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FRAMING THE INNOVATION MINDSET

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ABSTRACT

Aim/Purpose	To build the skills of innovation, we must first establish a framework for the belief system that surrounds effective innovation practice. In building any belief system, sometimes outdated beliefs need to be replaced with better, more carefully researched ideas. One such belief, discovered in our research and elsewhere, is that creativity is innate and that great ideas arise through chance or happenstance.
Background	One belief regarding innovation and creativity, discovered in our research and elsewhere, is the belief that creativity is innate. History has repeatedly shown this to be untrue, yet people still believe it. We have found within our research another belief is that innovation happens through random, unstructured processes -- that great ideas arise through chance or happenstance. However, participants also believed that innovation is a skill. If someone believes innovation is a skill but also believes innovation is innate, random, and unstructured, this disconnect presents obstacles for the training and development of innovation skills.
Methodology	This research is based on a combination of background research and direct survey of innovators, educators, scientists, and engineers, in addition to the general public. The survey is used to illuminate the nature of significant beliefs related to creativity and innovation practice
Contribution	We examine the myths and truths behind creativity as well as the false beliefs behind innovation as we present a closed model for innovation and the key framing elements needed to build a successful, trainable, developable system that is the innovation mindset. And like any skill, creativity and innovation can be taught and learned using tools and processes that can be followed, tracked, and documented. If innovation is a skill, creativity should not require magic or the production of ideas out of thin air.

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Findings	This paper identifies the historic nature of creativity as well as the general strategies used by innovators in implementing innovation practices and proposes a framework that supports the effective development of the innovation mindset.
Recommendations for Practitioners	Apply the framework and encourage ideation and innovation participants to appreciate that they can learn to be creative and innovative. Start as early as possible in the education process, as all of these skills can be instructed at early ages.
Recommendations for Researchers	Continue to gather survey data to support a refined understanding of the motivations behind the disconnect between innovation as a methodical skill and the beliefs in the use of random ideation techniques.
Impact on Society	Transforming the understanding of creativity and innovation from one of mythical belief to one of methodical skill application will dramatically alter the lifelong impact of knowledge gained in support of global economic and environmental challenges.
Future Research	A continuation of the recommended research paths and collaboration with other creativity researchers leading to improved methods for dissuading mythical beliefs toward formalized, systematic ideation and innovation practices.
Keywords	creativity, ideation, innovation, mindset, professional development, problem solving, training

INTRODUCTION AND BACKGROUND

Historian, Liddell Hart, said that "the only thing harder than getting a new idea into the military mind is getting an old idea out." The same is true of any organization and, perhaps, the innovation culture, as well. Laszlo (2018) stated, "a critical concern lies in the fact that in the face of increasingly VUCA (volatile, uncertain, complex, ambiguous) futures, many leaders, institutions, and structural societal conventions appear to be preparing for the world of yesterday instead of that of tomorrow" (p. 382).

McLaughlin and McLaughlin (2020) demonstrated that experienced innovation populations believe, as part of their mindset toward innovation, that innovation is a skill. However, when queried for their belief in what comprises that skill, namely that it is a clear, predictable, planned process; they respond with beliefs that innovation is an ambiguous, unpredictable, and unplanned process -- seemingly centered in some innate human characteristic.

While these are dissonant concepts, they nevertheless form an integral part of the current mindset for innovation and creativity. There is a belief in magical or God-given genius AND there is a belief in process-oriented, hard-work-enabled innovation. Highlighting, if not resolving, this dissonance is the focus of this paper.

First, we will discuss this concept of magical genius, followed by a review of survey results regarding ideation practices. We then move to the nature of creative problem solving, and finally address the question of mindset as we march toward recommendations for reasoned instruction of innovation practices.

CREATIVITY AND GENIUS

Weisberg (1993, 2020), and Drucker (2001) have provided a consistent narrative that innovation must be intentional, and creativity is not an innate form of genius. Instead, innovation requires deep subject knowledge and plain old hard work and persistence.

