It took one scientist to come up with the theory of gravitational waves but more than a thousand scientists to prove it. Albert Einstein predicted the existence of gravitational waves more than 100 years ago, as part of his General Theory of Relativity. Einstein’s world-changing theory stated that space and time curve in the presence of mass and that this curvature produces the effect known as gravity. When two black holes orbit each other they stretch and squeeze, creating vibrations known as gravitational waves. Even Einstein had doubts about the concept, so it was a scientific moment on par with the moon landing when an “explosion” was heard by LIGO (Laser Interferometer Gravitational-Wave Observatory) detectors in Louisiana and Washington in 2015, after 50 years of efforts to capture the waves. LIGO was constructed in 1990 (amid much controversy about money being wasted because of the completely theoretical nature of gravitational waves) and refined for 25 years. Over the years, more than a thousand scientists from 14 countries were involved with the project. Engineers learned how to create a pure vacuum for detecting sounds. U.S. scientists worked with German teams to create more sensitive lasers and enormous mirrors for capturing data. Teams of scientists from around the world analyzed data, searching in vain for positives within the collected data. Within LIGO itself, validation groups reviewed how instruments were calibrated, took apart software code, and were cognizant of charting worldwide environmental disturbances that affected listening parameters. But the most secretive was a small group whose job it was to create “blind injections” or false evidence of gravitational waves to keep scientists on point. “We didn’t know what, when or who,” said a fellow scientist. The refinements paid off when a newly improved detector, mere hours after going online, detected waves from a black hole collision 1.1 billion years ago. The implications for understanding the nature of the universe are enormous.1

Effective communication is essential for high-performance teamwork. However, as teamwork grows more specialized, communication and knowledge-sharing become more difficult. This chapter examines how team members communicate and develop mental models for understanding tasks and processes. We discuss team mental models, transactive memory systems, knowledge sharing and describe the information-dependence problem—the fact that team members depend on one another for critical information and knowledge. We do an in-depth exploration of transactive memory systems (TMS), which are the ways in which team members encode, store, and retrieve critical information necessary for doing their work. Finally, we make some recommendations for team learning.

**COLLABORATION**

Functionally diverse teams are composed of people who have different information, knowledge, and expertise and must share and integrate it. Collaboration is the art and science of sharing and using knowledge. Collaborative problem solving requires that groups generate new information and make inferences that no individual group member could have inferred. In this regard, three types of inferences might be distinguished: individual (generated by a single team member), shared (generated by the group, who all possess the information), and collaborative (new information that can be inferred from individual members’ information). Groups are best able to generate inferences from shared information, followed by individual information, but are least adept at generating collaborative inferences. One strategy for improving the quality of pooled information during collaborative problem solving is by allowing individual group members the time to internally recall and record details of personal experience or observation that can be shared later with the group as a whole. Another strategy that improves collaborative problem solving is following a process script of information gathering and sharing. This structured script or training regimen allows each group member to experience the same process and problems, establishes time for individual and group work phases, and encourages positive argument construction. Several factors can threaten the ability of teams to accurately share and use knowledge.

**Uneven Communication**

The uneven communication problem refers to the fact that in virtually any group, a handful of people do the majority of the talking. For example, in a typical five-person group, two people do more than 60 percent of the talking; in a six-person group, three people do about 60 percent of the talking; and in a group of eight, four people do more than 80 percent of the talking. Unfortunately, people who do the majority of the talking might not be the people who are the most informed about the problem. Exhibit 6-1 plots the percentage of communication attributed to each member in groups of 3–8 members; in all cases, communication is uneven and skewed.

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Knowledge Specialization

Knowledge specialization, such as that present in cross-functional teams, has both positive and negative outcomes. Compared to group members with shared expertise, members with unique expertise feel out of the loop, particularly when their expertise is given less weight in group decisions. However, members who possess unique expertise do not decrease their likelihood of emerging as a leader.

Knowledge Sharing and Knowledge Hiding

Team members can either engage in explicit knowledge sharing which leaves little room for interpretation, or they might engage in tacit knowledge sharing which requires receivers to make a series of inferences. Team members who have dissimilar expertise from their teammates are more likely to exhibit creativity when the team as a whole engages in tacit, rather than explicit knowledge sharing, but when members have similar expertise to their teammates, explicit knowledge sharing leads to more creative idea generation.

Knowledge hiding occurs when people conceal knowledge from others. This triggers a reciprocal distrust loop in which teammates are unwilling to share

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knowledge. Moreover, the very act of hiding knowledge reduces the conceiver’s own creativity.  

**TRANSFORMING KNOWLEDGE INTO SOLUTIONS**

**Absorptive capacity** is a person’s ability to transform new knowledge into usable knowledge. Absorptive capacity involves knowledge assessment, knowledge assimilation, and knowledge application. For example, team members high in absorptive capacity agree with statements such as the following: “The people in my team are able to decipher the knowledge that is most valuable to us” (assessment), “The shared knowledge in my team makes it straightforward to understand new material in our technical areas” (assimilation) and “My team can adapt our work to utilize new technical knowledge” (application). According to **information elaboration theory**, functionally diverse teams need to transform their breadth of knowledge into actionable solutions. Both cognitive ability and low preferences for self-reliance increase information elaboration in teams in turbulent environments.

**EXPERIENCED COMMUNITY OF PRACTICE**

**Experienced community of practice** is the extent to which a person is engaged with the given practice community. Key indicators of involvement in relevant knowledge communities include the following: open communication among members (e.g., “I feel comfortable communicating freely with others in my technical specialty”); a shared vocabulary (“There is a common understanding within my technical specialty of the words and meanings that are used within the technical specialty”); recall of previous lessons (“Participating in meetings with members of my technical specialty helps me to remember things we have learned”); and learning from one another (“I learn new skills and knowledge from collaborating with others in my technical specialty”).

