Building an Effective Team

How to Manage a Team to Make Good Decisions

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"To implement policies and practices that increase the diversity of the workforce without understanding how diverse individuals can come together to form effective teams is *irresponsible*" (emphasis added).

Elizabeth Mannix and Margaret A. Neale[1]

- Many organizations use teams and promote diversity. But without implementation of proper processes, teams will fare poorly despite the best of intentions.
- There are three types of diversity: social category, cognitive, and value. The best teams have high cognitive diversity and low value diversity. Social and cognitive diversity often, but not always, go together.
- The optimal team size is four to six people. Teams that are too large are ineffective because of the cost of process coordination and social loafing.
- How the team votes makes a big difference in how the team decides. There is no perfectly fair way to vote, but leaders should make sure team members are independent in voicing their opinions.

Executive Summary

- Many organizations use teams and promote diversity. But without implementation of proper processes, teams fare poorly despite the best of intentions.
- The optimal team size is four to six people. Teams that are too large are ineffective because of the cost of process coordination and social loafing.
- There are three types of diversity: social category, cognitive, and value. The best teams have high cognitive diversity and low value diversity. Social category and cognitive diversity frequently, but not always, go together.
- Teams have a tendency to discuss shared information. But quality decision making requires revealing unshared information as well.
- Teams perform better when trained in methods to effectively gather and evaluate alternatives.
- Good team leaders focus on process, not outcome, and maintain focus.
- Effective leaders extract information from all team members, including introverts and those of lower social status.
- How the team votes makes a big difference in how the team decides. There is no perfectly fair way to vote, but leaders should make sure team members are independent in voicing their opinions.
- Groupthink is rare but debilitating. Symptoms of groupthink include overestimation of the group's abilities, close-mindedness, and pressure to conform.
- There are substantial effects related to the time of day. When team members are tired, they tend to default to the status quo.

Introduction

In the late 1980s, a professor of social and organizational psychology named J. Richard Hackman set out to edit a book on the topic of effective teams. Hackman recruited colleagues to share 30 or so case studies on task forces, performing arts groups, and customer service teams. The working title he suggested to his editor was *Groups That Work*.

After reading the draft, Hackman's editor pointed out that only four of the teams that the researchers studied were actually effective. So he suggested a revised title: *Groups That Work (and Those That Don't)*.[2] As Hackman later noted ruefully, the subtitle captured reality better than the title did.[3] If you have been part of a team, and especially a committee, you can probably relate to the fact that most teams aren't as effective as they could be.

This is a big deal because teams make lots of consequential decisions. For example, investment committees oversee about $5 trillion in assets, and there is clear evidence that they have a tendency to buy high and sell low.[4] Further, approximately 60 percent of equity mutual funds are run by groups or teams of individual managers, up from 30 percent in the early 1990s.[5]

This report is about how to build, manage, and lead a team so as to make effective decisions. We will place special emphasis on investment committees, a group with a fiduciary responsibility to make financial decisions on behalf of beneficiaries. Most organizations form and operate teams with the best of intentions but fail to improve decision making because most participants in the group don't know how to be effective. This is particularly true of team leaders.

A successful team understands the task it is charged to complete, generates options as to how to accomplish the task most effectively, decides the best course of action, and executes on the decision. Ideally, the team's results should be measurable, and the team's members should be held accountable for their decision-making process.

In recent decades, most organizations have created programs to promote diversity. Creating a diverse organization may be redeeming on multiple levels, but one ostensible objective of a diversity program is to sharpen the quality of decisions. Yet, as Elizabeth Mannix and Margaret Neale suggest in the quotation at the top, promoting diversity without understanding how to manage diversity is irresponsible. Thoughtful leaders must be aware of what makes for a successful team and must be explicit about managing the team properly.

Building the Team

There are three main considerations in building a team: its features, size, and composition. Each area presents opportunity and risk. It is crucial to be alert to these considerations and to be explicit in constructing a team so as to minimize mistakes.

Hackman suggests that real teams have certain essential features, including a team task, clear boundaries, authority to manage work processes, and an element of membership stability.[6] Teams that lack these conditions are generally doomed to fail from the beginning.

We tend to use the term "team" loosely, but a team exists only when there is interaction among the members. In a company there may be many individuals who have similar responsibilities and who report to the same manager. But unless those workers interact with one another to do their jobs, they are a co-acting group and not a team.

So it is important to start by determining the nature of the task and by asking whether an individual or a team is in a better position to handle the job. Lots of tasks are better done by individuals than teams, including writing and executive leadership.[7] A task is a specific outcome that an observer can measure and where there is accountability.[8] Team tasks should have a stated purpose and process.

Good teams also have defined boundaries, which simply means that it is clear who is part of the team and who is not. Because many professionals interact with lots of others inside and outside their organizations, they run the risk of being unclear about which teams they belong to. But there is peril in running too far the other way, too. Teams operate in a larger organizational context, and it is important that the group maintain and manage relations in the larger social system. So you want your team to be clearly defined but not isolated from the broader organization in which it operates.

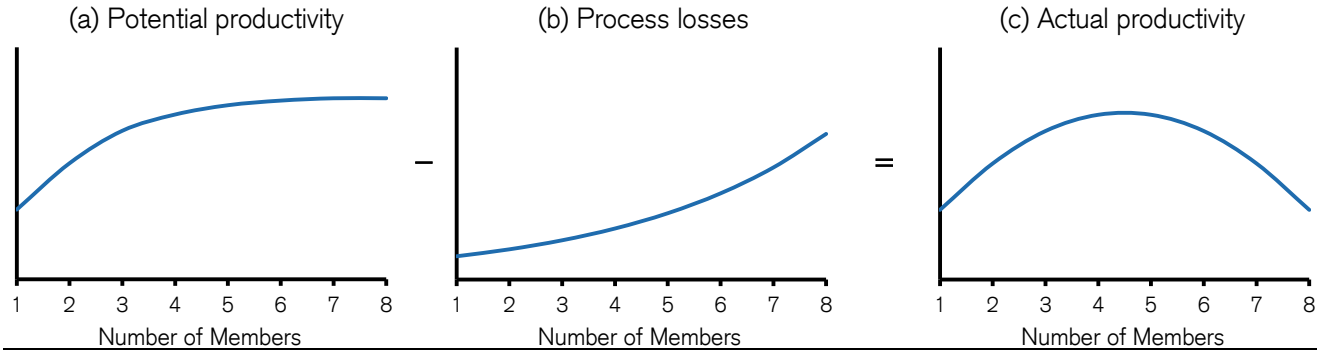
That a team has clear authority is also critical. This means that team members understand which decisions are theirs to make. Generally speaking, management is most effective at setting the task and building the team, whereas the team members are better suited at figuring out the work process and executing on the ground. But alternative team structures may require allocating responsibilities in very different ways. For example, a manager may assume authority for all functions save execution, while a self-governed team may assume authority for all aspects of successful task completion.

Finally, the research shows that stable teams tend to perform better than teams that have members who rotate constantly. For example, analysis by the National Transportation Safety Board found that 73 percent of aircraft "incidents" occur on a crew's first day of flying together.[9] The reason stability is valuable is that the team members learn about the strengths and weaknesses of each member, figure out how to work together, and generally grow to appreciate their shared goals.