> *"The purposeful innovation resulting from analysis, system, and hard work is all that can be discussed and presented as the practice of innovation. But this is all that need be presented*

> *since it surely covers at least 90 percent of all effective innovations. And the extraordinary performer in innovation, as in every other area, will be effective only if grounded in the discipline and master of it." Drucker (2001)*

Weisberg (2020) argues that indeed the percentage is close to 100 percent as there are simply no examples of intentional, purposeful creativity without antecedents. Much earlier, Weisberg (1993) defined creativity simply as novel, goal-oriented works or activities, and then later (2015 and 2020) clarified that we do not need to consider the value of creativity and that, indeed, we are all potentially geniuses. In summarizing his extensive review of a range of creative activities and in doing so debunking the idea that there is genius in creativity, Weisberg (1993, 2020) made several key points, briefly summarized here, regarding creativity that should be comforting to many who feel they have missed their opportunity for creative genius (or want to teach others to be creative):

1. The concept of genius does not exist in research or in practice.
2. Accidents happen, but without intent an accident is not creative.
3. Creativity requires no value judgements.
4. Novelty should be judged independent of its creator.
5. Creative ideas do not spring up from nothing.

Weisberg (2020) goes on to note elements of the creative environment that include techniques for ideation, the need for domain research or expertise, and, above all, the need for persistence; each of these being teachable, developable human skills. These developable human skills, too, help frame the innovation mindset.

Problem-Solving, Not Creativity, is Innate

Having defined creativity and demonstrated that it and its environment are fully understandable, we are left with the remaining problem of ideation. Are there any natural human abilities, possessed by all, that we can build on to improve the implementation of creative and innovative practices, i.e., the innate ability to want to solve tractable problems? Louis Lee and Johnson-Laird (2013) describe research into the basic steps most humans use to solve problems, including seeking the most obvious (or salient) solution paths, but as they consider the problem and discover additional constraints, they begin to uncover more strategic, or perhaps elegant or creative, options, that may improve on initial solutions. The key point here is, we argue, that humans do this without much prompting and to a statistically significant level of consistency. Hence, humans are problem-solvers, but are there limits to what problems they will attempt?

While as noted, creativity is not magic, and genius does not exist; what is also readily demonstrable is that generating thoughts and ideas is innate and that these ideas often address problems or conflicts or gaps of some kind. Successful problem-solving is not, however, guaranteed without the efforts tied to creativity, notably deep domain knowledge and persistence.

A simple thought experiment suffices to illustrate the point. You may even join in as you read these words. Imagine you are in a conference room sitting at a table with several chairs around it. There is a door, and someone asks you to leave the room without touching the floor. In a split second, our minds make an immediate assessment of the surroundings, based likely on years of experience, and begin to pose possible solutions subconsciously. As the moments, often milliseconds pass, we filter those solutions and an emergent, logically tested solution begins to form until it is strong enough to become what we would consider a thought or idea. As more time passes (perhaps only seconds), we subconsciously continue to refine our idea, test it, alter it, until we are satisfied that we have a rational strategy. At this point, our eyes focus on the next step and our arms and legs begin to act.

We did all of this without effort, hardly any motivation, and with incredible speed. We did this because we have the physical wiring in our brains to do this. The neural pathways are structured, genetically, to accomplish this task without training, and we are limited in our solutions to this specific problem only by our past experiences. Were this wiring not in place, humans would likely not have survived and prospered. Indeed, no being, even the simplest, capable of reacting to its surroundings would, hence the rationale for the genetic roots of this amazing ability.

For further elaboration, Johnson (2010) presents this entire process well in his story of the classic coffee shop environment for innovation and notes that the concept of a eureka moment in ideation is improper, but rather solutions arise as what he describes as "a slow hunch" wherein thoughts are generated and then developed through immediate or developed knowledge of the subject, much as a solution to getting out of the room above evolves as more consideration of internal knowledge or the collection of external data is obtained. For simple problems as described here, this is still a relatively fast process, but for complex problems, the timeline extends significantly.

And while humans may have an innate sense for problem-solving and internal systems to match patterns and connect disparate ideas necessary for problem-solving, this is not an innate characteristic for basic creativity. Not all solutions are creative or innovative. Instead, when faced with environments (natural or seeded, as with our experiment) and the realities of the constraints that arise naturally, humans can draw on these skills to generate creative solutions provided they have sufficient background or experience in the original pattern matching or knowledge capture process. In essence, we cannot solve a problem for which we have no analogous framework or pattern to compare it to, and we cannot solve a problem if we lack the source or domain knowledge of the mechanisms affected by the constraints embodied in the problem. If we are to build a skill for creativity, it is critical that we separate our innate problem-solving skill from the recognition of constraints and core knowledge required to produce a creative solution.

Stimulating Our Innate Abilities

At this point we argue that seeding creativity with defined problems or constraints takes direct advantage of our innate problem-solving abilities and, when married with deep knowledge or expertise, we can readily and intentionally generate ideas and solutions, regardless of whether they are yet deemed creative (novel) or innovative (having value). Figure 1 illustrates this simple linkage.

