Brainstorming Groups in Context: Effectiveness in a Product Design Firm

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Experimental research indicates that people in face-to-face brainstorming meetings are less efficient at generating ideas than when working alone. This so-called productivity loss has led many brainstorming researchers to conclude that there is overwhelming evidence for the ineffectiveness of these sessions. We question this conclusion because it is based on efficient idea generation as the primary effectiveness outcome and on studies that do not examine how or why organizations use brainstorming. We report a qualitative study of a product design firm that uses brainstorming sessions. These sessions had six important consequences for this firm, its design engineers, and its clients that are not evident in the brainstorming literature, or are reported but not labeled as effectiveness outcomes: (1) supporting the organizational memory of design solutions; (2) providing skill variety for designers; (3) supporting an attitude of wisdom (acting with knowledge while doubting what one knows); (4) creating a status auction (a competition for status based on technical skill); (5) impressing clients; and (6) providing income for the firm. This study suggests that when brainstorming sessions are viewed in organizational context and the "effectiveness at what" and "effectiveness for whom" questions are asked, efficiency at idea generation may deserve no special status as an effectiveness outcome. We propose a broader perspective for assessing brainstorming effectiveness in organizations.•

Osborn's (1957) book *Applied Imagination* fueled the spread of group brainstorming as a tool for increasing creativity in organizations. He proposed four rules for these sessions: don't criticize, quantity is wanted, combine and improve suggested ideas, and say all ideas that come to mind, no matter how wild. Much research has since been conducted on brainstorming effectiveness. *Psychological Abstracts* indicates that brainstorming was considered in 208 articles between 1967 and 1994. Findings from numerous experiments, however, have led researchers to conclude that face-to-face brainstorming is ineffective. We propose that this conclusion is suspect because it is based largely on a single effectiveness outcome from studies that do not examine how and why organizations use brainstorming. We draw on an ethnography of an organization that uses face-to-face brainstorming to develop a broader view of brainstorming effectiveness.

Much of the brainstorming literature, especially experiments, focuses on two accepted facts. On the one hand, face-to-face brainstorming is portrayed as a popular tool for doing creative tasks in organizations like developing products, overhauling business systems, and improving manufacturing. On the other hand, experiments show that, compared to when people generate ideas alone and output is aggregated to the group level (called "nominal groups"), face-to-face groups generate fewer nonoverlapping ideas per person. These articles often suggest that such lower productivity is surprising given the widespread faith in brainstorming and given Osborn's (1957) claim that, compared with working alone, the

average person in a brainstorming group could generate twice as many ideas.[1]

Recent reviews conclude that this "productivity loss" is observed consistently in brainstorming groups with more than two members (e.g., Mullen, Johnson, and Salas, 1991; Stroebe and Diehl, 1994; Paulus, Brown, and Ortega, 1996). In Mullen, Johnson, and Salas's (1991) meta-analysis, they concluded further that nominal groups generate higher quality ideas than face-to-face groups. Diehl and Stroebe (1987) showed, however, that there is little evidence across brainstorming studies that face-to-face groups generate better or worse ideas. Fewer studies examine quality than quantity. Those that do so typically use quality measures confounded with quantity of ideas, and we were unable to uncover any study that has found significant differences in the mean quality of ideas generated by the two kinds of groups. Diehl and Stroebe concluded that face-to-face brainstorming produces fewer ideas and fewer good ideas (outcomes correlated at about .8) but, beyond this evidence of productivity loss, research on quality is otherwise equivocal.

Much research has considered why productivity loss occurs. Diehl and Stroebe (1987) proposed that three factors may explain this loss: (1) evaluation apprehension (group members may not express some ideas because they worry about what others think); (2) free-riding or social loafing (compared with working alone, individuals in groups do not feel as accountable for producing ideas, so they devote less effort); and (3) production blocking (compared with working alone, individuals' idea generation is "blocked" while they wait their turn to talk, and listening to others hampers thinking).

Evaluation apprehension has received some support: Productivity loss is greater when an authority figure is present (Mullen, Johnson, and Salas, 1991) and when some or all group members are disposed toward high anxiety about social interaction (Camacho and Paulus, 1995). Little support has been found for free-riding or social loafing. The strongest support has been found for production blocking, especially in Diehl and Stroebe's series of experiments (for reviews, see Stroebe and Diehl, 1994; Paulus, Brown, and Ortega, 1996). Paulus and Dzindolet (1993) found that productivity loss may also be explained partly by social comparison processes. Members of face-to-face brainstorming groups tended to match their productivity to members who generated the fewest ideas, resulting in lower productivity than nominal groups.

Related research uses the insight that people are more efficient when they work alone to develop (presumably) better idea-generating procedures. The Delphi (Dalkey, 1968) and nominal groups techniques (Van de Ven and Delbeq, 1974) entail first generating ideas alone, then using several rounds of interaction to refine and evaluate ideas. Recent research focuses on electronic brainstorming, in which people type solutions into a computer that has a second "window" of ideas generated by others who are simultaneously working on the problem. Advocates suggest that this method allows people to build on and be inspired by others' ideas without the blocking that occurs in face-to-face interaction. Groups

[1]
Many articles on productivity loss present this claim from pages 228 and 229 of Osborn's 1957 edition, apparently to create a contrast with evidence that people in face-to-face brainstorming groups actually generate fewer ideas than when brainstorming alone. Mullen, Johnson, and Salas (1991) and Diehl and Stroebe (1991) both referred to it in their opening paragraphs. Stroebe and Diehl's (1994: 272) review stated, "Osborn claimed that adherence to these rules would more than double the ideas of group members." Our reading of the three editions of *Applied Imagination* indicates, however, that this claim was only made in the 1957 edition. The 1963 edition contains no claims that group brainstorming is superior to generating ideas alone. Osborn (1963: 152) only stated that "a brainstorming session, properly conducted, can produce more good ideas than a conventional conference—and in less time," which is supported by a modest body of research comparing meetings that follow brainstorming rules with meetings that do not (McGrath, 1984). The only direct statement we can find in this edition about individual versus group productivity is that "Despite the many virtues of group brainstorming, individual ideation is usually more useable and can be just as productive" (Osborn, 1963: 191). Many authors repeat Osborn's claim of increased individual productivity in brainstorming sessions, but we can find no published paper recognizing that this claim was abandoned by 1963. Thus many studies and reviews are presented as if they are debunking Osborn's claim, even though he abandoned it long before nearly all of this research was conducted.

that use electronic brainstorming produce more ideas per person than face-to-face groups and do not appear to suffer from individual productivity loss when compared with nominal groups (e.g., Gallupe et al., 1992; Valacich, Dennis, and Connolly, 1994).

Experiments that compare face-to-face to nominal group brainstorming report several consequences in addition to productivity loss (Stroebe and Diehl, 1994; Paulus, Brown, and Ortega, 1996). Many experimenters report that subjects have more positive reactions to face-to-face than nominal groups, including satisfaction with the experience and their performance, perceptions that time passed faster, and beliefs that more and better ideas were generated. Recent brainstorming literature almost always presents such additional consequences as distinct from effectiveness (e.g., Mullen, Johnson, and Salas, 1991; Stroebe and Diehl, 1994; Paulus, Brown, and Ortega, 1996). Positive reactions are portrayed largely as sources of overconfidence, self-serving biases, pressures for consistency, or cognitive errors that fuel illusions of effectiveness, not as effectiveness outcomes in their own right.

This literature rarely addresses the question of whether or not generating ideas is, or should be, the primary effectiveness criterion for face-to-face brainstorms. Objective indicators of idea generation are portrayed as the only legitimate effectiveness outcomes, and most experimenters portray the number of ideas generated per person as the sole effectiveness outcome. Individual efficiency at idea generation *is* brainstorming effectiveness in this literature, where it is used interchangeably with "productivity," "effectiveness," "efficacy," and "performance." Diehl and Stroebe (1991: 392) used evidence on the number of ideas generated per-person to conclude that there is "overwhelming evidence" for face-to-face brainstorming's "ineffectiveness" and titled a recent review "Why Groups are Less Effective than Their Members: On Productivity Loss in Idea Generating Groups" (Stroebe and Diehl, 1994: 271). Paulus, Brown, and Ortega's (1996) review treated ideas generated per person and the performance of brainstorming groups as synonymous concepts. Mullen, Johnson, and Salas (1991: 18) drew primarily on findings about productivity loss in face-to-face brainstorming groups to conclude: "It appears particularly difficult to justify brainstorming techniques in terms of any performance outcomes, and the long-lived popularity of brainstorming techniques is unequivocally and substantively misguided."

Productivity loss is documented in numerous experiments and the effect size is large, but we question the firmness of conclusions that face-to-face brainstorming is "ineffective" or leads to lower "performance." We do so because of the theory and data this literature does *not* contain, especially about how and why brainstorming is used in organizations. We have not uncovered a single scholarly study of brainstorming in an organization where it is a routine part of the work. Paulus, Larey, and Ortega (1995) did document productivity loss in face-to-face groups composed of co-workers from the same organization. These subjects brainstormed about "ways to improve the organization" and were described as working in a "team culture" and having "as many

as 3 days of training in group dynamics" (p. 253). But they did not appear to be trained specifically in brainstorming techniques nor to have used brainstorming techniques in their work before the experiment, so this study does not appear to address how or why an organization uses brainstorming routinely.[2] Nearly all other brainstorming research was done with participants who (1) had no past or future task interdependence; (2) had no past or future social relationships; (3) didn't use the ideas generated; (4) lacked pertinent technical expertise; (5) lacked skills that complement other participants; (6) lacked expertise in doing brainstorming; and (7) lacked expertise in leading brainstorming sessions.[3]

We suspect that many of these factors are reversed in organizations that use brainstorming and that these factors influence important consequences. Lack of attention to context is not unique to brainstorming experiments. Hackman (1985: 131) reported that this tendency toward "holding constant (or ignoring) the relationship between groups and the context in which they operate" is evident across group performance experiments; he argued that by controlling for these powerful variables, experimenters are also "ruling out any possibility of learning about their effects." Incomplete or oversimplified conclusions about group and individual behavior in organizations may be reached when contextual factors like task interdependence, friendship patterns, network ties, hierarchical relationships, and incentives are ignored (Mowday and Sutton, 1993). Constraints and opportunities like these can explain variation in dependent variables, alter conclusions about which outcomes are important, and make visible who benefits and is harmed by given outcomes.

