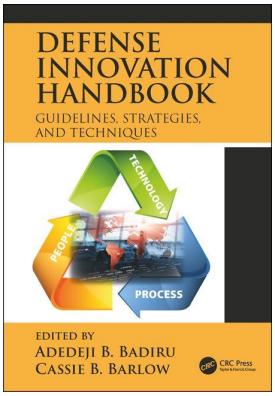

Defense Innovation Handbook
Guidelines, Strategies, and Techniques

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Enhancing innovation Methods, cultural aspects, ideation approaches, and box busters

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Enhancing innovation

Methods, cultural aspects, ideation approaches, and box busters

Daniel D. Jensen and Cory A. Cooper

Contents

Introduction

Innovation can be either "incremental" or "disruptive." "Incremental" innovation describes the small changes to an idea, process or technology that allow it to progress up the innovation S-curve toward maturity. "Disruptive" innovation describes the implementation of new ideas, processes or technologies that cause a jump to a new S-curve. In reality there

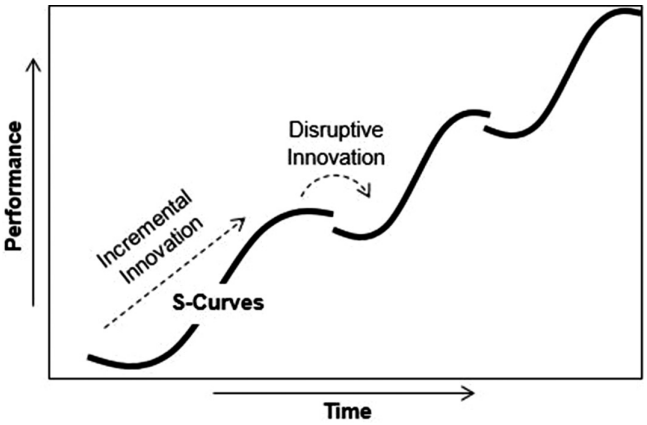

Figure 12.1 Innovation S-curves, incremental verses disruptive innovation. (From Foster, R. N., *Research Management*, 29(4), 17–20, 1986; Christensen, C. M., *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*, Harvard Business Review Press, Cambridge, MA, 2013.)

is a continuum between incremental and disruptive innovation. However, in general, disruptive innovation occurs when developments allow us to meet new customer needs or provide new capabilities [1,2] (Figure 12.1).

The following three sections cover major ways to improve innovation in an organization and achieve innovative results. The descriptions and approaches are based on decades of study on the art and science of innovation and observations in top companies. The methods have been applied with award-winning results at the US Air Force Academy, other Department of Defense organizations, and top international companies.

In the following, a set of five methods that organizations use to strengthen their innovative ability are described. This is followed by a discussion of a number of aspects of an organization's culture that promote creativity and the resulting disruptive innovation. Finally, a set of concept generation (or ideation) methods which can be used to improve individual or group creativity and innovation are described.

Methods for increasing an organization's capability to innovate

Organizations may enhance their ability to innovate in these five ways:

1. Acquire innovative organizations
2. The "innovation guru" method (ex: Steve Jobs)
3. Skunk Works® model
4. Research and Development (R & D)
5. Integrate a culture that fosters innovation throughout the organization

Each of these five methods is described briefly in the following.

Acquire innovation organizations: Corporate acquisitions can be a very productive way to enhance the innovation capabilities of a company. One positive aspect of this method is that the acquired company has already proven its ability to innovate. In addition, the acquired organization may be able to integrate their innovation abilities into the larger company. This model was used successfully by Amazon to support and develop

the integration of Alexa (artificial intelligence and automation control) to Echo and Dot technology platforms. The acquisition of smaller, innovative companies such as Alexa, a2z, Lab126, and Brilliance Audio set the stage to be able to leverage, integrate, and innovate. This acquisition approach to innovation does not always work though. If the larger (acquiring) company does not have certain cultural/structural features, it may inadvertently crush the innovation capability of the acquired company.

The "innovation guru" method: Some examples of this method are Steve Jobs of Apple Inc., Larry Page of Google LLC., Marissa Mayer of Yahoo!, and Ed Catmull of Pixar Animation Studio. Clayton Christensen has done significant work in characterizing the attributes that a leader must possess in order to play the role of the innovation guru (see *The Innovator's DNA*) [3]. Companies that have a "guru" seem to be able to retain the capability to innovative despite the tremendous pressure to default to safe, non-innovative, organizational structures or culture. However, innovative gurus are expensive, difficult to find and often create significant turmoil as they fight to create and maintain an innovative culture. Also, past success can be a predictor for future success, but there is no guarantee that the guru can create and maintain an innovation capability. This is especially true when trying to create disruptive (as opposed to incremental) innovation, as disruptive innovation is inherently risky and relatively unpredictable. Finally, the characteristics of the innovation guru are often not the same as those needed to facilitate a company's incremental growth. Therefore, the organization may struggle to maintain its ability to sustain incremental innovation or growth. A company's self-awareness of its place on the innovation S-curve is important to know which leaders it should be utilizing.

