may be the crucial

"locus" for mind and that intelligence is to be found in patterns of behavior rather than in individual knowledge.

Hutchins (1990, 1991: 289) has used connectionist networks, such as the "constraint satisfaction network," to model how interpretations based on distributed cognitions are formed. These simulations are part of a larger inquiry into how teams coordinate action (Hutchins, 1990) and the extent to which distributed processing amplifies or counteracts errors that form in individual units. Hutchins' analysis suggests that systems maintain the flexible, robust action associated with mindful performance if individuals have overlapping rather than mutually exclusive task knowledge. Overlapping knowledge allows for redundant representation that enables people to take responsibility for all parts of the process to which they can make a contribution (Hutchins, 1990: 210).

The potential fit between connectionist imagery and organizational concepts can be inferred from Hutchins' (1990: 209) description of coordination by mutual constraint in naval navigation teams:

> [The] sequence of action to be taken [in group performance] need not be explicitly represented anywhere in the system. If participants know how to coordinate their activities with the technologies and people with which they interact, the global structure of the task performance will emerge from the local interactions of the members. The structure of the activities of the group is determined by a set of local computations rather than by the implementation of the sort of global plan that appears in the solo performer's procedure. In the team situation, a set of behavioral dependencies are set up. These dependencies shape the behavior pattern of the group.

The lessons we use from Hutchins' work include the importance of redundant representation, the emergence of global structure from local interactions, and behavioral dependencies as the substrate of distributed processing.

Our own attempt to describe group mind has been informed by these three sources but is based on a different set of assumptions. We pay more attention to the form of connections than to the strength of connections and more attention to mind as activity than to mind as entity. To make this shift in emphasis clear, we avoid the phrases "group mind" and "organizational mind" in favor of the phrase "collective mind." The word "collective," unlike the words "group" or "organization," refers to individuals who act as if they are a group. People who act as if they are a group interrelate their actions with more or less care, and focusing on the way this interrelating is done reveals collective mental processes that differ in their degree of development. Our focus is at once on individuals and the collective, since only individuals can contribute to a collective mind, but a collective mind is distinct from an individual mind because it inheres in the pattern of interrelated activities among many people.

We begin the discussion of collective mind by following the lead of Ryle (1949) and developing the concept of mind as a disposition to act with heed. We then follow the lead of Asch (1952) and develop the concept of collective

interrelating as contributing, representing, and subordinating, and illustrate these activities with examples from carrier operations. We next combine the notions of heed and interrelating into the concept of collective mind as heedful interrelating and suggest social processes that may account for variations in heedful interrelating. Finally, we describe three examples of heedful interrelating, two from carrier operations and one from the laboratory, and present an extended example of heedless interrelating that resulted in a $38-million accident.

MIND AS DISPOSITION TO HEED

"Mind" is a noun similar to nouns like faith, hope, charity, role, and culture. "Mind" is not the name of a person, place, or thing but, rather, is a dispositional term that denotes a propensity to act in a certain manner or style. As Ryle (1949: 51) said,

> The statement "the mind is its own place," as theorists might construe it, is not true, for the mind is not even a metaphorical "place." On the contrary, the chessboard, the platform, the scholar's desk, the judge's bench, the lorry-driver's seat, the studio and the football field are among its places. These are where people work and play stupidly or intelligently.

That mind is actualized in patterns of behavior that can range from stupid to intelligent can be seen in the example Ryle (1949: 33) used of a clown who trips and stumbles just as clumsy people do. What's different is that "he trips and stumbles on purpose and after much rehearsal and at the golden moment and where the children can see him and so as not to hurt himself." When a clown trips artfully, people applaud the style of the action, the fact that tripping is done with care, judgment, wit, and appreciation of the mood of the spectators. In short, the tripping is done with heed. Heed is not itself a behavior but it refers to the way behaviors such as tripping, falling, and recovering are assembled. Artful tripping is called heedful, not so much because the tripping involves action preceded by thought but because the behaviors patterned into the action of tripping suggest to the observer qualities such as "noticing, taking care, attending, applying one's mind, concentrating, putting one's heart into something, thinking what one is doing, alertness, interest, intentness, studying, and trying" (Ryle, 1949: 136). These inferences, based on the style of the action, are called "heed concepts" and support the conclusion that the behaviors were combined intelligently rather than stupidly.

The word "heed" captures an important set of qualities of mind that elude the more stark vocabulary of cognition. These nuances of heed are especially appropriate to our interest in systems preoccupied with failure-free performance. People act heedfully when they act more or less carefully, critically, consistently, purposefully, attentively, studiously, vigilantly, conscientiously, pertinaciously (Ryle, 1949: 151). Heed adverbs attach qualities of mind directly to performances, as in the description, "the airboss monitored the pilot's growing load of tasks attentively." Notice that the statement does not say that the airboss was doing two things, monitoring and also checking to be sure that the

monitoring was done carefully. Instead, the statement asserts that, having been coached to monitor carefully, his present monitoring reflects this style. Mind is in the monitoring itself, not in some separate episode of theorizing about monitoring.

Heedful performance is not the same thing as habitual performance. In habitual action, each performance is a replica of its predecessor, whereas in heedful performance, each action is modified by its predecessor (Ryle, 1949: 42). In heedful performance, the agent is still learning. Furthermore, heedful performance is the outcome of training and experience that weave together thinking, feeling, and willing. Habitual performance is the outcome of drill and repetition.

When heed declines, performance is said to be heedless, careless, unmindful, thoughtless, unconcerned, indifferent. Heedless performance suggests a failure of intelligence rather than a failure of knowledge. It is a failure to see, to take note of, to be attentive to. Heedless performance is not about ignorance, cognition (Lyons, 1980: 57), and facts. It is about stupidity, competence, and know-how. Thus, mind refers to stretches of human behavior that exhibit qualities of intellect and character (Ryle, 1949: 126).

Group as Interrelated Activity

Ryle's ideas focus on individual mind. To extend his ideas to groups, we first have to specify the crucial performances in groups that could reflect a disposition to heed. To pinpoint these crucial performances, we derive four defining properties of group performance from Asch's (1952: 251–255) discussion of "mutually shared fields" and illustrate these properties with carrier examples.[2]

The first defining property of group performance is that individuals create the social forces of group life when they act as if there were such forces. As Asch (1952: 251) explained it,

> We must see group phenomena as both *the product and condition* of actions of individuals. . . . There are no forces between individuals as organisms; yet to all intents and purposes they act as if there were, and they actually create social forces. Group action achieves the kind of result that would be understandable if all participants were acting under the direction of a single organizing center. No such center exists; between individuals is a hiatus, which nevertheless, they succeed in overcoming with surprising effectiveness.

An example from carriers occurs during flight operations. The men in the tower (Air Department) monitor and give instructions to incoming and departing aircraft. Simultaneously, the men on the landing signal officers' platform do the same thing. They are backed up by the men in Air Operations who monitor and instruct aircraft at some distance from the ship. From the aviator's viewpoint, he receives integrated information about his current status and future behavior from an integrated source when, in reality, the several sources are relatively independent of one another and located in different parts of the ship.