The heavy reliance on a single effectiveness outcome and lack of attention to context suggests that it is premature to conclude that face-to-face brainstorming groups are ineffective. In the experimental literature, face-to-face brainstorming is viewed primarily as a tool for generating ideas during a single session; less significance is attached to what else might be gained or lost by holding these gatherings. This narrow focus is reminiscent of early "machine theories" about organizations, like those by Taylor and Gulick which, according to Katz and Kahn (1978: 260), "imply that just as we build a mechanical device with given specifications for accomplishing a task, so we construct an organization according to a blueprint to achieve a given purpose." Machine theories take a closed-system view that ignores how transactions with the environment affect resource flows into the organization and the acceptability of the organization's output to those who use it. Machine theories also do not adequately take into account that, regardless of which tasks an organization is constructed to do, it produces other important consequences not imagined or intended at the outset (Merton, 1968), and such theories ignore member attraction, retention, and motivation as primary tasks for organizations (March and Simon, 1958).

This view that social systems produce a broad rather than narrow range of important consequences is reflected in theory and research on group effectiveness in organizations (Hackman, 1985, 1987; Ancona, 1993), organizational effec-

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Paulus, Larey, and Ortega (1995) provided only a vague description of the kind of group dynamics training given to these subjects, making no mention of whether it included training in brainstorming techniques. They also suggested that the subjects in this study had "task and social cohesiveness" (p. 253) outside the brainstorming sessions, but the extent and uniformity is unclear. They stated: "Employees in most cases signed up for the experiment with members of their work unit" (p. 253), which suggests that some groups were composed of employees from different units. Paulus and his colleagues did, however, acknowledge the possible lack of external validity of their findings: "Our results should not be interpreted as a rejection of the efficacy of group brainstorming. We did not employ the types of procedures that are typically employed by trained facilitators of group brainstorming, such as using flip charts, keeping the group task-oriented and ensuring adherence to the brainstorming rules, suggesting new apparatus to the problem when idea generation ceases, and providing brief breaks or incubation periods" (p. 259).

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There are a few exceptions. Osborn (1963) described anecdotal evidence about organizations that use brainstorming as a routine part of their work, but these are vague "success" stories. There is early evidence that, when experimental subjects are given training in brainstorming, productivity loss is reduced (Parnes and Meadow, 1959). Stroebe and Diehl (1994) also described an unpublished 1992 study by Diehl showing that when groups were formed so that there was heterogeneous knowledge between members about the brainstorming topic, significant productivity loss was not evident. Diehl's findings indicate that when groups are composed of members with complementary knowledge, they generate more ideas than groups composed so that there is homogeneous knowledge between members or so that members are randomly assigned. Finally, face-to-face brainstorming groups led by trained facilitators generate significantly more ideas than groups without facilitators, and while face-to-face groups without facilitators produced fewer ideas than nominal groups, no significant differences in idea production were observed when face-to-face groups were led by trained facilitators (Offner, Kramer, and Winter, 1996).

tiveness (Goodman et al., 1977), and organizational performance (Meyer and Gupta, 1994). These writings conclude that if effectiveness can be defined and measured at all, it is a multidimensional construct, because social systems produce many consequences and have multiple participants with inconsistent preferences. Researchers must ask "effectiveness at what?" and "effectiveness for whom?" to assess effectiveness in social systems. The answer to the "what" question in brainstorming research is usually restricted to "efficient generation of ideas by individuals," while the "whom" question is rarely addressed.

These concerns about brainstorming research were sparked by our ethnography of a product design firm. Existing literature led us to wonder if this firm was wasting resources by holding face-to-face brainstorms and ought to restrict idea generation to solo activities. Rather than accepting individual efficiency at idea generation as the primary effectiveness criterion, however, we considered a range of ways that brainstorming sessions might affect this firm, its product designers, and its clients. We blend this evidence with pertinent literature to develop inferences about six other consequences of brainstorming sessions that are worthy of the effectiveness label in this setting. We then develop more tentative inferences about the effectiveness of face-to-face brainstorming in other organizations.

Research Setting

This study was conducted at IDEO, the largest product design consulting firm in the United States. IDEO was founded by chief executive officer (CEO) David Kelley in 1978. It employs more than 150 designers who develop products for other companies. Headquarters are in Palo Alto, California, with smaller offices in Boston, Chicago, Grand Rapids, London, San Francisco, New York City, and Tokyo. The bulk of their work is in mechanical engineering and industrial design. Mechanical engineers design products for physical performance and ease of manufacturing; industrial designers use artistic skills (with an appreciation of engineering) to design products that are attractive and easy to use. Our study focuses on the 45 or so engineers in Palo Alto who do mechanical engineering and, to a lesser extent, electrical and software engineering and on the 35 or so managers and staff who support their work. We follow our informants' usage and describe IDEO's engineers as "product designers" or "designers" most often, but we (and they) sometimes use "engineers."

IDEO projects last from a few weeks to three years, with an average of about a year. Results range from sketches of products to crude working models, to complete new products. Clients range from Fortune 50 to start-up companies. IDEO has contributed to the development of over 3,000 products in at least 40 industries. Examples are the Macintosh DuoDock, Crest toothpaste tubes, tooth brushes, a cholesterol tester, the original Apple computer mouse, an electric guitar, bike helmets, telephones, a combination beach chair and cooler, furniture, angioplasty devices, a recharger for General Motors electric vehicles, fishing equipment, laptop computers, lamps, Nike sunglasses, Smith ski goggles, a

carbon-fiber bicycle wheel, and a motor scooter. IDEO is widely praised in the business press and won more *Business Week* Design Excellence Awards in 1993, 1994, and 1995, and over the last decade, than any other product design firm.

We received no pay or financial support from IDEO for this study, which we were permitted to do because of our prior relationships with IDEO employees and because they hoped to use our findings. David Kelley teaches at the same university as the first author, but they did not meet until the study began. The second author studied, practiced, and taught product design in Silicon Valley for eight years before becoming an organizational researcher. He was a college classmate in a product design program with several IDEO designers and took classes from, taught classes with, and taught classes to IDEO designers in this program. He also worked at IDEO for 15 months and was an IDEO client when working for Apple Computer. Managers and designers at IDEO were interested in our findings because clients like Samsung and Steelcase had started working with them partly to learn how to build an innovative culture like IDEO's. They hoped our observations about IDEO's design process, structure, and norms would help them explain and transfer these elements to such clients. We reached an agreement with David Kelley that, while employees' names would not be revealed without their permission, neither his identity nor his firm's would be disguised. We decided to reveal these identities because it would be impossible to halt news of our study in the product design community, in our university, and among clients we talked to about IDEO or who heard about it from IDEO employees.[4]

METHODS

Each of us spent six to eight hours per week doing fieldwork with IDEO informants from March 1994 through May 1995. Fieldwork continued at a less intensive level through February 1996, with at least one of us visiting IDEO each week. We wrote field notes after each visit or meeting. Any visit to IDEO entailed unplanned conversations, because many employees knew us before the study, they were curious about our research, and IDEO norms support friendly talk about the firm and the design process. The building in which most engineers work has a modified open office plan, which further facilitated informal talk. Other IDEO buildings in Palo Alto (industrial design, administrative offices, two machine shops, and a joint venture with Samsung) are within a few blocks (CEO Kelley calls it "the small town"), so many unplanned but enlightening conversations occurred on the street.

We began this ethnography with a vague research question: "How does IDEO innovate routinely?" Following guidelines for inductive research, we were as descriptive as possible until major themes emerged from the data (Glaser and Strauss, 1967). When a promising theme like brainstorming emerged, we focused data collection on it, read pertinent literature, and did preliminary analyses to decide if it was worth pursuing. Our interest in brainstorming was sparked in October 1994 when a colleague told us it was "proven to be ineffective," leading us to wonder if IDEO's brainstorming

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The identity of most IDEO clients and products are revealed here because this is public knowledge, but about 10 percent are disguised to avoid revealing sensitive information.

sessions were a waste of time and money. The evidence guiding our descriptions of and inferences about brainstorming at IDEO is divided into eight rough categories:

1. Observed brainstorms. We observed 24 brainstorms in which products were designed, 6 in person and 18 on videotape. These sessions lasted between 45 minutes and two hours. The videotapes were recorded by IDEO engineers, who used them in the design process. The topics ranged widely: three about personal appliances, three about furniture, three about video cameras, two about surgical tools, two about medical devices to aid healing, two about blood analyzers, two about laptop computers, two about personal communication, one about remote controls, one about ski goggles, one about vacuum cleaners, one about faucets, and one about a portable traffic control system. We wrote field notes about each and were given "brainstorming reports" for 11 of the 24, which are prepared for clients to summarize the generated ideas and to develop promising ideas in greater depth.

2. Interviews with the CEO, managers, and designers. We conducted 60 semistructured interviews; 37 were tape-recorded and transcribed; we took notes during others. We had multiple interviews with some informants, so approximately 35 people were interviewed. Initial interviews entailed asking senior managers and designers general questions about IDEO's history, clients, competitors, structure, human resource practices, and work process. Subsequent interviews focused on themes we wanted to learn about in detail. Brainstorming was the primary focus of 12 interviews and was discussed in nearly all interviews.

3. Informal discussions. We had hundreds of informal conversations with managers, designers, and support staff, ranging from brief exchanges (e.g., an engineer runs up, shows us a prototype for ten seconds, says, "this will be great if the client doesn't screw it up," and runs away) to long talks over lunch. These talks often turned to brainstorming because informants attended sessions routinely and knew we were studying them. We talked with almost every employee at the Palo Alto headquarters and had dozens of conversations with the CEO, other top managers, and senior designers. We also talked with approximately 10 IDEO clients about the company.

4. Tracking design teams. Each author followed a development team as it designed a product, one for six months and the other for four months. We met with team members about once every two weeks, attended design meetings (including brainstorms), and were given sketches, reports, and videotapes, which were sometimes produced in or inspired by brainstorms. The first team worked on personal appliances. We followed it until initial prototypes and detailed drawings were completed. The second team nearly finished designing a household appliance, but the client's new CEO stopped work on it and other designs to evaluate the firm's product strategy. Several months after we stopped tracking the team, the client decided that IDEO should finish the design.