In considering a task for a team, management is also well served to consider intrinsic motivation. What kinds of tasks motivate team members? Good direction is challenging, clear, and consequential. Challenge ensures that team members must use all of their skills so that achieving the task is motivating and energizing. Clarity aligns the performance with the broader strategic and financial objectives of the organization. And consequential engages the team members because they know that their work makes a difference.[10]

The next consideration in building a team is the appropriate size. A larger team offers potential productivity (PP), as a large group is likely to know more information and have more skills than a small group. However, process losses (PL) grow as the size of the group increases. These losses include reduced motivation and elevated costs of coordination. Actual productivity (AP) is the difference between the two (PP – PL = AP). Exhibit 1 shows this.

Exhibit 1: Actual Productivity Is Potential Productivity Less Process Loss



Source: J. Richard Hackman, Leading Teams: Setting the Stage for Great Performance *(Boston, MA: Harvard Business School Press, 2002), 117.*

The research suggests that an optimal team size is four to six.[11] Scientists asked actual teams of varying sizes whether "the group is too small" or "the group is too large" and found that the intersection was between four and five. Hackman suggests that no team should have membership in the double digits and that it's better to have a team that is too small than one that is too large.[12]

Consistent with the equation that determines actual productivity, the goal in building a team is to have as much information and skill as possible—diversity—while maintaining a group size that is sufficiently small to work effectively. A survey of more than 120 investment committees revealed that 32 percent of them had 1-5 members, 45 percent had 6-8, 16 percent had 9-11, and 7 percent had 12 or more. A majority of people on investment committees of six or more said that they would prefer a smaller group.[13]

Most organizations strive to promote diversity but are unclear about how different types of diversity contribute to performance. There are three types of diversity: social category diversity, cognitive diversity, and value diversity.[14] Social category diversity addresses what most people think of when they hear about diversity in the workplace. It reflects differences in race, ethnicity, gender, age, religion, sexual orientation, and physical abilities. Cognitive diversity includes differences in education, training, experience, expertise, information, personality, cultural background, and motivation.[15] (See Exhibit 2.) Value diversity captures differences in the perception of the team's task, goal, or mission.

Exhibit 2: Examples of Social Category and Cognitive Diversity

Social category diversity	Cognitive diversity
Race	Education
Ethnicity	Functional knowledge
Gender	Information or expertise
Age	Training
Religion	Experience
Sexual orientation	Abilities

Source: Elizabeth Mannix and Margaret A. Neale, "What Differences Make a Difference? The Promise and Reality of Diverse Teams in Organizations," Psychological Science in the Public Interest*, Vol. 6, No. 2, October 2005, 36.*

Ideally, you want a team to have high cognitive diversity and low value diversity. High cognitive diversity ensures that the team has the requisite tools and information to solve problems effectively, and low value diversity means the team is unified in its purpose. Social category diversity's impact on team performance is more equivocal. While social category diversity can boost morale, it can also lead to process losses as the team members have more conflict and have trouble integrating socially and communicating. In truth, a majority of people feel most comfortable dealing with others who are in similar social categories.

So it is possible to have a team where the members look the same but think differently. Likewise, it is possible to have a team that looks different but thinks the same. There is some evidence that social category diversity is related to cognitive diversity, but they are clearly not the same.[16] At the end of the day, you want cognitive diversity.

A survey by John Payne, a professor of psychology at Duke University, and Arnold Wood, President and CEO of Martingale Asset Management, suggests that most investment committees are a homogenized bunch. For example, they found that 85 percent of committee members were white males over 50 years old, found no members under the age of 30, and that only 15 percent were women. While it is possible that these

committees have high cognitive diversity, the social category profile suggests that those who assembled the committees placed a greater emphasis on similarity and low conflict than on cognitive diversity.

Why does cognitive diversity matter so much? Scott E. Page, a professor of complex systems, political science, and economics at the University of Michigan, answers the question through what he calls the "diversity prediction theorem."[17] Here's the equation:

Collective error = average individual error – prediction diversity

Collective error captures the quality of the group's decisions. Average individual error reflects how accurate the people are within the group. And prediction diversity captures the dispersion of views, or how different the group members are. You can think of average individual error as "smarts" and prediction diversity as "diversity."

Two axioms come out of the diversity prediction theorem. The collective error is always smaller than the average individual error. That's why a group performs better than an individual. Second, minimization of collective error is equal parts smarts and diversity.

All organizations want to assemble smart teams, but they often fail to appreciate the significance of diversity in reducing errors. When judgments become highly correlated, the quality of the team's decisions plummets for all but the simplest of tasks. The appendix provides an example of how the diversity prediction theorem works, including the math behind it.

Psychologists have studied in great detail the concept of an individual's general intelligence, a measure of ability across a range of tasks, which is denoted as the "*g* factor." A recent research paper examines whether groups have a similar ability, which the scientists call "collective intelligence," or the "*c* factor."[18] They indeed found a "c factor" in groups of two to five people, and that the factor was not strongly correlated with the average intelligence of the team members or with having one super-smart person.

There was a noteworthy correlation between the level of performance and the degree of social sensitivity, which is the ability to read others. For example, teams that had a member or two who dominated the conversation fared worse than teams where the discussion was more equal among the members. The study also showed that women contribute social sensitivity to teams, and hence the proportion of women in a team was positively correlated with the "*c* factor."

Research suggests that stable teams do better than teams that constantly rotate members. But it also stands to reason that new team members can inject energy and diversity. Two network theorists, Brian Uzzi at Northwestern University and Jarrett Spiro at Stanford University, examined the interactions between all of the artists who created Broadway shows from 1945-1989.[19] In this unique study, Uzzi and Spiro focused on the degree of connectedness between the creative artists.

The scientists found that critical and commercial successes tended to have an intermediate amount of connectedness. Collaborating artists who hadn't worked together before, and therefore had weak connections, tended to do poorly. The same was true for artists who worked together all the time and hence were highly connected. Some balance between novelty and familiarity produced the best results. Erring on the side of too much connectedness appears to be better than too little connectedness.

The benefits of diversity may extend beyond simply bringing together multiple points of view. One study suggests that diverse groups of individuals tend to actually put more effort into tasks than do homogeneous groups.[20] The researchers found that diverse groups are less concerned with social relationships and as a

result get right to work, whereas homogeneous groups expend too much effort avoiding conflict and too little effort addressing the task at hand.

Building a successful team requires structuring the team properly and recruiting the right number of members with high cognitive diversity and low value diversity. A high performance team will create collective intelligence, but only if the team is properly managed.

Managing the Team

Simply stated, a team's mission is to agree on a task, identify options to best approach the task, decide how to proceed, and see to it that the organization executes the plan.

One useful starting point in leading a team is the categorization of problems. Some problems have clear and correct answers. These are factual questions, and someone on the team may know the answer or know how to access the answer. In these cases, the team should quickly defer to that individual and move on to more challenging problems. In other cases, it is appropriate to combine the resources of the team to solve the problem. In either case, there is a discernible answer.

The harder problems are complex and generally require some sort of prediction. These are the most consequential problems a team faces, and there are rarely simple answers. Examples for an investment committee might include asset allocation decisions, investment manager changes, and anticipating the returns for various asset classes. With the correct process in place, committees are more effective than an individual at addressing these questions.

Another essential element in managing a team is monitoring time allocation. The survey by Payne and Wood asked committee members to rank their tasks from most to least important and then asked the members to keep track of how they actually allocated their time. They found a substantial mismatch: The committees spent a great deal of time on issues that they did not deem important and little time on the topics they perceived to be of the highest importance. Wood suggests that the less important topics provide committee members with "easy gratification," a sense that they are getting things done. But they fail to address the more relevant, and often more difficult, issues where agreement may not be easy to achieve.[21]

Perhaps the most essential role of a team is unearthing, pooling, and weighing information so as to arrive at an informed decision. If committee members have a point of view that they don't reveal, or they defer unnecessarily to perceived experts on the team, prediction diversity suffers.