Skunk Works® model: The term "Skunk Works®" was originally coined by Lockheed Aircraft Corporation as a name for a design/development group tasked to create disruptive innovation in the aircraft industry [4]. The group had several key characteristics that apparently led to their success. First, they had significant support from top organizational leadership. This support took the form of finances, personnel, infrastructure and rewards. In addition, the group was insulated from the normal constraints and requirements of the larger corporate culture. Normal constraints on purchasing, prototyping and risk taking were removed. Also, requirements for reports, documentation and many other normal "checks and balances" were drastically changed. This model has been used successfully by many organizations. However, it is quite difficult to keep the mid- and top level managers from encroaching on the group and inhibiting the innovation. Also, the fact that the Skunk Works® group is insulated from the normal organization is critical to its ability to be innovative, but it also largely prohibits it from spreading its enthusiasm and strategies for innovation throughout the rest of the organization. Finally, as with all of these innovation strategies, there is no guarantee of success for this particular strategy.

Research and development: Research and development is not the same as innovation. While many organizations communicate that they are facilitating innovation through their funding of research and development (R & D) budgets, this may not be the case. R & D investment leads to one of three outcomes: (1) incremental advancement, (2) disruptive advancement, or (3) no advancement at all. The culture of the R & D group, which most often flows from the culture of the larger organization, will determine the likelihood of the three different outcomes. The manner in which the reward system is integrated into the R & D culture determines much of the outcome of the R & D efforts. If R & D developments that prove to have immediate application to a company's product line see the biggest rewards, then that will obviously shift the focus of the R & D to incremental and applied research. If research that results in new products, S-curve jumps in product development or original contributions to

a research area receives significant rewards, then the R & D focus will shift toward disruptive innovation. One caveat to this is that for a culture of disruptive innovative to flourish, risk must be handled carefully. New ideas, products or inventions that do not show immediate effect to the corporate bottom line must still be rewarded appropriately. As a balance to this however, these new ideas must still receive some level of scrutiny to avoid ideas that are intellectually sloppy.

Integrate a culture that fosters innovation throughout the organization: This is probably the most challenging and the most rewarding of the five methods. The challenges come from the tremendous inertia in the culture of most organizations coupled with the need to align the organization's culture in a way that facilitates innovation. Also, it is quite possible that it is unwise to realign the entire organization's culture to foster innovation. This is true if the core productivity of a group is coming from (and possibly should continue to come from) incremental innovation as opposed to disruptive innovation. Note that there may be some incremental cultural changes that could be made to facilitate an organization's transition from a Skunk Works® model to a full innovation culture model. For example, a larger acceptance of risk may be communicated throughout the organization, but aggressive risk taking may only be fully implemented in certain segments of the organization. There are numerous aspects of an organization's culture that must be considered in order to access that organization's capacity for disruptive innovation. These will be discussed in detail in the following.

Organizational cultures that foster innovation

There are many aspects to an organizational culture that facilitate disruptive innovations. Although there appear to be general principles regarding this culture, it is likely that the details of many of these aspects differ for different organizations depending on the organization's goals, resources, and people. In broad strokes, the aspects of the culture can be broken down into the following eight categories:

1. Top level leadership's commitment to change
2. Organizational stability and resources
3. Reward structure
4. Risk tolerance
5. Physical environment
6. Communication culture
7. Characteristics of key personnel
8. Creativity/innovation training

Some comments in each area are provided in the following. Organizations desiring disruptive innovation are encouraged to self-assess their current organizations for potential adoption of the following aspects.

Top level leadership's commitment to change

Cultural change is most often quite difficult. Resistance to change is prevalent in all levels of most organizations. This general resistance to change can result in a tremendously hostile environment for those attempting to facilitate the changes. If the cultural changes intended to support disruptive innovation are not supported by the top levels of leadership

of an organization, the odds of successful implementation are low. Exceptions to this occur if a group is able to function for a period of time outside of the oversight of the main leadership (similar to an unapproved Skunk Works® model) or if they are able (miraculously) to produce successful disruptive innovation that facilitates the company's bottom line in a short enough period of time to avoid corporate intervention.