5. **Design team interviews.** We did retrospective interviews with four design teams, which were tape-recorded and transcribed. Prototypes and the final product were brought to two interviews. We asked each group to describe how their project unfolded and the role that each member played. We then turned to the interpersonal, political, and technical aspects of the project. Each project required multiple engineering disciplines, and each used brainstorming sessions with IDEO designers who were not on the project team.

6. **Other meetings.** We attended a session about how to handle a major client and a session with that client about their design process. We attended a meeting with two engineers who were trying to codify and describe IDEO's own design process. We also attended about 12 "Monday morning meetings." Most Mondays, CEO Kelley meets with the 75 or so employees in Palo Alto who do or support "engineering design." They usually sit on the floor in a circle. Meetings start with Kelley talking about pressing, interesting, or funny events. Then managers and designers describe potential or new projects and give progress reports on ongoing projects. "Show and tell" is next, in which designers display and describe new products, prototypes, materials, and methods. We also participated in three brainstorms about IDEO's design process. The first focused on how IDEO's process could be applied to make another company more innovative, the second on aligning disparate descriptions of IDEO's process, and the third on how engineers combine diverse technical knowledge to design products.

7. **Materials about IDEO.** We gathered several dozen stories about IDEO from popular media sources, including *Fortune, Business Week, Wired, Fast Company, ID* and popular books. We viewed approximately ten television programs about IDEO first shown on outlets that included ABC, CNN, the BBC, and the Discovery Channel and explored a CD-ROM "tour" of IDEO. We gathered other materials produced by and about IDEO including a *Methodology Handbook* for engineers (with nine pages about "brainstormers"), four additional brainstorming reports, sketches of prototypes, a Harvard case about a keyboard support that resulted partly from IDEO brainstorms (Leonard-Barton, 1995), and a magazine story about a brainstorming session in which a bicycle commuter cup was designed so the reporter could pedal without spilling her coffee (O'Brien, 1995).

8. **Brainstorming survey.** We distributed a short survey to engineers in the Palo Alto office about participating in and leading brainstorms at IDEO. Following Eisenhardt and Bourgeois (1988), we used these quantitative data to further guide and ground our inferences, not to test them. The survey was distributed in March 1995, about six months after we began to focus on brainstorming. It has 40 items about topics derived from qualitative data: 37 use 5-point Likert scales, and three ask how many brainstorms the engineer attended and led. We distributed 45 surveys to these engineers: 37 were returned, and 27 contained written responses to a request for "other comments about brainstorming at IDEO."

A Description of Brainstorming at IDEO

We used these data to describe IDEO's brainstorming sessions and then to develop inferences about their effectiveness. An IDEO "brainstorm," or a "brainstormer," is a scheduled, face-to-face meeting called to generate ideas, usually about designing products. Design teams call and lead brainstorms to gather ideas from IDEO engineers who are not team members (and, less often, from industrial designers and support staff). The time spent on brainstorming is usually billed to clients. The survey indicated that engineers participated in 4 to 80 brainstorms in the past year (mean = 24); 31 of 37 respondents facilitated a brainstorm in the past year, with a range of 2 to 20 (mean = 6). Managers reported that engineers spend about 5 percent, and rarely more than 10 percent, of their time preparing for, being in, and writing reports about brainstorms. Facilitators and participants reflect IDEO's demographic mix: Most are 25 to 40 years old, male (about 80 percent), white (about 80 percent), and usually have a B.S. or M.S. in engineering. Clients attend about 20 percent of the brainstorms, most often during the first weeks of a long-term project, when they need to explain their product or industry before brainstorming and more detailed design work can begin. Clients also sometimes hire IDEO for a few brainstorms to help decide whether or not to use these consultants for a long-term project, or just to get some new ideas from outside of their firm or industry.

Designers believe that brainstorming skills take time to learn, that facilitation and participation are distinct skills, and that such skills vary even among experienced engineers. They first learned to brainstorm in university classes on product design and, by working at IDEO, gained experience and a reputation for having or lacking brainstorming skills. One said: "The skills for successful brainstorming develop in an individual over time. The skill set for successfully leading brainstormers seems to take much longer to develop—at least for me. I consider myself a good brainstormer but only a fair facilitator. A year ago, I was a good brainstormer and a poor facilitator."

A facilitator organizes a brainstorm by first compiling a list of participants with pertinent and complementary skills and then inviting them over e-mail, in person, or by phone to attend. Field notes from a brainstorm on ski goggles indicated:

Eve said that her team invited people with the specific mix of expertise they needed: one knew foam, the other knew clear plastic, and another knew manufacturing. She also said that in this case, as in others, she sent out a preliminary e-mail asking for help. She used the responses to screen for interest and skill mix, to decide who should be invited.

Brainstorming topics range from broad or "blue sky" ("What can a computer be used for when it is off?") to narrow ("This tool is too noisy.") design problems. Brainstorms last 45 to 120 minutes and are attended by 3 to 10 participants; broad brainstorms last longer and have more participants. A project typically uses two to four broad brainstorms during the first weeks to help generate an array of possible solutions. Brainstorms are then used sporadically to get new

ideas when designers go stale or need help with a specific problem; a typical team might call one every month or two.

Brainstorming is done in conference rooms. IDEO's version of the brainstorming rules are displayed (either painted on the walls or on sheets of paper) in several locations in each room so that every participant can see them. These rules are (1) defer judgment, (2) build on the ideas of others, (3) one conversation at a time, (4) stay focused on the topic, and (5) encourage wild ideas. These are the only rules displayed at IDEO.[5] These rules follow Osborn's fairly closely; notable differences are that "quantity is wanted" is missing, and "defer judgment" replaces "don't criticize." Each room has a table, comfortable chairs, and large white boards. As IDEO's *Methodology Handbook* recommends, facilitators prepare rooms by writing the topic on the board, ordering food and drinks, putting butcher paper and pens at each seat, and bringing in products like those being designed, along with less closely related products, to inspire creativity.

The facilitator or client typically spends the first 5 to 30 minutes explaining the topic; if it is highly technical, reading material is distributed or an informational meeting is held first. Idea generation starts after participants appear to understand the problem but is sometimes interrupted when they ask for more information. Facilitators playfully enforce the rules and write or sketch suggestions on the board. Participants usually follow the rules and insist that others (including clients) do too, pointing to the rules on the wall when violations occur. "Defer judgment" is the only rule we saw violated consistently. Informants did not mention Osborn's guidelines, but his "don't criticize" rule is used instead. Facilitators and participants discourage criticism, even negative facial expressions, but often smile, nod, and say "wow" and "cool" in response to an idea. Osborn's "quantity is wanted" is also missing. Facilitators encouraged quantity but said that building on ideas is more important, and pressing for quantity can reduce quality. After a brainstorm, facilitators photograph the board and collect sketches and lists from participants, which they use to write a brainstorming report and to guide their subsequent work.

IDEO brainstorms thus use rules much like those proposed by Osborn but that differ from those in most experiments, because people who attend have (1) past and future task interdependence, (2) past and future social relationships, (3) a use for the ideas, (4) pertinent technical expertise, (5) complementary skills, (6) expertise in doing brainstorming, and (7) expertise in leading brainstorming.

BRAINSTORMING EFFECTIVENESS AT IDEO

We used an iterative process to develop inferences about effectiveness outcomes resulting from brainstorming sessions at IDEO. Following Glaser and Strauss (1967) and Miles and Huberman (1995), a set of iterations usually began with a hunch inspired by the data or literature (e.g., an informant said clients are impressed by brainstorms). Then, to see if a hunch could be grounded, we compiled evidence from the eight data sources (e.g., we looked for evidence that clients were, or were not, impressed), which led us to

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IDEO is a decentralized organization with few formal rules and procedures. CEO Kelley jokes, "We have a no-policy policy."

abandon, modify, or maintain the inference (e.g., we retained the inference that brainstorms impress clients). We summarized evidence for retained inferences in Table 1, which shows how strongly each consequence is grounded in each data source (e.g., all eight data sources indicate clients were impressed). We then wrote a section explicating our inferences about each retained consequence (like impressing clients) that weaves together conceptual arguments, additional evidence, and pertinent literature. We also considered, but did not retain, several tentative inferences that we found could not be supported by the data.[6]

We found that face-to-face brainstorming sessions at IDEO serve as more than idea generators. Even if IDEO designers are less efficient at generating ideas during the five percent or so of their time they spend in these sessions, other (largely positive) consequences may compensate for the "productivity loss" identified in experimental research. Table 1 indicates we found that brainstorms at IDEO had six other consequences beyond generating ideas that were important enough to IDEO, its designers, and clients to be labeled effectiveness outcomes (1) supporting the organizational memory of design solutions, (2) providing skill variety, (3) supporting an attitude of wisdom (acting with knowledge while doubting what one knows), (4) creating a "status auction" (a competition for status based on technical skill), (5) impressing clients, and (6) providing income. We explicate these consequences below.

Supporting the Organizational Memory of Design Solutions

Brainstorms help IDEO designers acquire, store, retrieve, adapt, and combine knowledge of potential solutions to design products. As Table 1 indicates, this is a consistent theme across data sources. As consultants to over 40 different industries, IDEO does detailed design work in many industries and does not specialize in one. They see a wider range of technologies than designers who develop products for one industry or organization. In network theory language, they are "well connected in several networks, rather than extremely central in just one" (DiMaggio, 1992: 130). As a result, much of their value to clients is as a broker, or a bridge, transferring information between previously unconnected sources of technical knowledge (Burt, 1992; DiMaggio, 1992).

IDEO acts as a "technology broker" by moving technical knowledge between industries (Hargadon and Sutton, 1996). Yet technology brokering at IDEO means more than just acquiring and transferring knowledge between diverse industries. Engineers store this knowledge, retrieve it from storage, blend it, and adapt it for new design problems. The "Jaminator," a toy guitar that IDEO designed part of, combines a microprocessor technology, new to the toy industry, with existing materials, speakers, and manufacturing and design principles. In another case, when there wasn't enough room to use traditional fasteners, IDEO designers used bicycle spokes to fasten the display of a Dynabook portable computer. When this computer went into production, a bicy-

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Several colleagues suggested, for example, that brainstorming sessions might increase commitment to a project among engineers who attended. We found a few hints of such commitment in the data but no consistent support for this hunch, so it was not retained.