One well-documented example comes from the study of shared versus unshared information. Shared information is knowledge the entire group has, whereas unshared information is unique to a particular individual. The goal of a team is to consider all relevant and available information, but the research consistently shows that teams fail to consider unshared information.

A pair of psychologists, Garold Stasser and William Titus, conducted a study that examined how effective teams were in incorporating unshared information into their decisions.[22] In groups of four, the teams had the task of selecting between three candidates for student body president. You can imagine the team selecting a new investment manager, which investment bank to hire, or the next leader of the organization.

The researchers constructed the facts so that the profile of candidate A had the most attributes that were valued highly. As a result, the group would deem candidate A the most attractive were all the information shared. They then ran two separate experiments. In the first case, all the members received the same

information, so all of their information was shared. When asked to select a candidate, the groups selected candidate A 83 percent of the time.

In the second case, the total pool of information the group received still favored candidate A. However, the researchers distributed the information differently. The members received a smaller amount of shared information than they did in the first case, and each individual also received some unshared information. The unshared information was positive about candidate A and negative about candidate B. So candidate B looked better based solely on the shared information, but with the pooling of the unshared information candidate A would still come out on top. Under this condition, the groups selected candidate B 71 percent of the time.

In discussions, team members tend to talk much more about their shared information than their unshared information, and they tend to place too great a weight on shared information at the expense of unshared information.[23] Failure to reveal and consider unshared information causes diversity to slip and hence a deterioration in the quality of decisions. Individuals withhold unshared information for myriad reasons, including a fear of challenging someone of higher status in the organization, a drive for group consensus or a shunning of conflict, poor communication skills, time constraints, and deference to a perceived expert.

One example of this comes from a study of airline pilots. In the 1990s, Korean Air had one of the worst safety records of any commercial airline. The rate at which the airline lost hulls, a case when the airplane is totally destroyed or damaged beyond repair, was 17 times higher than that of the leading U.S. carriers despite having a modern and functional fleet of planes.

Communication in the cockpit was the problem. Cockpits can be hierarchical, with the captain in charge and the first officer in a lower position. A number of Korean Air incidents were marked by the first officer using indirect language to communicate to the captain, which preserved the hierarchy but failed to convey crucial information in a sufficiently direct manner. These cases reveal an inability to communicate unshared information as the result of social dynamics.[24]

In building teams, leaders frequently seek to find experts to match the types of problems that they anticipate facing. For example, if an endowment is considering increasing its weight in alternative investments, it may seek to add a private equity expert to its investment committee. However, the evidence is strong that experts are no better than informed individuals, and worse than groups, at making predictions in realms that are complex, including politics, economics, and markets.

Philip Tetlock, a psychologist at the University of Pennsylvania, has studied the quality of expert predictions in depth. He argues that, “People who devoted years of arduous study to a topic were as hard-pressed as colleagues casually dropping in from other fields to affix realistic probabilities to possible futures.” He says that the degree of sophistication is “pegged in the vicinity of savvy readers of high-quality news sources such as the *Economist*, the *Wall Street Journal*, and the *New York Times*.”[25] Experts do tend to talk more during team meetings, but there is no evidence that teams with experts are any more accurate than those without them.[26]

While failure to share all relevant information is a clear risk, there is something you can do about it. Research suggests that teams that receive training do a better job of sharing information.[27] This has two parts. First, leaders teach the team to plan how they are going to make their decision. Most teams simply jump into the task without giving consideration of what strategies they seek to employ to address the task.

The second part of the training emphasizes working hard to reveal all relevant information and cautions against embracing the first solution that the group considers. Both aspects of the training make overt the process of revealing information.

Effective teams spend time categorizing problems, develop a strategy to approach their tasks, make sure that their time allocation matches their priorities, and work hard to reveal and consider all relevant information. Team leadership is essential to the effectiveness.

Leading the Team

The goal of a team leader is to establish and maintain the handful of organizational conditions that foster competent teamwork and, ultimately, quality decision making. Simply stated, the role of the leader is to make sure that the process of revealing information, weighing alternatives, and voting on the best option is done correctly.

Studies suggest that the best leaders are those who focus intently on process rather than outcome. Leaders who advocate for one position going into a discussion get low marks from the team, and those teams tend to make poor decisions unless that leader has specific insight. Leaders who work hard to unearth all options and alternatives score high marks from teams and generate better decisions.[28]

Effective leaders maintain focus. Focus means prioritizing issues, allocating time accordingly, and ensuring that the team members with dominant personalities are kept in check. If you've ever been on a team or committee you know the type of person who gets off topic easily and fills airtime with inanities. A good leader makes sure that no one derails the process of decision making.

Studies of teams categorize leaders as "participative" or "directive." Participative leaders "share their power with subordinates by actively including them in the decision-making process" while directive leaders "perceive less value in member input and are less inclined to examine a variety of solution alternatives."[29]

Not surprisingly, participative leaders coaxed more information to the surface, and teams led by directive leaders frequently made decisions that were consistent with the leader's initial views. When the information of a directive leader does not point to the best alternative, the quality of the team's decision suffers dramatically.

Good leaders listen carefully and can detect information no matter how the speaker conveys it. All of us speak both directly and indirectly. For instance, in the case of a chilly room, a person of superior status may say to an underling, "close the window" or, simply, "it's cold in here." Whether we speak directly or indirectly is a function of our personality, the situation, and the culture in which we operate.

Problems arise when others misinterpret the intention of the speaker. Direct orders can be offensive, for example, and indirect orders can be perceived as unclear. Context is crucial, and good leaders read the situation effectively.[30]

One useful technique that leaders can use for gathering information is called a "premortem."[31] Gary Klein, a psychologist who developed this technique, suggests that the premortem is the hypothetical opposite of a postmortem, where decision makers review a past failure to better understand the cause. Postmortems are a useful tool for learning from past mistakes, but do nothing about the bad outcome.

With a premortem, the team assumes that it has come to a decision and has proceeded with the project. The leader then asks the team members to catapult themselves into the future, say one year from now, and assume that the project was a fiasco. The members then write down, independently, why the project failed. Research suggests that this approach of using "prospective hindsight" sharply improves the ability to reveal overlooked or underappreciated factors.

The leader then collects the reasons for failure. Experience shows that this exercise opens up the minds of team members and can also reveal information that was either unshared or insufficiently considered.

How to Decide

Years ago I was on a committee that was voting on bringing a candidate into an organization. I had seen this scientist's application, reviewed his letters of recommendation, and participated in our group discussion of the pros and cons of having him join. Based on what I saw and heard, I thought he would make a good addition and was prepared to vote for him.

The chair of the committee then went around the conference room table asking each member for a "yea" or a "nay." Seated to my right, and set to vote a moment before me, was a physicist who had won the Nobel Prize and is likely the smartest person I have ever met. When the vote came to him, he said nay. My heart sank as I felt an acute conflict: I was prepared to say yea and the world's smartest man just said nay. When my turn came, I said nay, slid down in my chair, and immediately regretted my decision.

