CHAPTER

3 Prelude to Whole-Brain Methods

Begin with the end in mind.
—*Stephen R. Covey, leadership expert*

Objectives:

After studying this chapter, you will be able to:

- Illustrate the universality of the divergent-convergent thinking process when resolving an issue, solving a problem, or pursuing an opportunity
- Explain how whole-brain methods enable intentional creativity and innovation
- Articulate the importance of method selection
- Discuss the value of using a series of multiple methods on many types of projects
- Show the limiting consequences of relying solely on the Einstellung Effect
- Report how we know that methods work
- Demonstrate the potential value of errors and accidents
- Summarize why a few methods are only good for individual or group use
- Review the fundamentals of facilitation

3.1 THE MORE IDEAS, THE BETTER

When faced with a well-defined issue, problem, or opportunity (IPO), we typically begin by developing a list of ideas or options. This is divergent thinking, as shown at the top of Figure 3.1. Then, we explore the pros and cons of each idea or option, make a decision, and act on it. This is convergent thinking, also shown at the top of Figure 3.1.

The quality of any of our decisions at any point in an endeavor, whether arrived at individually or as a team, is likely to be better when we consider more ideas (more

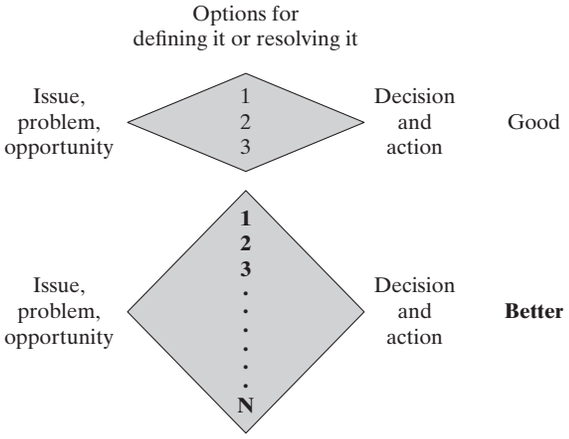

Figure 3.1
The useful divergent-convergent thinking process can generate even more ideas or options to define and resolve a challenge when it is enhanced with whole-brain tools.

options), as shown in the bottom of Figure 3.1. The value of more ideas is widely applicable in engineering; it enhances our ability to address challenges we face with structures, facilities, systems, products, and processes as well as nontechnical challenges. We want the divergent thinking effort to be rich and varied. In the world of idea generation, more is usually better! Scientist Pauling said, "The best way to have a good idea is to have lots of ideas." American writer Steinbeck put it this way: "Ideas are like rabbits. You get a couple, and learn how to handle them, and pretty soon you have a dozen."

This *early on, more is better* concept applies whether we are striving to *define* an IPO or endeavoring to *resolve* one. For example, some of the whole-brain tools described in this text will enable you and/or your team to generate many more ideas about the possible causes of a problem in the divergent portion of the divergent-convergent process and then zero in on the most likely cause in the convergent portion. Similarly, some tools will help you generate options for solving the problem within the divergent portion of the divergent-convergent process and then select the best solution in the convergent portion.

Whether you are attempting to define or resolve an IPO, separate your and/or your group's divergent and convergent thinking to maximize idea generation. Do the divergent part thoroughly before even thinking about the convergent part. Don't mix the two cognitive processes, and don't rush through either of them, lest you fail to do either one well. Furthermore, remember what you learned about the subconscious mind in Section 2.9 and try to practice both divergent and convergent thinking intermittently to engage and benefit from the 24-7 subconscious thinking of all participants.

3.2 THE TOOLBOX

Let's introduce and begin to explore a toolbox with contents that will enable you to take a whole-brain approach. Although these are just tools, recognize that in the right hands—yours and those of your teammates—they can help you be creative and innovative.

3.2.1 Many Methods

Fortunately, many methods are available to help you engage both cranial hemispheres, whether working alone or in collaboration with others. You can employ your conscious and subconscious minds and make use of other brain basics

Table 3.1 Twenty whole-brain methods are described in this text.

Method	Applicability		User		Highly Visual?
	Definition of an Issue, Problem, Opportunity	Resolution of an Issue, Problem, Opportunity	Individual	Team	
In Chapter 4					
Ask-Ask-Ask	X	X	X	X	No
Borrowing Brilliance	X	X	X	X	No
Brainstorming	X	X	X	X	No
Fishbone Diagramming	X	–	X	X	Yes
Medici Effect	X	X	–	X	No
Mind Mapping	X	X	X	X	Yes
Ohno Circle	X	–	X	–	Yes
Stream of Consciousness Writing	X	X	X	X	No
SWOT	X	–	X	X	Yes
Taking a Break	X	X	X	X	No
What If?	X	X	X	X	No
In Chapter 7					
Biomimicry	–	X	X	X	Yes
Challenges and Ideas Meetings	X	X	–	X	No
Freehand Drawing	X	X	X	X	Yes
Music	X	X	X	–	No
Process Diagramming	X	X	X	X	Yes
Six Thinking Caps	X	X	X	X	Yes
Supportive Culture and Physical Environment	X	X	X	X	Yes
TRIZ: Theory of Inventive Problem Solving	X	X	X	X	No
Taking Time to Think	X	X	X	–	Yes

described in the Chapter 2 so that you can more creatively and innovatively address IPOs. Table 3.1 lists twenty whole-brain methods described in this text. The items in this cognitive toolkit will stimulate you and, more powerfully, your group to think more deeply and widely. Your group might focus on a project, planning, design, research, experimental, marketing, or another area. Your group's goal is to generate more ideas, analyze them, explore many and varied optional courses of action, select from among them, and implement the best choice.