Table 1

Evidence from Data Sources Supporting Six Consequences of Brainstorming*

Effects	Observed brainstorms	Semistructured interviews	Informal discussions	Tracking design teams
Supporting Organizational Memory	Strong evidence Eight existing laptop computers are on the table, two designed partly by IDEO. The client's current vacuum cleaner is described and taken apart.	Strong evidence "We just had every tool that you can imagine using to cut hedges on the table." "Brainstorms teach us what designers and clients know, and how to fit it together."	Strong evidence Designers say brainstorms are a place to learn about the designs used in other industries. An engineer reads old brainstorming reports to help him design a new product.	Strong evidence A designer talks about using ideas from farm combines to cut hedges. One designer says to another: "I didn't know you knew so much about manufacturing."
Providing Skill Variety	Strong evidence Laughter when a giant stapler for cardboard is brought in, then serious silence as designers do sketches to apply the idea to skin staplers.	Strong evidence "You get away from the detail work and do the best part of design."	Strong evidence "You get to do the hardest and most fun part of design, coming up with new ideas for a product you've never thought much about before you walk in the door."	Moderate evidence "I was in a brainstormer last week. I had to get away from [my project] for an hour. I needed the vacation."
Supporting Attitude of Wisdom	Strong evidence Facilitator says, "We couldn't come up with these ideas alone. One person knew the materials, one knew manufacturing, one knew the industry, and one drew a great sketch for us." Two engineers build a crude prototype out of duct tape and paper.	Strong evidence "At IDEO there are not a few single brilliant designers who solve all of the problems." "We talk to people a lot; we allow our assumptions to be challenged or even deflated."	Strong evidence "Brainstorms are one of the best ways to get others to help you start a project or make sure that you are not missing something later." "You try out ideas. Most aren't used. But we sometimes develop ideas from one brainstorm to another that eventually turn up in products."	Strong evidence "We flushed out the old group and got another eight people to generate ideas for us. We didn't say 'It is my project, I'm going to protect it, I don't want anybody else to touch it'." An engineer and a human factors expert do a series of sketches that build on one another's ideas.
Creating Status Auctions	Strong evidence After the session ends, the organizer asks, "Which ideas should we develop?" There is agreement that "Claire's" and "Tyler's" ideas are best.	Strong evidence "It's fun, it's a break from what you're doing. You get invited to brainstorms by your performance in the past. So, there's a motivation to do well because then you get invited back."	Strong evidence "It is a place to strut your stuff." Informant says IDEO defines brainstorms as a place where creativity happens. If you aren't creative there, it means something is wrong with you.	Sporadic evidence A brainstorm facilitator jokes: "Cool idea—you earned your cookie."
Impressing Clients	Moderate evidence A client says, "That is a great idea. I didn't know that."	Strong evidence "Clients come here for brainstormers. They see the creativity. So it's a way of hooking them. It is not like anything subversive. It is just the way we are."	Moderate evidence A designer describes a prospective client who had "great fun and heard great ideas" in two brainstorms.	Strong evidence A project leader reports that a potential client was impressed with the brainstorms she attended and the resulting report, and has signed up for a long-term project.

Table 1 (*Continued*)

Design team interviews	Other meetings	Written materials and videos	Survey†
Sporadic evidence	Sporadic evidence	Strong evidence	Moderate evidence
"We started by looking closely at a similar product." "Most of us had never thought about (that product) before the brainstormer."	CEO suggests a "cool" new material might be suggested so often that it becomes "like Velcro or Nitinol in brainstorms."‡	"Somebody is always running off to get something—a piece of hardware, a tool, a model, some materials, etc., so that by the end of the brainstormer the table is covered with [related] stuff."	*Brainstorms help me to learn about projects other designers are working on.*(4.43) *The same idea is suggested in many different brainstorms.* (3.86)
Sporadic evidence	Sporadic evidence	Moderate evidence	Moderate evidence
Designer reports initial brainstorms were more fun than usual because the client was a good engineer who helped them do advanced designs.	"I was too busy to go to that brainstorm. But it was about toys. I love learning about toy design and doing it. I had to go."	"People aren't in their normal crank-it-out mode here. They're getting a break."	*Brainstorms are a nice change of pace from my other work.* (4.81) *Brainstorms are one of the most fun things that I do at IDEO.* (4.3)
Moderate evidence	Sporadic evidence	Strong evidence	Sporadic evidence
A designer says, "We think that the more engineers that look at something, the better it will be. They [at another company] don't think like that. They are afraid to show their work to anybody until they think it is done."	The CEO says, "We think that good design means passing it through a lot of engineers' heads and having them all tweak it a bunch of times, like we do in our brainstormers."	"[Brainstorming with many engineers] is worth blowing a chunk of your budget in the beginning to get everyone thinking about your project. When you get a lot of people thinking about the issues, you multiply the chances that somebody will come back with an idea."	*Brainstorms are an efficient way for me to get ideas from other designers.* (4.77) "Brainstorms only work when the organizer is willing to be vulnerable. A show-off wouldn't be included in very many."
Sporadic evidence	Sporadic evidence	Moderate evidence	Moderate evidence
A designer discusses a brainstorm, saying "Fred's idea was especially good, he always does incredible sketches."	The CEO names a designer and says that he deserves congratulations for coming up with an idea in a brainstorming session that led to a viable product.	"Brainstormers can also inspire friendly competition—you want to be the one to think up the best ideas. If you are relaxed and fluent the excitement can spur you on."	*Brainstorms are a way for me to demonstrate my creativity to other designers.* (4.0) "Designers try to impress each other by displaying skill, intelligence, and creativity."
Moderate evidence	Sporadic evidence	Moderate evidence	Moderate evidence
"We did an extra brainstorm to think of ways to add value without cost. It wasn't something they asked for; it was to impress them with our design thoughtfulness."	A designer says, "They liked the brainstorms. We are waiting to see if they want us to develop the ideas further."	"Brainstorming is a way of wooing the client: it's a courtship technique."	*Brainstorms are a good way of showing clients how creative people at IDEO are.* (4.57) *Clients usually have fun at brainstorms.* (3.89) *Clients usually find the ideas developed at brainstorms to be valuable.* (3.97)

Table 1 *(continued)*

Effects	Observed brainstorms	Semistructured interviews	Informal discussions	Tracking design teams
Providing Income	Sporadic evidence	Strong evidence	Strong evidence	Moderate evidence
	Designers joke that brainstormers are both good for the client and a good way to bill hours.	A designer says a brainstorm provides "a nice blast of cash."	Designer wants to make sure that, although he had fun at a brainstorm, the client will be billed.	A designer reports the firm makes "good money" on brainstorms.

*Strong evidence = A dominant theme in this source, consistently supported; Moderate evidence = A frequent but not constant theme in this source, consistently supported; Sporadic evidence = A theme that appears now and then in this source but is consistently supported; No evidence = Little or no evidence in this source that supports or refutes the proposed consequence. Informant comments and statements from internal documents are in quotes, survey items are in italics, and comments without quotation are from field notes or summaries of field notes.

†Respondents assessed these items on a 5-point Likert scale (1 = very inaccurate; 5 = very accurate). The mean sample score is in parentheses.

‡Nitinol is a nickel-titanium alloy that temporarily and consistently changes shape with temperature changes. IDEO designers usually tell "the Nitinol joke" at some point in a brainstorm, when they try to come up with an amusing but plausible application. After years of Nitinol jokes, a senior designer's suggestion that Nitinol could be part of a mechanism for ejecting PCMCI cards was used and is now available in a laptop by Apple Computers.

cle store in downtown Palo Alto supplied custom spokes to the manufacturer.

IDEO's network position facilitates such creativity because designers have a storehouse of tried-and-true solutions from many industries that they can draw on to use in new ways. This storehouse fits Walsh and Ungson's (1991: 61) definition of an organizational memory because it is "stored information from an organization's past that can be brought to bear on present decisions." Walsh and Ungson described information acquisition, retention, and retrieval as processes that support organizational memory. Brainstorms are among the main ways that design solutions are added to, stored in, and retrieved from IDEO's memory.

Brainstorms provide an opportunity to add new design solutions to IDEO's memory because they are among the first steps in designing a product. Brainstorms often concern products and parts IDEO has not designed before, so preparation entails gathering related products by the client and its competitors. Even when a brainstorm is about an industry in which IDEO is experienced (like laptop computers or vacuum cleaners) or is held later in a project, it almost always begins with the facilitator or client teaching participants about the product and the design challenge to generate ideas about. We watched two videotaped brainstorming sessions on designing skin-staplers for surgery. The facilitator showed a videotape demonstrating the client's current stapler. He passed around the client's stapler and five or six competing staplers while he explained the product and industry. Designers played with the staplers throughout the meeting and asked many questions. Another facilitator asked participants to create a "new fishing experience" that was easier and more fun for novices. The facilitator first "got ten people on the roof with fishing rods in their hands, practicing casting and experiencing what it was like." Other brainstorms we saw or heard about taught designers about cameras, channel changers, vacuum cleaners, chargers for electric cars, faucets, goggles, computers, bandages, wine boxes, and tools

Table 1 (*continued*)

Design team interviews	Other meetings	Written materials and videos	Survey†
Sporadic evidence	Sporadic evidence	Sporadic evidence	No evidence
19 designers attend two brainstorms, and the client is billed for their time.	A manager says about brainstorms: "Clients pay good money for them, but they are a bargain at twice the price."	"How much you do depends on your budget and time."	

for artificially growing and harvesting human skin for burn victims.

Brainstorms are also an efficient way to disperse design knowledge among IDEO engineers, reminding experienced designers and teaching newcomers about which solutions had been considered in the past and spreading information about solutions that are new to the company. IDEO is a small enough company that if, say, one brainstorming session is held with 10 engineers, about 20 percent of those in Palo Alto are exposed to the technical problems and solutions discussed. Designers also gossip after brainstorms, so useful, funny, or strange ideas spread quickly to those who don't attend.

The design solutions acquired, recalled, and developed in brainstorms are stored mostly in three locations. First, they are stored in the minds of designers who attend and hear about a brainstorm. Second, products and prototypes acquired for, brought to, and built in brainstorms are kept and then used to design future products. Designers collect old products and prototypes, display them in their offices (which don't have doors or have doors that are usually left open), talk about them, and loan them to one another because, an informant asserted, they are "solidified intellect, not an object, but rather a collection of ideas." One engineer's office had a chrome-plated plastic nameplate from an Isuzu Trooper, a 1950s Hamilton Beach blender, molded rubber ears from a past project on headsets, the final headset and several early prototypes, toy cars that contained flywheels, a butane torch that runs on a cigarette lighter, an oversized computer trackball for kids, the prototype for that product made of machined aluminum and electrical components, several surgical products he had designed, and a toy dart-gun. Many of these objects were first acquired for brainstorms and were often brought to brainstorms. Third, ideas developed in brainstorms are archived in reports and, occasionally, in videotapes. We saw one designer ask another for a brainstorming report about flexible surgical tubing to get ideas about designing a personal appliance. Another designer said that he sometimes watches old videotapes of especially fruitful brainstorms so that he doesn't forget the "cool" ideas he learned.