Field studies reveal that teams high in knowledge-sharing practices have higher customer satisfaction and better performance. A meta-analysis of 4,795 groups revealed the following:

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that information sharing in groups predicted team performance.\textsuperscript{12} In one investigation, a comparison of businesses operating under the same industry conditions examined how executives in each business understood, searched for, and used knowledge to create unique advantages for their firms. The strategic outcomes of firms were predicted by each manager’s understanding of the company’s micro-level knowledge processes. In particular, not only do senior leaders differ in their beliefs about what information is available in their companies, but also how their beliefs lead to different scanning orientations. In particular, knowledge becomes a strategic resource when managers engage in proactive scanning (mindful and rich search efforts) and then put that knowledge into practice via knowledge adaptation (clever, improvisational solutions to problems) and knowledge augmentation (challenging, changing, and expanding knowledge).\textsuperscript{13}

**Adaptive Capacity**

Adaptive capacity refers to a team’s ability to adapt their strategy in the face of change and upheaval. For example, in a simulation in which teams managed a new city that required growth strategies but were then abruptly switched to manage a city that was already established and required revitalization strategies, the teams that formed similar and accurate strategy mental models and shared goal-relevant information were more successful.\textsuperscript{14}

**Monitoring and Talking to the Room**

Two implicit coordination behaviors emerge within teams working in high-risk environments: team member monitoring and talking to the room. Talking to the room is defined as undirected talk to relay relevant information or comment about the performance of real-time self behavior.\textsuperscript{15} For example, an investigation of 27 anesthesia teams revealed that higher-performing teams were those in which a team member’s monitoring was followed by speaking up, giving assistance, and talking to the room.\textsuperscript{16}

**Team Mental Models**

Mental models are mental representations of the world that allow people to understand, predict, and solve problems in a given situation.\textsuperscript{17} Mental models can represent

\begin{itemize}
\end{itemize}
a simple physical system, such as the trajectory of a thrown object, and also can represent a complex social system, such as an organization or financial system.

**A team mental model** is a common understanding that members of a group share about how something works. Team members have mental models about the work they do, and about the operation of their team. Mental models develop through the process of role identification behaviors (through which team members share information regarding their specialized knowledge, skills, and abilities). Teams with a cognitive foundation, such as a mental model, perform better than teams that lack a cognitive foundation.

**REFLECTIVE VS. REFLEXIVE MENTAL MODELS**

Reflective mental models (C-system) are formed through reasoning and deliberation; in contrast, reflexive mental models (X-system) are more automatic, intuitive, and affective in nature. X-system representations pertaining to the team’s task and members can compete with shared C-system mental models. For example, even when team members have similar C-system mental models, their X-system representations might not be similar; or vice versa, producing illusory concordance (i.e. thinking they agree when they don’t) or surface discordance (believing that they disagree when in fact they do agree).

**REPRESENTATIONAL GAPS**

A team that has a large **representational gap** has inconsistent views about the definition of the team’s problem or task, such that team members have different mental models about the task. In one investigation, a large cross-functional project team at a U.S. automobile manufacturer was studied. The vehicle design team was composed of more than 200 members responsible for all aspects of auto design, engineering, and future model production. The vehicle team was subdivided into small teams, each responsible for a specific component or system of the car (e.g., body and chassis). Intensive study of these teams and how they worked on a day-to-day basis revealed that task disagreement was a necessary part of team functioning. The greater the representational gap, the more teams disagreed about a task (see Exhibit 6-2). To effectively close representational gaps in cross-functional teams, teams should share some degree of collective understanding about a problem so that they can “translate” their own knowledge.

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22 Ibid.

bases. Team members who are motivated to learn about others’ perspectives are more successful than those who are less motivated.

**Accuracy**

Suppose that you are asked to explain how the thermostat in your house operates. According to one (erroneous) model, the “valve” model, the thermostat works much like the accelerator in a car. People who hold a valve mental model of a thermostat reason that just as greater depression of the accelerator causes the car’s speed to increase at a faster rate, turning the thermostat setting to high temperatures causes the room temperature to increase at a faster rate.

A different (and correct) mental model is the “threshold” model, in which the heat is either on or off and the thermostat setting determines the duration for which the heat is on. The greater the discrepancy between the current room temperature and the thermostat setting, the longer the heat will be on. These two models have different implications for how people set the thermostat in their homes. People with valve models will continually adjust their thermostat setting in an effort to reach a comfortable room temperature. In contrast, those with threshold models will determine at what temperature they are comfortable and set the thermostat to only one or two settings per day, a nighttime setting and a daytime setting. Thermostat records revealed that people’s models of how thermostats operate predicted the stability of their actual thermostat settings.

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The use of an incorrect mental model can result in inefficient or undesirable outcomes. People with an incorrect mental representation of a thermostat as a valve will spend greater time and effort adjusting the thermostat setting. In addition, they will be perpetually uncomfortable because they will be either too warm or too cold.

One investigation examined the cognitive styles of team members performing a navigation and identification task. Teams high in spatial visualization were more process-focused than teams high in object visualization, and greater process focus was associated with fewer errors.

**Correspondence**

Effective teams adapt to external demands and anticipate other members’ information needs because of shared or compatible knowledge structures or team mental models. For example, when novel or unexpected events are encountered (such as when one airplane enters another’s airspace), teams that cannot overtly strategize must rely on preexisting knowledge and expectations about how the team must perform to cope with task demands. The greater the overlap or commonality among team members’ mental models, the greater the likelihood that team members will predict the needs of the task and team, adapt to changing demands, and coordinate activity with one another successfully. For example, the negative effects of fatigue on air crew performance can be overcome when crews develop interaction patterns over time. An investigation of 69 software development teams revealed that “expertise coordination”—the shared knowledge of who knows what—was a key predictor of team performance over and above expertise and administrative coordination. And, transformational leadership behaviors are associated with team mental model similarity (correspondence) and greater similarity predicts team efficacy.

Consider Perrow’s description of the Cuyahoga disaster in his book on “normal accidents”: On a dark evening in the fall of 1978, two vessels in the Chesapeake Bay sighted and approached each other. One vessel was the Coast Guard vessel, The Cuyahoga, whose captain assumed the approaching boat was a small fishing vessel. The captain thought he only saw 2 lights on the vessel, meaning the boat was going in...