2
We could just as easily have used Blumer's (1969: 78–79) discussion of "the mutual alignment of action."

The second defining property of group performance is that when people act as if there are social forces, they construct their actions (contribute) while envisaging a social system of joint actions (represent), and interrelate that constructed action with the system that is envisaged (subordinate). Asch (1952: 251–252) explained this as follows:

> There are group actions that are possible only when each participant has a representation that includes the actions of others and their relations. The respective actions converge relevantly, assist and supplement each other only when the joint situation is represented in each and when the representations are structurally similar. Only when these conditions are given can individuals subordinate themselves to the requirements of joint action. These representations and the actions that they initiate/bring group facts into existence and produce the phenomenal solidity of group process.

The simultaneous envisaging and interrelating that create a system occur when a pilot taxies onto the catapult for launching, is attached to it, and advances his engines to full power. Even though pilots have to rely on the catapult crew, they remain vigilant to see if representations are similar. Pilots keep asking themselves questions like, "Does it feel right?" or "Is the rhythm wrong?" The referent for the question, "Does *it* feel right?" however, is not the aircraft but the joint situation to which he has subordinated himself. If a person on the deck signals the pilot to reduce his engines from full power, he won't do so until someone stands in front of the plane, directly over the catapult, and signals for a reduction in power. Only then is the pilot reasonably certain that the joint situation has changed. He now trusts that the catapult won't be triggered suddenly and fling his underpowered aircraft into a person and then into the ocean.

The third defining property of group performance is that contributing, representing, and subordinating create a joint situation of interrelations among activities, which Asch (1952: 252) referred to as a system:

> When these conditions are given we have a social system or a process of a definite form that embraces the actions of a number of individuals. Such a system does not reside in the individuals taken separately, though each individual contributes to it; nor does it reside outside them; it is present in the interrelations between the activities of individuals.

An example from carriers is a pilot landing an aircraft on a deck. This is not a solitary act. A pilot doesn't really land; he is "recovered." And recovery is a set of interrelated activities among air traffic controllers, landing signal officers, the control tower, navigators, deck hands, the helmsman driving the ship, etc. As the recovery of a single aircraft nears completion in the form of a successful trap, nine to ten people on the landing signal officer's platform, up to 15 more people in the tower, and two to three more people on the bridge observe the recovery and can wave the aircraft off if there is a problem. While this can be understood as an example of redundancy, it can also be interpreted as activities that can be interrelated more or less adequately, depending on the care with which contributing, representing, and subordinating are done.

The fourth and final defining property of group performance suggested by Asch is that the effects produced by a pattern of interrelated activities vary as a function of the style (e.g., heedful-heedless) as well as the strength (e.g., loose-tight) with which the activities are tied together. This is suggested by the statement that, in a system of interrelated activities, individuals can work with, for, or against each other:

> The form the interrelated actions take—on a team or in an office—is a datum of precisely the same kind as any other fact. One could say that all the facts of the system can be expressed as the sum of the actions of individuals. The statement is misleading, however, if one fails to add that the individuals would not be capable of these particular actions unless they were responding to (or envisaging the possibility of) the system. Once the process described is in motion it is no longer the individual "as such" who determines its direction, nor the group acting upon the individual as an external force, but individuals working with, for, or against each other. (Asch, 1952: 252)

It is these varying forms of interrelation that embody collective mind. An example of interrelating on carriers can be seen when ordnance is loaded onto an aircraft and its safety mechanisms are removed. If there is a sudden change of mission, the live ordnance must be disarmed, removed, and replaced by other ordnance that is now activated, all of this under enormous time pressure. These interrelated activities, even though tightly coupled, can become more or less dangerous depending on how the interrelating is done.

In one incident observed, senior officers kept changing the schedule of the next day's flight events through the night, which necessitated a repeated change in ordnance up to the moment the day launches began. A petty officer changing bombs underneath an aircraft, where the pilot couldn't see him, lost a leg when the pilot moved the 36,000-pound aircraft over him. The petty officer should have tied the plane down before going underneath to change the load but failed to do so because there was insufficient time, a situation created by continual indecision at the top. Thus, the senior officers share the blame for this accident because they should have resolved their indecision in ways that were more mindful of the demands it placed on the system.

Although Asch argued that interrelated activities are the essence of groups, he said little about how these interrelations occur or how they vary over time. Instead, he treated interrelations as a variable and interrelating as a constant. If we treat interrelations as a variable and interrelating as a process, this suggests a way to conceptualize collective mind.

HEEDFUL INTERRELATING AS COLLECTIVE MIND

The insights of Ryle and Asch can be combined into a concept of collective mind if we argue that dispositions toward heed are expressed in actions that construct interrelating. Contributing, representing, and subordinating, actions that form a distinct pattern external to any given individual, become the medium through which collective mind is manifest. Variations in heedful interrelating

correspond to variations in collective mind and comprehension.

We assume, as Follett (1924: 146–153) did, that mind begins with actions, which we refer to here as contributions. The contributions of any one individual begin to actualize collective mind to the degree that heedful representation and heedful subordination define those contributions. A heedful contribution enacts collective mind as it begins to converge with, supplement, assist, and become defined in relation to the imagined requirements of joint action presumed to flow from some social activity system.

Similar conduct flows from other contributing individuals in the activity system toward others imagined to be in that system. These separate efforts vary in the heedfulness with which they interrelate, and these variations form a pattern. Since the object of these activities ("the envisaged system," to use Asch's phrase) is itself being constituted as these activities become more or less interrelated, the emergent properties of this object are not contained fully in the representation of any one person nor are they finalized at any moment in time. A single emergent property may appear in more than one representation, but seldom in all. And different properties are shared in common by different subsets of people. Asch seems to have had this distributed representation of the envisaged system in mind when he referred to "structurally similar representations." This pattern of distributed representation explains the transindividual quality of collective mind. Portions of the envisaged system are known to all, but all of it is known to none.

The collective mind is "located" in the process of interrelating just as the individual mind for Ryle was "located" in the activities of lorry driving, chess playing, or article writing. Collective mind exists potentially as a kind of capacity in an ongoing activity stream and emerges in the style with which activities are interrelated. These patterns of interrelating are as close to a physical substrate for collective mind as we are likely to find. There is nothing mystical about all this. Collective mind is manifest when individuals construct mutually shared fields. The collective mind that emerges during the interrelating of an activity system is more developed and more capable of intelligent action the more heedfully that interrelating is done.

A crude way to represent the development of a collective mind is by means of a matrix in which the rows are people and the columns are either the larger activities of contributing, representing, and subordinating, or their component behaviors (e.g., converging with, assisting, or supplementing). Initially, the cell entries can be a simple "yes" or "no." "Yes" means a person performs that action heedfully; "no" means the action is done heedlessly. The more "yeses" in the matrix, the more developed the collective mind.