In addition to adding to and preserving IDEO's memory, brainstorms are a setting in which old design solutions are retrieved and then adapted and blended together to help

solve new design problems. An engineer wrote on his survey:

I look for others with related expertise that might see the idea from a different perspective. The most fruitful brainstorms are when at least one participant has a good deal of specific, available knowledge from a different area that is still very applicable. In these cases, the client is probably unaware of this new information, and we can transfer a lot of detailed, implementable solutions.

Designers in brainstorms retrieve ideas from past brainstorms, from products they or others they knew had designed, from ongoing IDEO projects, and from personal experiences prior to and outside of IDEO. It is especially "cool" to suggest ideas from hobbies like remote control airplanes or sailing. Some technologies, like Velcro or Nitinol (a nickel-titanium alloy that changes shape in response to temperature changes), are suggested at many brainstorms. Other solutions are more unusual, like the designer who suggested using technology from "weed-whackers" to cut skin in surgery. Some solutions come from products that IDEO had designed: Two designers tried to use ideas from a vacuum cleaner to reduce the noise made by another appliance. Designers retrieve other solutions from the "cool stuff" that they display in their offices and bring to brainstorms. A senior designer explained why he brings toys: "Toys have so many neat things, they are high volume, mass production, often plastic, clever, and so cheap. I especially love Japanese toys with good design. We bring 'em out in brainstormers and apply the ideas to skin staplers or mechanisms, whatever."

This stored information about existing design solutions is used to help make decisions about new products, again reflecting Walsh and Ungson's (1991) definition of organizational memory. So our first answer to the "effectiveness at what" question is that brainstorms help add to, maintain, and draw on IDEO's memory of design solutions. Brainstorms facilitate acquisition of new solutions, spread new solutions throughout the company, refresh memories of old solutions, and help retrieve old organizational memories. This memory enhances the ability of IDEO designers to talk about and do product design, which attracts clients. These memories can help clients to manufacture and sell more creative products. Finally, brainstorms benefit engineers by increasing their design knowledge and, in a point developed next, by making their jobs more interesting.

Providing Skill Variety

As Table 1 indicates, designers laughed, joked, and smiled in brainstorms, described them as "a vacation" and "fun," and agreed with the survey item that "Brainstorms are one of the most fun things I do at IDEO." A newcomer even wondered if they had "too much fun" in brainstorms and ought to present a "more serious image." IDEO designers enjoyed brainstorms partly because of extrinsic pleasures like good food, "hanging out" with friends, and the chance to bill time to clients. Brainstorming is also, as an informant put it, "one of the funnest, most invigorating aspects of the job" because the tasks done during these sessions are so challenging. IDEO brainstorms give designers a chance to use,

stretch, and learn a wide range of knowledge and techniques, in other words, to experience skill variety (Hackman and Oldham, 1980). Designers do a variety of interesting tasks in brainstorms, like learning about products and industries, blending old ideas in new ways, refining others' ideas, sketching new designs, and occasionally making crude prototypes. The brainstorms for creating a "new fishing experience" entailed trying to "fish" off the roof, hearing about fishing, and then generating ideas about the mechanics of the rod and reel (e.g., a "slingshot" method of launching lures), human factors (e.g., where to put finger cushions), making a "green" product (e.g., using little or no packaging), manufacturing (e.g., making the rod, reel, and handle all one piece), and graphics (e.g., displays explaining the product to fishing novices).

Going to brainstorms also expands the skills a designer uses during a typical day or week. Because IDEO's clients are diverse, designers work on a broad mix of products, perhaps laptop computers, then toothpaste tubes, then a vacuum cleaner, and then a motor scooter. IDEO's lack of task specialization also means that every designer uses many skills during a long-term project. But a designer often focuses on a narrow task during any week or month, perhaps reading hundreds of patents, spending long hours using a computer-aided design (CAD) program to refine a prototype, or checking dozens of two-dimensional drawings. An invitation to a brainstorm means spending an hour or two generating ideas to help designers on another project. Designers called them "vacations" and agreed that "Brainstorms are a nice change of pace from my other work" (4.81 on a 5-point scale). Brainstorms provide variety because designers learn about new products and industries and develop new product concepts; they do the most challenging parts of product design without responsibility for the less interesting detail work needed to transform a concept into a manufactured object. One designer said, "Brainstorms are one of the rewards of working here. You think of this kind of neat cutting edge stuff that's completely different from what you are working on now."

IDEO brainstorms provide the opportunity to use high-level technical skills, a benefit not given to most participants in brainstorming experiments. They are similar to the brainstorms in experiments, however, because participants have positive reactions to the interesting tasks and social interaction. Experimental researchers have not labeled emotions as "effectiveness" or "performance" outcomes. This approach is reasonable if brainstorms are convened for the sole purpose of generating a lot of ideas; positive emotions may mask or impede this outcome. The way that designers felt about their work and IDEO during and after a brainstorm, however, were also important effectiveness outcomes in this context.

IDEO can recruit and retain engineers who are in demand in Silicon Valley, partly because the work is more interesting than elsewhere. IDEO pays competitive salaries and shares profits with employees. But it is privately owned and unlikely to go public, so it cannot provide the dream of getting rich from stock options like a small start-up can or the chance for stock options that many large companies offer. IDEO is also

a relatively small organization with a flat hierarchy, so it offers fewer opportunities for promotion than a large corporation. Designers come to IDEO and stay because, although these incentives are absent, the work is so interesting. They understand this exchange before taking the job and stay because they view it as fair. Most could leave (often for more money) if they are willing, as one put it, "to do the boring work most engineers do in the Valley."

This exchange is not attractive to all designers. It is attractive to most at IDEO because they are selected and socialized to have intrinsic interest in product design. A client emphasized that IDEO designers were "guys with red shoelaces" who cared more about doing good design than making money. A designer confirmed this view: "the kinds of people who work here are intellectually curious, inquisitive; they like the design process. They are here because they love designing stuff and you get to stick your fingers into more things to design." IDEO engineers enjoy brainstorms because they are a way to "stick their fingers" into many design problems, apply design knowledge in new ways, and learn about new products and industries without ruining progress on their long-term projects.

Supporting the Attitude of Wisdom

Brainstorming is also important to IDEO and its designers because these meetings help set, reinforce, and reflect organization-wide values and norms. Designers referred to "real" brainstorms as scheduled meetings in conference rooms led by a facilitator. But they described IDEO as "one long brainstorm that never stops" and brainstorming "as a way of life." They did so because the rules they followed, the design process they used, and the way they treated one another in brainstorms shaped and reflected more general expectations for thought and action.

Meacham's (1990) concept of the attitude of wisdom provides a useful compact summary of these values and norms: It means acting with knowledge while simultaneously doubting what one knows. Wise people do not suffer from excessive caution or confidence that dampens the curiosity they need to be adaptive in the face of uncertainty (Weick, 1993). Excessive caution dampens curiosity because it causes people to fear experimentation, failure, and criticism. Excessive confidence, or arrogance, dampens curiosity because people "know" they are doing the right thing and see no reason to test their ideas, to try new ideas, or to ask for advice. Sternberg's (1985) research suggests that understanding the limits of one's knowledge, in combination with constant attempts to learn from others, distinguishes wisdom from intelligence or creativity. Attributes that best distinguish wisdom from intelligence and creativity include considering advice, feeling that one can always learn from others, being a good listener, listening to all sides of an issue, and not being afraid to admit making mistakes.

As Table 1 indicates, IDEO brainstorms were used and talked about in ways that reflected and reinforced the attitude of wisdom, especially in asking others for help and experimenting. Designers call brainstorms to ask others for ideas that they haven't thought of, indicating that they do

not understand all aspects of a problem and are neither too confident nor too cautious to ask for help. Designers emphasized that brainstorms and other conversations are essential to the design process. They asserted that no person can consistently design good products alone; the process requires knowledge about too many things and making too many trade-offs between constraints. They insisted that the only way to avoid major mistakes, or at least make fewer mistakes, is to talk to a lot of smart people. These beliefs also meant that every engineer at IDEO was expected to give others help when he or she was asked to do so, and even when engineers weren't asked, they knew that if they could help another designer, they were expected to do so. These persistent themes are evident in Table 1 and in this comment on brainstorming:

We are all very smart people, but given the complexity and constant trade-offs associated with the design process, brilliance comes from the minds of lots of smart designers rather than the actions of one brilliant designer. A true design genius wouldn't be happy here. But I don't know if they exist. I have never met one smart enough to consider all of those variables at once.

Designers viewed brainstorms as one of the best ways to get help and give help to others because, compared with e-mails or brief conversations, richer information was exchanged and attention was focused narrowly on the problem. A designer wrote on the survey, "Brainstormers are useful in getting detailed knowledge about your project out so it stimulates others to suggest solutions or offer leads that a simple e-mail message might not."

A brainstorm also sets the stage for organizers to get help from others after the meeting adjourns. Brainstorms are often used early in a project and a large percentage (20–40 percent) of the engineers in Palo Alto attend these "kick-off" brainstorms. As the quote in Table 1 indicates, participants often come back to the design team with ideas that occurred to them after the session. Participants also talk ("gossip" is more accurate) about brainstorms to designers who didn't attend, which teaches others about the project and sparks more ideas that are passed along to the team. This gossip also means that when team members ask others for advice during the project, conversations can be short but technically sophisticated.

Brainstorms called after the "kick-off" period are often admissions that the organizer has designed him- or herself "into a corner" and needs help, reflecting Sternberg's (1985) finding that wise people admit mistakes and believe they can learn from others. IDEO's *Methodology Handbook* encourages designers to call brainstorms "for getting unstuck" when something won't fit, might break, or is too expensive. Designers said that being too busy, arrogant, or embarrassed to ask for help resulted in bad products "you deserve all of the blame for." They believed that getting stuck is endemic to product design, especially in engineering, so they expected one another to ask for and give help. A designer told us:

What it really is, I mean, it's kind of a state of mind. Where I worked before, you just didn't ask for help. It was a sign of weakness. What they thought brainstorming was compared to what we

think it is are very different things. We don't have time to screw around. At the first hint I don't know something, I'll ask "Does anyone know about this?" The whole thing here is you've got to leverage as much as possible. You ask for help. You are expected to ask for help here.