Do you or your team miss the satisfaction of creating and innovating? Maybe you're not in your right mind—or more precisely, not in your right mind *enough*. This book's methods, as introduced in Table 3.1, will get you there. This text's methods support the idea that "a problem well-stated is a problem half-solved," as stated by engineer and inventor Kettering. "If we really understand the problem, the answer will come out of it," according to Indian philosopher Krishnamurti, "because the answer is not separate from the problem." As shown by the second column in

Table 3.1, essentially all of the twenty methods can help you define an IPO. The second and third columns indicate that most of the methods are applicable in both defining an IPO and for resolving it. Columns four and five reveal that most of the methods can be used by an individual or group. Finally, half of the methods are highly visual, as noted in the last column.

The methods in this text's toolbox stimulate more right-brain activity to supplement your left-brain activity and, as a result, yield more creativity and innovation. Rather than relying only on what Gerard Nierenberg, author of *The Art of Creative Thinking* (1982), calls "accidental creativity," these methods facilitate intentional creativity and innovation by engaging both hemispheres, the conscious and unconscious minds, and the synergism among all of them.

We cannot will ourselves to be more creative and innovative. Instead, we need stimulating techniques to steer us away from conventional thinking (Michalko 2001). The Russian inventor Altshuller (1996), while acknowledging that trial and error works, argues for a more systematic approach, such as his Theory of Inventive Problem Solving, one of this book's methods (Section 7.9). Creative and innovative work will always require some trial and error, but why not minimize it?

Having made a case for a more systematic and intentional approach, I will note that there seems to be a tendency to believe that creativity and innovation are more accidental than intentional, more the result of inspiration than perspiration, and like magic and limited to very few of us. A 2013 survey (Kluger 2013) asked 2,040 consumers this question: "Does it take a lot of time thinking about a problem to produce creative ideas, or are they usually sparked by sudden inspiration?" About 60 percent of the respondents selected "sudden inspiration." The accident-inspiration-magic approach will produce some creativity and innovation, but much less than if we proactively pursue it.

Creative and innovative ideas lie within most of us, but we need mechanisms to release them. "We know where most of the creativity, the innovation, the stuff that drives productivity lies," according to former GE Chairman Welch, "in the minds of those closest to the work." We need methods to engage those minds and synergistically release that creativity. Good news: You and your team and organization are loaded with creative and innovative ideas; you and those you work with are a gold mine of creativity and innovation. You need only to mine the gold using whole-brain methods.

3.2.2 Just Tools

I sometimes refer to the whole-brain methods we are about to discuss as *tools*. In doing so, I am suggesting that we should avoid fancy-sounding euphemisms, such as associative thinking methodologies, creativity/innovation stimulation devices, or neuro-optimization techniques. I choose to suggest that the methods in this text—like the tools you have in your shop, at your desk, in your laboratory, or on your computer—should be viewed by you as readily available aids that you select and apply as needed.

Some methods can be explained and then applied somewhat methodically—that is, in step-by-step manner—such as Brainstorming, Fishbone Diagramming, Mind Mapping, Strength-Weaknesses-Opportunities-Threats (SWOT), and Process Diagramming. Other methods are more of a way of thinking about an IPO, a manner used to approach a challenge, an attitude taken when faced with a complex situation, or an environment in which good things happen—for example, Borrowing Brilliance, Medici Effect, Taking a Break, What If?, Freehand Drawing, Supportive Culture and Physical Environment, and Taking Time to Think. I mention this

spectrum of methods, ranging from methodical to attitudinal in how they are described, to prepare you for the discussions in Chapters 4 and 7.

Although the features of each method are important, equally important is your or your group's ability, acquired through experience, to select the most appropriate tools for a given situation and use them effectively and efficiently. You may be able to drive a nail with the handle of a screwdriver, but a hammer produces better results—and while both ball-peen and claw hammers can drive nails, the latter can also remove them.

3.2.3 Breaking Barriers

Application of the Medici Effect, which means assembling and then energizing a highly diverse group, is discussed in Section 4.6. Various kinds of diversity are available and desirable, including people with markedly different organizational power. Individuals such as presidents, department heads, mayors, and other highly placed individuals accustomed to being on top of things and always in control may be reluctant to wholeheartedly participate in open discussions seeking creative and innovative resolution of IPOs. Nevertheless, they can be valuable sources of knowledge and experience (Brenner 2014). Because of their structure and full-participation expectation, whole-brain methods can relax such constraints and engage individuals who tend to be reserved and guarded in normal interactions within highly diverse groups. This assumes that the initial "ice" has been broken, as discussed in Section 3.8.4.

3.2.4 Free to Be Foolish

Asimov, biochemistry professor and prolific author of popular science books, suggests that the creative and innovative process can be embarrassing. "For every good idea you have, there are a hundred . . . foolish ones, which you naturally do not care to display." The path to creatively and innovatively resolving the current IPO requires the freedom to be foolish, daring, unreasonable, unconventional, and eccentric, and, to use Asimov's words, to "fly in the face of reason, authority, and common sense." He notes that initially suggesting that the earth was round instead of flat or that it moved around the sun seemed very unreasonable (Asimov 2014).

You or I, when working and thinking alone, may be able to free ourselves to be at least temporarily foolish, but we may have difficulty doing so when interacting with our teams. We are naturally likely to be inhibited and fearful of embarrassment, and want to act "professional." One way to enable temporary foolish, daring, unreasonable, unconventional, and eccentric thinking and behavior is to use the methods described in this text, especially when working in a group setting. A given method can be viewed as a game we agree to play as we divert attention from personal concerns and foolishly generate lot of ideas, out of which comes an amazing solution. That solution often will seem obvious after the fact and cause us to wonder how anyone could have initially labeled it as foolish. For example, why did we put a person on the moon before we put wheels on luggage?