We portray collective mind in terms of method rather than content, structuring rather than structure, connecting rather than connections. Interrelations are not given but are constructed and reconstructed continually by individuals (Blumer, 1969: 110) through the ongoing activities of

contributing, representing, and subordinating. Although these activities are done by individuals, their referent is a socially structured field. Individual activities are shaped by this envisioned field and are meaningless apart from it. When people make efforts to interrelate, these efforts can range from heedful to heedless. The more heed reflected in a pattern of interrelations, the more developed the collective mind and the greater the capability to comprehend unexpected events that evolve rapidly in unexpected ways. When we say that a collective mind "comprehends" unexpected events, we mean that heedful interrelating connects sufficient individual know-how to meet situational demands. For organizations concerned with reliability, those demands often consist of unexpected, nonsequential interactions among small failures that are hard to see and hard to believe. These incomprehensible failures often build quickly into catastrophes (Perrow, 1984: 7–12, 22, 78, 88).

An increase in heedful interrelating can prevent or correct these failures of comprehension in at least three ways. First, longer stretches of time can be connected, as when more know-how is brought forward from the past and is elaborated into new contributions and representations that extrapolate farther into the future. Second, comprehension can be improved if more activities are connected, such as when interrelations span earlier and later stages of task sequences. And third, comprehension can be increased if more levels of experience are connected, as when newcomers who take nothing for granted interrelate more often with old-timers who think they have seen it all. Each of these three changes makes the pattern of interrelations more complex and better able to sense and regulate the complexity created by unexpected events. A system that is tied together more densely across time, activities, and experience comprehends more of what is occurring because the scope of heedful action reaches into more places. When heed is spread across more activities and more connections, there should be more understanding and fewer errors. A collective mind that becomes more comprehensive, comprehends more.

Variations in Heed

If collective mind is embodied in the interrelating of social activities, and if collective mind is developed more or less fully depending on the amount of heedfulness with which that interrelating is done, we must address the issue of what accounts for variations in heed. We suspect the answer lies in Mead's (1934: 186) insight that mind is "the individual importation of social process." We understand the phrase "social process" to mean a set of ongoing interactions in a social activity system from which participants continually extract a changing sense of self-interrelation and then re-enact that sense back into the system. This ongoing interaction process is recapitulated in individual lives and continues despite the replacement of people.

Mead stressed the reality of recapitulation, as did others. Ryle (1949: 27), for example, observed that "this trick of talking to oneself in silence is acquired neither quickly nor

without effort; and it is a necessary condition to our acquiring it that we should have previously learned to talk intelligently aloud and have heard and understood other people doing so. Keeping our thoughts to ourselves is a sophisticated accomplishment." Asch (1952: 257) described the relationship between the individual and the group as the only part-whole relation in nature "that depends on recapitulation of the structure of the whole in the part." The same point is made by Morgan (1986) and Hutchins (1990: 211), using the more recent imagery of holograms: System capacities that are relevant for the functioning of the whole are built into its parts. In each of these renderings, social processes are the prior resources from which individual mind, self, and action are fashioned (Mead, 1934: 191–192). This means that collective mind precedes the individual mind and that heedful interrelating foreshadows heedful contributing.

Patterns of heedful interrelating in ongoing social processes may be internalized and recapitulated by individuals more or less adequately as they move in and out of the system. If heedful interrelating is visible, rewarded, modeled, discussed, and preserved in vivid stories, there is a good chance that newcomers will learn this style of responding, will incorporate it into their definition of who they are in the system, and will reaffirm and perhaps even augment this style as they act. To illustrate, Walsh and Ungson (1991: 60) defined organization as a "network of intersubjectively shared meanings that are sustained through the development and use of a common language and everyday social interactions." Among the shared meanings and language on carriers we heard these four assertions: (1) If it's not written down you can do it; (2) Look for clouds in every silver lining; (3) Most positions on this deck were brought in blood; and (4) Never get into something you can't get out of. Each of these guidelines, if practiced openly, represents an image of heedful interrelating that can be internalized and acted back into the system. If such guidelines are neglected, ignored, or mocked, however, interrelating still goes on, but it is done with indifference and carelessness.

Whether heedful images survive or die depends importantly on interactions among those who differ in their experience with the system. While these interactions have been the focus of preliminary discussions of communities of practice (e.g., Lave and Wenger, 1991: 98–100) involving apprentices and experts, we highlight a neglected portion of the process, namely, the effects of socialization on the insiders doing the socializing (Sutton and Louis, 1987).

When experienced insiders answer the questions of inexperienced newcomers, the insiders themselves are often resocialized. This is significant because it may remind insiders how to act heedfully and how to talk about heedful action. Newcomers are often a pretext for insiders to reconstruct what they knew but forgot. Heedful know-how becomes more salient and more differentiated when insiders see what they say to newcomers and discover that they thought more thoughts than they thought they did.

Whether collective mind gets renewed during resocialization may be determined largely by the candor and narrative skills of insiders and the attentiveness of newcomers. Candid insiders who use memorable stories to describe failures as well as successes, their doubts as well as their certainties, and what works as well as what fails, help newcomers infer dispositions of heed and carelessness. Insiders who narrate richly also often remind themselves of forgotten details when they reconstruct a previous event. And these reminders increase the substance of mind because they increase the number of examples of heed in work.

Narrative skills (Bruner, 1986; Weick and Browning, 1986; Orr, 1990) are important for collective mind because stories organize know-how, tacit knowledge, nuance, sequence, multiple causation, means-end relations, and consequences into a memorable plot. The ease with which a single story integrates diverse themes of heed in action foreshadows the capability of individuals to do the same. A coherent story of heed is mind writ small. And a repertoire of war stories, which grows larger through the memorable exercise of heed in novel settings, is mind writ large.

The quality of collective mind is heavily dependent on the way insiders interact with newcomers (e.g., Van Maanen, 1976). If insiders are taciturn, indifferent, preoccupied, available only in stylized performances, less than candid, or simply not available at all, newcomers are in danger of acting without heed because they have only banal conversations to internalize. They have learned little about heedful interdependence. When these newcomers act and try to anticipate the contributions of others, their actions will be stupid, and mistakes will happen. These mistakes may represent small failures that produce learning (Sitkin, 1992). More ominous is the possibility that these mistakes may also represent a weakening of system capacity for heedful responding. When there is a loss of particulars about how heed can be expressed in representation and subordination, reliable performance suffers. As seasoned people become more peripheral to socialization, there should be a higher incidence of serious accidents.

We have dwelt on insider participation simply because this participation is a conspicuous phenomenon that allows us to describe collective mind, but anything that changes the ongoing interaction (e.g., preoccupation with personalities rather than with the task) can also change the capability of that interaction to preserve and convey dispositions of heed. Those changes in turn should affect the quality of mind, the likelihood of comprehension, and the incidence of error.

ILLUSTRATIONS OF HEED IN INTERRELATING

The concepts of heed, interrelating, contributing, representing, subordinating, intelligent action, comprehension, recapitulation, and resocialization come together in the concept of collective mind as heedful interrelating. Applying the language of collective mind to four examples of complex systems, we illustrate the adequate comprehension produced by heedful interrelating and the

problematic comprehension produced by heedless interrelating.