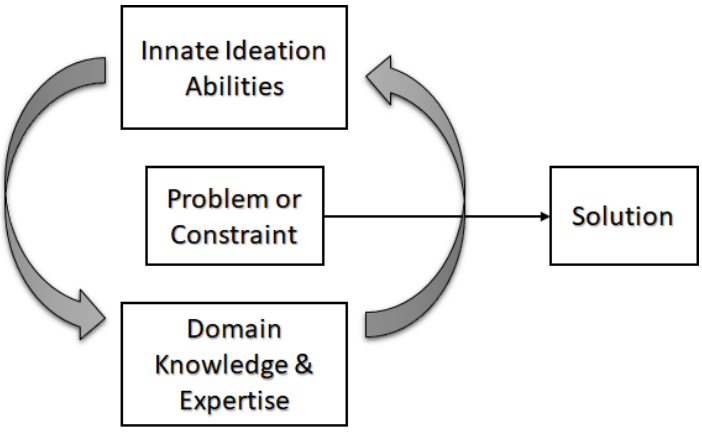

Figure 1: The Path to a Solution

Boyd and Goldenberg (2013), and Rietzschel et al. (2014) document the benefit on successful innovation outcomes provided by systematic methods applied to problem solving; however, this research has not been widely disseminated, internalized, or implemented. Blank and Newell (2017) concur that innovation is a process and one that with constraint can be systematic and not random. Relying on

random generation of ideas has proven to be less fruitful and productive than when a systematic approach is implemented (Boyd & Goldenberg, 2013; Rietzschel et al., 2014).

Indeed, moving away from this belief in an innate sense of creativity toward a more systematic process for creativity should free learners of the concern that they might not be somehow gifted with great creativity, or that creativity may only arise from an outside power, and allow them to grow as innovators using their truly innate skills for problem solving ideation.

Defining Innovation

Returning to Point 3 in Weisberg's clarifications on creativity, in defining an innovation mindset, we argue that the term "innovation" does require a value judgement and only creative ideas that have value or cause productive change are innovative. Weisberg (1993, 2020) describes creativity as intentional and with no imposed judgement toward value. However, to gain the attention of those who would seek to benefit from training and practices in innovation, we need to expand on creativity toward a definition that includes this value judgement. Indeed, previous terms for genius likely include some sort of value judgement that is irrelevant to the study of creativity, so that hereby, a genius might be better described as an individual capable of consistent, valued forms of intentional creativity. The important assertion is that the mindset and skill that builds this genius remains highly trainable, detectable, dissectible, and thus the innovation mindset seeks to build geniuses of all kinds in every discipline.

Cognitive Dissonance as a Creativity Motivator

Given the presentation of a problem, *what precedes our ideation?* We have discussed our innate ability to generate ideas, creative or not. Why do we switch on this ability to be ideate? Plato's adage of "necessity is the mother of invention" includes a need, requirement, or indispensability for invention, but lacks the direct element of motivation or even the perception of a problem. Even if one were to include a 'moral compulsion' in the definition of necessity, the motivation to act has not been addressed. Can the human mind be sparked toward problem-solving? What else is needed to "mother" invention besides the mere necessity? And what is the raw fuel driving the engine of the creative process?

Recognizing a Closeable Gap

In tapping into our innate human abilities, we must now examine what causes these abilities to be utilized. In doing so, we propose that there is also an innate ability, when the mind is suitably prepared by research or experience, for the mind to recognize a gap between current and desired states. And further, to recognize that closing that gap is achievable with reasonable resources and reasonable risk, both factors critical to collecting the will to act.

First though, there is recognition of a gap. Not knowing what is for dinner is a problem we might all recognize, but a detailed problem in mathematical physics might not be recognized until we have sufficient training and experience. Regardless of the level of technical detail, when we recognize a problem, something happens inside our brains that starts an engine of creative problem-solving.

There is a cognitive dissonance between the state we are in and the state we wish we were in. The motivation to resolve that dissonance or close that gap is affected by many factors, but given sufficient motivation, the mind sets to work on the problem at hand.

That motivation is affected by the answer to two basic questions: Can it be done, and might it be done? These might seem like the same question, but each of us understands the difference between an ability to do something and the risk of failure or plausibility of success in doing that thing. For simple problems, the questions are personal. For more complex problems, the questions take on greater significance regarding available resources and risks to a group or organization.