3.2.5 Using Multiple Methods

As will become more apparent, many whole-brain methods are available, with each intended for one or more circumstances or purposes. Just as you might use a series of software tools to complete a class assignment or tools available on your workbench to work on your car or complete a home project, so too you can use a series of creativity and innovation methods to conduct a project.

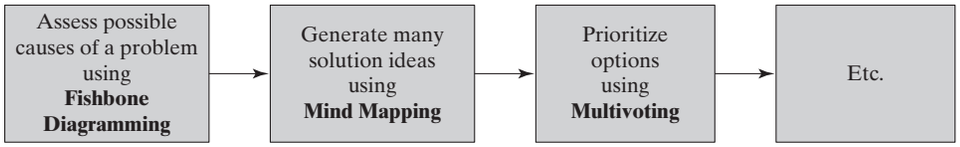

Figure 3.2
A team might use a series of methods to define and then solve a problem.

For example, assume your team wants to solve a problem. As shown in Figure 3.2, your group might use Fishbone Diagramming to thoroughly explore the possible causes of the problem. After selecting the most likely causes and building on that broad understanding, Mind Mapping might be used to generate many potential solutions, which could then be prioritized using Multivoting, which is presented in Section 4.4.2 as a supplemental tool. After identifying the highest-priority solution, the team might discuss how to implement it and, in doing so, use one or more additional methods.

As an individual, you might use the Ohno Circle to observe and define a problem (Figure 3.3). Then, you could engage an interested group in Brainstorming to generate many solution ideas, and then thoroughly analyze the options using Six Thinking Caps. You and/or the team might then use other methods to explore ways to implement the selected solution.

3.3 A TWO-CHAPTER APPROACH

The twenty whole-brain methods offered in this book are presented in Chapters 4 and 7. This two-chapter format is intended to help you appreciate the diversity of the described methods as reflected by factors such as the effort required to understand and apply them, their use by individuals and teams, how they draw on brain basics, the many functions they perform, their positive and negative features, and the kinds of results they produce.

Accordingly, Chapter 4 includes eleven methods, which differ in important ways, and that can be quickly learned and applied to yield useful results. For example, traditional Brainstorming is quickly understood and generates many ideas in the form of a list. In contrast, Mind Mapping—which may be viewed as a highly visual and nonlinear form of brainstorming—typically produces more ideas. As indicated in Table 3.1, very few of these methods only address IPO definition or IPO resolution; most are applicable to both functions. Most of the Chapter 4 methods can be used by an individual or by a team. Chapter 4 alone offers a powerful toolbox that you and/or your group can readily use.

For those who want an even larger toolbox, Chapter 7 offers nine additional, more advanced methods (Table 3.1). Almost all of these methods apply to IPO definition and resolution, and most can be applied by an individual or a group. These advanced methods typically take more time to understand and effectively apply, and that effort might be rewarded by even better results. For example, Six Thinking Caps, a team procedure, requires special props, a detailed explanation, and an effective facilitator. However, in return, this method can fully engage participants by expecting all team members to serially focus on specific aspects of an

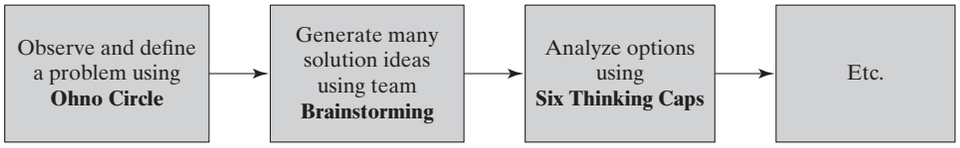

Figure 3.3
An individual might apply one method to define a problem and then engage a team using more methods to resolve it.

IPO, such as facts, emotion, risks, hope, creativity and innovation, and organization and control.

A first-year, introductory, *exploring engineering* type of course that uses this book may readily achieve its creativity and innovation learning objectives by using Chapter 4. The Chapter 7 methods are available for students to use in subsequent undergraduate or graduate courses and in professional practice.

3.4 AVOIDING THE EINSTELLUNG EFFECT TRAP

Another way to view the methods in Chapters 4 and 7 is to recognize the need to set aside, at least temporarily, old ideas and processes, even though they have worked and can work. As noted by change thinker Maxwell (2003), "The difficulty lays not so much in developing new ideas as in escaping from the old ones." The methods described and illustrated in this text can help you and your team escape from doing what you have always done, or at least supplement or parallel your traditional approaches with potentially powerful new thinking methods.

More specifically, this text's methods can help you complement the traditional approach called the Einstellung Effect (Brooks 2011). The German word *einstellung* means approach, mind set, or attitude. The Einstellung Effect means trying to resolve an IPO only by using approaches, mind sets, or attitudes that have worked in similar situations, rather than looking at each new situation on its own terms. This dogged tendency "sometimes blinds people to more efficient or appropriate solutions than the ones they already know" (Bilalic and McLeod 2014).

Another term for this creativity/innovation barrier is *design fixation*, defined as an "unintentional adherence to set of ideas or concepts limiting the output of the conceptual design" (Genco, Holtta-Otto, and Seepersad 2012). The ominous word in that sentence is *unintentional*; it reminds us that we may unknowingly or habitually rule out a fresh perspective. We may welcome a new challenge and be committed to resolving it but be unwittingly locked into the past. This predisposition to familiarity may prevent consideration of much better approaches.