Organizational stability and resources

In most cases, disruptive innovative takes significant time and resources (people and money) to be successful. It requires an S-curve jump that places the organization back on the lower slope area of a new S-curve. In addition, it is far more difficult to predict how long it will take to produce disruptive innovation than it is for incremental innovation. If a company is driven by the quarterly stock price, then the long wait and relative uncertainty of success when pursuing disruptive innovation will likely cause abandonment of the strategy. Unfortunately, many organizations address their need to facilitate innovation only when they are experiencing substantial financial struggles. If a cultural shift toward production of innovation necessitates significant, long term expenditure of resources, then it may not be possible for a struggling organization to accomplish. As an example, it is not uncommon for a product development group tasked with creating disruptive innovation to require multiple full time people over multiple years to produce results. This group is dedicated to jumping S-curves—some pan out, others take a long time to move out of the lower portion of the 'S,' and others never do. Even when these resources are allocated, there is no guarantee of results.

Reward structure

Whether an organization's reward structure is explicitly stated or not, personnel quickly learn what is counted as "success." Disruptive innovation often requires significant time, in a direction not recognizable as contributing to incremental progress (during which there may be multiple failed attempts). If incremental progress is what is rewarded, those working on disruptive innovation can quickly lose motivation. On the other hand, if methods are employed to reward creativity, risk-taking and the "potential" of a concept, then motivation for activities that can produce disruptive innovation is enhanced. In addition, research shows that individual rewards as opposed to traditional rewards tend to foster innovation. Examples of traditional rewards are base salary or promotions. Most traditional rewards are given from the top level of the organization. Sometimes traditional rewards are seen as being a function of the number of years in the organization, as opposed to reward based on actual performance. Individual rewards are personal recognition (especially from your peers or supervisor) or recognition that comes from satisfied customers.

Risk tolerance

An organization's attitude toward risk is critical for creating a culture that facilitates disruptive innovation. Many organizations verbalize the positive aspects of taking risks and the tolerance for failure, but their unwritten rules, codified in quarterly reports and mid-level management's assessment of those that report to them, loudly nullify any tendency to take risks. Mantras such as "fail early, fail often" must be backed up by supervisors and top-level management in ways that are clearly seen by those asked to take the risks [5]. Note that organizations that are successful at achieving disruptive innovation both

embrace risk and, at the same time, have risk mitigation strategies [6]. As an example of these strategies, "high risk—high payoff" activities are tolerated more easily when they are not in the critical development path of a key product. Other risk mitigation strategies will be discussed in the section of creativity methods.

Physical environment

Physical environment should mimic, or even display, the organization's commitment to seek disruptive innovation. Physical environment often tells a story regarding the organization's leadership structure and communication protocols. For example, if top leadership offices are located far from the majority of the other personnel and if those offices are seen as "off limits" to the majority of the people, then the flow of creative ideas is limited. Physical environment can also create an atmosphere that leans either toward creative thought, or toward a culture that emphasizes simple repetition of both activities and thought. Research shows that creativity occurs when a familiar idea, process or technology is either applied in a different manner or is combined with another idea in a way that is new [7]. This different application or new combination is facilitated by environments that provide freedom and promote a wide variety of thought processes. One additional aspect of physical environment is that in order to create solutions to problems, the organization needs access to the people that will be affected by the solutions (customers or end users). There are numerous techniques for implementing changes to physical environments to enhance the creativity process. The company IDEO has done some great work in this area [5].

Communication culture

Some of the communication issues related to disruptive innovation have been addressed earlier. The keys to providing a communication culture that enhances innovation take two forms. First, the research shows that open communication facilitates disruptive innovation simply because great ideas can come from a variety of sources [8]. In particular, it appears that the combining of ideas is most likely to create innovation when those ideas come from people with very different perspectives (sometimes called the "Medici Effect" [9]). This difference in perspectives could be due to training, experience, age (or numerous other aspects). Therefore, communication protocols that facilitate different types of people addressing the same problem improve the novelty of the solutions. The second key to providing a communication culture that enhances innovation is to provide an environment for people to internally process and refine ideas. This obviously crosses over to the category of physical environments. For example, if an organization only provides physical space where open communication is the norm, then refinement of ideas will be hampered. This contrast of communication cultures is representative of the dichotomy of introverted and extroverted personality types as well. Recent research shows that both are critical in an effective organization and both have different communication strengths and styles [10–12].