A designer who worked on an electric vehicle charging station for GM/Hughes told us how he got "unstuck": "I couldn't make one part clear another part. I didn't know how to put a hinge on it. I called a 45-minute brainstorm with 5 people. Three minutes before the end, one of the designers, she came up with an idea that became the final design."

In addition to being requests for help and creating a setting in which designers help one another, IDEO's brainstorms also reflect and reinforce a norm of experimentation. People who experiment a lot, and expect to fail a lot and learn from failures, are acting with knowledge while doubting what they know. If they lacked wisdom, they would be afraid to test ideas or be so confident they wouldn't believe any testing was needed. Designers spend much of their time sketching ideas for products and drawing ideas with CAD software programs, quickly producing physical prototypes, using them to stimulate their thinking and feedback from others, changing them, building new ones, and continuing this iterative process until the final design (Boyle, 1996). David Kelley describes prototyping as a "way of life" at IDEO.[7] For example, one team used brainstorms to launch a six-week "blitz" that yielded 10 prototype computers; they generated over 60 prototypes during this year-long project.

IDEO brainstorms teach and remind designers to generate many ideas, develop a few in depth, make many changes in developed ideas, and reflect the belief that many bad ideas can lead to a few good ones. This iterative process occurs in brainstorms as participants generate lists and sketches; it is most visible when designers build on suggested ideas. During a brainstorm on Smith ski goggles, for example, a comment by one designer inspired a sketch by another, which was then redrawn several times by other designers who changed, added, and deleted features during each iteration. The words and sketches generated during brainstorms spur designers to produce prototypes after these sessions. Designers use materials like cardboard, foam, silver tape, Lego blocks, and crude combinations of existing products to "get three-dimensional as quickly as possible." One engineer took two hours to shape and glue together some plastic, a motor, a battery, and wires to build a prototype suggested in a brainstorm.[8] IDEO's machine shop is integral to this prototyping process, producing wood, metal, foam, and plastic models based on designers' sketches or CAD drawings. Designers also sometimes assemble crude prototypes during brainstorms. Several designers combined a pencil, a small electric motor, and a paper clip to create a silly writing instrument that wiggled around and created swirling patterns. One yelled, "This is a great toy, kids will love this, we've got a product." Neither these designers nor any IDEO client developed it, but several years later an identical design concept was sold as the "Wigglewriter."

This constant talk and experimentation hampers IDEO's short-term efficiency. The talking and listening during and

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This emphasis on experimentation is also reflected in David Kelley's view of structural change. The firm tried a variety of structural arrangements in 1995 and 1996. Kelley encouraged designers to view each new structural arrangement (e.g., teams, smaller "companies within the company") as changeable prototypes, just like the products they design. To reinforce this message, he had little "Experiment" signs hung throughout the company and shaved off his trademark Groucho-Marx-style mustache. He told us that he told his employees, "The changes they were trying were just like shaving off my mustache, they are temporary and reversible experiments."

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The client chose to pursue this concept largely as a result of seeing and using this prototype. This designer then spent more than a year refining it before the final design was complete.

after brainstorms takes time away from other tasks: Helping on other projects delays a designer's own projects, informal conversations after brainstorms are usually not billed to clients, and trying many prototypes consumes time and money. In contrast, however, the attitude of wisdom reflected in brainstorms appears to have positive long-term consequences. IDEO benefits because its reputation is enhanced by better products. Individual designers benefit because talking about design increases their technical knowledge and skill, which may lead to credit for designing better products. Clients may benefit because they get designs reflecting the knowledge dispersed throughout the company and the most promising of many alternatives that were considered and tested.

Creating a Status Auction

The attitude of wisdom means that design engineers go out of their way to help one another, that they respect each other's skills, and that they believe "everyone here is smart." Yet there are marked status differences between them, distinctions based largely on technical ability and on using it to help others. Top managers determine designers' pay and responsibility and they place weight on the number of hours billed, but compensation decisions are based largely on informal reputation among fellow designers and formal peer reviews. A top manager described IDEO as a "peer-oriented meritocracy." The result, a designer emphasized, is that "the only way to enhance your status in the organization is by earning the respect of your peers." Respect means having a reputation as a skilled and helpful designer, and status means relative standing in the informal technical hierarchy, not one's formal position. There is little differentiation by formal position at IDEO. We asked respondents to include a business card with their completed brainstorming surveys. They varied widely in management responsibility, pay, and design experience, but the title on every card read "Engineer," except for one (a co-founder's), listing no title.

This technical hierarchy was so dominant that managers sometimes complained they didn't get enough credit, because "every one here acts like being a good designer is all that matters, like nothing else matters, even though they need us desperately." Even David Kelley fretted that, because he no longer has time to design products, his reputation is based on vague factors like "making money," "building a company," and "keeping people happy," not "designing cool stuff, which is the only thing that really matters here."

Brainstorming sessions are an important (and efficient) means through which competition for status based on technical skill occurs between engineers. Like meetings studied by anthropologists, brainstorms can be described as "prestige" or "status" auctions, in which people bid for status, and depending on how others respond, their status may go up or down (Schwartzman, 1986). Elders in the Merina culture (in Madagascar), for example, try to claim status by creating the impression that a meeting starts the moment they arrive; if they arrive and the meeting does not start or it starts without them, their status drops. If the meeting starts

the moment they arrive, their status is preserved or enhanced because it signals their importance. People in meetings also make status bids by the people they arrive with, where they sit, what they say, when they say it, and by their displayed emotions (Bloch, 1975).

Table 1 summarizes the evidence that brainstorms are status auctions. Informants often portrayed brainstorms as places in which bids for status were made, and depending on how participants, facilitators, and clients reacted, an engineer's status was maintained or changed. An industrial designer said, "You are probably going to ask me about how brainstorms lead to creative products, but what strikes me is that those engineers treat it as a competition. It's a competition!" An engineer added:

There is this positive peer pressure. One of the greatest rewards here at IDEO is to be seen as a brilliant, clever, innovative designer. There is no better forum (or it is one of the best forums) for people to hear your great ideas than in a brainstorming session. The more you do this the more people seek after you to be a guru in their brainstorms. It self-perpetuates. People know each other and they know who to ask.

Brainstorms at IDEO can be viewed as games in which the rules assure that the status auction flows rapidly and fairly. The "players" are gathered for a fixed time in a room where they will not be interrupted with other chores, so that each has a chance to contribute ideas. They restrict attention to one problem ("Stay focused on the topic"), which means that all play roughly the same game. Brainstorming guidelines facilitate many bids (facilitators encourage many ideas) and different kinds of bids ("encourage wild ideas"). They don't criticize ideas but do praise promising ones, which also encourages many "bids." There is little cost for suggesting a bad idea as long as a person occasionally comes up with a good one. The rules also encourage civility. Participants are not only forbidden to criticize each other (or even to look grumpy), they are forbidden to interrupt, and once a person starts a bid, he or she is given time to finish it ("one conversation at a time").

The "players" do, however, get a lot of feedback about how well their ideas are received. When a designer makes a suggestion, he or she sees others' immediate facial expressions. The espoused guideline is "defer judgment," but "don't criticize" is used. A suggestion may be followed by silence, treated as a joke rather than "real," or generate enthusiastic comments like "wow" or "cool." In addition, although facilitators try to record all suggestions, it is hard to do so. A designer gets a positive signal when his or her idea is recorded (or better yet, sketched on the board) and a negative signal when it isn't. It is also a positive sign when others build on an idea, because there isn't time to build on all ideas.

Brainstorms often end with the facilitator asking, "Which ideas should we develop further?" Designers usually show consensus about which ideas were best and refer to ideas by the name of the designer who suggested it, so "winning bids" are often identified. The competition doesn't always end after the brainstorm is adjourned. Designers may make suggestions after a brainstorm because they are unhappy

with their creativity during the session. One said, "I like be-ing one of the three or four people who came up with the creative ideas. If I am not, I sometimes spend a couple more hours afterwards to develop better ideas." This informant reported he never billed a client for these extra hours. He added that IDEO clients get a lot of free work because engi-neers are so competitive and obsessed with design that they do extra work they don't feel they can bill.

Designers develop reputations for having varying levels of brainstorming skill. This theme in our qualitative data was corroborated by answers to the survey item, "Some design-ers are more skilled at brainstorming than others" (4.78 on a 5-point scale). One informant asserted, "There are only 20 [out of 45 or so] designers who are really good at brain-storming and only 5 who are great." These reputations af-fect how many brainstorms designers are invited to and how many they turn down. These reputations also affect how of-ten they are given the chance to facilitate brainstorms. A de-signer's reputation for participating in and leading brain-storms was viewed as an important indicator of overall status on IDEO's technical hierarchy. The CEO told us that there is no need to fire the occasional designer who is hired but doesn't have the right mix of skills, because "they real-ize that they had better get another job when no one invites them to any brainstorms."

So another answer to the "effectiveness at what" question is that brainstorms create a social arena in which status auc-tions occur. These contests were desirable for engineers because they are selected and socialized to be a bit competi-tive and believe they can design better products than most others. Brainstorms provide a forum to demonstrate their skill. But brainstorms have unpleasant consequences for some participants: There are winners and losers in these competitions, and losers suffer status losses and negative emotions. A quote in Table 1 suggests that, given the belief at IDEO that creative things happen in brainstorms, a "los-er's" self-esteem may drop because "if you aren't creative there, it means something is wrong with you." The conse-quences for IDEO as a whole appear more uniformly posi-tive. This competition focuses attention and effort on devel-oping technical skill, displaying it to others, and using it to help others design products. This collective focus on product development (and away from less task-relevant factors) may enhance IDEO's designs, which can please current clients and attract new ones.

Impressing Clients

Clients were not only often impressed with the concepts, prototypes, and finished products that resulted from brain-storms, they were often impressed with the creativity dis-played by IDEO designers and the fun everyone had. Design-ers claimed, "We really wow 'em in brainstorms," and "It is a real chance to show off our capability." Qualitative and sur-vey data in Table 1 indicate that brainstorms were fun and impressive for clients and helped "hook" them for long-term projects. A designer explained, "You do it to show the client that you've got a good start, to show them that you've got a grasp of the problem and are being clever. You want them

to think, Wow, I'm glad I came to these guys. They are starting out with a bang!"