Engineering professor McCuen (2012) explains the Einstellung Effect by putting it in the context of the following four-step process:

1. **Observation:** "Facts are collected and observations are made on the system."
2. **Recollection:** "Past experience is reviewed and solutions to similar problems in the past are identified."
3. **Reasoning:** "The pros and cons of the possible decisions are identified and the implication of each alternative stated."
4. **Decision:** "The best alternative is selected."

This traditional, time-proven engineering approach is sound. It's resulted in untold numbers of successful engineered structures, facilities, systems, products, and processes. So why the concern? Why question it and mess with success?

Looking at McCuen's crisp, four-step description of the standard operating procedure (SOP), I'm most concerned about Step 2, which only focuses on similar past problems and their solutions. Shouldn't we try to do more than rehash old solutions—successful as they may have been? Might we find great value in also exploring fundamentally new approaches? How can we resist the Einstellung Effect?

The first part of the answer to the last question is to be aware of the effect, and that's the major reason I present it in this text. We can't fix something if we don't know it exists. Couple being aware of the Einstellung Effect with using this text's combination of relevant neuroscience and whole-brain methods. Consider the

tried-and-true approach to address a given IPO while paralleling it with a fresh perspective, a whole-brain approach. The French philosopher Bergson in effect warned us about the Einstellung Effect trap when he said that our eyes see only what our mind is inclined to comprehend. We should prepare our minds to comprehend more than what we have done in the past.

VIEWS OF OTHERS: THINK FRESH

Consider reflections on the *same old, same old* approach from a variety of individuals. "Given that most engineers are exposed to a plethora of existing engineered products or systems, the prevalence of design fixation is a significant concern because it indicates that engineers may find it difficult to generate original or creative solutions" (Genco, Holtta-Otto, and Seepersad 2012). "Business [people] go down with their businesses because they like the old way so well they cannot bring themselves to change," according to Ford, who led the development of the automobile assembly line. He went on to say that they are people "who do not know that yesterday is past and who woke up this morning with their last year's idea" (Brinkley 2003). If his sentiment was true over a century ago, think how much more applicable it is in today's dynamic global and technical environment. Commenting on our reaction to reflecting on someone else's creative experience, author May (1976) asks, "Why were we so stupid as to not have seen it earlier?" He goes on to provide the answer: "We were not psychologically ready to see it"; in other words, we habitually fall into the same old approach. We are stung by Einstellung.

3.5 HOW DO WE KNOW THE METHODS WORK?

I am confident you will benefit significantly from the whole-brain methods described in Chapters 4 and 7, based on the following three types of evidence:

1. **Personal experience:** I have successfully used some of the methods in my engineering, management, teaching, and facilitation work.
2. **Observation of students and practitioners:** I consistently see and hear animated conversation and enthusiasm and then observe results when students in a classroom or practitioners in a conference room are invited to form small groups and use whole-brain methods to creatively/innovatively address hypothetical or real IPOs. Overwhelmingly positive post-event evaluations by participants reinforce my observations.
3. **Neuroscience findings:** Scientists tell us that we can't use more of our brain, because our whole brain is working all the time, but we can make our brain work more productively. The following three brain-oriented strategies are available to those of us who want to be more creative and innovative:
   - The first is to *focus, to stay on task*: "By concentrating, your brain can master the neural tools it needs to tackle a complex problem" (Gordon 2012). Research reveals that "our performance deteriorates drastically when we attempt to focus on more than one task at a time" (Strayer and Watson 2012). Therefore, a group's use of a whole-brain method to define and resolve an IPO is one way to focus for a prescribed time period. The methods provide "social glue" (Cain 2012) to bind diverse individuals, for at least a short

period of time, in a fruitful collaborative process. As Einstein said, "It's not that I'm so smart; it's just that I stay with problems longer."

- The second brain-oriented strategy is to *escape established ways of thinking*—that is, seek a wider variety of possible answers by "looking beyond your personal biases and blind spots to consider [even more] possible solutions" (Gordon 2012). Methods help us to escape from or to complement the previously-discussed Einstellung Effect or design fixation. "Recent studies show promise for techniques that break down people's established ways of viewing the world" (Chrysikou 2012). Most of the methods described in Chapters 4 and 7 enable individuals and groups to take a much wider view of possibilities than they would without the methods.
- Finally, studies reveal great promise for thinking methods that *encourage subconscious thought processes* (Chrysikou 2012; Dijksterhuis and Meurs 2006). For example, based on experiments by Dijksterhuis and Meurs, they "concluded that whereas conscious thought may be focused and convergent, unconscious thought may be more associative and divergent." Some of the whole-brain methods presented in Chapters 4 and 7 explicitly engage the subconscious mind, such as Stream of Consciousness Writing and Taking a Break. However, all the methods can leverage the subconscious minds of participants if the process is used intermittently. That is, apply a method as an individual or as a group, put it aside for a day or so, and then resume and expect fresh insights.

3.6 HOPING FOR FORTUITOUS ERRORS AND ACCIDENTS

While applying whole-brain methods, expect—better yet, hope for—errors and accidents. They can be the stuff of creativity and innovation. I don't want you and/or your team's errors or accidents to cause physical harm to you or others or to result in great economic loss or other problems. However, some embarrassment or ego deflation is acceptable and, as suggested by the following five examples, can be very fruitful.

3.6.1 Cardiac Pacemaker

While a student at Cornell in 1951, electrical engineer Greatbatch learned from surgeons about the danger of irregular heartbeats. Five years later, while teaching electrical engineering in Buffalo, New York, and perhaps guided subconsciously by the danger of irregular heartbeats, he helped a physician by developing an oscillator that could record human heartbeats using silicon transistors, which at the time were replacing vacuum tubes.