Characteristics of key personnel

Research shows that, while innate intellectual capacity (measured by IQ scores) has a significant inherited (genetic) component to it, creative abilities do not [3,13]. Simply put, creativity can be learned. However, in any organization there are those that find the creative process enjoyable and those that do not. Even if other aspects of the organization's culture are aligned to facilitate innovation, if an individual is not motivated to engage in creative

processes, their productivity in that environment will be reduced. People can obviously change their desire to engage in innovation-oriented tasks over a period of time, but an initial evaluation of a potential team member's desire to engage in creative processes may help formulate an "innovation team" with greater chance for success. Numerous tests, including MBTI and 6-Hats, have components which can be helpful in identifying potential team members for innovation oriented teams [12].

Creativity/innovation training

A recent large survey of CEOs indicated that creativity is the #1 "leadership competency" of the future [14]. Because research shows that creativity is a learned skill, techniques that develop that skill are critical for development of an organization's innovation capability. These techniques are most effective when they are first learned, then practiced and finally incorporated into the culture and common practices of an organization. Numerous techniques are described in the following.

Methods for enhancing creativity and the resulting innovation

As mentioned previously, creativity and the ability to innovate can be enhanced through training and practice. In this light, a set of concept generation or ideation methods which facilitate innovation are described in the following. Research shows that the quantity, quality and novelty of concepts can be enhanced by use of the following methods [15]. Ideation is the process of developing this solution space.

We divide the innovation training into what we label "ideation methods" and what we call "box-busters." Ideation methods are multi-step processes that produce increased quantity, quality and novelty of the potential solutions to a problem. "Box-busters" are a set of techniques that can be used in the context of different ideation methods to improve that method's ability to expand the solution space.

Ideation methods

The following ideation methods form a suite of options for an organization looking to generate a large quantity of novel and quality concepts. These methods can be applied as a full or partial set depending on the organization's goals and resources. In the following are ten major categories of ideation methods.

1. Customer interaction
2. Background research
3. Functional description
4. Morphological brainstorming
5. C-Sketch rotational drawing exercises (also known as "6-3-5")
6. Analogies
7. Mind maps
8. Physical or multi-sense engagement
9. Group engagement
10. Embracing risk

Each of these major ideation methods are described in the following with sufficient detail to attempt the methods in one's organization.

Customer interaction

Customer needs analysis almost always involves interviewing and surveying customers. However, more extensive customer interaction can be used as an ideation technique. Watching the customer use the product or process, suggesting to the customer the use of new technologies to enhance the product's capability and engaging with high-value groups of customers (called lead users) that are pushing the envelope on how the product is used can all lead to expansion of the design space. Some further interaction methods are described in the following.

- *Interview the customer:* In-person or survey methods are useful. Care should be used to ask general questions first and avoid leading questions [16]. Several web-based survey sites enable broad sharing of a survey to distributed user groups.
- *Observe the customer:* Use of anthropological methods to study the customer's current process and limitations. This may result in broad, possibly non-materiel, solutions. It can also highlight the manner in which the problem must fit within the customer's abilities, culture, and integrated resources.
- *Become the customer:* Experiential observations tend to stick with and motivate the designer more directly than do interview/observations alone. This method is especially useful with the designer is addressing a need for a customer base far removed from their own life experience (e.g., users with disabilities, different ages, different locations/environments) [17].
- *Tech push:* Rapid adoption and experimentation of lower technical readiness level technology into domains not originally intended for. This adoption of existing tech to solve unassociated domain problems can serve as the basis of novel inventions.
- *Crowd sourcing:* Through effective use of surveys, competitions, and observing large quantities of ideas, the designer can put the creativity of the customer's themselves to use. Related to the concept of "co-designing," the user is valued for their own ideas which can be used to enhance or spawn further novel ideas [17].
- *Quality Function Deployment (QFD):* This method once dominated the Japanese manufacturing industry and was then adopted by many American industries to trace the voice of the customer throughout the entire designed product. It is still a valuable method to derive measurable design requirements from original customer needs through use of QFD tools such as the House of Quality [16].
- *Lead user engagement:* Designers interview and observe the lead users in the problem domain. These users may already approach the problem in a novel, though informal, way. These approaches can be observed for advanced ideas. Lead users can also be a valuable source of feedback on early prototypes [18].
- *Contextual analysis:* As the designer engages with customers, a prioritization of customer needs is necessary. A contextual analysis of the customer needs is a useful way to understand the full context (who, where, when, how, etc.) [19].