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the same direction as his ship. The Cuyahoga’s First Mate, however, saw 3 lights, a signal for an approaching vessel. The first mate thought the captain had made the same assessment as he had, so he didn’t question the captain as the ships grew closer. The captain wrongly assumed the other fishing vessel was one he could pass and ordered a turn to port. This misjudgment of approach caused the Cuyahoga to collide with what turned out to be a large cargo vessel, and the collision caused the deaths of 11 sailors on the Cuyahoga. Clearly, the captain’s mental model was incorrect. In addition, there was a lack of correspondence between the captain and the first mate’s mental models.

In one investigation of 83 teams working on a complex skill task over a 2-week training protocol, both mental model accuracy and mental model correspondence were tested. Accuracy was the stronger predictor of team performance. And, the teams’ ability was related more strongly to accuracy than to mental model correspondence.

**TRANSACTIVE MEMORY SYSTEMS**

A transactive memory system (TMS) is a shared system for attending to, encoding, storing, processing, and retrieving information. Think of TMS as a division of mental labor. When each person learns in some general way what the other people on the team might know in detail, team members can share detailed memories. In essence, each team member cultivates the other members as external memory, and in doing so, they become part of a larger system. A TMS develops implicitly in many teams to ensure that important information is not forgotten. A TMS is a combination of two things: knowledge possessed by particular team members and awareness of who knows what. In this way, a TMS serves as an external storage device, such as a library or computer, that can be visited to retrieve otherwise unavailable information. Teams that have a TMS have access to more and better information than any single group member has alone. A TMS is beneficial to small groups that use quality as a performance measure, but more beneficial to large groups, groups in dynamic task environments, and groups in volatile knowledge environments that involve time as a critical performance measure.

Team members instinctively expect that the “experts” on the team will remember the details most closely associated with their area of expertise. Even when the experts are not so clearly defined, people specialize in remembering certain kinds of information, and it is generally understood by all members of the team (although often implicitly) which person is to remember what. This way of processing information provides

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an advantage to teams because they collectively remember and use more information than individuals acting on their own—even the same number of individuals considered separately.

**Centralized vs. Decentralized TMS**

Teams perform better when their members know who is good at what. For example, when bank loan officers review the financial profiles of various companies and predict whether each company will go bankrupt, diversity in expertise and the ability of groups to recognize expertise improve predictions. Unexpected problems can be solved faster and with more ease when members know who is good at what. Such knowledge allows team members to match problems with the people most likely to solve them. People learn and recall more information in their own area of expertise when their partner has different, rather than similar, work-related expertise. One investigation compared groups who were trained to use their knowledge to solve problems with individuals to groups with no training. The groups who were trained to share information had more effective dialogues, were better able to recognize which members had expertise, and had better performance.

**Metaknowledge** in TMS is the knowledge of “who knows what.” In some teams, metaknowledge is concentrated within one central member (centralized TMS); whereas in other teams, metaknowledge is distributed evenly among members (decentralized TMS). Centralized metaknowledge offers teams a performance advantage over decentralized metaknowledge because the central member can act as a catalyst for information exchange and integration.

**Differentiated vs. Integrated TMS**

Another distinction of TMS is differentiated TMS and integrated TMS. Differentiated knowledge structures connect knowledge distributed across team members, such that different items of information are stored in different individual memory stores, but individuals know the general locations of the information they do not hold personally. In contrast, integrated knowledge structures connect knowledge common to all team members.

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members, such that the same items of information are held in different individual memory stores and the individuals are aware of the overlap because they share location information as well.

**Tacit Coordination**

Tacit coordination is the synchronization of members’ actions based on assumptions about what others on the team are likely to do. Task-oriented groups rarely discuss plans for how to perform their tasks unless they are explicitly instructed to do so. Team members’ attempts to coordinate tacitly begin prior to interaction. Evaluating the competence of other team members however, can be difficult. Claims of personal competence by coworkers cannot always be trusted because they might reflect members’ desires to impress one another. Accepting coworkers’ evaluations of one another’s competence can be risky as well because these secondhand evaluations are often based on limited information and might reflect impression-management efforts by the people who provide them. TMS eliminates much of the coordination loss that can plague team effectiveness. Teams that have a transactive memory structure because their members are familiar with one another are less likely to fall prey to the common information effect compared with teams composed of previously unacquainted persons.

**Routine vs. Nonroutine Tasks**

In one investigation, the completion times of teams of doctors performing total joint replacements in hospital surgeries were examined. Three types of learning were examined: organizational experience (i.e., the number of times that kind of procedure had been performed), individual experience (i.e., the number of times a given person on a given team had performed the surgery), and team experience (i.e., the number of times any two people on a team had performed the surgery together). If successful surgical procedures were simply a function of accumulated expertise, then “team learning” should not matter. However, it does: The more times people have worked together as a

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47 Gruenfeld, Mannix, Williams, & Neale, “Group composition and decision making.”

team, the faster (and smoother) is their surgery. For example, holding all other kinds of experience constant, a team whose members have performed 10 total knee replacements together takes 5 percent less time to complete the procedure when compared to a team that is just as accomplished but that has no experience in working together.

The benefits of TMS are not limited to teams that perform routine tasks. For example, emergency response teams, such SWAT and tactical police teams who have a TMS are better able to coordinate and adapt, resulting in better performance.49

Resilience to Team Member Loss

Teams with well-developed TMS are better equipped to withstand the unplanned loss of a team member. A study of 78, four-person teams engaged in a command-and-control simulation revealed that TMS positively affected team performance following the loss of a member.50 However, the benefits of TMS are reduced following the loss of a critical team member because team members have more difficulty engaging in plan formation.

Reaction to Free-Riding

Teams with an integrated TMS structure more often perform the job for a noncontributory member, whereas teams with a differentiated structure more often facilitate the team member in performing his or her job.51 Teams with a differentiated TMS suffer more negative socioemotional interactions, lower cohesion and greater conflict than teams with an integrated TMS.