Heedful Interrelating

The first example of interrelating that is heedful involves a laboratory analogue of collective mind (Weick and Gilfillan, 1971). Three people who can neither see nor talk with one another are given target numbers between 1 and 30. Whenever a target number is announced, each person is to contribute some number between 0 and 10 such that, when all three contributions are added together, they sum to the target number.

There are many ways to solve this problem (e.g., a target number of 13 can be achieved with a 3s strategy, 4-4-5, or a 10s strategy, 10-3-0). Once a group evolves a strategy, people are removed one at a time, and strangers, who know nothing of the strategy in use, enter. The questions are, how do old-timers interrelate with newcomers, what strategy emerges, how soon does it emerge, and how stable is it?

Austere as these operations are, they have the rudiments of a collective mind. A newcomer knows a number of things: (1) There are others in the activity system but they must be envisioned, since it is impossible to communicate with them (representation); (2) the two other people have had some experience with the system and with the game (there are imagined requirements to which one must subordinate); (3) each contribution is important and must interrelate with the others (contributions must converge, supplement, assist, and be defined in relation to one another); (4) to learn the existing system or to create a new one requires attention, careful calculations, and clear signals of intent (heedful contribution, representation, and subordination); and, (5) casual, indifferent interrelating will not be punished severely, because people are anonymous, and the rewards for participation are trivial (heedless responding is an option).

Just as the newcomers know these things, so do the old-timers. When these three people try to work out and maintain a system that hits each target on the first try, they are attempting to interrelate. They contribute, represent, and subordinate with varying amounts of heed. Their interrelating is better able to distinguish a mistake from an intentional effort to change strategy the more heedfully it was assembled. Likewise, heedful interrelating can "read" a newcomer's intentions quickly, whereas heedless interrelating cannot. These discriminations are not accomplished by single individuals but are accomplished by interrelated activities and the heedfulness with which those activities are defined in relation to one another. Heedful action at any one of these three positions can be undermined if it is not reciprocated at the other two. What is undermined, however, is a pattern of interrelations, not a person. A pattern of nonreciprocated heedfulness represents a loss of intelligence that is reflected in missed targets and slow change.

Heedful interrelating on carriers looks a lot like the pattern of interrelating seen in the common-target game. A vivid example of this similarity is Gillcrist's (1990: 287–288)

account of what it feels like to land and taxi on a carrier deck at night. Having successfully trapped onto the deck, Gillcrist watched the flight director's two amber wands:

> I raised the hook handle with my right hand and simultaneously added a lot of power to get the Crusader moving forward. There was an urgency in the taxi signal movement of the wands, telling me that there must be another plane close behind me in the groove. They wanted to get my airplane completely across the foul line as quickly as possible. Taxiing at night was more carefully done than in the light of day, however. We'd had enough airplanes taxi over the side at night to learn that lesson. . . . The wands pointed to another set of wands further up the flight deck and I began to follow their direction as my F-8 was taxied all the way to the first spot on the bow. "God, how I hate this," I muttered to myself. "Do they really have to do this or are they just trying to scare me?" In spotting me in the first taxi spot on the bow, the taxi director was turning the F-8 so close to the edge of the flight deck that the cockpit actually swung in an arc over the deck's edge. All I could see was black rushing water eighty feet below. "Jesus" I said to myself, "I hope that guy knows what he is doing."

The taxi director does know what he is doing, as does the pilot, but that alone does not keep the plane from dropping off the deck. The interrelating of their know-how keeps the plane on the deck. A command from the director that is not executed by the pilot or a pilot deviation that is not corrected by the director are equally dangerous and not controllable by either party alone. The activities of taxiing and directing remain failure-free to the extent that they are interrelated heedfully.

A third example of heedful interrelating is of special interest because so much of it appears to involve the mind of one individual, in this case, the person responsible for deck operations (the bos'n). One of the people in this position who was interviewed had 23 years of experience on 16 carriers. At the time he joined this carrier's crew, it took six hours to spot 45 aircraft on the deck. He reduced that time to two hours and 45 minutes, which gave his crew more time to relax and maintain their alertness.

This person tries constantly to prevent the four worst things that can happen on a deck: It catches fire, becomes fouled, locked (nothing can move), or a plane is immobilized in the landing area. The more times a plane is moved to prevent any of these conditions, the higher the probability that it will brush against another plane ("crunch"), be damaged, and be out of service until repaired.

This bos'n, who is responsible for the smooth functioning of deck operations, gets up an hour early each day just to think about the kind of environment he will create on the deck that day, given the schedule of operations. This thinking is individual mind at work, but it also illustrates how collective mind is represented in the head of one person. The bos'n is dealing with collective mind when he represents the capabilities and weaknesses of imagined crewmembers' responses in his thinking, when he tailors sequences of activities so that improvisation and flexible response are activated as an expected part of the day's adaptive response, and when he counts on the interrelations among crewmembers themselves to "mind" the day's activities.

The bos'n does not plan specific step-by-step operations but, rather, plans which crews will do the planning and deciding, when, and with what resources at hand. The system will decide the operations, and the bos'n sets up the system that will do this. The bos'n does this by attempting to recognize the strengths and weaknesses of the various crews working for him. The pieces of the system he sets up may interrelate stupidly or intelligently, in large part because they will either duplicate or undermine the heedful contributing, representing, and subordinating he anticipates.

Heedless Interrelating

When interrelating breaks down, individuals represent others in the system in less detail, contributions are shaped less by anticipated responses, and the boundaries of the envisaged system are drawn more narrowly, with the result that subordination becomes meaningless. Attention is focused on the local situation rather than the joint situation. People still may act heedfully, but not with respect to others. Interrelating becomes careless. Key people and activities are overlooked. As interrelating deteriorates and becomes more primitive, there is less comprehension of the implications of unfolding events, slower correction of errors, and more opportunities for small errors to combine and amplify. When these events are set in motion and sustained through heedless interrelating, there is a greater chance that small lapses can enlarge into disasters.

An incident that happened during a nighttime launch and recovery, which was described to us in interviews and correspondence, illustrates the steady loss of collective mind as interrelating became less heedful. This incident began to unfold during a night launch in which one-third of the planes in the mission were still on deck waiting to be launched, even though other planes were already beginning to be recovered.

Aircraft A, which was in the air and the fourth plane in line to land, had an apparent hydraulic failure, although the pilot was able to get his gear and tail hook down. This failure meant that if the plane were landed, its wings could not be folded, and it would take up twice the space normally allotted to it. This complicates the landing of all planes behind it.

While the pilot of plane A was trying to get help for his problem on a radio channel, plane B, an F-14, which was number three in order of landing, had a compound hydraulic failure, and none of his back-up hydraulic systems appeared to work, something that was unheard of. Plane C, which was fifth in line to land, then developed a control problem. Thus, the airboss was faced, first, with several A-7 aircraft that still had to be launched. This is not a trivial complication, because the only catapult available for these aircraft was the one whose blast-deflector panel extends part way into the area where planes land. Second, the airboss had a string of planes about to land that included (1) a normally operating A-7, (2) a normally operating A-7, (3) plane B with a compound hydraulic failure, (4) plane A with a hydraulic failure but gear and tail hook down, and (5) plane C with an apparent control problem.