Background research

Background research is an important part of an overall ideation strategy. It helps to frame the problem and, when accomplished properly, keeps the group from "reinventing the wheel." It can assist in identifying where on the development S-curve the problem is currently located. This, in turn, helps identify where the opportunities lie and whether they are more likely incremental or disruptive innovation in nature. Some of our recent research

involves the use of patents and trade publications in the ideation process. Intellectual property considerations should also be an important part of the background research process.

- *Patent research:* the study of existing patents can serve two purposes. First, it can expand the solution space through understanding and combination of existing ideas. This type of study happened to be the basis of the TIPS/TRIZ ideation method [16]. Secondly, the study of patents will help shape intellectual property protection efforts that are critical for tech transfer success [20].
- *Use of S-Curves to identify design innovation opportunities* (*ex: Honda* [21])*:* For well-understood markets, the innovation S-curve model can be used to identify when incremental or disruptive innovation is appropriate. Background research will identify whether underlying technology readiness supports rapid tech transfer, or in some cases, when market saturation demands a disruptive innovation approach.
- *Reverse the customer flow:* Classic design processes move the designer from customer needs to a solution. Through background research, it may be found that an organization has certain technology, expertise, or resources that a customer needs without realizing it. A designer may simply need to understand and then connect those areas to the appropriate customer base.
- *Image searches:* Through use of existing search engine algorithms, the initial results, may help highlight other considerations in design of products, process, or features. Fringe images are also highly useful in forcing the designer to determine how they may be related in creative ways. This remote link can serve to leap-frog the designer to another idea altogether.
- *Google Scholar:* Similar to patent research, it is important to understand the basis for existing technology. Results from this area of research will form the academic or scientific basis of understanding which is important for further development scoping.
- *Tech journals:* Tech journals will help identify technology of various stages of development and usually focuses on the potential for various applications. This method of background research is especially useful if a tech push approach to ideation is desired.

Functional descriptions

The idea of functional decomposition is to break a problem into descriptions of "what the solution to the problem needs to accomplish." This helps maximize the quantity of ideas in the solution space. To do so, the descriptions of the problem must be related to WHAT the solution needs to do, not HOW it will do it [16].

As a brief example, suppose that a customer orders a product online and as a result the customer needs to receive that product. If the question is specified as "Should we use FedEx or DHS or UPS to deliver the product?" then the solution space is limited. If the relevant question is phrased as "How do we move a product from point A to point B?" then we've opened up the design space to include a far larger variety of possible solutions (maybe a drone is used to do the delivery). However, even this last question is limiting. If the question is rephrased as "How can the customer end up with the product?" then additional solutions where the product is not moved, but somehow the product still ends up with the customer, are added to the solution space. For example, maybe rapid prototyping machines are supplied to all customers and the software code is delivered to build the product—the customer builds their product at their location. The overall functional description earlier can be broken into incremental functional descriptions. For example we may need to: identify customer, communicate with customer, identify purchased product, build product (or locate product), deliver product, confirm delivery. Some of these

incremental subfunctions may occur in different sequences depending on the actual solution details. For example, will the product be delivered or will the information to build the product at the customer's site be delivered?

Morphological brainstorming

Morphological brainstorming is most often used in conjunction with the functional description method described earlier. It is a formal approach to combinatorial design. For each of the subfunctions of the problem, a number of different solutions can be imagined. The different combinations of the solutions to the subfunctions constitute the set of possible overall solutions to the problem. The beauty of this process is that, if there are "S" subfunctions and each subfunction has "I" imagined solutions, then the number of unique combinations of different subfunction solutions is "I^s." This quickly populates the overall solution space with a large number of alternative combinations of solutions for each subfunction. Not all combinations of solutions may be possible across subfunctions, but it is a rapid way of developing many system-level designs through novel combinations. These system-level concept variants are then able to be placed in decision models to compare their overall utility in solving the original problem.

C-Sketch rotational drawing

Traditional brainstorming is ineffective for developing a set of solutions (solution space) to an ill-defined problem. Specifically, the research that substantiates this follows this pattern [15]:

- An ill-defined problem is given to two groups.
- Each group has *N* individuals (with similar background and training)

Group 1	Group 2
• In group 1, each of the *N* individuals develops a solution space (without communicating with the others in their group). • The solutions spaces from each of the individuals in group 1 are combined and any redundancy is removed.	• Group 2 develops a solution space using a classic group brainstorming process [22]

- Group 1's combined solution space is compared with the solution space produced by group 2.
- Group 2's solution space will not have greater quantity, quality or novelty than the combined solutions space from group 1.