Our data, in combination with pertinent literature, suggest that clients' positive reactions stem from two characteristics of brainstorms. First, brainstorms are an efficient way for clients to explain their design problems and gather ideas from others. We first heard this argument when an informant said: "You know, even if designers are a little faster working alone than in a brainstorm, it is faster for the guy who calls it or for the client." The first five to 30 minutes of a brainstorm are spent explaining the problem to participants. Like the logic of classroom instruction, it is faster for a client (or facilitator) to explain it once to a group of, say, six designers than to explain it six times to six people.

Clients (and facilitators) also can gather ideas more quickly in a brainstorm than through a series of conversations with individual designers. Facilitators who completed the survey agreed that "brainstorms are an efficient way for *clients* to get ideas from IDEO designers" (4.17 on a 5-point scale) and, especially, that "brainstorms are an efficient way for *me* to get ideas from other designers" (4.77 on a 5-point scale). Numerous experiments show that face-to-face brainstorms are more efficient than nominal groups for gathering ideas from others. For example, Stroebe, Diehl, and Abakoumin (1992) did a 15-minute experiment with four-person groups of high school students who brainstormed into a microphone about improving traffic safety. The average yield per person was higher in nominal than face-to-face groups (mean = 27.71 ideas versus 21.14). But the average yield for listening to a 15-minute tape of a face-to-face group was over three times greater than for listening to a 15-minute tape of a person brainstorming alone (mean = 84.55 versus 27.71).

The brainstorming literature rarely mentions that face-to-face groups generate ideas more rapidly than individuals, and we can't find any scholar who asserts that the effectiveness of brainstorming sessions is indicated by efficiency at gathering ideas. This more rapid idea generation has been portrayed as supporting illusions of effectiveness. Stroebe, Diehl, and Abakoumin (1992: 649) proposed that these higher yields per unit of time help fuel a "baseline fallacy," in which people who hear more ideas in face-to-face than in nominal groups overestimate their own productivity and the productivity of their group. From the perspective of a person using a brainstorm to gather ideas, however, greater productivity is not a fallacy. A group meeting is objectively more efficient for gathering ideas than a series of meetings with individuals. Hearing ideas at several times the rate of one-on-one conversations may help explain why IDEO's brainstorms impress clients. As a designer put it, clients are "amazed when we come up with almost every solution they've ever thought of during the first 30 minutes."

Second, brainstorming guidelines fuel clients' positive reactions. These sessions require displayed positive emotions that, like other organizational norms about expressed emotions, are supported by training, rewards, and punishments (Rafaeli and Sutton, 1989). Clients, like others at IDEO brain-

storms, are taught to praise ideas, build on suggested ideas, be playful, wait their turn before talking, and not be critical. The justification for such guidelines is that they facilitate the flow of ideas. A side-effect is that participants are encouraged (nearly required) to express only positive feelings. If designers or clients are negative, or just look grumpy, they are gently reminded to be more upbeat. IDEO's *Methodology Handbook* says "everyone should have a good time" and urges facilitators to remind clients of the rules "when they jump in with criticism" and to "get them to turn their criticism into an idea."

Clients may also convey positive feelings because of emotional contagion, the well-documented tendency for a person to converge emotionally with others. Human beings automatically make social comparisons with people around them and adjust behavior so that it is similar. They "mimic and synchronize facial expressions, vocalizations, postures, and movements" (Hatfield, Cacioppo, and Rapson, 1994: 5). Clients at a brainstorm join a temporary group in which people express enthusiasm about generated ideas, about each other's design skill, and about IDEO. The respect designers convey to one other, their smiles, and their laughter may be "caught" by clients.

Brainstorming norms and emotional contagion encourage IDEO clients to express positive emotions and to say positive words about the ideas generated during these meetings. Research on commitment and attitude formation and change indicates that people induced to express public sentiments that they have no prior opinions about, or even disagree with, resolve inconsistencies between thought and action by aligning their private opinions with public behavior (Salancik, 1977; Petty, 1995). This finding holds as long as people believe they have expressed sentiments of their own free will. So when clients express positive emotions and opinions about IDEO's designers and their ideas during brainstorms, they may then align their private beliefs to match their public behavior, regardless of prior beliefs.

These forces help explain why clients who attend brainstorms may view them as a more efficient way for gathering ideas and react more positively than if they had a series of one-on-one meetings with designers. Brainstorms may increase IDEO's effectiveness by causing positive evaluations of its output by those who use and pay for it. These evaluations may also enhance IDEO's overall reputation and benefit designers who, as a result of impressing clients, gain more status and responsibility.

Providing Income

Brainstorming is not a primary source of income for the firm; few designers devote more than 5 percent of their billed hours to brainstorms. But, as Table 1 indicates, people at IDEO viewed brainstorms as a useful income source; 15 to 25 hours of designer time are billed for the "back-to-back" brainstorms usually held at the start of a project, along with time for organizing the meetings and writing the report. Brainstorms provide the only income from some clients, who, rather than signing up for a long-term project, hire IDEO primarily to hold and write reports about brainstorms.

In addition, designers are expected to bill a certain number of hours per week. One informant told us that, when he was not overloaded, if he went to a brainstorm instead of having lunch with friends, he could do some fun design, get a free lunch, bill time, and go home an hour earlier.

Our finding that the more hours billed to clients, the more IDEO and its designers benefit, suggests a reversal of the assumption throughout the experimental brainstorming literature that efficient idea generation indicates effectiveness. This view is valid for clients who pay for designers' time. If we extend the "effectiveness for whom" question to IDEO and its designers, however, inefficiency at individual idea generation may mean greater effectiveness. If designers are less efficient at generating ideas in brainstorms than working alone, then clients will be billed for more hours for the same amount of work. Whether designers are a bit more or less efficient at generating ideas probably is not very important. They rarely spend more than 5 percent of their time in brainstorms, and these gatherings have other positive consequences. Nonetheless, given that individual efficiency at generating ideas is the most widely studied and accepted effectiveness indicator in brainstorming experiments, it is interesting that, when brainstorming is viewed in this organizational context, efficiency may indicate ineffectiveness for some participants.

Informants also reported that clients are less likely to complain about bills for brainstorming than about most other work that designers do. As with all consulting firms, IDEO clients occasionally complain about bills. Complaints about IDEO's brainstorms are rare because it is an expected part of the design process, which is endorsed and used by legitimate sources of authority and expertise. Designers are taught to use brainstorming in university classes through lectures, practice sessions, and textbooks (e.g., McKim, 1980). Even though many organizations that hire IDEO do little or no brainstorming, most clients have heard of brainstorming and accept it as a legitimate practice. Group brainstorms are rarely challenged because, as institutional theory suggests, even if they are not the most technically efficient way to generate ideas, their legitimacy is supported by widely promulgated and accepted "rational myths" (Meyer and Rowan, 1977).

DISCUSSION

This study suggests that when brainstorming sessions are viewed in an organizational context and the "effectiveness at what" and "for whom" questions are asked, efficiency at idea generation deserves no special status as the sole effectiveness outcome. We identified six other important consequences for the organization, its employees, and its clients that are not examined in the experimental literature, or when studied, are not labeled as effectiveness outcomes. IDEO brainstorms may not be the most efficient means for generating ideas or for doing any other single task, but they are efficient for accomplishing a variety of important tasks at once. In addition to generating possible design solutions, brainstorms support the organization's memory of technical solutions, provide skill variety, support an attitude of wisdom

in and outside the session, create a status auction that maintains a focus on designing products, and they impress clients and generate income.

The approach to theory building we use here is "knowledge growth by extension," which means "a relatively full explanation of a small region is carried over to an explanation of adjoining regions" (Weick, 1992: 177). Our detailed explanation of brainstorming effectiveness in one organization sets the stage for (more tentative) inferences about brainstorming in other organizations. These inferences are tentative, because we used subjective data and had close rather than detached relationships with informants, which may bias our interpretations. These inferences are also tentative because IDEO may not represent other organizations that use brainstorming; it is small, has few rules, consults to diverse industries, and its norms reflect and reinforce brainstorming guidelines.

This study may, however, suggest a shift toward a broader view of brainstorming effectiveness when the findings are blended with theory on groups in organizational contexts (e.g., Hackman 1985, 1987; Ancona, 1993). The experimental literature on face-to-face versus nominal brainstorming groups contains many nuances, but there is consensus that data about idea generation are sufficient for judging effectiveness. Our study does not contrast face-to-face and nominal groups, but it does suggest that a broader set of measures and perspectives can be used to assess their effectiveness. Our findings and conceptual perspective imply that when evaluating effectiveness, it may be more useful to consider all of the outcomes gained and lost by generating ideas in face-to-face versus nominal groups.

The consequences we identified at IDEO fit into this broader perspective but are likely too idiosyncratic for assessing brainstorming groups across organizations. The criteria in Hackman's (1985, 1987) effectiveness model are more general and have proven useful for framing the "effectiveness at what" and "for whom" questions for groups in a variety of organizations. Group effectiveness is indicated by the degree that (1) the group's product or service meets the standards of people who receive, review, and use it; (2) carrying out the group's work enhances its capability to do competent work in the future; and (3) the group experience contributes to members' growth and personal well-being.

Our research suggests some modification of Hackman's criteria, because effectiveness is reflected largely in consequences for organizations in which brainstorming occurs and for people who attend them, not for the brainstorming group. Brainstorming at IDEO is usually done by temporary groups that are disbanded after one session. But participants have enduring relationships in a shared organization or are clients who may work with IDEO on long-term projects. This perspective is also evident in writings on total quality management (TQM), which report that brainstorming is used by temporary and permanent groups to generate ideas about improving quality (e.g., Ishikawa, 1985). Brainstorming may have immediate effects on such groups, but advocates assert that this and other TQM methods affect interdependent

knowledge and actions throughout the organization, enhanc-
ing the intended outcome of organizational effectiveness
(Hackman and Wageman, 1995). This limited information
suggests that the most important effects of a brainstorming
session (or of forming and disbanding a series of sessions)
are often on the organization it occurs in and on individuals,
not on these often-ephemeral groups.