Developing a TMS

Work Planning Teams spend a disproportionate amount of their time together doing the task, rather than deciding how it should be done. Teams whose members will work together should plan their work. The data on medical errors at St. Francis Hospital in Hartford, Connecticut revealed the importance of planning: The more times a nurse had to leave the operating room to get something, the higher the patient infection rate.52 That discovery led to a new team process of preparing for surgery.

Training Training is one of the most effective ways of ensuring that groups quickly and accurately develop a TMS, and thereby protect team effectiveness. For example, federal work-hour caps to reduce training were established in 2003 in teaching hospitals that trained medical residents. A subsequent study found that patient complications in neurological brain


A fundamental question that companies face is whether to train individuals independently or as part of a team. As a guiding principle, there should be a high degree of correspondence between workers’ experiences during training and their experiences on the job. The key reason is that similar conditions will facilitate the transfer of knowledge learned in training to how individuals actually carry out their job. Training can be specifically geared toward developing specific TMS structures. For example, teams can plan who will be responsible for what types of information; they can also make explicit efforts to discern expertise and then make that information known to members. Transactive memory training might be especially important when team members will work together only for a single project or when the team interacts with several other teams across the organization. It is important to align the unit of work—for example, individual, small team, and large group—with the unit that is being trained. Therefore, when small teams work together, they should train together; when large groups work together, they should train together; when individuals work alone, it might be best to train them individually.

If a company has limited resources for training, it is important that employees who will work together receive their technical training together. If that is not feasible, the training that they do undergo together should be directly connected to the work they will do together: Merely having workers undergo interpersonal skills training together (which is largely divorced from the real work they will do together) can undermine performance. The key to effective learning in most situations is the receipt of timely and effective feedback.

EXAMPLE OF TRAINING IN WORK GROUPS As an illustration of the effect of a TMS on performance, simulated work groups were asked to assemble AM radios as part of a training experience. Training was organized in two ways: (1) individually-based training (as is common in many companies) and (2) group training, in which groups of three people worked together. In the training phase, all individuals and groups received identical information. Groups were not given any instructions in terms of how they should organize themselves. The only difference was whether people were trained alone or as part of a group.

Exactly one week later, the participants were asked to assemble the radios again. This was more difficult because no written instructions were provided, as had been the case in the training phase. In this part of the investigation, everyone was placed into a three-person team, given the parts of the radio, and asked to assemble it from memory. This meant that some of the groups were composed of people who had trained individually and others of those who had trained with a team. Thus, any difference in performance between the two types of groups would be attributable to the differences in training.

Not surprisingly, the groups that had trained together performed dramatically better. They were more likely to complete the assembly and did so with fewer errors. The intact groups performed better than did the ad hoc groups because they were able to tap into the TMS that had developed spontaneously during training.

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A TMS and an emphasis on team training are most relevant to tactical teams (i.e., teams that carry out a procedure) as opposed to creative or problem-solving teams. Thus, if a team is assembling radio parts, operating machinery in a coal mine, flying a jetliner, or performing heart surgery, it greatly benefits the members to have trained together on the job. (See Exhibit 6-3 for a case analysis of training effectiveness.)

PRELIMINARY INVESTIGATION

At a certain factory that assembles radios, a consultant was called in to assess variations in performance. To create healthy within-company competition, workers were organized into self-managing teams. There were four such teams in the plant, but performance varied dramatically across the four teams. What was the problem?

The consultant began her investigation by asking for information about how the different teams were trained. She uncovered four distinct training programs used by each of the teams. Upon interviewing each team in the plant, she found that each team was convinced that its method was the best one. When the consultant confronted teams with the evidence pointing to clear differences in performance, the team identified a number of countervailing factors that could have affected their performance. The managers were particularly concerned because the company was about to hire and train four new plant teams, and they did not know which method would be best. The consultant devised the following test using the radio assembly task. Everyone in the entire plant received identical technical training and ultimately performed in a three-person group. However, certain aspects of the training were systematically varied. The consultant tracked the following teams:

- **Red team:** Members of the red team were trained individually for one day.
- **Blue team:** Members of the blue team were given individual training for one day and then, the entire team participated in a two-day team-building workshop designed to improve cohesion and communication.
- **Yellow team:** Members of the yellow team were given group training for one day but were reassigned to different teams on the test day.
- **Green team:** Members of the green team were given group training for one day and remained in the same team on test day.

TEST DAY

On test day, the consultant wanted to capture the four key measures of team performance outlined in Chapter 5. While the hiring organization seemed primarily interested in productivity—as measured by number of units successfully completed—the consultant also was interested in assessing other indicators of team performance, such as cohesion, learning, and integration.

The consultant first asked each team to recall as much as they could about the training. In short, each team was asked to reconstruct the assembly instructions from memory. The consultant used this as a measure of organizational memory. The consultant then asked each team to assemble the radios without the benefit of any kind of written instructions. Thus, each team was forced to rely on the training principles they had learned and (hopefully) remembered. Results were timed so that each team could be evaluated with respect to both efficiency and how accurately they met specifications.

Then, the consultant asked each team member to evaluate other team members in terms of their task expertise. This was a measure of the tendency to specialize in remembering distinct aspects of the task, as well as who was regarded by all team members as having a relevant skill. The consultant videotaped each team during the critical test phase and documented how smoothly members worked together in terms of the principles of coordination. Specifically, did members drop things unintentionally on the floor? Lose parts? Bump elbows? Repeat questions and directions? Question each others’ expertise and knowledge? Or alternatively, did the team work together seamlessly?
The videos revealed the level of team motivation and also allowed the consultant to document things such as how close members of the team sat to one another and the tone of their conversation. Finally, the consultant recorded the “We-to-I” ratio, or the number of times team members said “we” versus “I” an implicit measure of team identity and cohesion. What do you think happened?

OUTCOME
The green team outperformed all of the other teams in terms of accuracy of completion.