The first plane was taken out of the landing pattern and the second was landed. Plane B, the one with the most severe problems, was told to land and then had to be waved off because the person operating the deflector panel for launches lowered the panel one second too late to allow B to land. The deflector operator had not been informed that an emergency existed. Plane B and its increasingly frightened pilot were reinserted into the landing pattern behind plane C for a second pass at the deck. Plane B then experienced an additional hydraulic failure. Plane A landed without incident, as did plane C. Plane C had corrected its control problem, but no one was informed. Thus, plane B's second pass was delayed longer than necessary because he had to wait for C to land in the mistaken belief that C still had a problem. The pilot of plane B became increasingly agitated and less and less able to help diagnose what might be wrong with his aircraft. The decision was made to send plane B to a land base, but it ran out of fuel on the way and the pilot and his RIO (radar intercept officer) had to eject. Both were rescued, but a $38-million aircraft was lost. If aircraft B had not been waved off the first time it tried to land, it would have been safely recovered. If we analyze this incident as a loss of collective mind produced by heedless interrelating, we look for two things: events that became incomprehensible, signifying a loss of mind, and increasingly heedless interrelating.

There were several events that became harder to comprehend. The failure of the hydraulic system in aircraft B was puzzling. The triggering of additional hydraulic failures was even more so. To have three of five aircraft on final approach declare emergencies was itself something that was hard to comprehend, as was the problem of how to recover three disabled planes while launching three more immediately.

Incomprehensible events made interrelating more difficult, which then made the events even harder to comprehend. The loss of heed in interrelating was spread among contributions, representations, and subordinations. The squadron representative who tried to deal with the stressed pilot in plane B was not himself a pilot (he was an RIO), and he did not scan systematically for possible sources of the problem. Instead, he simply told the pilot assorted things to try, not realizing that, in the pilot's doing so, additional systems on the plane began to fail. He didn't realize these growing complications because the pilot was both imprecise in his reports of trouble and slow to describe what happened when he tested some hypothesis proposed by the representative. And the representative did nothing to change the pilot's style of contributing.

But heedless interrelating was not confined to exchanges between pilot and representative. The RIO in plane B made no effort to calm the pilot or help him diagnose. The deflector operator was not treated as a person in the *recovery* system. Three different problems were discussed on two radio frequencies, which made it difficult to sort out which plane had which problem. No one seemed to register that the squadron representative was himself getting farther behind and making increasingly heedless contributions. The

airboss in command of the tower was an F-14 pilot, but he was preoccupied with the five incoming and the three outgoing aircraft and could not be pulled completely into the activity system that was dealing with the F-14 problem. As heed began to be withdrawn from the system, activities and people became isolated, the system began to pull apart, the problems became more incomprehensible, and it became harder for individuals to interrelate with a system of activities that was rapidly losing its form. The pattern of interrelated activities lost intelligence and mind as contributions became more thoughtless and less interdependent.

Had the pattern of interrelations been more heedful, it might have detected what was subsequently said to be the most likely cause of the failures in plane B. Although the aircraft was never recovered, the navy's investigation of the incident concluded that too many demands were placed on the emergency back-up systems, and the plane became less and less flyable. Sustained heedful interrelating might well have registered that the growing number of attempted solutions had in fact created a new problem that was worse than any problem that was present to begin with.[3]

It is important to realize that our analysis, using the concepts of collective mind and heedful interrelating, implies something more than the simple advice, "be careful." People can't be careful unless they take account of others and unless others do the same. Being careful is a social rather than a solitary act. To act with care, people have to envision their contributions in the context of requirements for joint action. Furthermore, to act with care does not mean that one plans how to do this and then applies the plan to the action. Care is not cultivated apart from action. It is expressed in action and through action. Thus people can't *be* careful, they *are* careful (or careless). The care is in the action.

The preceding analysis also suggests that it is crucial to pay attention to mind, because accidents are not just issues of ignorance and cognition, they are issues of inattention and conduct as well. The examples of incomprehension mentioned above are not simply issues of fact and thinking. Facts by themselves are of no help if they cannot be communicated or heard or applied or interpreted or incorporated into activities or placed in contexts, in short, if they are not addressed mindfully. One "fact" of this incident is that plane B could have landed had it not been waved off because of the extended deflector. Furthermore, individuals within the system were not ignorant of crucial details (e.g., the pilot of plane C knew he no longer had a problem).

One interpretation of this incident is that individuals were smarter than the system, but the problem was more complex than any one individual could understand. Heedful interrelating of activities constructs a substrate that is more complex and, therefore, better able to comprehend complex events than is true for smart but isolated individuals. The F-14 may have been lost because heedful interrelating was lost. Heightened attentiveness to social process might have prevented both losses.

3

There is a limit to heedfulness, given the number and skill of participants, and on this night this ship was at that limit. The system was overloaded, and the situation was one that managers of high-technology weapons systems worry about all the time. They call it OBE (overcome by events). Given perhaps only minor differences in the situation, the outcomes might have been different. In this situation, for example, had the carrier air group commander come to the tower (which he often does), he would have added yet another set of eyes and ears, with their attendant skills. Perhaps he could have monitored one aspect of the situation while the boss and mini boss took charge of others, and the situation would have been a more heedful one. Had the squadron representative in the tower been a pilot, he might have searched through his own repertoire of things that can go wrong and helped the F-14's pilot calm down and solve his problem, increasing the heedfulness of the situation.

DISCUSSION

We conclude from our analysis that carrier operations are a struggle for alertness and that the concept of heedful interrelating helps capture this struggle. We began with the question, How can we analyze a complex social activity system in which fluctuations in comprehension seem to be consequential? We focused on heed (understood as dispositions to act with attentiveness, alertness, and care), conduct (understood as behavior that takes into account the expectations of others), and mind (understood as integration of feeling, thinking, and willing).

We were able to talk about group mind without reification, because we grounded our ideas in individual actions and then treated those actions as the means by which a distinct higher-order pattern of interrelated activities emerged. This pattern shaped the actions that produced it, persisted despite changes in personnel, and changed despite unchanging personnel. Thus, we did not reify social entities, because we argued that they emerge from individual actions that construct interrelations. But neither did we reify individual entities, because we argued that they emerge through selective importation, interpretation, and re-enactment of the social order that they constitute.

In broadening our focus, we conceptualized mind as action that constructs mental processes rather than as mental processes that construct action. We proposed that variations in contributing, representing, and subordinating produce collective mind. Common hallmarks of mind such as alertness, attentiveness, understanding, and relating to the world were treated as coincident with and immanent in the connecting activities. To connect *is* to mind.

For the collective mind, the connections that matter are those that link distributed activities, and the ways those connections are accomplished embody much of what we have come to mean by the word "mind." The ways people connect their activities make conduct mindful. Mindless actions ignore interrelating or accomplish it haphazardly and with indifference (Bellah et al., 1991).

