

CREATIVITY

# How Mindfulness Can Help Engineers Solve Problems

by [Beth Rieken](#), [Shauna Shapiro](#), [Shannon Gilmartin](#), and [Sheri D. Sheppard](#)

JANUARY 04, 2019



DIMITRI OTIS/GETTY IMAGES

Engineering work demands creativity and innovation in order to solve complex, interdisciplinary problems. But creativity and innovation skills are not emphasized in many traditional engineering courses. So engineers enter the workforce with important analysis skills, but may struggle to “think outside the box” when it comes to creative problem-solving. Our research shows that mindfulness can help engineers strengthen their ability to generate new ideas, leading to new ways of thinking and better solutions.

## The importance of divergent thinking

In the typical technical workplace, engineers are asked to design devices, systems, or processes, which can have conflicting goals and multiple potential solutions. In general, the process for approaching these tasks is called the engineering design process. The engineering team is given or identifies a problem, defines the scope of the problem, generates many ideas for solutions, evaluates the ideas, and proposes a solution. Throughout this process, engineers engage in convergent and divergent thinking.

Convergent thinking is linear, involving going through a list of steps to get to a single correct answer. In contrast, divergent thinking is exploring different directions from an initial problem statement to generate many possible ideas. In the design process, engineers use divergent thinking when generating ideas, so they can identify a wide range of potential solutions. They use convergent thinking when evaluating ideas to determine the optimal solution.

Both types of thinking are important to finding the best final solution, but divergent thinking is particularly important for developing innovative solutions. However, divergent thinking skills are largely ignored in engineering courses, which tend to focus on a linear progression of narrow, discipline-focused technical information. This leads engineering students to become experts at working individually and applying a series of formulas and rules to structured problems with a “right” answer.

It is no surprise then that engineers struggle with divergent thinking when they enter the workforce. Fortunately, there are many techniques to help enhance divergent thinking, like brainstorming and needfinding, which rely on a common set of attitudes. During brainstorming, for example, people are asked to *defer judgment* and to be *curious*. The Stanford d.school promotes navigating ambiguity by being *present in the moment* and suggests to *relax and reach a mode of acceptance* while prototyping.

These elements of presence and curiosity are part of a fundamental human capacity called *mindfulness*.

### How mindfulness promotes divergent thinking

Mindfulness is defined as intentionally paying attention with openness, kindness, and curiosity. Although psychologists continue to explore the exact mechanisms by which mindfulness facilitates divergent thinking, there is convincing evidence demonstrating a causal link between being mindful and being able to engage in divergent thinking.

While previous research on mindfulness and divergent thinking has focused on general populations, our research sought to explore the relationship between mindfulness, divergent thinking, and innovation, specifically among engineering students and recent engineering graduates.

We performed two studies. In the first, we looked at the impact of a 15-minute mindfulness meditation on divergent thinking performance among 92 engineering students at Stanford University. Previous studies have shown that a single meditation can improve idea generation in general student populations.

Prior to the experiment, all participants completed a questionnaire to measure baseline mindfulness. Then, participants were divided into a treatment group and a control group and asked to complete two divergent thinking tasks: a generic idea generation task, where they were told to list as many alternative uses for a brick as possible; and an engineering design task, where they were asked to list all the factors they would consider in designing a retaining wall for a river flood scenario. In the treatment group, the participants were guided through a 15-minute meditation prior to completing the tasks. In the control group, the participants watched a 15-minute video on stress-reduction prior to completing the tasks.

In both groups, baseline mindfulness correlated with the number and the originality of ideas that participants wrote down in the idea generation task and with the number of factors considered in the engineering design task. Engineering students who reported higher baseline mindfulness performed better on the divergent thinking tasks.

While the results demonstrated a clear relationship between mindfulness and enhanced divergent thinking, results were mixed on the impact of a single 15-minute mindfulness session on divergent thinking performance. The meditation did improve the *originality* of ideas in the idea generation task, but it did not impact the *number* of ideas students came up with in the idea generation task or the engineering design task with statistical significance.

Our results suggest that 15-minutes of mindfulness practice may improve originality of ideas, but perhaps not quantity. Future studies could benefit from including more substantial mindfulness training, beyond a single 15-minute session, to discern if mindfulness practice can increase quantity of ideas in addition to quality of ideas.