We modified Hackman's criteria so they can be applied to
the consequences of brainstorming sessions for organiza-
tions and individuals. The first is *the extent to which the
products of brainstorming sessions meet the standards of
the people who receive, review, and use that output.* To as-
sess these criteria, researchers need to identify the "clients"
who review and receive the output, identify the standards
they use, and measure how well clients judge that these
standards are met. People who hire and pay IDEO to design
products for their organizations are external clients. Design
team members who call brainstorms and use the resulting
ideas are internal clients, as are IDEO managers who (infor-
mally) review the ideas and billed hours. Brainstorms will
have different types of clients elsewhere, but multiple cli-
ents will be present in most settings.

Hackman (1985: 129) proposed that this perspective "shifts
primary control over the choice of assessment standards
from researchers to those who are affected by and use what
is produced." He added that, even if objective criteria are
present, people who review group outputs often make sub-
jective judgments that are influenced little, if it all, by objec-
tive evidence. The three types of "clients" at IDEO notice if
brainstorming sessions produce many or few ideas, but they
use subjective factors like "there were a lot of cool ideas,"
"there was a great idea," "we can build a good prototype
now," or "everybody was excited about the ideas" to judge
the quality of the output.

This perspective means that brainstorming effectiveness is
based on the evaluations that researchers find *are* used by
the people who receive, review, and use the output, not on
the evaluations that researchers believe that they *should*
use. It suggests, for example, that whether or not external
clients' reactions to the brainstorming process *should* color
their assessment of outputs, if these assessments *are* en-
hanced, it is reasonable to label them as effectiveness out-
comes for IDEO and its engineers, because they result in
satisfaction and business from impressed clients and in a
good reputation that may bring in business from other cli-
ents. The subjective criteria clients use to judge brainstorm-
ing effectiveness will vary across settings. The general les-
son is that what happens to organizations and participants
who use brainstorming "depends far more on others' as-
sessments of output than on any objective performance
measure" (Hackman, 1985: 129).

The second criteria is *the extent to which brainstorming ses-
sions attenuate or accentuate the organization's capability to
do competent work in the future.* The effects that brain-
storming sessions have on the long-term capabilities of orga-
nizations in which they occur have not (to our knowledge)
been studied. These outcomes cannot be examined in most

brainstorming experiments because they are not done in organizations and participants have no future task interdependence. Our research suggests that these are among the most important benefits that IDEO would lose if it abandoned brainstorming sessions. Brainstorms help maintain and enhance IDEO's memory of design solutions, communicate and reinforce organizational norms for collaboration and constant experimentation, help maintain a status order based on technical knowledge and skill, and provide skill variety (and opportunities to interact with friends and eat good food) that helps IDEO attract, retain, educate, and motivate a skilled and mobile workforce.

These findings suggest that brainstorming sessions may affect the capability of other organizations to do competent work in the future. We do not mean to imply, however, that brainstorming sessions will have the same consequences we observed at IDEO, or even generally positive effects, on other organizations. Brainstorming sessions may occur so rarely that the organization is not affected. Other organizations may have core tasks, values, and norms that are so inconsistent with or detached from brainstorming sessions that they have no effects or only negative effects. Lawler and Mohrman (1985) suggested that quality circles (which use brainstorming) were a fad that faded, in part, because encouragement to participate and respect for ideas within group meetings often clashed with expectations for other organizational roles. This contrast led to employee dissatisfaction, which was one reason that managers disbanded quality circles.

The third criteria is *the extent to which participating in brainstorming sessions contributes to the growth and personal well-being of participants.* Hackman suggested that working in some groups may lead to opportunities for learning, personal satisfaction, and other aspects of well-being, while working in other groups teaches participants little they find valuable, frustrates them, and harms well-being in other ways. Experiments indicate that participants find face-to-face brainstorms to be enjoyable, a theme that was also evident in our study. IDEO brainstorms give designers a break from less interesting tasks and give them a chance to participate in the most fun part of design and to learn new design skills. These sessions also give them a chance to interact with friends, eat good food, and fulfill management's expectations by billing hours. Finally, brainstorms have a positive effect on designers who are esteemed by peers for generating great ideas and for being skilled facilitators who enable others to generate ideas. Brainstorms may, however, hamper the well-being of designers who are rarely invited or who are viewed as poor brainstormers. They may feel bad about themselves and leave the company.

The effects of brainstorms on personal growth and well-being will vary across settings and participants within settings, both in terms of which aspects are affected and whether brainstorms are generally beneficial or harmful. Available evidence suggests that brainstorms will have largely positive consequences. But the overall effects may be harmful in some settings and for some participants. Boredom and frustration may arise, for example, when participants are given

trivial problems or are asked to brainstorm about the same problem again and again. And if there are competitive pressures to display creativity and intelligence, participants who believe they have not done so (or are labeled as not having done so) may suffer distress and harm to their careers.

These three criteria sacrifice the precision and simplicity of idea counts for a more complex but, we believe, more accurate, conception of brainstorming effectiveness. These complexities include enduring effects of brainstorming on organizations and participants, measures of task performance that change from objective idea counts to multiple subjective evaluations, and variance in the weights placed on different effectiveness criteria across settings and people. The inclusion of multiple criteria and perspectives suggests that trade-offs will be identified in how brainstorming sessions are structured and orchestrated. Research on electronic brainstorming procedures already suggests a trade-off between producing positive reactions in participants and generating ideas: When participants were identified to each other (rather than anonymous) and worked with a supportive (rather than critical) confederate, they had higher process satisfaction and self-rated effectiveness but generated fewer ideas (Connolly, Jessup, and Valacich, 1990).

These criteria do, however, provide a simple set of minimum standards, because, as Hackman (1985: 129–130) implied, an adequate brainstorming session only requires "output judged by those who receive it as more than acceptable, a performance unit that winds up its work more competent than when it started, and performers who are more satisfied than frustrated by what happened." It is premature to assume, however, that face-to-face brainstorming sessions are generally effective across organizations; that is an empirical question.

This revised approach provides a more complete picture of brainstorming effectiveness. But it, too, may be oversimplified, because we have portrayed brainstorming sessions as different and separate from other aspects of organizational life. We have implied that, compared with other ways that people at IDEO do their work, distinct norms are present in brainstorms and these sessions bring about a distinct set of (largely desirable) outcomes for IDEO, its designers, and its clients. An alternative view is that, just as Geertz (1973) found that cock fights were gatherings that made visible the overall Balinese character and culture, brainstorming sessions may provide a vantage point from which we can see the values, norms, work methods, and social structures that are prevalent throughout IDEO. Designers conveyed this view with statements like "brainstorming is a way of life here" and "we have a brainstorming culture."

IDEO is a place in which people, in doing much of their work, try to avoid criticizing others, build on others' ideas, have one conversation at a time, stay focused on the topic, encourage wild ideas, and generate a lot of ideas. These aspirations and actions are often easier to observe in brainstorming sessions than in informal conversations or e-mail exchanges, but there often isn't much difference between the way that designers act inside and outside of these ses-

sions. We have emphasized that brainstorming sessions establish and reinforce practices used outside these sessions, suggesting a simple, unidirectional model that masks the reciprocal influence between events inside and outside of the sessions. Causality may run primarily in the opposite direction or, more likely, beliefs and actions inside and outside of these sessions are mutually reinforcing. Moreover, the vividness of IDEO's values, norms, work practices, and structures during brainstorming sessions may have led us to overemphasize the impact of these sessions on IDEO as a whole. IDEO's overall effectiveness may be weakly affected by the 5 percent or so of the time that designers spend in these sessions and strongly affected by the far longer periods that they spend in this "brainstorming culture" but outside of brainstorming sessions.

Our study also led us to wonder how much group brainstorming is actually done in organizations. Researchers often suggest that brainstorming is worth studying because it is so widely used (e.g., Diehl and Stroebe, 1991; Paulus et al., 1993), but they offer no definitive evidence about its prevalence. Our study raises the questions of how widely *any* gatherings labeled "brainstorming" occur in organizations. IDEO worked with clients from engineering, research and development, manufacturing, and marketing groups of hundreds of diverse organizations. Clients had always heard of brainstorming and sometimes employed IDEO for its brainstorming skill. Yet few clients worked in organizations that used brainstorms, which is why IDEO sends clients the brainstorming rules before they visit and why facilitators devote much effort to assuring that clients follow these rules. Our research also raises the question of whether organizations *claiming* to use brainstorming are using the method studied in experiments. Institutional theory suggests that organizations may claim brainstorming is used to convey that they are using a legitimate and widely endorsed practice (Meyer and Rowan, 1977). Similar to research on rhetoric versus the reality in total quality management (Zbaracki, 1995), however, spokespersons may claim that their organizations do "brainstorming" although there may not be even an attempt to follow Osborn's rules. IDEO's David Kelley attended a "brainstorming session" at a company where the highest-status person spoke first and criticized others, while lower-status people said little. Kelley's reaction was "I don't know what it was, but it sure wasn't brainstorming." If large-scale studies are used to determine the prevalence of brainstorming, "yes" and "no" questions won't do. More direct measures like structured observations will be needed.

Finally, our research suggests that just because a group effectiveness outcome is accepted by a community of researchers doesn't mean it is the best metric for the groups studied, for the groups that researchers want to generalize findings to, or for the general progress of theory or research. March (1994) observed that once a performance measure is accepted, its meaning is often obscured because it is treated as a magic number that actually *is* performance. A community of researchers may take for granted that one measure *is* effectiveness because it has sufficient variance, it yields consistent significant differences, it is convenient to assess,

there is conceptual justification that it is *one* indicator of effectiveness, and it has been used often in the past. These factors appear to help explain why individual efficiency at idea generation is so widely used and endorsed as the primary, often the lone, effectiveness metric for experiments on face-to-face versus individual brainstorming.[9] When the machine theory view of brainstorming groups is abandoned and brainstorming groups are viewed in organizational context, however, the reasons for other researchers who study brainstorming, for people who do brainstorming, and for people who use, receive, and review the output of brainstorming to accept this single consequence as the magic number seem to wither.

More generally, effectiveness and performance are not objective truths that exist independently of the people who monitor, measure, and report the outcomes. These judgments are motivated by what is valued and what is not by the people who make them. As a result, which outcomes are labeled as effectiveness and which are not, and which effectiveness outcomes are assessed and which are not, may reflect as much about the measurers as the measured.

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These comments do not apply as readily to researchers who study electronic brainstorming, who sometimes examine a wider range of effectiveness outcomes.

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