As a result of our analysis, we now see the importance of disentangling the development of mind from the development of a group. In Asch's description of the essence of group life, as well as in other discussions of group cognition, the development of mind is confounded with the development of the group. As a group matures and moves from inclusion through control to affection (Schutz, 1958), or as it moves from forming through storming, norming, and performing (Tuckman, 1965), both interrelating and intimacy develop jointly. If a mature group has few accidents or an immature group has many, it is difficult to see what role, if any, mind may play in this. An immature group of relative strangers with few shared norms, minimal disclosure, and formal relationships might well find it hard to cope with nonroutine events. But this has nothing to do with mind.

In our analysis we have assumed that there is something like a two-by-two matrix in which a group can be developed

or undeveloped and a collective mind can be developed or undeveloped. And we assume that the combinations of developed-group–undeveloped mind and undeveloped-group–developed mind are possible. These two combinations are crucial to any proposal that collective mind is a distinct process in social life.

The combination of developed-group–undeveloped mind is found in the phenomenon of groupthink (Janis, 1982), as well as in cults (Galanter, 1989), interactions at NASA prior to the *Challenger* disaster (Starbuck and Milliken, 1988), and ethnocentric research groups (Weick, 1983). Common among these examples is subordination to a system that is envisaged carelessly, or, as Janis (1982: 174) put it, there is an overestimation of the group's power, morality, and invulnerability. Furthermore, contributions are made thoughtlessly; as Janis (1982: 175) put it, there is self-censorship of deviations, doubts, and counterarguments. And, finally, representations are careless; members maintain the false assumption that silence means consent (Janis, 1982: 175). In the presence of heedless interrelating, comprehension declines, regardless of how long the group has been together, and disasters result.

The combination of undeveloped-group–developed mind is found in ad hoc project teams, such as those that produce television specials (e.g., Peters, 1992: 189–200) or motion pictures (Faulkner and Anderson, 1987), and in temporary systems such as those that form in aircraft cockpits (Ginnett, 1990), around jazz improvisation (Eisenberg, 1990), in response to crises (Rochlin, 1989), or in high-velocity environments (Eisenhardt, 1993). The common feature shared among these diverse settings is best captured by Eisenberg (1990: 160), who characterized them as built from nondisclosive intimacy that "stresses coordination of action over alignment of cognitions, mutual respect over agreement, trust over empathy, diversity over homogeneity, loose over tight coupling, and strategic communication over unrestricted candor."

Translated into the language of heedful interrelating, what Eisenberg depicted were relationships in which shared values, openness, and disclosure, all hallmarks of a developed group, were *not* fully developed, but in which collective mind was developed. Nondisclosive intimacy is characterized by heedful contributing (e.g., loose coupling, diversity, strategic communication), heedful representing (e.g., mutual respect, coordination of action), and heedful subordinating (e.g., trust).

If heedful interrelating can occur in an undeveloped group, this changes the way we think about the well-known stages of group development. If people are observed to contribute, represent, and subordinate with heed, these actions can be interpreted as operations that construct a well-developed collective mind; however, those same actions can also be seen as the orienting, clarifying, and testing associated with the early stages of a new group just beginning to form (McGrath, 1984: 152–162). By one set of criteria, that associated with group formation, people engaged in forming are immature. By another set of criteria, that associated with

collective mind, these acts of forming represent well-developed mental processes.

These opposed criteria suggest that groups may be smartest in their early stages. As they grow older, they lose mind when interrelating becomes more routine, more casual, more automatic. This line of reasoning is consistent with Gersick's (1988) demonstration that groups tend to re-form halfway through their history. In our language, this midcourse reshuffling can be understood as redoing the pattern of interrelations that constitute mind, thereby renewing mind itself. If groups steadily lose mind and comprehension as they age, their capability for comprehension may show a dramatic increase halfway through their history. If that is plausible, the sudden surge in comprehension should be accompanied by a sudden decrease in the number of accidents they produce.

The Conceptualization of Topics in Organizational Theory

Our analysis of collective mind and heedful interrelating throws new light on several topics in organizational theory, including organizational types, the measurement of performance, and normal accidents.

The concept of mind may be an important tool in comparative analysis. LaPorte and Consolini (1991) argued that high-reliability organizations such as aircraft carriers differ in many ways from organizations usually portrayed in organizational theory as (for convenience) high-efficiency organizations. Typical efficiency organizations practice incremental decision making, their errors do not have a lethal edge, they use simple low-hazard technologies, they are governed by single rather than multilayered authority systems, they are more often in the private than the public sector, they are not preoccupied with perfection, their operations are carried on at one level of intensity, they experience few nasty surprises, and they can rely on computation or judgment as decision strategies (Thompson and Tuden, 1959) but seldom need to employ both at the same time. LaPorte and Consolini (1991: 19) concluded that existing organizational theory is inadequate to understand systems in which the "consequences and costs associated with major failures in some technical operations are greater than the value of the lessons learned from them."

Our analysis suggests that most of these differences can be subsumed under the generalization that high-efficiency organizations have simpler minds than do high-reliability organizations. If dispositions toward individual and collective heed were increased in most organizations in conjunction with increases in task-related interdependence and flexibility in the sequencing of tasks, then we would expect these organizations to act more like high-reliability systems. Changes of precisely this kind seem to be inherent in recent interventions to improve total quality management (e.g., U.S. General Accounting Office, 1991).

Our point is simply that confounded in many comparisons among organizations that differ on conspicuous grounds, such as structure and technology, are less conspicuous but potentially more powerful differences in the capability for

collective mind. A smart system does the right thing regardless of its structure and regardless of whether the environment is stable or turbulent. We suspect that organic systems, because of their capacity to reconfigure themselves temporarily into more mechanistic structures, have more fully developed minds than do mechanistic systems.

We also suspect that newer organizational forms, such as networks (Powell, 1990), self-designing systems (Hedberg, Nystrom, and Starbuck, 1976), cognitive oligopolies (Porac, Thomas, and Baden-Fuller, 1989: 413), and interpretation systems (Daft and Weick, 1984) have more capacity for mind than do M forms, U forms, and matrix forms. But all of these conjectures, which flow from the idea of collective mind, require that we pay as much attention to social processes and microdynamics as we now pay to the statics of structure, strategy, and demographics.

The concept of mind also suggests a view of performance that complements concepts such as activities (Homans, 1950), the active task (Dornbusch and Scott, 1975), task structure (Hackman, 1990: 10), group task design (Hackman, 1987), and production functions (McGrath, 1990). It adds to all of these a concern with the style or manner of performance. Not only can performance be high or low, productive or unproductive, or adequate or inadequate, it can also be heedful or heedless. Heedful performance might or might not be judged productive, depending on how productivity is defined.

Most important, the concept of mind allows us to talk about careful versus careless performance, not just performance that is productive or unproductive. This shift makes it easier to talk about performance in systems in which the next careless error may be the last trial. The language of care is more suited to systems concerned with reliability than is the language of efficiency.