DEBRIEF WITH MANAGERS
One of the managers found it difficult to believe that team training received by the blue team in the area of cohesion and interpersonal skills did not make an appreciable difference. “We spend a lot of money every year trying to build trust and cohesion in our teams. Is this going to waste?” The consultant then shared the information shown in “Effects of Various Training Methods on Assembly Errors.”

The results in the graph directly compare teams with a total of six weeks of working intensively with one another on cohesion-building (non-technical skill-building) tasks with teams who are virtual strangers, with the exception of having trained together. The fewest number of errors were made by groups who trained with one another and then performed together; having special training in cohesion on top of that does not seem to matter much.

![Effects of Various Training Methods on Assembly Errors](chart)

**Exhibit 6-3 Case Analysis of Different Types of Training Effectiveness**

GROUP TRAINING  In tactical and problem-solving teams, members who work and train together perform better than do teams whose members are equally skilled but do not train together. Team member change causes high levels of coordination loss when teams have key roles and when members change to a more strategically core role. In contrast, team training increases performance by facilitating recognition and utilization of member expertise.

The importance of work group familiarity vis-à-vis training is hard to overestimate. For example, familiarity among team members is associated with fewer accidents and fatalities among pairs of crew members working closely together in coal mines (e.g., miner operators and miner helpers). Although familiarity with the terrain has somewhat more impact than personnel similarity, the latter factor is clearly important, especially when teams work in less familiar terrain. Familiarity is associated with higher levels of crew productivity, even after labor, technology, and environmental factors are taken into account.

STRESS REDUCTION  Acute stress affects team mental models and transactive memory in teams. In one investigation, the performance of 97 teams working on a command-and-control simulation was negatively affected when teams were under acute stress. However, stressors that were regarded as a challenge (challenge stressor) improved performance and transactive memory; hindrance stressors negatively affected performance (even when combined with a challenge stressor). Similarly, when nuclear power plant control room crews were examined in a simulated crisis, higher-performing crews were more adaptable in terms of exhibiting fewer, shorter, and less complex interaction patterns.

COMMON INFORMATION EFFECT  By pooling their different backgrounds, training, and experience, team members have the potential to work in a more informed fashion than would be the case if the decision were relegated to any single person. The fact that team members are dependent on one

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another for information is the information dependence problem. As an example of information dependence in groups and the dire consequences it can have, consider the case in Exhibit 6-4.

When the team consists of members who come from different functional areas—with different areas of expertise, different information, different priorities, and different perceptions of problems and opportunities—the information dependence problem is exacerbated.

Suppose a three-member top-executive committee is charged with the task of hiring a new manager for an important division. The company has determined that six pieces of information are critical to evaluate for this position:

- Previous experience (A)
- Academic grades (B)
- Standardized test scores (C)
- Performance in Round 1 interview (D)
- Cultural and international experience (E)
- Letters of recommendation (F)

The committee has narrowed the competition to three candidates. As is standard practice in the company, members of the hiring committee specialize in obtaining partial information about each candidate. Consider three possible distributions of information (see Exhibit 6-5):

- **Non-overlapping case** Each partner has unique information about each candidate.
- **Distributed, partial overlap** Each partner not only knows something about each candidate that others also know (common information) but also knows some unique information.

Exhibit 6-4 Information Dependence Problem


In 1955, Jonas Salk announced the development of the first polio vaccine. In the previous year before Salk’s public announcement for launching efforts for nationwide vaccination, the Centers for Disease Control convened a group of six vaccine manufacturers. These manufacturers met with the Division of Biological Standards, Jonas Salk, and a number of other experts to discuss issues related to the production of the vaccine. Some of the manufacturers shared with the group that they had encountered problems during their efforts to inactivate the virus during the manufacturing processes. One of the manufacturers began to explain how his company’s process had been more effective and successful at inactivating the virus. Early in this representative’s explanation, a member from another vaccine manufacturer left the room to take a phone call and came back after the discussion was finished. Within 2 weeks of the start of the nationwide vaccination program, the Centers for Disease Control began to receive reports of polio. Significantly, the children who had received the vaccine 6 to 8 days earlier had contracted polio, almost without exception, in the leg or arm where they had received the polio vaccination. Of the half-dozen reported cases, the contaminated vaccine, containing the live virus, was manufactured in the lab of the representative who took the phone call during the pivotal discussion on inactivating the virus.
Part 2 • Team Performance

Each partner knows full information about each candidate. In this sense, the partners are informational clones of one another.

The only difference among these three cases is the information redundancy, or how equally the information is distributed among decision makers. The collective intelligence of the partners is identical in all three cases. Does the distribution of information affect the way the partners make decisions? In a rational world, it should not, but in real teams, it does. The impact of information on the aggregate decision of the team is directly related to the number of members of the team who know the information prior to making a group decision. Simply put, the main determinant of how much a given fact influences a group decision is not the fact itself, but rather, how many people happen to be aware of this fact prior to group discussion. This team fallacy is known as the common information effect.

This means that even though (in an objective sense) the six pieces of information are really equally important, the top management group will tend to overemphasize information (such as A and C in the distributed case) more than is warranted.

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The common information effect has several important consequences. First, team members are more likely to discuss information that everyone knows, as opposed to unique information. This often means that technical information (which is often not fully shared) is not given the weight that experts believe it should have. Information that people have in common is not only more likely to be discussed but it also gets discussed for a longer period of time, and this too can exert a significant bias on the integrity of decision making. People are better at remembering information they have read or described more than information they hear from others. The result is that teams often fail to make the decision that would be supported if all the team members had full information about the choices.

**Hidden Profile**

A hidden profile is a superior decision alternative, but its superiority is hidden from group members because each member has only a portion of the information that supports this superior alternative. Stated another way, the information held in common by group members favors a particular choice, whereas the unshared information contradicts the choice.

For the sake of example, let’s consider an executive meeting, in which three candidates (Alva, Jane, and Bill) are under consideration for promotion to partner in the organization. Each of the three candidates has been with the company for some number of years; each has made a different number and type of accomplishments. The executive group can promote only one person for the position at this time.