You may argue that I was wrong but you probably sympathize with my plight. I fell prey to social pressure, which probably took at least two forms. It is socially comfortable to vote the same way as an eminent individual. It put us on the same side. Also, his vote caused me to call into question my favorable assessment. If a super-smart scientist is saying no, who am I to say yes? But as we have already seen, experts are not necessarily better forecasters than informed laymen. That was probably true in this case.

This story introduces the idea of how best to decide. The simple answer is to vote independently. By going around the room as he did, the chair of that committee invited social conformity and quashed independence. Submitting and tallying ballots is a quick and easy way to ensure that team members can express their diverse views. A leader who skillfully surfaces all information risks losing the benefit of that effort if the aggregation process fails. Independence, which preserves diversity, is essential.

The mechanism of voting is also very important. First, a team must decide what constitutes a successful vote. There are a handful of voting thresholds, each of which serves a different purpose. With a quorum, a subset of the members decides on behalf of the team. Quorums are often sufficient for decisions that must be quick. Honeybees, for example, use a quorum-sensing technique to find new homes. When approximately 15 bees sense one another at an attractive abode, they return to the swarm and prompt it to move in.[32]

The next threshold is a majority, or a modal selection when there are multiple options. This threshold works well. For instance, a number of prediction markets collect votes on the winners of the various categories for the Academy Awards. These markets have a very good track record at identifying the winners.

Consensus is the most stringent threshold. In dealing with predictions, a consensus is generally too high a bar to clear. Most committees that reach a consensus on important issues of the future are likely too homogenous or are suppressing the views of dissenters. It is common for some team members to sublimate their view in order for the team to move forward. This creates a false sense of harmony and undermines a proper process of decision making.

Although voting by ballot may seem to be a straightforward approach to deciding on issues, there is no single way to best reflect the views of the group. There is a large literature on the theory of voting methods, and a core finding is that there is no such thing as a single, "fair" voting system. In other words, the method you choose for voting can provide different outcomes.[33]

Here's a simple example. Let's say you are part of a five-person investment committee that is seeking to hire a new investment manager. The process comes down to three candidates, A, B, and C. The committee hears each manager's presentation and debates the merits of each. Now it's time to decide.

You are the chair of the committee. Let's say you hand out ballots with a simple instruction: "Please write down your favorite candidate." All of the members comply. When you tally the results, this is what you see:

	Committee member				
	1	2	3	4	5
	B	B	C	B	C

Three members vote for B, two vote for C, and none vote for A. Since B wins three votes to two, you call investment manager B and share the good news, "You're hired!"

But what if you did something slightly different? Say you told each committee member that he or she had 100 points to allocate to the managers. So instead of a simple preference, you instruct the members to weight their preferences.

When you tally those results, here's what you get:

	Committee member				
	1	2	3	4	5
First	B=50	B=60	C=60	B=40	C=70
Second	C=40	A=30	A=20	C=35	B=20
Third	A=10	C=10	B=20	A=25	A=10

In this case, C garners 215 points, B 190 points, and A just 95 points. Even though three out of five committee members placed B first, which we saw in the prior voting round, C earns 215 points to B's 190 points and surfaces as the winner. So you call investment manager C with the congratulations.

The lesson is that there is no perfectly fair way to vote, but some approaches are fairer than others. Here's some guidance that may be useful. If the criterion for deciding is simple and clear, a simple vote of preference will suffice. But if the decision rests on multiple criteria, it behooves the committee to be explicit about those criteria and to weight them if possible. Then, a point allocation method may be a richer way to capture the views of the committee.

How Teams Go Wrong

We opened with a quotation from Elizabeth Mannix and Margaret Neale that suggests that encouraging diversity without understanding how to manage it is irresponsible. At this point, it should be clear that effective teams are those that navigate between too little and too much diversity. Most descriptions of how teams fail suggest a swing toward one of those extremes.

Let's start with team composition. Teams that are too large allow for social loafing, a case when team members do not contribute sufficiently to achieving the task at hand. When many people are involved in completing a task, it can be rational for an individual to assume that others will carry the load of work and hence slack off.

In an experiment from a century ago, a French engineer named Max Ringelmann asked individuals to pull on a rope attached to a strain gauge in order to measure their effort. He then asked multiple subjects to pull on the rope and found that people pull less hard when in a group. This is called the "Ringelmann effect," which suggests an inverse relationship between the size of the team and the magnitude of each individual's effort.[34]

Teams that are too large, or too diverse, also fail to collaborate effectively. One study of more than 50 teams at large companies found that large or diverse teams tended to form subgroups. The "in-group" worked well together and solidified beliefs and felt dismissive of the "out-group."[35] Ideal teams have 4-6 members who are cognitively diverse and have low value diversity. Such a team maximizes potential productivity and minimizes process losses. Naturally, effective leadership is also crucial.

You want team members to share all of their information, including the voicing of dissenting views.[36] Prior beliefs, the revelation of information, and group dynamics are all highly relevant in the process of surfacing information. Teams frequently fail to consider all of the information that is relevant to the task at hand.

For example, research shows that team members prefer information that supports their initial preferences to information that conflicts with their views.[37] Teams, similar to individuals, suffer from confirmation bias, the tendency to seek confirming evidence and to disavow or dismiss disconfirming evidence. Having even one member of the team dissent weakens this effect. This underscores the significance of cognitive diversity.

A side effect of seeking or incorporating only information that supports an initial viewpoint is that the group's confidence rises more than the group's accuracy justifies. For teams as well as individuals, more information leads to more confidence without an accompanying improvement in forecast accuracy. You should not seek information for its own sake or information that merely reaffirms your view. Rather, seek information that challenges your prior beliefs.[38]

Teams with insufficient diversity can polarize, seriously eroding the quality of decisions. In one experiment, researchers assembled groups of citizens in the state of Colorado. The first group was from Boulder, a city known to be politically liberal, and the second group was from the conservative city of Colorado Springs. The researchers asked the individuals about their views on socially contentious issues such as global warming, affirmative action, and same-sex marriage. They then put the citizens from each city into groups of five and asked them to deliberate on the issues.

For both cities, the deliberations caused the groups to adopt more extreme views than the individuals. The citizens of Boulder, liberal to start, became even more liberal following deliberation. The same pattern held for Colorado Springs. As the researchers conclude, "Deliberation thus increased extremism."[39]

A related concept is "groupthink," which occurs when a team minimizes conflict and seeks a consensus. A concept developed and popularized by a social psychologist named Irving Janis, groupthink arises when the striving for group unanimity overrides the "motivation to realistically appraise alternative courses of action." Groupthink is associated with a number of decision-making disasters including the Bay of Pigs Invasion in 1961 and the explosion of the space shuttle Challenger in 1986.[40]

Janis noted three symptoms of groupthink. One is overestimation of the group, including the group's power and morality. Second is a group that is close-minded. This is a case where confirmation bias is taken to dangerous levels. The last symptom is pressure to conform, where team members either censor themselves or pressure nonconforming members to embrace the group's view. While full blown cases of groupthink are rare, it is common to see some of these symptoms plague teams.

Another way teams fail is by improperly aggregating information as the result of faulty voting. Once the team has surfaced alternatives and it comes time to make a decision, the leader of the team should make all efforts to ensure that voting is independent. Soliciting answers or going around the room invites social conformity and degrades the quality of the decision.

We'll end the discussion of how teams go wrong with a factor that most leaders overlook: the time of day. Say an investment committee has a full day meeting with a jam-packed agenda. Schedulers will naturally allow for breaks. It turns out the timing of the breaks has a large influence on the team's decisions.