Much of the interest in organizations that are vulnerable to catastrophic accidents can be traced to Perrow's (1981) initial analysis of Three Mile Island, followed by his expansion of this analysis into other industries (Perrow, 1984). In the expanded analysis, Perrow suggested that technologies that are both tightly coupled and interactively complex are the most dangerous, because small events can escalate rapidly into a catastrophe. Nuclear aircraft carriers such as those we have studied are especially prone to normal accidents (see Perrow, 1984: 97) because they comprise not one but several tightly coupled, interactively complex technologies. These include jet aircraft, nuclear weapons carried on aircraft, nuclear weapons stored on board the ship, and nuclear reactors used to power the ship. Furthermore, the marine navigation system and the air traffic control system on a ship are tightly coupled technologies, although they are slightly less complex than the nuclear technologies.

Despite their high potential for normal accidents, carriers are relatively safe. Our analysis suggests that one of the reasons carriers are safe is because of, not in spite of, tight coupling. Our analysis raises the possibility that technological tight coupling is dangerous in the presence of interactive

complexity, unless it is mediated by a mutually shared field that is well developed. This mutually shared field, built from heedful interrelating, is itself tightly coupled, but this tight coupling is social rather than technical. We suspect that normal accidents represent a breakdown of social processes and comprehension rather than a failure of technology. Inadequate comprehension can be traced to flawed mind rather than flawed equipment.

The Conceptualization of Practice

The mindset for practice implicit in the preceding analysis has little room for heroic, autonomous individuals. A well-developed organization mind, capable of reliable performance is thoroughly social. It is built of ongoing interrelating and dense interrelations. Thus, interpersonal skills are not a luxury in high-reliability systems. They are a necessity. These skills enable people to represent and subordinate themselves to communities of practice. As people move toward individualism and fewer interconnections, organization mind is simplified and soon becomes indistinguishable from individual mind. With this change comes heightened vulnerability to accidents. Cockpit crews that function as individuals rather than teams show this rapid breakdown in ability to understand what is happening (Orlady and Foushee, 1987). Sustained success in coping with emergency conditions seems to occur when the activities of the crew are more fully interrelated and when members' contributions, representations, and subordination create a pattern of joint action. The chronic fear in high-reliability systems that events will prove to be incomprehensible (Perrow, 1984) may be a realistic fear only when social skills are underdeveloped. With more development of social skills goes more development of organization mind and heightened understanding of environments.

A different way to state the point that mind is dependent on social skills is to argue that it is easier for systems to lose mind than to gain it. A culture that encourages individualism, survival of the fittest, macho heroics, and can-do reactions will often neglect heedful practice of representation and subordination. Without representation and subordination, comprehension reverts to one brain at a time. No matter how visionary or smart or forward-looking or aggressive that one brain may be, it is no match for conditions of interactive complexity. Cooperation is imperative for the development of mind.

Reliable performance may require a well-developed collective mind in the form of a complex, attentive system tied together by trust. That prescription sounds simple enough. Nevertheless, conventional understanding seems to favor a different configuration: a simple, automatic system tied together by suspicion and redundancy. The latter scenario makes sense in a world in which individuals can comprehend what is going on. But when individual comprehension proves inadequate, one of the few remaining sources of comprehension is social entities. Variation in the development of these entities may spell the difference between prosperity and disaster.

REFERENCES

Asch, Solomon E.
1952 Social Psychology. Englewood Cliffs, NJ: Prentice-Hall.

Bellah, Robert N., Richard Madsen, William M. Sullivan, Ann Swidler, and Steven M. Tipton
1991 The Good Society. New York: Knopf.

Blumer, Herbert
1969 Symbolic Interaction. Berkeley: University of California Press.

Boden, Margaret A.
1990 "Introduction." In Margaret A. Boden (ed.), The Philosophy of Artificial Intelligence: 1–21. New York: Oxford University Press.

Bruner, Jerome
1986 Actual Minds. Possible Worlds. Cambridge, MA: Harvard University Press.

Churchland, Paul M.
1992 "A deeper unity: Some Feyerabendian themes in neurocomputational form." In Steven Davis (ed.), Connectionism: Theory and Practice: 30–50. New York: Oxford University Press.

Daft, Richard, and Karl E. Weick
1984 "Toward a model of organizations as interpretation systems." Academy of Management Review, 9: 284–295.

Dornbusch, Sandford M., and W. Richard Scott
1975 Evaluation and the Exercise of Authority. San Francisco: Jossey-Bass.

Dreyfus, Hubert L., and Stuart E. Dreyfus
1990 "Making a mind versus modeling the brain: Artificial intelligence back at a branch point." In Margaret A. Boden (ed.), The Philosophy of Artificial Intelligence: 309–333. New York: Oxford University Press.

Eisenberg, Eric
1990 "Jamming: Transcendence through organizing." Communication Research, 17: 139–164.

Eisenhardt, Kathleen M.
1989 "Building theories from case study research." Academy of Management Review, 14: 532–550.
1993 "High reliability organizations meet high velocity environments: Common dilemmas in nuclear power plants, aircraft carriers, and microcomputer firms." In Karlene Roberts (ed.), New Challenges to Understanding Organizations: 117–135. New York: Macmillan.

Elman, Jeffrey L.
1992 "Grammatical structure and distributed representations." In Steven Davis (ed.), Connectionism: Theory and Practice: 138–178. New York: Oxford University Press.

Faulkner, Robert R., and A. B. Anderson
1987 "Short-term projects and emergent careers: Evidence from Hollywood." American Journal of Sociology, 92: 879–909.

Follett, Mary Parker
1924 Creative Experience. New York: Longmans, Green.

Galanter, Marc
1989 Cults. New York: Oxford University Press.

Gersick, Connie G.
1988 "Time and transition in work teams: Toward a new model of group development." Academy of Management Journal, 31: 9–41.

Gillcrist, P. T.
1990 Feet Wet: Reflections of a Carrier. Novato, CA: Presidio Press.

Ginnett, Robert C.
1990 "Airline cockpit crew." In J. Richard Hackman (ed.), Groups That Work (and Those That Don't): 427–448. San Francisco: Jossey-Bass.

Glaser, Barney, and Anselm L. Strauss
1967 The Discovery of Grounded Theory: Strategies for Qualitative Research. Chicago: Aldine.

Hackman, J. Richard
1987 "The design of work teams." In Jay Lorsch (ed.), Handbook of Organizational Behavior: 315–342. Englewood Cliffs, NJ: Prentice-Hall.

Hackman, J. Richard (ed.)
1990 Groups That Work (and Those That Don't). San Francisco: Jossey-Bass.

Hedberg, Bo L. T., Paul C. Nystrom, and William H. Starbuck
1976 "Camping on seesaws: Prescriptions for a self-designing organization." Administrative Science Quarterly, 21: 41–65.

Homans, George C.
1950 The Human Group. New York: Harcourt.

Hutchins, Edwin
1990 "The technology of team navigation." In Jolene Galegher, Robert E. Kraut, and Carmen Egido (eds.), Intellectual Teamwork: 191–220. Hillsdale, NJ: Erlbaum.
1991 "The social organization of distributed cognition." In Lauren B. Resnick, John M. Levine, and Stephanie D. Teasley (eds.), Perspectives on Socially Shared Cognition: 283–307. Washington, DC: American Psychological Association.