The group can benefit the organization by pooling individual members’ information so as to gain a complete picture of the qualifications of each candidate. This is particularly important when individual members of the decision-making team are biased by virtue of their own agendas.

Information that is known to only one or a few members often will be omitted from discussion. Team members are more likely not only to mention information if it was known to all before the discussion but also to bring it up repeatedly and dwell on it throughout the discussion. Thus, the team decision often will reflect the common knowledge shared by members before discussion rather than the diverse knowledge emanating from their unique perspectives and experiences.

Consider the scenario in Exhibit 6-6. In this situation, the initial bias favors Bill. At the outset of the meeting, each team member has more information about him (five pieces of information). The information the team has about Bill is fully shared, meaning that all team members are apprised of this candidate’s qualifications prior to the meeting. Obviously, Bill has done an excellent job of marketing his own achievements within the organization.

Next consider Alva, who has a combined total of eight pieces of favorable information supporting his candidacy for the partnership. However, each member of the executive team is privy only to three pieces of information about this candidate, and the

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information is not redundant. In an objective sense, Alva is by far the most qualified; yet his accomplishments are not fully shared among the top management team—a factor that will not be corrected with discussion (at least unstructured discussion).

If this team was immune to the common information effect, and the members optimally combined and pooled their unique information, Alva would prevail.

Common information also affects people’s memory for team discussions. People recall fewer unshared arguments from team discussion.66 Moreover, analysis of recorded discussions reveals that unshared arguments are less likely to be expressed.67

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There are a lot of plausible-sounding strategies for reducing the common information effect that unfortunately, are ineffective and might cause more harm than good, such as the following:

**INEFFECTIVE STRATEGIES**

**INCREASE THE AMOUNT OF DISCUSSION** Even when teams are explicitly told to spend more time discussing information, they still fall prey to the common information effect.68

**SEPARATE REVIEW FROM DECISION** In one investigation, team members were given instructions intended to curb the common information effect.69 Team members avoided stating their initial preferences and were encouraged to review all relevant facts. However, the discussion primarily favored those facts initially shared by team members (67 percent of all shared facts were discussed in contrast to 23 percent of unshared facts).

**INCREASE SIZE OF THE TEAM** As team size increases but the distribution of information stays the same, the tendency to discuss common information increases. For example, the common information effect is more pronounced in six-person groups than in three-person groups. In a typical three-person group, 46 percent of shared information is mentioned, in contrast to only 18 percent of unshared information. This difference is even larger for six-person groups.70 Moreover, if unique information is held by racially diverse members, even less information is shared.71

**INCREASE INFORMATION LOAD** If members of the team are given additional information but the relative distribution of information remains the same, the common information effect still plagues the team.72 In fact, the bias to discuss shared information is most likely to occur when there is a large number of “shared” facts to discuss. Groups perform better when they can reduce their cognitive load.73

**ACCOUNTABILITY** Accountability refers to the extent to which people and teams feel responsible for their actions and decisions. Surprisingly, teams that are accountable are less likely to focus on unshared information than groups that are not held accountable.74 Many professional teams are highly accountable for their decisions.

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70Ibid.


For example in one investigation, medical teams composed of a resident, an intern, and a third-year medical student, were given information about a patient and asked to reach a diagnosis. Videotaped analysis of the discussion revealed that shared information about the patient was mentioned more often (67 percent) than was unique information (46 percent). More disconcerting was that the teams offered incorrect diagnoses substantially more often for the hidden profile patient case than the standard patient cases: Overall, 17 of the 24 hidden profile cases were diagnosed correctly (a hit rate of about 70 percent), whereas all of the standard (shared information) cases were correctly diagnosed. Clearly, the medical teams’ overreliance on previously shared information and the inability to appropriately utilize unique information led to worse decisions.\(^7^5\)

In contrast, when groups are made to be accountable for their process (rather than outcome), they are more likely to repeat unshared information and make better decisions.\(^7^6\)

**PRE-DISCUSSION POLLING** One of the most common strategies for beginning a discussion is polling the group. However, this strategy can have extremely negative effects on the quality of the discussion that follows if the initial preferences of the team members are based on insufficient information. If the group is unanimous, members might not see the point of discussion. Furthermore, the very act of polling triggers conformity pressure, such that lower-status group members, eager to secure their position in the organization, might agree with the majority. For example, in teams deciding which of two cholesterol-reducing drugs to market, initial preferences were the major determinants of the group’s final decision.\(^7^7\) Moreover, people tend to regard the information that they possess to be more valid than other information.\(^7^8\)

**EFFECTIVE INTERVENTIONS**

Fortunately, there are ways to defeat the common information effect.

**LEADERSHIP** Team leaders are consistently more likely than are other members to ask questions and repeat unshared (as well as shared) information.\(^7^9\) Leaders play an important information management role during team discussion by focusing the team’s attention, facilitating communication, stimulating member contributions, and ensuring that critical information brought out during discussion is kept alive and factored into the team’s final decision. Directive leaders are more likely than participative leaders to repeat

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unshared information and consequently identify the best options. Leaders with more experience are also more effective.

**REDIRECT AND MAINTAIN THE FOCUS OF THE DISCUSSION TO UNSHARED (UNIQUE) INFORMATION** The more team members repeat common information, the less likely they are to uncover hidden profiles. Direct the focus of the discussion to unique information, and reintroduce noncommon information after it has been dismissed. The longer the delay in mentioning unique items of information, the lower the team’s performance. When team members are identified personally, the likelihood that unshared clues will be mentioned during discussion increases. When team members know who has expertise in specific knowledge domains, the amount of unshared information discussed increases significantly. Moreover, when groups are prompted to reflect upon who-knows-what, they make better decisions. In studies of groups that contain a “minority” information holder, groups make more profitable use of that knowledge when the minority information holder also possesses different information; in this sense, the social category differences signal important informational differences.