This research finding leads to the conclusion that organizations need methods that enhance the effectiveness of group ideation. One of these methods is "C-Sketch rotational drawing exercises," also known as "6-3-5" [15]. In this method, members of a group (optimally six people) each create three solutions to an ill-defined problem in five minutes (hence the 6-3-5 label). The three solutions are developed by each group member by creating three drawings on a single, large piece of paper. The drawings can also have written descriptions. This is done in a location where all six of the group members are present, but they are not allowed to communicate during the five minutes when they are creating their three solutions. Once the initial five minutes has passed, each member rotates their paper to the colleague next to them and that person has five minutes to augment the drawings by adding to, commenting or recreating, the ideas they received. After five minutes the drawings are rotated again. Rotations occur every five minutes until each group member has worked on

every other group member's drawings. Once the rotations have completed, the group can then discuss the different drawings and corresponding solution options. With a nominal group size of six members, this method can easily produce 108 novel and variant ideas. This process has been documented to increase quantity, quality and novelty of the solution space when compared with either individual work or classical group brainstorming ideation [15].

Analogies

Some cognitive psychologists believe that all "new" ideas come from analogy; meaning that the ideas are not really "new" in the strict, literal sense, but come from applying an existing idea in a new manner, or combining two or more existing ideas. In order to use the idea of analogies in design, techniques are needed to help uncover effective analogies. Two categories of analogies have been used to develop designs. First, grammatical techniques leverage the power and versatility of human language. Typically, a seed word (possibly a key part of the functional description developed earlier) is used to produce a list of similar words. A variety of computer programs can be used to develop the analogues words. Second, biological analogies are also often used to produce ideas. Again, a number of different resources (computer programs, web sites, and written material) are used to facilitate this process.

- *Grammatical analogies:*
  - *Wordnet (wordnet.princeton.edu/)*: a lexical database that groups words by cognitive synonyms
  - *Visual thesaurus (visualthesaurus.com/)*: a thesaurus that presents its results in a rotational hierarchy (i.e., spider diagram) format to enhance understanding of word linkages.
- *Biological analogies:*
  - *The Biomimicry Institute (AskNature.org)*: nature inspired strategies, ideas, and resources
  - *Encyclopedia of Life (eol.org)*: information about biological solutions
  - *Tree of Life Web Project (tolweb.org/tree/)*: information about biological solutions
  - *International Journal of Design & Nature & Ecodynamics*: covers general area of how nature relates to modern scientific thought and design
  - *Materials found in nature (Nature.com/nmat)*: provides a forum for materials found in nature
  - *Bio-Inspired Engineering*, Chris Jenkins, Momentum Press, 2012. Text on bio-inspiration. Proponent of the idea that design by analogy (DBA) is really backward compared to normal design in that you study natural system and then see if they relate to any current engineering problem as opposed to knowing the problem and looking for a solution.

Mind maps

Mind mapping can be used in combination with many of the other methods presented here. It is a way to organize and display information [23]. This rotational hierarchical format, sometimes also called spider diagrams, is a graphical method for information organization helps to create categories and highlight relationships between the different pieces of information. Mind mapping has been shown to enhance ideation in many ways. Most often it helps increase the quantity of potential solutions to an ill-defined problem by creating categories of solution possibilities where additional ideas can be imagined. The developed solution categories can be used as a starting point for further ideation. This, in turn fills in more of the mind map, which can then lead to further grouping and categories.

Physical or multi-sense engagement

Providing the problem-solver with first-hand experience with the problem often expands the design space. Most often, this first-hand experience involves having the problem-solver use the existing product if one exists. Using the product in different contexts and with different methods or constraints can increase quantity, quality, and novelty of the solution space. If no product/process is available to use, then using whatever currently best meets the core customer need(s) can be helpful.

- *Prototyping strategies:* A deliberate approach to prototyping feasible solutions will include use by the designers and/or user groups. This use of iterative prototypes can highlight areas of the solution of experience that can be enhances through further prototyping [24].
- *Activity diagrams:* Sometimes described as functional flow diagrams, use of activity diagrams can be used to focus on the user's activities. This can help identify parts of an existing process that are high value wasteful [16].
- *Role play:* Role-playing the various users and stakeholders can help to identify interface issues, information needs, and other constraints in advance of live user engagement. Capturing this role-playing can be accomplished through "story-boarding" a scenario of product usage so that the experience can be easily communicated to other non-participants [25].