Janis, Irving
1982 Groupthink, 2d ed. Boston: Houghton-Mifflin.

Langer, Eleanor J.
1989 "Minding matters: The consequences of mindlessness-mindfulness." In Leonard Berkowitz (ed.), Advances in Experimental Social Psychology, 22: 137–173. New York: Academic Press.

LaPorte, Todd R., and Paula M. Consolini
1991 "Working in practice but not in theory: Theoretical challenges of high-reliability organizations." Journal of Public Administration Research and Theory, 1: 19–47.

Lave, Jean, and Etienne Wenger
1991 Situated Learning: Legitimate Peripheral Participation. New York: Cambridge University Press.

Lyons, William
1980 Gilbert Ryle: An Introduction to His Philosophy. Atlantic Highlands, NJ: Humanities Press.

McGrath, Joseph E.
1984 Groups: Interaction and Performance. Englewood Cliffs, NJ: Prentice-Hall.
1990 "Time matters in groups." In Jolene Galegher, Robert E. Kraut, and Carmen Egido (eds.), Intellectual Teamwork: 23–61. Hillsdale, NJ: Erlbaum.

Mead, George Herbert
1934 Mind, Self, and Society. Chicago: University of Chicago Press.

Morgan, Gareth
1986 Images of Organization. Beverly Hills, CA: Sage.

Orlady, Harry W., and H. Clayton Foushee
1987 Cockpit Resource Management Training. Springfield, VA: National Technical Information Service (N87-22634).

Orr, Julian E.
1990 "Sharing knowledge, celebrating identity: Community memory in a service culture." In David Middleton and Derek Edwards (eds.), Collective Remembering: 169–189. Newbury Park, CA: Sage.

Perrow, Charles
1981 "The President's Commission and the normal accident." In D. Sills, C. Wolf, and V. Shelanski (eds.), The Accident at Three Mile Island: The Human Dimensions: 173–184. Boulder, CO: Westview Press.
1984 Normal Accidents. New York: Basic Books.

Peters, Tom
1992 Liberation Management. New York: Knopf.

Porac, Joseph F., Howard Thomas, and Charles Baden-Fuller
1989 "Competitive groups as cognitive communities: The case of Scottish knitwear manufacturers." Journal of Management Studies, 26: 397–416.

Powell, Walter W.
1990 "Neither market nor hierarchy: Network forms of organization." In Barry M. Staw and Larry L. Cummings (eds.), Research in Organizational Behavior, 12: 295–336. Greenwich, CT: JAI Press.

Quinlan, Phillip
1991 Connectionism and Psychology. Chicago: University of Chicago Press.

Roberts, Karlene H., Denise M. Rousseau, and Todd R. LaPorte
1993 "The culture of high reliability: Quantitative and qualitative assessment aboard nuclear powered aircraft carriers." Journal of High Technology Management Research (in press).

Roberts, Karlene H., Susan Stout, and Jennifer J. Halpern
1993 "Decision dynamics in two high reliability military organizations." Management Science (in press).

Rochlin, Gene I.
1989 "Organizational self-design is a crisis-avoidance strategy: U.S. naval flight operations as a case study." Industrial Crisis Quarterly, 3: 159–176.

Rochlin, Gene I., Todd R. LaPorte and Karlene H. Roberts
1987 "The self-designing high-reliability organization: Aircraft carrier flight operations at sea." Naval War College Review, 40(4): 76–90.

Rumelhart, David E.
1992 "Towards a microstructural account of human reasoning." In Steven Davis (ed.), Connectionism: Theory and Practice: 69–83. New York: Oxford University Press.

Ryle, Gilbert
1949 The Concept of Mind. Chicago: University of Chicago Press.

Sandelands, Lloyd E., and Ralph E. Stablein
1987 "The concept of organization mind." In Samuel Bacharach and Nancy DiTomaso (eds.), Research in the Sociology of Organizations, 5: 135–161. Greenwich, CT: JAI Press.

Schneider, David J.
1991 "Social cognition." In Lyman W. Porter and Mark R. Rosenzweig (eds.), Annual Review of Psychology, 42: 527–561. Palo Alto, CA: Annual Reviews.

Schneider, W., and R. M. Shiffrin
1977 "Controlled and automatic human information processing: I. Detection, search and attention." Psychological Review, 84: 1–66.

Schutz, William C.
1958 FIRO: A Three-Dimensional Theory of Interpersonal Behavior. New York: Holt, Rinehart, and Winston.

Sitkin, Sim
1992 "Learning through failure: The strategy of small losses." In Barry Staw and Larry Cummings (eds.), Research in Organizational Behavior, 14: 231–266. Greenwich, CT: JAI Press.

Starbuck, William H., and Francis J. Milliken
1988 "Challenger: Fine-tuning the odds until something breaks." Journal of Management Studies, 25: 319–340.

Sutton, Robert I., and Meryl R. Louis
1987 "How selecting and socializing newcomers influences insiders." Human Resource Management, 26: 347–361.

Thompson, James D., and Arthur Tuden
1959 "Strategies, structures, and processes of organizational decision." In James D. Thompson (ed.), Comparative Studies in Organization: 195–216. Pittsburgh: University of Pittsburgh Press.

Tuckman, Bruce W.
1965 "Developmental sequence in small groups." Psychological Bulletin, 63: 384–399.

U.S. General Accounting Office
1991 Management Practices: U.S. Companies Improve Performance through Quality Efforts. Document GAO/NSIAD-91-190. Washington, DC: U.S. Government Printing Office.

Van Maanen, John
1976 "Breaking in: Socialization to work." In Robert Dubin (ed.), Handbook of Work, Organization and Society: 67–130. Chicago: Rand McNally.

Walsh, James P., and Gerardo R. Ungson
1991 "Organizational memory." Academy of Management Review, 16: 57–91.

Wegner, Daniel M.
1987 "Transactive memory: A contemporary analysis of the group mind." In Brian Mullen and George R. Goethals (eds.), Theories of Group Behavior: 185–208. New York: Springer-Verlag.

Wegner, Daniel M., Ralph Erber, and Paula Raymond
1991 "Transactive memory in close relationships." Journal of Personality and Social Psychology, 61:923–929.

Wegner, Daniel M., Toni Giuliano, and Paula T. Hertel
1985 "Cognitive interdependence in close relationships." In William J. Ickes (ed.), Compatible and Incompatible Relationships: 253–276. New York: Springer-Verlag.

Weick, Karl E.
1983 "Contradictions in a community of scholars: The cohesion-accuracy tradeoff." Review of Higher Education, 6(4): 253–267.

Weick, Karl E., and Larry Browning
1986 "Arguments and narration in organizational communication." Journal of Management, 12: 243–259.

Weick, Karl E., and David P. Gilfillan
1971 "Fate of arbitrary traditions in a laboratory microculture." Journal of Personality and Social Psychology, 17: 179–191.

Wilson, G. C.
1986 Supercarrier. New York: Macmillan.