While working with the device, he inserted the wrong resistor into the oscillator. Because of that error, the device simulated heartbeats rather than recording them, which in turn stimulated Greatbatch and the physician, Chardack, to develop the cardiac pacemaker. Two years after the error, a cardiac pacemaker was successfully implanted in a dog's heart. By 1960, pacemakers were functioning within ten human hearts, and pacemakers have now lengthened the lives of millions of people around the world. Besides illustrating a fruitful accident, this story points to the role of engineering in medicine (Beakley, Evans, and Keats 1986; Johnson 2010).

3.6.2 Vulcanization

Think of some of the uses of rubber: balls, boots, erasers, floor mats, gloves, rubber bands, and tires. We owe these products to the worker, dreamer, self-taught scientist-engineer, and entrepreneur Goodyear (Kumar and Nijasure 1997; Mann 2011;

Somma 2014). His obsessive venture that eventually led to commercialization of rubber began in New Haven, Connecticut, in the mid-1800s. At that time, milky sap bled from trees in Brazil became a crude form of rubber when it hardened. This rudimentary rubber held promise because it could be molded into various forms and was impervious to water. However, on the negative side, this early rubber cracked in the winter cold and melted in the summer heat. The rubber industry was in need of a temperature-stable version.

Goodyear devoted five years to experimenting with various rubber and chemical mixes, sometimes in his kitchen. In 1839, after suffering financial, health, family, and other setbacks, he accidentally spilled a portion of rubber, sulfur, and other ingredients on a hot stove. The rubber did not melt, and its interior retained its shape and elasticity at high temperature. The persistent Goodyear had discovered a way to produce temperature-stable rubber. He worked for several more years and received a US patent in 1844 (ten years after taking on the challenge) for the process called vulcanization, after Vulcan, the Roman fire god.

Somehow, a sample of Goodyear's practical rubber was obtained and studied by the English engineer Hancock. He claimed the vulcanization process as his and also obtained a patent from the British government in 1844. Although both Goodyear and Hancock knew how to cause vulcanization, neither understood the chemistry behind why it worked, that sulfide bridges connect rubber polymer chains.

In 1860, Charles Goodyear died in debt, having never been able to overcome his financial circumstances and the health and family price he paid. We may be reminded of his persistent creativity and innovation when we use a rubber product, see the Goodyear blimp, or think of the Goodyear Tire and Rubber Company, which was named in Goodyear's honor but had no direct connection to him.

3.6.3 Photosynthesis

Scientist and clergyman Priestly put a mint plant in a sealed jar in about 1773 and expected it to die, like similarly placed spiders and mice. He was wrong: The plant thrived and did so even when he burned the oxygen from the jar. Priestly discovered, contrary to his erroneous hypothesis, that plants produced oxygen via photosynthesis. Oh, that we could make such a productive mistake! As a child, Priestly trapped spiders in glass jars and watched and wondered why they died. Perhaps his subconscious mind had been pondering the mysteries of sealed glass jars for decades (Johnson 2010).

3.6.4 Microwave Oven

In 1946, self-taught electrical engineer Spencer was working at Raytheon on a team that was building a magnetron—that is, an electron tube used to generate alternating currents at microwave frequencies and used in radar. During an experiment with electromagnetic radiation, he noticed that a candy bar in his pocket melted. This little accident led to the big invention of a way to cook with high-frequency radio waves: the microwave oven, which early on was called the radar range (Johnson 2010; Murray 1958). Would you like to have an accident like that?

3.6.5 Penicillin

In 1928, Scottish biologist Alexander Fleming, while conducting research on antibacterial substances, inadvertently contaminated one of his slides with the mold *Penicillium notatum*. Later, he noticed a circle around the mold that was free of bacteria. Maybe the mold came through an open window or from a crumb of moldy bread. Regardless, this accident led to the discovery of penicillin, as named by

Fleming, which destroys bacteria that cause many types of infections and inspired scientists to develop other antibacterial drugs (Johnson 2010; Van Doren 1991).

3.6.6 Errors and Accidents: Learning Opportunities

When accidents or errors occur, see them as opportunities to learn what not to do and gain insight about what to do next. Take comfort in British economist Jevons' observation that "in all probability the errors of the great mind exceed in number those of the less vigorous one" (Johnson 2010). You and/or your team may be in good company, and that last accident or error may be the door to a creative or innovative result.

Of course, we all like to be right and to avoid errors and accidents, but try to put that aside as you seek creative and innovative approaches to IPOs. Recognize that "being right keeps you in place. Being wrong forces you to explore" (Johnson 2010). Finally, consider the advice of Bonasso (2005), engineer, inventor, and entrepreneur: "Success is when we predict something will happen and it happens. Failure is when we predict something will happen and something else happens." Remember that failure provides new information. Success isn't final, and failure isn't fatal.

3.7 CAVEATS

Before I begin to describe and, in most cases, illustrate the use of whole-brain methods, consider some caveats. I already mentioned one: Successful use of the methods depends on your and/or your group's prudent selection and wise use of one or more of them. Here are some other factors to consider when selecting and using the whole-brain methods described in Chapters 4 and 7:

- **Individual versus team use:** As indicated in Table 3.1, only a few of the methods are intended for use only by an individual and a few others only by a team or group. However, importantly, almost all methods can be used by an individual *or* by a team or group.
- **Inconsistent names:** The methods are named, by and large, using their formal or most common names. Accordingly, the names come from many and varied sources and are not in a consistent style. Furthermore, some names are descriptive and/or familiar (e.g., Brainstorming and Freehand Drawing), whereas others are not very informative (e.g., Mind Mapping and Six Thinking Caps). Because many of the names are not descriptive, if a particular one attracts your attention for whatever reason, simply go directly to its description to quickly determine the tool's essence. With one exception (Taking Time to Think), the methods are arranged alphabetically in each part of Table 3.1 and in Chapters 4 and 7 for quick access.
- **Not mutually exclusive:** The methods are not mutually exclusive; some overlap with others. For example, Brainstorming and Mind Mapping have common elements. However, the latter is more visual and less likely to be viewed as a linear, one-idea-follows-another, left-brain listing process.
- **Define challenges and then address them:** As shown in Table 3.1, a few methods facilitate only IPO definition, and one supports only resolving an IPO. For example, Fishbone Diagramming is effective for exploring possible causes of a problem or determining the likely facets of a challenge. In contrast, Biomimicry focuses on finding the "best" solution to a problem. As appropriate, these strengths are noted when the individual methods are discussed.
- **Individual and group use of multiple methods:** Creatively or innovatively addressing an issue, solving a problem, or pursuing an opportunity is likely to

engage several to many methods. Furthermore, during that process, some methods will be used by a team or group and others by individual members of the team or group.

- **Wide applicability:** Please remember that although I am an engineer writing to students of engineering and other scientific and technical professions, essentially all of the whole-brain methods are applicable in both technical and nontechnical areas. That is, although the methods can be applied to planning, design, research, experimentation, IT, and other technical areas, they can also be used to address marketing, finance, project management, human resources, strategic planning, and other nontechnical areas or processes.

  Besides being applicable to widely varying functions, creativity and innovation would seem to be important in all professions, thus further expanding the potential uses of these methods. Finally, the methods described in this chapter are readily used outside of the education and work spheres—that is, in your community, family, and personal lives.

Soon, you will have access to and understanding of a large set of highly varied, whole-brain tools. Their use builds on the foundation of the brain basics described in Chapter 2. Most of the methods can be used by an individual or by a team or group. The methods are not mutually exclusive. Some help define a challenge, some assist in resolving it, and most do both. Multiple methods are likely to be used by individuals and by a team in addressing an issue, solving a problem, or pursuing an opportunity. Finally, the toolbox can be used for technical and nontechnical challenges—both within engineering and in other professions and beyond.

3.8 FACILITATION

We turn now to facilitation, a process you are likely to benefit from and hopefully lead. After describing the need for facilitation, I describe the work of the facilitator before, during, and after a facilitated session.

3.8.1 What Is Facilitation?

Section 3.2.1 noted that almost all of the twenty whole-brain methods presented in this text can be used productively by teams or groups. Most team or group discussions of any IPO can be enhanced and often greatly improved, as indicated by the value of the outcomes, through the efforts of a facilitator, who strives to enable all members to do their best thinking and to effectively share the resulting thoughts so that the group benefits from the synergism. One indication of a facilitator's success is that an IPO is resolved and all participants know that they have contributed.

Facilitation is introduced now in this text because Chapters 4 and 7 describe and illustrate many whole-brain methods. When your team or group applies these tools, facilitation will enhance your effectiveness; by definition, such methods are intended to stimulate thinking in new directions. New-direction thinking is hard for some of us and will need nudging, which is one of a facilitator's roles.

You may already have benefitted as an engineering student or practitioner from the efforts of a facilitator, or maybe you have been a facilitator. Be assured that as you go forward in your career you will participate in many more facilitated sessions and have opportunities, which I urge you to accept, to serve as the facilitator. While preparing for and performing facilitation, you will grow and you will contribute to your team's or group's efforts. Traditional group discussions that are not facilitated are far more commonly encountered, but you and others in your group should at

least experiment with the much more productive facilitation approach the next time you take on an IPO.

One way to consider the merits of facilitation is to review the tendencies listed in Table 3.2. The left column lists tendencies, not certainties, associated with traditional group discussions that are not assisted by a facilitator. The right column presents the much more positive and productive tendencies associated with facilitated discussions.

Table 3.2 Traditional versus facilitated team or group discussions tend to exhibit very different interaction environments and, as a result, produce very different outcomes, with the facilitated discussions being much more productive.

In traditional group discussions, the tendency is for. . .	**In facilitated group discussions, the tendency is for. . .**
. . .a few aggressive/articulate individuals to dominate the discussion and to overly influence the results.	. . .everyone to participate because they are expected to and because, if they don't, the facilitator will engage them.
. . .participants to frequently interrupt, as in "If I don't state my view now, I may not get the chance."	. . .participants to allow others to express themselves because everyone is expected to contribute and have opportunities to do so. "I'll listen to your idea because I know I will get a turn to share mine."
. . .participants to listen for what they want to hear or to not listen, because they feel compelled to push their agenda right now, lest things get out of hand. They do not want to hear contrary views, which must then be disputed in a combative manner.	. . .participants to listen to others, even those with very contrary views, because they know they will be able to question them and be able to offer their views.
. . .different views to be seen as problems or potential conflicts that must be ignored, challenged, or quickly resolved.	. . .different views to be taken as positive inputs and as having the potential to ultimately help resolve the issue, problem, or opportunity at hand.
. . .probing questions to be viewed as challenges, or even threats, to be dealt with in a protective or defensive manner.	. . .probing questions to be viewed as desirable means to understand the views of others and the breadth and depth of the challenge faced by the group.
. . .deep disagreements to be ill-defined or denied and then carried outside of the group and shared with others, most of whom are not in a position to resolve the matter.	. . .deep disagreements to be acknowledged, discussed, understood, and resolved within the group.
. . .the real discussions and the real decisions to be made outside of the group discussions, because the members lack a common vision or goal and mistrust prevails. "The three of us know what's best; the others don't know how things work around here. Let's go through the motions with the team and then get together and make it happen our way."	. . .the real discussions and the real decisions to be made within the group. What you see is what you get in that all significant business is conducted in the groups. "That's a different idea. Let's take it to the team and see if it flies."
. . .an IPO to be considered resolved when the fastest, most aggressive "thinkers" announce the course of action. Others are expected to go along.	. . .an IPO to be considered resolved when essentially all participants involved in the decision making and all stakeholders affected by the selected course of action understand the reasoning, and most support what has been decided.