**APPROACH THE TASK AS A “PROBLEM TO BE SOLVED,” NOT A “JUDGMENT TO BE MADE”** Define the task as a “problem” to be solved with “demonstrable evidence.” Teams are less likely to overlook unshared information if they believe that their task has a demonstrably correct answer. As an example, members of the jury are explicitly told to pay attention to the facts and evidence. They are cautioned that the lawyers representing the parties in the case are not witnesses but rather are attempting to sway members of the jury to adopt a particular belief. It is precisely for this reason that trial lawyers have an opportunity to dismiss potential jurors who are regarded as unable to consider the facts because their mind is already made up—that is, they enter the courtroom with a particular bias or belief.

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82Van Swol, Savadori, & Sniezek, “Factors that may affect the difficulty of uncovering hidden profiles.”


RANK RATHER THAN CHOOSE  When teams are instructed to “rank” candidates or alternatives, they are more likely to make the best decision than when they are simply told to “choose.”89

CONSIDER ALTERNATIVES ONE AT A TIME  Discuss one alternative fully before turning to the next.90

SUSPEND INITIAL JUDGMENT  Caution team members against arriving at a judgment prior to the team discussion. The common information effect is a direct result of the biases that people bring to discussion, not the team discussion itself.91 The more group members choose the same alternative prior to the group discussion, the more strongly the group prefers information supporting that alternative.92 Even in the absence of dysfunctional group-level processes, group members tend to adhere to their initial, suboptimal decision preferences because of their tendency to evaluate information in a way consistent with their initial preference. In fact, even when all relevant information is exchanged by group members, nearly 50 percent of all groups fail to detect the superior alternative.93

BUILD TRUST AND FAMILIARITY AMONG TEAM MEMBERS  Teams whose members are familiar with one another are less likely to make poor decisions resulting from the common information effect than are teams whose members are unacquainted.94 The more team members perceive themselves to be cooperatively interdependent with others on their team, the more they share information, learn and are effective.95 Conversely, team members who are competitive with one another withhold unique information compared to members who are cooperative.96 Groups who realize that they share a goal of elaborating on information are more likely to make better decisions than groups who do not elaborate.97 The willingness to share information in a mixed-motive situation might depend on whether people have a pro-self or pro-social orientation. Pro-social people

consistently reveal their private and important information, but pro-self individuals strategically conceal or even lie about their private and important information.98

TEAM REFLEXIVITY   Team reflexivity is the process of discussing the groups’ tasks and goals and the way in which those goals can be reached.99 When group members don’t initially realize the importance of elaborating on information, team reflexivity increases the degree to which that importance is understood.100

COMMUNICATE CONFIDENCE   Teams whose members are encouraged to express confidence about their decisions and judgments perform more effectively and learn significantly more from their interaction than do teams whose ability to communicate confidence during interaction is reduced.101 Team members who self-servingly attribute a group’s past successes to themselves are more likely to share unique information and consider more divergent alternatives.102 Moreover, teams who have at least one member experiencing positive affect share more unique information than do groups composed of members who are neutral in affect.103

MINIMIZE STATUS DIFFERENCES   In one investigation, groups were formed to contain either equal-status members or unequal-status members.104 In some of these groups, the critical information required to make the best decision was given only to the low-status member. As compared with equal-status groups, mixed-status groups made poorer decisions and made fewer references to the critical information than the equal-status groups. Perhaps it is for this reason that nurses and doctors at St. Francis Hospital and Medical Center “level the authority gradient”: Everyone in the surgical room—regardless of role—is called by their first names, and not by their titles.105 Moreover, in elaborate role-plays, doctors and nurses reverse roles so they learn how they treat others. Dr. Scott Ellner immediately realized that he treated subordinates in a condescending fashion when a nurse took on the role of doctor and he felt the effects.

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98Steinel, W., Utz, S., & Koning, L. (2010). The good, the bad and the ugly thing to do when sharing information: Revealing, concealing and lying depend on social motivation, distribution and importance of information. Organizational Behavior and Human Decision Processes, 113(2), 85–96.
DEFENSIVE VS. OFFENSIVE ORIENTATION A defensive team strategic orientation leads to greater information search than does an offensive team strategic orientation and ultimately better performance in hidden profile tasks.106

VIRTUAL TEAMING It might seem paradoxical to suggest that a group that could meet face-to-face would instead choose a virtual meeting, but a large-scale analysis of 94 studies of 5,596 groups indicate that virtuality improves the sharing of unique information in groups, which is linked to performance in face-to-face meetings. However, the effects of virtual teaming on openness of information sharing appear to be curvilinear, such that low levels of virtuality improve the openness of information sharing, but high levels hinder it. In other words, virtual teaming enhances the process of sharing unique information within a group, but hinders the process of promoting openness of information sharing.107

TEAM LEARNING

Group learning involves the basic process of sharing knowledge, storing knowledge, and retrieving knowledge.108 How do teams learn from their environment, newcomers, and outsiders?

ENVIRONMENT

In an analysis of organizational learning on improvement project teams in hospital neonatal intensive care units, two distinct key factors emerged: learn-what (activities that identify current best practices) and learn-how (activities that operationalize practices in a given setting).109 The hospital teams had greater success when they implemented practices that were supported by extensive evidence and when project team members engaged in learning activities designed to promote engagement by the unit. Thus, both learn-what (content) and learn-how (means) are important.

NEWCOMERS AND ROTATORS

Many groups are porous in the sense that newcomers join groups and people rotate in and out of the group. Groups are more likely to adopt the routine of a rotator when they share a superordinate identity with that member.110 A group also is more likely to adopt a routine from a rotator when it is superior to their own. When groups do not share a superordinate identity, they fail to adopt the rotator’s ideas and knowledge, even when those ideas are superior to their own and would have improved their performance.

VICARIOUS VS. IN VIVO EXPERIENCE

Is team performance affected when members have direct experience with a task versus task experience acquired vicariously from others? Direct task experience leads to higher levels of team creativity and more divergent products than does indirect task experience (vicarious experience).vicariovs. in vivo experience

Teams who learn through direct task experience develop better transactive memory systems than do teams who learn vicariously.