In a recent study, psychologists examined decisions regarding parole for prisoners.[41] The parole board consisted of a judge, a criminologist, and a social worker. The criminologist and social worker gave the judge professional advice, but the judge had the final say.

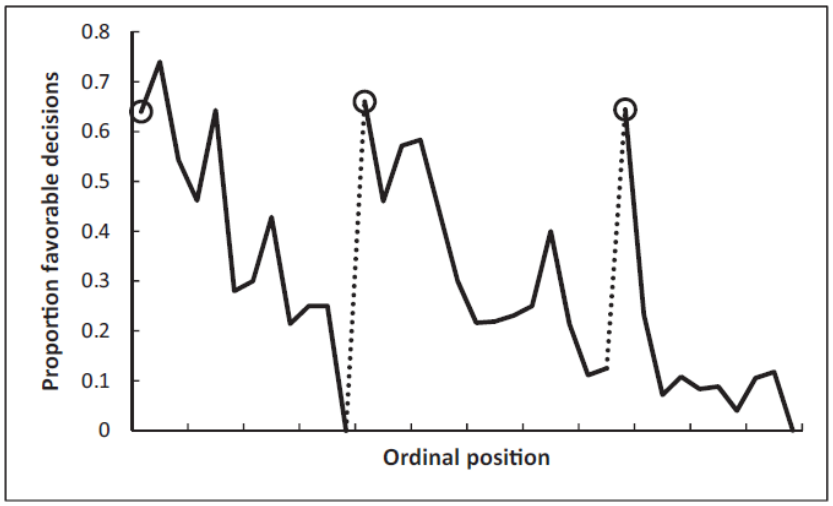
The judges had two breaks a day, a late morning snack and lunch, so the researchers could separate the day into three "decision sessions." They found the timing of those breaks had an enormous influence on favorable rulings. At the beginning of a decision session, the prisoner had about a two-thirds chance of a beneficial ruling. But that probability drifted toward zero just prior to a break.

Exhibit 3 shows this pattern, with the ordinal position of the prisoners on the horizontal axis and the percentage of favorable rulings on the vertical axis. There did not appear to be a deliberate ordering based on the characteristics of the prisoners. Contrary to the principle of legal formalism, an extraneous factor seems to have played a prominent role in judicial decisions.

One reasonable interpretation of this finding is that judges get tired and hungry. As a result, just prior to rest and refueling, they default to the status quo. In this study, the status quo meant saying no to a request.[42]

It takes little imagination to see how this finding is relevant for other teams as well. This research presents at least two lessons. The first is for leaders to set the agenda so that tougher issues arise when the team is at its best—the beginning of a decision session. The second is the awareness that many factors beyond a rational and deliberative process influence outcomes. No team member, and especially not a leader, should discount the social context of group decision making.

Exhibit 3: Teams Default to the Status Quo Right Before Breaks



Source: Figure 1 from Shai Danziger, Jonathan Levav, and Liora Avnaim-Pesso, "Extraneous Factors in Judicial Decisions," PNAS, *February 2011.*

Summary

Research tells us that more than 80 percent of white collar workers partner with co-workers in order to do their jobs.[43] But research also shows that most teams do not function as well as they should or could. One reason is that most leaders and team members simply do not understand what goes into being effective.

The key is to assemble a small, cognitively diverse group, work hard to surface unshared information and avoid bias, and decide in an independent and unbiased fashion. The details are important. Leaders must define clearly who is on the team, determine the responsibilities and authority of the team, and hold the team accountable for its decisions.

Endnotes

[1] Elizabeth Mannix and Margaret A. Neale, "What Differences Make a Difference? The Promise and Reality of Diverse Teams in Organizations," *Psychological Science in the Public Interest*, Vol. 6, No. 2, October 2005, 31-55.
[2] J. Richard Hackman, ed., *Groups That Work (and Those That Don't)* (San Francisco, CA: Jossey-Bass Publishers, 1990). See also Jon R. Katzenbach and Douglas K. Smith, *The Wisdom of Teams: Creating the High-Performance Organization* (Boston, MA: Harvard Business School Press, 1993). Katzenbach and Smith write, "Despite the attention teams have been receiving, the true high-performance team—that is, one that outperforms all other like teams, and outperforms expectations given its composition—is very rare."
[3] J. Richard Hackman, *Leading Teams: Setting the Stage for Great Performance* (Boston, MA: Harvard Business School Press, 2002), 255-256.
[4] John Payne and Arnold Wood, "Individual Decision Making and Group Decision Processes," *Journal of Psychology and Financial Markets,* Vol. 3, No. 2, 2002, 94-101; Amit Goyal and Sunil Wahal, "The Selection and Termination of Investment Management Firms by Plan Sponsors," *Journal of Finance*, Vol. 63, No. 4, August 2008, 1805-1847.
[5] Richard T. Bliss, Mark E. Potter, and Christopher Schwarz, "Performance Characteristics of Individually-Managed versus Team-Managed Mutual Funds," *Journal of Portfolio Management*, Spring 2008, 110-119.
[6] Hackman, *Leading Teams,* 41-59.
[7] Susan Cain, *Quiet: The Power of Introverts in a World That Can't Stop Talking* (New York: Crown Publishers, 2012), 71-94.
[8] Hackman, *Groups That Work,* 4.
[9] Hackman, *Leading Teams,* 55.
[10] Ibid., 72-73.
[11] J. Richard Hackman and Neil Vidmar, "Effects of Size and Task Type on Group Performance and Member Reactions," *Sociometry*, Vol. 33, No. 1, March 1970, 37-54.
[12] Mallory Stark, "Leading Teams: Setting the Stage for Great Performances – The Five Keys to Successful Teams," *HBS Working Knowledge Series*, July 15, 2002.
[13] "Reflections on Investment Committee Governance," *Pavilion Advisory Group,* 2012, and Payne and Wood.
[14] Karen A. Jehn, Gregory B. Northcraft, and Margaret A. Neale, "Why Differences Make a Difference: A Field Study of Diversity, Conflict, and Performance in Workgroups," *Administrative Quarterly*, Vol. 44, No 4, December 1999, 741-763.
[15] Mannix and Neale.
[16] Douglas Medin, Will Bennis, and Michael Chandler, "Culture and the Home-Field Advantage," *Perspectives on Psychological Science*, Vol. 5, No. 6, November 2010, 708-713.
[17] Scott E. Page, *The Difference: How the Power of Diversity Creates Better Groups, Firms, Schools, and Societies* (Princeton, NJ: Princeton University Press, 2007), 205-212.
[18] Anita Williams Woolley, Christopher F. Chabris, Alex Pentland, Nada Hashmi, and Thomas W. Malone, "Evidence for a Collective Intelligence Factor in the Performance of Human Groups," *Science*, Vol. 330, October 29, 2010, 686-688.
[19] Brian Uzzi and Jarrett Spiro, "Collaboration and Creativity: The Small World Problem," *American Journal of Sociology*, Vol. 111, No. 2, September 2005, 447-504. The degree of connectedness is related to the average path length and cluster coefficient. Average path length is the number of intermediaries between all of the pairs of actors in the network. This is related to the idea of "six degrees of separation." Cluster coefficient measures the average fraction of an actor's collaborators who are also collaborators with one another.
[20] Denise Lewin Loyd, Cynthia S. Wang, Katherine W. Phillips, and Robert B. Lount Jr., "Social Category Diversity Promotes Premeeting Elaboration: The Role of Relationship Focus," *Organization Science*, Vol. 24, No. 3, May-June 2013, 757-772.