Source: Adapted, in part, from Kaner et al. 1996.

3.8.2 Who Is the Facilitator?

Sometimes, the chair or leader of a committee, project team, or other group has the knowledge, skills, and attitudes to serve as the facilitator when certain topics are discussed. If the chair or leader is not an effective facilitator or is unable to take a neutral stance in a particular situation, then he or she could ask someone else within the group to serve as facilitator. A third option is to arrange for an outside facilitator, someone who is not a member of the group. This third option can be the best choice when a potentially contentious IPO must be addressed and/or when special subject experience and knowledge are needed.

Let's further explore facilitation by seeing the process from the facilitator's perspective, or maybe from your perspective as a potential facilitator. More specifically, consider how the facilitator might prepare for, conduct, and follow up on a facilitated discussion. I've drawn on my facilitation and meeting experiences (Walesh 2012) and on ideas offered by others (Kaner el al. 1996; McCuen 2014). Review the many suggestions and select those most suited to your facilitation situation.

3.8.3 How Does the Facilitator Prepare to Facilitate?

The sound advice to *plan your work and work your plan* (PYWAWYP) certainly applies for the facilitator. He or she should consider the following while preparing for the facilitation:

- Understand the IPO to be addressed by the group. If it is not already articulated and documented in writing, make that happen, and then frequently refer to it and sometimes quote it. Groups of smart and energetic people can easily go off on a tangent, and it's your job, beginning with planning the first session, to keep the group on target.
- Influence the diversity of the group, to the extent you can. For an in-depth discussion of the meaning and value of diversity, refer to Section 4.6, "Medici Effect."
- If you can, affect the size of the group. Somewhere in the range of five to ten members will provide enough individuals to assure diversity and not so many as to become unwieldy.
- Select the methods that you believe will be most effective with the group and for the IPO. Candidates include many of the methods described in Chapters 4 and 7.

PERSONAL: METHODS USED IN FACILITATION

As part of my work, I have facilitated sessions using some of this book's methods. For example, SWOT, Freehand Drawing, and Six Thinking Caps helped groups define challenging situations. In other cases, Brainstorming and Mind Mapping generated many and varied options for teams. In one case, a combination of What If? and Mind Mapping enabled a group to more fully explore the possible implications of two viable and very different courses of action. Using methods like these always seems to produce better results than if the facilitation had proceeded without them. The tools are effective because they are highly visual, they focus the participants, and they encourage whole-brain thinking.

- Arrange the on-site logistics. Select an attractive, well-lit room. Have a large table with comfortable chairs for participants on three sides and, if you care to sit, for you on the fourth side, so that participants can see each other and you and you can see all of them. Avoid classroom-style seating, which impedes face-to-face communication among participants. Regardless of the methods you plan to use, you are likely to need a newsprint pad on a tripod, a whiteboard, or another means to record progress in real time during the session. Consider arranging for someone else to assist with recording results. Prepare handouts and arrange for special equipment, props, or other items that may be needed. The devil is in the details.
- Ask some members of the team or group to do specific tasks in preparation for the upcoming meeting. For example, be prepared to brief the participants on some aspect of the challenge, arrange for special equipment, host a new member or visitor, or bring refreshments. Asking people to do "jobs" engages them in the overall effort, causes them to think about the upcoming session, and spreads the workload.
- Send materials to the group to help them prepare, such as an agenda, the description of the IPO be addressed by the group, a statement of the hoped-for outcome (without presuming too much), and maybe some background documents.

3.8.4 What Does the Facilitator Do During the Session?

Everyone has arrived and is ready to go to work. Here are some things the facilitator may want to do and can tailor to the particular situation:

- Make sure that everyone knows something about everyone else. Brief self-introductions work well.
- Discuss the IPO to be addressed by the group; get everyone on the same page. Perhaps write and post a summary, in a highly visible manner, so that the challenge is figuratively and literally in front of the group throughout the session.
- Consider discussing and agreeing on the definitions of key words or expressions and documenting those definitions. Failure to do so can lead to later unnecessary disagreement or even conflict.
- Review the agenda and include an explanation of the tool or tools to be used.
- Suggest protocol such as everyone is expected to contribute, participants are urged to frankly share their views, turn off cell phones, honor action items, and not exceed ninety minutes.
- Launch into the process; get the discussion going. Try to engage everyone while not allowing anyone to dominate the conversation. Draw people out by using what you know about their position or their experience. Assume an unbiased, neutral, encouraging, nonjudgmental, and helpful position. Paraphrase some ideas offered by participants to reassure them that their ideas have value and to clarify the ideas.
- Offer a prepared and thought-provoking concept, idea, or suggestion if there is a lull in the conversation. For example, apply the What If? method (Section 4.12), as in, "How would we solve this problem if funds were unlimited?" or "What would Superman do?" or "How would we build this thing if we had to do it in a week?" (See the Taco Bell restaurant story in Section 4.12.2.) Do something to stimulate the group to think wider and deeper.
- Discourage premature closure during the divergent thinking phase, which was discussed near the beginning of this chapter. Some groups want to move quickly to closure—to defining the IPO or identifying options for resolving it—so that

they can move on to other concerns or tasks. In doing so, they may miss the opportunity to fully define the IPO or find truly creative and innovative alternatives. Similarly, a team may want to rush convergent thinking and, as a result, not fully consider all the implications of the available options.
- Recap the principal points and the action items.
- Set a schedule, with emphasis on the date, time, place, and focus of the next session.
- Take photos of the visuals that were prepared by the group for possible use when documenting the session.