It is important to consider the feedback offered via experience; feedback that is too detailed and specific might do more harm than good. A study of 48 trainees in a furniture factory performance simulation revealed that increasing feedback specificity hindered knowledge transfer. Those who received less specific feedback relied more heavily on explicit information processing and had more exposure to the challenging aspects of the task than did those who received more specific feedback.112 A study of learning in a Japanese manufacturing company revealed that when teams learn, reinforcing vertical mechanisms are necessary to coordinate TMSs.113

THREAT, CHANGE, AND FAILURE

It is inevitable that teams will fail or that the environment will challenge their ability to perform in unexpected and dramatic ways. For example, studies of teams’ ability to adapt to sudden and dramatic changes in workload, revealed that learning and performance orientation affected their ability to adapt.114 And studies of team project failure revealed that teams that believed that their organization normalized failure were able to recover more quickly.115

AFTER-ACTION REVIEW (AAR)

After-action review (AAR) or after-event review or debriefing is an approach to learning and training based on a review of people’s performance on tasks. Teams that receive AAR have better team performance, team efficacy, enhanced communication and are more cohesive than are non-AAR teams.116

ROUTINIZATION VS. INNOVATION TRADE-OFFS

Teams whose members work together for longer periods are more likely to develop a TMS and therefore will be more productive. However, there is a countervailing force at work in teams that have been together for long periods of time, namely, routinization.

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That is, because a TMS is basically a set of expectations, certain working relationships might become entrenched over time. For example, groups that experience partial membership change tend to rely on the TMS structure that their old-timers developed in their original group and this is ultimately detrimental to performance.117 However, when old-timers are instructed to reflect upon their collective knowledge, these negative effects are minimized. When delegation is optional (which a TMS does not ensure), and in a world in which the team’s expectations about what is needed (e.g., consumer demand) are accurate, then more TMS should basically lead to more routinization of the task and, to a more efficient channeling of efforts by team members. This will occur because there will be less coordination loss involved in understanding each team member’s role. Such expectations would seem best when there is little need for innovation. Thus, a precarious trade-off exists between routinization and innovation.

For much of the work that organizations do, routinization is a good thing; however, for a large part of what organizations do, innovation is desirable and necessary to meet the competitive challenges we outlined in Chapter 1. Thus, a well-defined TMS could hinder the team’s ability to be adaptive.

For these reasons, there might be significant problems associated with extended team longevity. As a case in point, consider an R&D facility of a large American corporation.118 The division included 345 engineers and scientific professionals and was geographically isolated from the rest of the organization. The 50 project groups in this division varied greatly in terms of their longevity—that is, how long members of one group had worked with one another. For a period of 15 weeks, professionals kept records of their work-related communication; any time a group member consulted or spoke with others, whether at the water cooler or in the parking lot, the interaction was recorded. Later, seven department managers and the two lab directors evaluated the performance of each project produced by each group with which they were technically familiar. The performance of these groups increased as they gained longevity, but only up to a point. After five years of working together, team project performance declined steeply, as did intraproject communication, organizational communication, and external professional communication—basically all the types of communication that served to bring fresh ideas to the group.

Four behavioral changes took place in groups that worked together for more than five years:

- **Behavioral stability** Project members interacting over a long time develop standard work patterns that are familiar and comfortable. This can happen very rapidly—for instance, the way people in a group tend to sit in the same places in meeting after meeting, even when there might be no logical reason for doing so. Over time, this behavioral stability leads to isolation from the outside. The group can grow increasingly complacent, ceasing to question the practices that shape their behavior.

- **Selective exposure** There is a tendency for group members to communicate only with people whose ideas agree with their own. It is related to the homogeneity

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bias—the tendency to select new members who are like members in the existing group. Over time, project members learn to interact selectively to avoid messages and information that conflict with their established practices and disposition.

- **Group homogeneity** Groups that are separated from the influence of others in the organization develop a homogeneous set of understandings about the group and its environment.

- **Role differentiation** Groups that work and train together become increasingly specialized in project competencies and roles. This results in greater role differentiation, which in turn results in less interaction among group members because the roles and expectations held by each are so well entrenched. Consequently, they lose access to much of the internal talent and diminished abilities to learn new ideas from one another.

Thus, in terms of actual task performance, as team longevity increases, certain social processes conspire to lower levels of project communication, which in turn decrease project performance. Project groups become increasingly isolated from key information sources both within and outside their organizations with increasing stability in their membership. Reductions in project communication adversely affect the technical performance of project groups. Variations in communication activities are associated more with the tenure composition of the project group than with the project tenures of the individual engineers. Stated another way, it is not the age of the employee that is of critical importance but the age of the team. Furthermore, individual competence does not account for differences in performance. Thus, it is not the case that the older, less skilled members were working in teams that were of greater longevity. Furthermore, the longevity of project groups does not appear to be part of the mental models of the managers—virtually no one was aware of the tenure demographics of their project groups.

What does all of this mean for team longevity? A certain amount of familiarity is necessary for teams to work together in a productive fashion. The effect of working together tends to make team members grow more familiar with each other’s relevant knowledge base, and hence, a TMS can develop. A TMS can be helpful in tasks where coordination losses need to be reduced and tactical precision is key. Although a certain amount of routinization is desirable in any team, the overly routinized team hinders communication and obstructs innovation. Looking at this question from a team design standpoint might offer some insights. It might be desirable, for example to design some teams whose primary objective is to act as innovation experts for the creation and transfer of the organization’s best practices. Groups are more likely to benefit from the knowledge and ideas brought by a newcomer when they share a superordinate identity with one another.119 Moreover, when members sit in an integrated fashion (versus sitting on opposite sides of a table), a superordinate identity is more likely to be established.

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Chapter Capstone

For teams to be effective in their work, they need to share knowledge, efficiently process and encode relevant information, and then act upon it in a thoughtful and appropriate fashion. Communication among team members is a collaborative effort. The development of accurate team mental models and a TMS can partially combat the threat of the common information effect and hidden profiles.