#### More on our methodology

To measure mindfulness, we used items from the Mindful Attention Awareness Scale and the Curiosity and Exploration Inventory-II to ask participants about their tendency to pay attention to everyday tasks and about their willingness to be curious about new and unpredictable experiences. To measure innovation self-efficacy, participants were asked how confident they were in their ability to practice behaviors, such as asking a lot of questions or generating new ideas by observing the world. These items were adapted from Dyer, Gregersen, and Christensen's work on innovative behavioral skills.

In the second study, we analyzed survey results from approximately 1400 engineering students and recent graduates across the U.S., to look at the relationship between mindfulness and innovation. We drew from the longitudinal Engineering Majors Survey, which is led by one of us (Sheri), to measure baseline mindfulness and confidence in one's ability to be innovative (what's called innovation self-efficacy).

We found that baseline mindfulness predicted innovation self-efficacy across our engineering sample. Interestingly, a particular component of mindfulness, called a mindful attitude, was the strongest predictor of innovation self-efficacy. While many studies focus on the attention aspect of mindfulness, our work suggests that the more essential component is the attitude with which you pay attention - or

whether you have an open, curious, and kind attitude.

Having an open and curious attitude is referred to as "beginner's mind" - the capacity to bring fresh eyes to a problem and engage in new perspectives for how to solve it. By remaining open to experiences, we are more likely to make connections between seemingly unrelated concepts, which is crucial to generating original ideas. Having a kind attitude is an aspect of self-compassion, which protects against harsh self-criticism and a fear of failure, inspiring people to take risks and explore uncharted territory, leading to novel solutions. Mindfulness supports both of these.

These studies have important implications for engineering education and for the technical workforce. While engineers need skills in analysis and judgment, they also need to cultivate an open, curious, and kind attitude, so they don't fixate on one particular approach and are able to consider new data. Future research could build on these promising yet preliminary findings, and explore best practices for strengthening mindfulness in engineering students and employees.

Decades of research demonstrate that mindfulness can be improved through practice. As a result, many pioneering Fortune 100 companies such as Google, Cisco, P&G,

Facebook, are integrating mindfulness training in the workplace to promote creativity and innovation, as well as emotional intelligence and well-being in their employees. In adapting these efforts to their engineering organizations, such companies would be well served to consider how mindfulness may heighten the divergent thinking that is so essential in technical design, and how a mindful attitude of openness, not just attention, may be a major catalyst for innovative mindsets.


Beth Rieken is recent PhD graduate of the Mechanical Engineering Department at Stanford University where she completed her dissertation on mindfulness and innovation in engineering education.

Shauna Shapiro is a professor at Santa Clara University, an author, speaker and internationally recognized expert in mindfulness and compassion.

Shannon Gilmartin is a senior research scholar at the Stanford VMware Women's Leadership Innovation Lab and an adjunct professor in Mechanical Engineering at Stanford University.

Sheri D. Sheppard is a professor of mechanical engineering at Stanford University, where she teaches both undergraduate and graduate design-related classes and conducts research on design and how people become engineers.

### This article is about CREATIVITY

 Follow This Topic

Related Topics: [Design](#) | [Education](#)

## Comments

Leave a Comment

Post Comment

### 8 COMMENTS

Andre Mech 3 months ago

Nice work.

As a practicing engineer I found mindfulness to be so helpful that I entered the teacher pathway at the CFM, UMass.


Years ago, while developing a fundamentally different technology that operated at the edge of capabilities, I found that test equipment did not exist that measured the parameters I needed to measure. Testing to failure was prohibitive so I was forced to "feel" what is going on by actually placing my forehead on the equipment as it came up to operating speed. It was so easy to develop an awareness by sense the flow, phase and heat transitions. It negated the need for test equipment that did not exist. The experience allowed me to understand what was going on and make modifications that resolved an issue that had befuddled the "highly experienced" engineering staff for some time.

Mindfulness teaches us to hone awareness, use all our senses and to live outside the box... all the time. It is a powerful adjunct to traditional engineering approaches.

Good work. I'd expect lots of push back from the old guard.

 Reply

 [Join The Conversation](#)

### POSTING GUIDELINES

We hope the conversations that take place on HBR.org will be energetic, constructive, and thought-provoking. To comment, readers must sign in or register. And to ensure the quality of the discussion, our moderating team will review all comments and may edit them for clarity, length, and relevance. Comments that are overly promotional, mean-spirited, or off-topic may be deleted per the moderators' judgment. All postings become the property of Harvard Business Publishing.