[21] Arnold Wood, "Behavioral Finance and Investment Committee Decision Making," *CFA Institute Conference Proceedings Quarterly*, December 2006, 29-37.
[22] Garold Stasser and William Titus, "Pooling of Unshared Information in Group Decision Making: Biased Information Sampling During Discussion," *Journal of Personality and Social Psychology*, Vol. 48, No. 6, June 1985, 1467-1478.
[23] Jennifer R. Winquist and James R. Larson, Jr., "Information Pooling: When it Impacts Group Decision Making," *Journal of Personality and Social Psychology*, Vol. 74, No. 2, February 1998, 371-377.
[24] For a popular account, see Malcolm Gladwell, *Outliers: The Story of Success* (New York: Little, Brown and Company, 2008), 177-223. Gladwell spends some time discussing the "Power Distance Index" (PDI), a concept developed by a Dutch psychologist named Geert Hofstede. Countries that score high in PDI are hierarchical, which can impede communication. Countries that are low in PDI are more egalitarian and lead to more direct discussions. Hofstede's argument is that the degree to which societies are hierarchical is to some degree cultural. Here is a ranking of countries: http://www.clearlycultural.com/geert-hofstede-cultural-dimensions/power-distance-index/. Gladwell suggests that more pilot errors occur at carriers domiciled in high PDI countries. We should note that Hofstede's theories have come under challenge. For example, see Brendan McSweeney, "Hofstede's Model of National Cultural Differences and Their Consequences: A Triumph of Faith – a Failure of Analysis," *Human Relations*, Vol. 55, No. 1, January 2002, 89-118.
[25] Philip E. Tetlock, *Expert Political Judgment: How Good Is It? How Can We Know?* (Princeton, NJ: Princeton University Press, 2005), 54-56.
[26] Timothy M. Franz and James R. Larson, Jr., "The Impact of Experts on Information Sharing During Group Discussion," *Small Group Research*, Vol. 33, No. 4, August 2002, 383-411.
[27] James R. Larson, Jr., Pennie G. Foster-Fishman, and Christopher B. Keys, "Discussion of Shared and Unshared Information in Decision-Making Groups," *Journal of Personality and Social Psychology*, Vol. 67, No. 3, September 1994, 446-461.
[28] Kathleen M. Galotti, *Making Decisions That Matter: How People Face Important Life Choices* (Mahwah, NJ: Lawrence Erlbaum Associates, 2002), 137-138.
[29] James R. Larson, Jr., Pennie G. Foster-Fishman, and Timothy M. Franz, "Leadership Style and the Discussion of Shared and Unshared Information in Decision Making," *Leadership and Information*, Vol. 24, No. 5, May 1998, 482-495.
[30] Deborah Tannen, "How To Give Orders Like a Man," *New York Times Magazine*, August 28, 1994.
[31] Gary Klein, "Performing a Project *Pre*Mortem," *Harvard Business Review*, September 2007, 18-19.
[32] Thomas D. Seeley, P. Kirk Visscher, and Kevin Passino, "Group Decision Making in Honey Bee Swarms," *American Scientist*, Vol. 94, No. 3, May-June 2006, 220-229.
[33] Kenneth J. Arrow, "A Difficulty in the Concept of Social Welfare," *Journal of Political Economy,* Vol. 58, No. 4, August, 1950, 328–346. See also "Voting Methods," *Stanford Encyclopedia of Philosophy* at http://plato.stanford.edu/entries/voting-methods/.
[34] Max Ringelmann, "Recherches sur les moteurs animés: Travail de l'homme," *Annales de l'Institut National Agronomique*, Vol. 12, No. 2, 1913, 1-40. See also Wood, 35.
[35] Lynda Gratton, Andreas Voight, and Tamara J. Erickson,"Bridging Faultlines in Diverse Teams," *MIT Sloan Management Review,* Summer 2007.
[36] Cass R. Sunstein, *Why Societies Need Dissent* (Cambridge, MA: Harvard University Press, 2003).
[37] Stefan Schulz-Hardt, Dieter Frey, Carsten Lüthgens, and Serge Moscovici, "Biased Information Search in Group Decision Making," *Journal of Personality and Social Psychology*, Vol. 78, No. 4, April 2000, 655-669.
[38] For group confidence, see Chip Heath and Rich Gonzalez, "Interaction with Others Increases Decision Confidence but Not Decision Quality: Evidence against Information Collection Views of Interactive Decision Making," *Organizational Behavior and Human Decision Processes*, Vol. 61, No. 3, March 1995, 305-326. For individual confidence, see Paul P. Slovic, "Behavioral Problems of Adhering to a Decision Policy," *Presented at the Institute for Quantitative Research in Finance, Napa, CA.,* May 1, 1973. See http://www.decisionresearch.org/pdf/Slovic1973handout.pdf.

[39] David Schkade, Cass R. Sunstein, and Reid Hastie, "What Happened on Deliberation Day?" *John M. Olin Law and Economics Working Paper No. 298,* June 2006.
[40] Irving Janis, *Groupthink: Psychological Studies of Policy Decisions and Fiascoes, 2nd ed.* (Boston, MA: Houghton Mifflin, 1982).
[41] Shai Danziger, Jonathan Levav, and Liora Avnaim-Pesso, "Extraneous Factors in Judicial Decisions," *PNAS*, February 2011.
[42] Roy F. Baumeister and John Tierney, *Willpower: Rediscovering the Greatest Human Strength* (New York: The Penguin Press, 2011), 96-99.
[43] Matt Vella, "The Truth of Collaborative Innovation," *Bloomberg Businessweek,* 2008.
See http://images.businessweek.com/ss/08/04/0417_in_data/index_01.htm.

Resources

Books

Baumeister, Roy F., and John Tierney, *Willpower: Rediscovering the Greatest Human Strength* (New York: The Penguin Press, 2011).

Cain, Susan, *Quiet: The Power of Introverts in a World That Can't Stop Talking* (New York: Crown Publishers, 2012).

Galotti, Kathleen M., *Making Decisions That Matter: How People Face Important Life Choices* (Mahwah, NJ: Lawrence Erlbaum Associates, 2002).

Gladwell, Malcolm, *Outliers: The Story of Success* (New York: Little, Brown and Company, 2008).

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

Hackman, J. Richard, *Leading Teams: Setting the Stage for Great Performance* (Boston, MA: Harvard Business School Press, 2002).

Janis, Irving, *Groupthink: Psychological Studies of Policy Decisions and Fiascoes, 2nd ed.* (Boston, MA: Houghton Mifflin, 1982).

Katzenbach, Jon R., and Douglas K. Smith, *The Wisdom of Teams: Creating the High-Performance Organization* (Boston, MA: Harvard Business School Press, 1993).

Page, Scott E., *The Difference: How the Power of Diversity Creates Better Groups, Firms, Schools, and Societies* (Princeton, NJ: Princeton University Press, 2007).

Sunstein, Cass R., *Why Societies Need Dissent* (Cambridge, MA: Harvard University Press, 2003).

Tetlock, Philip E., *Expert Political Judgment: How Good Is It? How Can We Know?* (Princeton, NJ: Princeton University Press, 2005).

Articles and papers

Arrow, Kenneth J., "A Difficulty in the Concept of Social Welfare," *Journal of Political Economy,* Vol. 58, No. 4, August, 1950, 328–346.