3.8.5 What Does the Facilitator Do After the Session?

The just-concluded facilitated session is likely to have generated many ideas and posed many new questions. The facilitator should maintain the thinking process and synergy momentum by promptly performing tasks such as the following:

- Within a day or two of the session, document ideas generated, questions posed, action items agreed to, the go-forward schedule, and various inevitable loose ends.
- Complete whatever action items were taken on by the facilitator; he or she should set an example.
- Begin planning the next session if that was one of the outcomes of the first session.
- Do whatever is needed (reminding, pushing, pulling, encouraging, stretching, and cajoling) to continue the process or bring it to closure. Get a return on the investment of the facilitator's and team members' time and, more important, their thinking.

Facilitation is not needed for all meetings. However, its absence sometimes means that the team or group and the organization of which it is a part is failing to use fully their most valuable resources: the motivated, experience-laden, and creative/innovative brains of their personnel. As a student or practitioner, you can help avoid that waste by using facilitation to bring readily available resources to bear on any IPO.

3.9 FORMAT USED TO PRESENT EACH METHOD

A similar format is used for presenting each whole-brain method so that you can easily move from studying one method to studying another one. Each description begins with a short overview to provide context and initial insight into the value of the method. Then it is described, sometimes as noted earlier in a step-wise manner, usually with the use of one or more actual or hypothetical examples. The neuroscience basis for the method follows, to link the method to your growing understanding of the human brain, as discussed in Chapter 2. This stresses the scientific basis for each method. Finally, positive and negative features of the method are noted.

For some methods, one or more Personal, Historic Note, and Views of Others textboxes supplement the description. Exercises at the end of Chapters 4 and 7 provide at least one opportunity to apply each of the twenty whole-brain tools included in this text.

3.10 SUMMARY

Building on the case for more creativity and innovation presented in Chapter 1 and the brain primer offered in Chapter 2, this chapter prepares you to learn about and apply eleven easy-to-learn and -use whole-brain tools in Chapter 4 and

nine more-advanced methods in Chapter 7. The key points presented in this chapter are as follows:

- The more ideas, the better
- The methods are just tools; their value lies in your selection and use
- Avoid using only the stifling Einstellung Effect
- Science and experience indicate that the methods work
- Hope for fortuitous errors and accidents
- Recognize common-sense caveats
- Consider facilitation to optimize the knowledge and experience of team members

Now, onto the thinking tools in Chapter 4—your way to start working smarter and being more creative and innovative.

> Nothing is impossible; there are ways that lead to everything,
> and if we have sufficient will, we should always have sufficient means.
> —*Francois de La Rochefoucauld, French writer*

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EXERCISES

Notes:

1. The goal of the exercises is to provide students, usually working alone, the opportunity to think about and use the ideas, principles, and information offered in the chapter.
2. However, many circumstances and corresponding teaching-learning opportunities may arise. For example, a stated situation may be altered to meet specific concerns or needs. Rather than work with the largely hypothetical situation described in a particular exercise, an individual or team may wish to take on an actual issue, problem, or opportunity facing the team or one or more of its members. These and similar variations are encouraged, subject to the concurrence or direction of the instructor.

3.1 RECOGNIZING THE EINSTELLUNG EFFECT TRAP: How did you choose your current career or course of study? Did you make the decision yourself or were you influenced by others? Were you guided only by the Einstellung Effect? If not, describe how you escaped the trap. If yes, describe

the decision you originally made, and if it was controlled by the Einstellung Effect, and indicate one or more creative or innovative alternative actions that you could have taken; and perhaps you still can. Rethink creative actions that you can take now to redirect your career or studies.

3.2 FORTUITOUS ERROR OR ACCIDENT (BY OTHERS): This exercise, which is intended for individuals, further illustrates the possible positive role of errors and accidents in the creative and innovative process. That process is inherently risky because it delves into the unknown, and therefore some errors and accidents are likely to occur.

Find another example similar to the cardiac pacemaker, vulcanization, photosynthesis, microwave oven, and penicillin incidents described in Section 3.6 in which a lucky error or accident stimulated a creative or innovative result. Describe that result and the events leading to it. Cite all of your sources.

3.3 FORTUITOUS ERROR OR ACCIDENT (BY YOU): Recall an incident in which you made a major error or experienced an accident that caused you to gain great insight, learn a valuable lesson, or be creative or innovative. Describe the incident and the resulting insight, lesson, or creative/innovative outcome.

3.4 YOUR TURN TO FACILITATE: Have you ever tried to facilitate a meeting or negotiation and felt shy or uncomfortable doing it? If your facilitation was successful, identify all that you had done (as per Section 3.8 or maybe outside it) that enabled you to succeed. If you were not successful, identify all the mistakes that you had committed.

Then, assume that you could redo the meeting and that you would be the outside facilitator. Drawing at least initially on the ideas and suggestions presented in Section 3.8, what would you do to encourage the group to make progress and perhaps even be creative and innovative? Does this exercise get rid of your shyness or discomfort?

3.5 HOW DO WE KNOW WHEN TO BE CREATIVE/INNOVATIVE?: Do we need to be creative/innovative all the time and in all contexts? The class should divide itself up into teams of 2. Each team assumes they are a particular company, like Pixar, Nokia, The Bill and Melinda Gates Foundation, the International Labour Organisation, a small company making steel pipes, a student organization and so on. There should be diverse types of organizations. Let the class do some background study, then imagine under what personal and organizational situations they would be motivated to be creative/innovative.