Group engagement

Although classical group brainstorming is not effective for ideation, there are other group techniques that are effective. One such method is the 6-3-5 exercise. In addition, there are many other techniques used effectively by many organizations. Often these are integrated into the organizations' culture and involve feedback groups like Pixar's Braintrust [26] and 3M's Innovation presentations [8]. They may also include structures for group resources (time and funding) [27] devoted to innovation or may involve techniques to facilitate the Medici Effect (3M rotates their employees from group to group even outside of their area of expertise).

Embracing risk

An organization's risk culture is critical to its ability to innovate. Although many organizations pay lip service to the idea that they tolerate risk, it is tremendously difficult to create a structure that addresses rick in a manner that actually facilitates creativity and fosters innovation. In addition to explicit statements that detail the organization's risk policies, there needs to be definitive evidence, in the form of positive performance reports and rewards, that these policies are real. Also, organizations that successfully navigate the risk issue often employ strategies that allow risk to be embraced, without the full ramifications of the failures that are necessary on the road to achieving disruptive innovation. Some of these strategies involve taking parallel paths where one is "high risk—high payoff" and the other path is less risky but more feasible. Another strategy involves taking risks that are not in the critical path of the product/process development. Organizational leadership can use the following questions to discover opportunities for enhancing a healthy risk culture.

- What percentage of projects fail?—aggressive innovation requires a large %
- How is failure defined?
- How do the different aspects of failure impact performance evaluations?
- Can a high risk solution or aspect of a solution, that is perpendicular to core performance, be developed in parallel to the low-risk solution?

Box Busters: Techniques to expand or reinvigorate the solution space with new ideas

The following is a list of techniques that can be selected to help a design team increase a solution space. The list overlaps with ideation methods, culture aspects, and organizational innovation methods presented earlier in the chapter, but are presented here to provoke thought within a design team.

1. *Do the opposite:* Explore the contrary. Suspend disbelief of a direction originally thought to be impossible, undesirable, or otherwise irrational. Sometimes this approach can yield ideas that are second or third-order removed from the initial "opposite."
2. *Suspend constraints:* Explore limitations. Sometimes the constraints are found to not actually exist due to customer misunderstanding. Other times, temporality removing the constraints allows for new ideas that can be made to fit back inside the constraints later.
3. *Violate physics (or norms, or company policy, or organizational culture, or values, or priorities):* Explore the "impossible." Sometimes referred to as "turning off physics" we try to revert to a completely clean sheet approach to what is physically possible. This unlearned approach can yield a wild idea that can serve as the central concept that could fit back into physics. Sometimes the identification of which part of physics needs to be turned off results in a better understanding of the phenomenon and other functional approaches to solving the problem.
4. *Analogies based in basic function:* Ask "How does nature do this or how do other systems do this?"
5. *Dedicate time to innovate:* Incorporate innovation methods and activities into the standard schedule similar to Google and 3M [27]. Tailor time, resources, and freedom based on an organizations culture and personnel competencies.
6. *Load—relax—capture:* Use when faced with a challenging problem where sustained effort is needed. "Load" or immerse in the problem, technical details, or functions required. Periodically, "relax" into a completely different setting, topic, or activity to allow the mind to restructure, combine, and connect salient information needed to solve the problem. Go have lunch, work out, or engage in a separate meeting or discussion. Then revisit the problem and "capture" the key elements that emerge to help the mind communicate the new connections that have developed [28].
7. *Using new tech in ways it was not intended for:* Explore the ways in which new technology can be used that the inventor may not have intended. Give it to unlearned or other user groups to observe their use of the tech.
8. *Medici effect:* Engaging outsiders, especially those from a different field. This increases the solution space in a combinatorial and even multiplicative manner [9].
9. *S-Curve analysis:* Identify if you need incremental or disruptive innovation.
10. *Avoid typical innovation traps:* Avoid group think, design fixation, structural pressure from power hierarchy.
11. *Function before form:* Focus on understanding WHAT needs to be accomplished, before ideating on HOW it can be done. Resist the urge to jump directly to possible physical forms too early. This eliminates the possibility of many other ways to accomplish an original function.
12. *Build, learn, and iterate:* Use physical mock-ups and prototypes. Use them early in the design, even as quick and low fidelity mock-ups to rapidly increase design feature knowledge [29].