Bliss, Richard T., Mark E. Potter, and Christopher Schwarz, "Performance Characteristics of Individually-Managed versus Team-Managed Mutual Funds," *Journal of Portfolio Management*, Spring 2008, 110-119.

Danziger, Shai, Jonathan Levav, and Liora Avnaim-Pesso, "Extraneous Factors in Judicial Decisions," *PNAS*, February 2011.

Franz, Timothy M., and James R. Larson, Jr., "The Impact of Experts on Information Sharing During Group Discussion," *Small Group Research*, Vol. 33, No. 4, August 2002, 383-411.

Goyal, Amit, and Sunil Wahal, "The Selection and Termination of Investment Management Firms by Plan Sponsors," *Journal of Finance*, Vol. 63, No. 4, August 2008, 1805-1847.

Gratton, Lynda, Andreas Voight, and Tamara J. Erickson,"Bridging Faultlines in Diverse Teams," *MIT Sloan Management Review,* Summer 2007.

Hackman, J. Richard, and Neil Vidmar, "Effects of Size and Task Type on Group Performance and Member Reactions," *Sociometry*, Vol. 33, No. 1, March 1970, 37-54.

Heath, Chip, and Rich Gonzalez, "Interaction with Others Increases Decision Confidence but Not Decision Quality: Evidence against Information Collection Views of Interactive Decision Making," *Organizational Behavior and Human Decision Processes*, Vol. 61, No. 3, March 1995, 305-326.

Jehn, Karen A., Gregory B. Northcraft, and Margaret A. Neale, "Why Differences Make a Difference: A Field Study of Diversity, Conflict, and Performance in Workgroups," *Administrative Quarterly*, Vol. 44, No 4, December 1999, 741-763.

Klein, Gary, "Performing a Project *Pre*Mortem," *Harvard Business Review*, September 2007, 18-19.

Larson, Jr., James R., Pennie G. Foster-Fishman, and Christopher B. Keys, "Discussion of Shared and Unshared Information in Decision-Making Groups," *Journal of Personality and Social Psychology*, Vol. 67, No. 3, September 1994, 446-461.

Larson, Jr., James R., Pennie G. Foster-Fishman, and Timothy M. Franz, "Leadership Style and the Discussion of Shared and Unshared Information in Decision Making," *Leadership and Information*, Vol. 24, No. 5, May 1998, 482-495.

Loyd, Denise Lewin, Cynthia S. Wang, Katherine W. Phillips, and Robert B. Lount Jr., "Social Category Diversity Promotes Premeeting Elaboration: The Role of Relationship Focus," *Organization Science*, Vol. 24, No. 3, May-June 2013, 757-772.

Mannix, Elizabeth, and Margaret A. Neale, "What Differences Make a Difference? The Promise and Reality of Diverse Teams in Organizations," *Psychological Science in the Public Interest*, Vol. 6, No. 2, October 2005, 31-55.

McSweeney, Brendan, "Hofstede's Model of National Cultural Differences and Their Consequences: A Triumph of Faith – a Failure of Analysis," *Human Relations*, Vol. 55, No. 1, January 2002, 89-118.

Medin, Douglas, Will Bennis, and Michael Chandler, "Culture and the Home-Field Advantage," *Perspectives on Psychological Science*, Vol. 5, No. 6, November 2010, 708-713.

Payne, John, and Arnold Wood, "Individual Decision Making and Group Decision Processes," *Journal of Psychology and Financial Markets,* Vol. 3, No. 2, 2002, 94-101.

Ringelmann, Max, "Recherches sur les moteurs animés: Travail de l'homme,"*Annales de l'Institut National Agronomique*, Vol. 12, No. 2, 1913, 1-40.

Schkade, David, Cass R. Sunstein, and Reid Hastie, "What Happened on Deliberation Day?" *John M. Olin Law and Economics Working Paper No. 298,* June 2006.

Schulz-Hardt, Stefan, Dieter Frey, Carsten Lüthgens, and Serge Moscovici, "Biased Information Search in Group Decision Making," *Journal of Personality and Social Psychology*, Vol. 78, No. 4, April 2000, 655-669.

Seeley, Thomas D., P. Kirk Visscher, and Kevin Passino, "Group Decision Making in Honey Bee Swarms," *American Scientist*, Vol. 94, No. 3, May-June 2006, 220-229.

Slovic, Paul P., "Behavioral Problems of Adhering to a Decision Policy," *Presented at the Institute for Quantitative Research in Finance, Napa, CA.,* May 1, 1973.

Stark, Mallory, "Leading Teams: Setting the Stage for Great Performances – The Five Keys to Successful Teams," *HBS Working Knowledge Series*, July 15, 2002.

Stasser, Garold, and William Titus, "Pooling of Unshared Information in Group Decision Making: Biased Information Sampling During Discussion," *Journal of Personality and Social Psychology*, Vol. 48, No. 6, June 1985, 1467-1478.

Tannen, Deborah, "How To Give Orders Like a Man," *New York Times Magazine*, August 28, 1994.

Uzzi, Brian, and Jarrett Spiro, "Collaboration and Creativity: The Small World Problem," *American Journal of Sociology*, Vol. 111, No. 2, September 2005, 447-504.

Vella, Matt, "The Truth of Collaborative Innovation," *BloombergBusinessweek,* 2008.

Winquist, Jennifer R., and James R. Larson, Jr., "Information Pooling: When it Impacts Group Decision Making," *Journal of Personality and Social Psychology*, Vol. 74, No. 2, February 1998, 371-377.

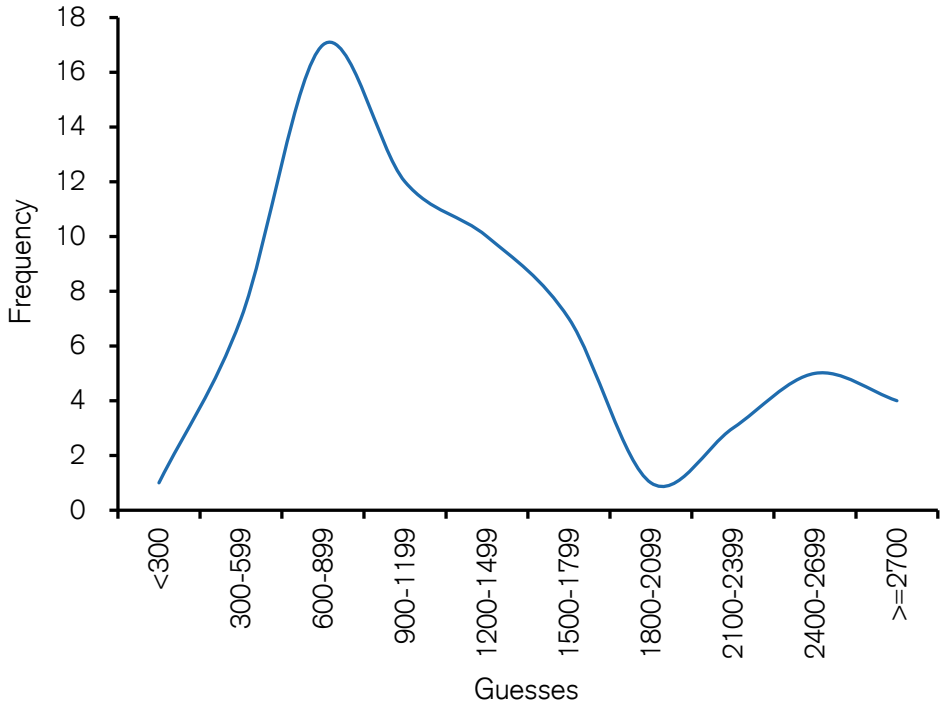
Wood, Arnold, "Behavioral Finance and Investment Committee Decision Making," *CFA Institute Conference Proceedings Quarterly*, December 2006, 29-37.