13. *Role play:* Story board the experience from key users' points of view. Script the entire mission of the product or process. Try being the device.
14. *Study the customer:* Ask, and then observe customer in their use of current or prototyped devices. Consider the use of anthropological methods.
15. *Tech push versus tech pull:* Design takes a balance of top-down methods, and bottom-up understanding of technology. When focused on one direction for too long, consider coming at the program from the other direction.
16. *Engage the unencumbered:* Work with user groups that are without limitations for their ideas. One example is children. They are especially good at implementing the "Suspend Constraints" and "Violate Physics" techniques.
17. *Explore the perfect solution:* Give in to the desire to chase the wants vs. just needs. Then identify impossibilities and explore possibilities [15].
18. *Explore transformation:* Transformation design principles can highlight opportunities to use either mono-or multi-form solutions. Comparing the features and functions of a design can yield efficient use of space, energy, volume, and time [30].
19. *Brain Trust:* Small innovation group with commitment to complete honesty. Remove barriers and expectations of hierarchical structure or repercussions of disagreements or wild ideas. Keys for a brain trust approach [26]:
    1. Deep understanding of the problem.
    2. No power in a brain trust group. Owner still has all the authority.
    3. Honesty is combined with trust.
    4. No competition within brain trust, instead a shared success.
    5. Knowledge that the creator is very likely to become married to their idea in a way that blinds them from thinking an idea needs iteration. So the creator must really want to hear the truth.
20. *Patents or trade publications:* Continue to explore other approaches to related problems to find overlapping ideas or ways that existing inventions can be adapted outside their original domains.
21. *Highlight innovative culture legacy:* Tell stories of past success to set vision and expectations but note that culture comes from shared experience not stories.
22. *Kill innovation barriers:* Ask what parts of an organization's rewards, logistics, or culture inhibits innovation? Seek to actively destroy the barriers with leadership and external organizations that may drive them.
23. *Celebrate "good failure:"* Ask when the last significant failure was. If it has been awhile, it is possible that the organization may be too risk adverse.
24. *Orthogonal performance:* Try to create risk experiences that are orthogonal to primary function. Once the primary functions and solutions are established, consider allowing further exploration in a direction not critical to the success of the primary function. These high risks may pay out huge, but do not put at risk the primary function.
25. *Prototype in parallel:* Create high risk high payoff prototypes in parallel with lower risk ones.
26. *Get true leadership buy-in to innovate:* Get buy-in from upper-level management for innovation and risk—then remove them from the process. Insure they understand the unorthodox methods and the mid-term goals (to include possible failure), and then trade oversight for rapid progress. This takes a great deal of trust in an organization.
27. *Cut out mid-management:* Keep middle management completely out of the picture (e.g., Skunk Works®). Rapid progress in the solution space requires a focus on the primary goal of innovation. Bureaucracy and tertiary processes of an organization will

kill the primary goal quickly if an organization does not value the need to innovate and the methods it requires.

28. *Treat every problem as a new problem:* Repeating or repackaging past successes will not work for new challenges. There must be legitimately new creative ideas and even processes. It's hard because sometimes process is tied to culture or even values in an organization…so where is it ok to change?
29. *Identify conflicts and separate solutions chronologically:* Methods such as the Transformational Design Methodology can be used to separate out the process steps needed to go from one subsolution to the next.
30. *Identify conflicts and separate solutions physically:* Explore physical solutions that may exist in other organizations. Get another entity to do one of the conflicting activities.
31. *Platforms or families of solutions:* Rather than trying to please all user groups with one solution, consider solutions with core structure of functionality that can then be modified or enhances to provide a suite of solutions meeting many customer needs (e.g., smart phones with different RAM or screen sizes).
32. *Quick customization for individual preference:* All design relates to a human user or interface for some function of the design. Focus on the user through deliberate discussion of their interface. Allow for feature customization to enhance the positive user experience (e.g., Keurig coffee makers, drill with different bits).
33. *Default to most desired state or configuration:* Change the default configuration or motivation of the system for the preferred status (e.g., minimum energy configuration or stable state).
34. *Frame the problem in competitive terms:* if the ill-defined problem is framed in a competition environment or warfare context, then several new ideation directions exist:
    1. Flank
    2. Asymmetric warfare
    3. Shock & Awe
    4. Confuse competition
    5. Demoralize competition
    6. "Art of war"—Sun Su
    7. Rules for radicals [31]

In conclusion, this chapter is meant to serve as an innovation guide for organizations. The first two sections described ways to enhance an organization's innovation and the major aspects of an innovative organization's culture. An organization's senior leadership may find these sections useful as they seek to recognize and develop an innovation culture. The final section showed direct methods to apply to a design challenge. These methods were grouped into ideation methods, and box-buster tips. Anyone tasked with developing solutions to problems should find many of these methods useful. Creativity and innovation, similar to many other life-long skills, CAN be developed through training and practice.

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