Woolley, Anita Williams, Christopher F. Chabris, Alex Pentland, Nada Hashmi, and Thomas W. Malone, "Evidence for a Collective Intelligence Factor in the Performance of Human Groups," *Science*, Vol. 330, October 29, 2010, 686-688.

Appendix

Here's a simple example of how the diversity prediction theorem works. In July 2013, we passed around a jar of jelly beans to 67 individuals who were participating in Credit Suisse's Intern Day. We then asked them to guess how many beans were in the jar, offering a reward for the best guess and the threat of shame for the worst guess. Exhibit 4 shows the distribution of the actual guesses. You can see it looks nothing like the bell-shaped distribution out of a textbook.

Exhibit 4: Distribution of Jelly Bean Guesses



Source: Credit Suisse.

The average of the guesses was 1,427 and the number of beans in the jar was 1,416. So the collective guess was 11 beans from the actual number, off by only 0.8 of 1 percent. No participant guessed more accurately than the collective. Now let's see how the diversity prediction theorem sheds light on this outcome. The equation is as follows:

Collective error = average individual error – prediction diversity

The *average individual error* is the average of each participant's difference from the right answer. If each individual guessed perfectly, the error would be zero. Statisticians square the errors [e.g., $(-5)^2 + (5)^2 = 50$] to make sure that positive and negative errors don't cancel out (e.g., -5 + 5 = 0).

Let's run through an example with Participant 1 (see in Exhibit 5). Her guess (Column A) was 250. Since the actual number was 1,416, her difference from actual (Column B) was -1,166. We then square -1,166 to get 1,359,556 (Column C). We calculate this squared difference from actual for each participant and take the average for the whole group.

In this experiment, the average individual error is 1,428,185 (bottom of Column C). The more accurate the individual guesses, the smaller the average individual error.

Prediction diversity measures the dispersion of guesses. The diversity is zero if the participants provide the same answer, whether or not that answer is accurate.

To calculate Participant 1's contribution to prediction diversity, we subtract her guess (250) from the group's average guess (1,427). Her difference from average (Column D) was approximately -1,177. We square this difference to get 1,385,013 (Column E). Again, we run this calculation for each participant and then take the average for the group.

For this experiment the prediction diversity is 1,428,067 (bottom of Column E). The less diverse the individual guesses, the smaller the prediction diversity.

We can now solve the equation:

118 = 1,428,185 – 1,428,067

Note the square root of the collective error, $\sqrt{118}$, is approximately 11. This is the difference between the consensus guess and the actual number of jelly beans in the jar.

According to Scott E. Page, the core insight of the diversity prediction theorem is that "individual ability (the first term of the right-hand side) and collective diversity (the second term) contribute equally to collective predictive ability. Being different is as important as being good."

The bean jar experiment, as simple as it is, shows clearly how diversity contributes to good results.

Exhibit 5: Calculation of Diversity Prediction Theorem for Jelly Bean Jar

Participant	COLUMN A Guess	COLUMN B "Difference From Actual"	COLUMN C Squared "Difference From Actual"	COLUMN D "Difference From Average"	COLUMN E Squared "Difference From Average"
1	250	-1,166	1,359,556	-1,177	1,385,013
2	362	-1,054	1,110,916	-1,065	1,133,939
3	395	-1,021	1,042,441	-1,032	1,064,747
4	450	-966	933,156	-977	954,267
5	470	-946	894,916	-957	915,592
6	500	-916	839,056	-927	859,080
7	577	-839	703,921	-850	722,272
8	578	-838	702,244	-849	720,573
9	600	-816	665,856	-827	683,707
10	602	-814	662,596	-825	680,403
11	650	-766	586,756	-777	603,520
12	650	-766	586,756	-777	603,520
13	700	-716	512,656	-727	528,334
14	700	-716	512,656	-727	528,334
15	712	-704	495,616	-715	511,033
16	718	-698	487,204	-709	502,491
17	735	-681	463,761	-692	478,678
18	784	-632	399,424	-643	413,276
19	790	-626	391,876	-637	405,598
20	804	-612	374,544	-623	387,962
21	836	-580	336,400	-591	349,122
22	850	-566	320,356	-577	332,774
23	876	-540	291,600	-551	303,453
24	876	-540	291,600	-551	303,453
25	888	-528	278,784	-539	290,376
26	900	-516	266,256	-527	277,587
27	925	-491	241,081	-502	251,869
28	960	-456	207,936	-467	217,964
29	973	-443	196,249	-454	205,994
30	998	-418	174,724	-429	183,926
31	1,000	-416	173,056	-427	182,214
32	1,004	-412	169,744	-423	178,815
33	1,050	-366	133,956	-377	142,028
34	1,100	-316	99,856	-327	106,841
35	1,104	-312	97,344	-323	104,242
36	1,125	-291	84,681	-302	91,123
37	1,155	-261	68,121	-272	73,911
38	1,200	-216	46,656	-227	51,468
39	1,200	-216	46,656	-227	51,468
40	1,200	-216	46,656	-227	51,468
41	1,289	-127	16,129	-138	19,007
42	1,350	-66	4,356	-77	5,908
43	1,352	-64	4,096	-75	5,605
44	1,352	-64	4,096	-75	5,605
45	1,378	-38	1,444	-49	2,388
46	1,403	-13	169	-24	570
47	1,457	41	1,681	30	908
48	1,523	107	11,449	96	9,242
49	1,540	124	15,376	113	12,799
50	1,599	183	33,489	172	29,630
51	1,641	225	50,625	214	45,854
52	1,650	234	54,756	223	49,789
53	1,650	234	54,756	223	49,789
54	1,734	318	101,124	307	94,331
55	2,000	584	341,056	573	328,483
56	2,153	737	543,169	726	527,271
57	2,160	744	553,536	733	537,486
58	2,193	777	603,729	766	586,962
59	2,400	984	968,256	973	946,990
60	2,473	1,057	1,117,249	1,046	1,094,397
61	2,500	1,084	1,175,056	1,073	1,151,617
62	2,600	1,184	1,401,856	1,173	1,376,244
63	2,610	1,194	1,425,636	1,183	1,399,807
64	2,896	1,480	2,190,400	1,469	2,158,356
65	5,600	4,184	17,505,856	4,173	17,415,050
66	6,300	4,884	23,853,456	4,873	23,747,438
67	6,550	5,134	26,357,956	5,123	26,246,505
Average	1,427		1,428,185		1,428,067

"Actual" # of Jelly Beans	1,416
"Average Guess" of # Jelly Beans	1,427
Average Individual Error (Average of Column C)	1,428,185
Prediction Diversity (Average of Column E)	1,428,067
Collective Error ("Average of Column A"-"Actual")^2	118

CHECKS:

Collective Error = Average Individual Error - Prediction Diversity

118 = 1,428,185 - 1,428,067

$\sqrt{\text{Collective error}}$ = ABS ["Average Guess" - "Actual"]

$\sqrt{118}$ = ABS [1,427 - 1,416] ≈ 11

Source: Credit Suisse.

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