Nevertheless, and most often within the mind of one individual, this calculation is done, and the ideation process begins. Thus, in finding an exit path to the conference room, we can all make the quick assessment that we can solve the problem and that the risks of doing so are minimal. Indeed, as ideas are generated, these questions continue to be asked and answered as the only instant set of logical guides available to test each new idea. That this happens within milliseconds only adds to our amazement at this innate human ability.

Motivation

We now propose that motivation in innovation reflects the general desire or willingness of someone to do something based both on necessity and on the perceived ability to do that thing.

In our conference room example, the mere asking was sufficient motivation to kick off the idea generation process. However, the level of motivation required must be commensurate with the size of the gap to be closed, the resources required, and the perception of risk. Insufficient motivation will fail to produce a noticeable response and the gap will be essentially left unnoticed or responded to. We can see this easily in a simple depiction of the innovation process (Figure 2) whereby ideas are generated, checked, and then a further test of whether there is motivation to continue generating ideas, even after failure.

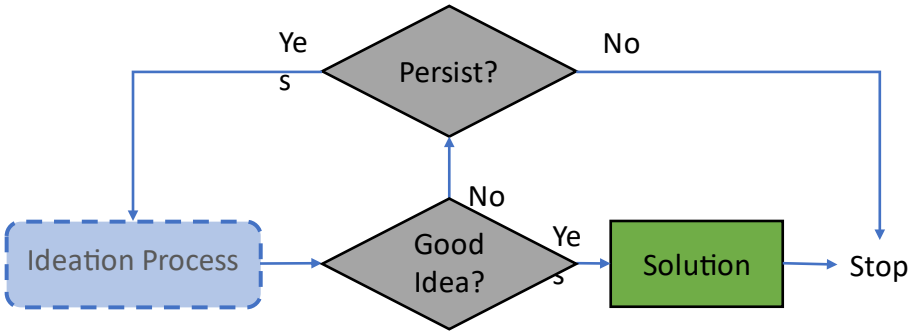

Figure 2: Persistence Drives the Innovation Process

Defined as perseverance and passion for long-term goals (Duckworth et al, 2007), grit or persistence is the full manifestation of motivation in individuals. And as with deep research or experience, persistence is a key element in the innovation process. Indeed, a sufficient supply of persistence is the fuel that sustains innovation. Research and expertise represent a fact base upon which ideas may be successfully constructed, but strong motivation is the fuel that powers the conversion of research and expertise toward a succession of tested, modified, and retested solutions. As Weisberg (2020) notes, even the greatest works of art are incrementally developed through time, testing, experimentation, and error checking. Where there is no motivation, the necessity that draws in the mother of invention is never recognized and never acted on.

Idea Generation Engine

Provided there is sufficient motivation, including both necessity (e.g., to eat or leave the room) and resources (e.g., to make or buy food, or to move) as well as manageable resources and risk in achieving success, solutions inherently begin to appear. As should be obvious now, we depict the elements of idea generation as the analogous elements of an engine spark plug wherein ideas are the result of the application of tools aimed at closing a gap between a need and an ability sparked and propelled by motivation. This set of connected elements is depicted in Figure 3.

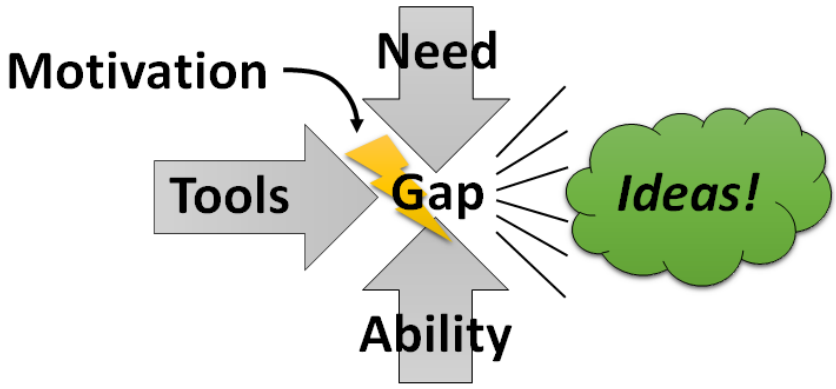

Figure 3: The Spark Plug of Ideation

Given even modest resources to solve problems, once recognized, it is this innate ability to generate ideas to solve problems that is also at the heart of a complete practice in innovation, but as shown, we need tools to draw out this innate ability and capitalize on the research and expertise we have accrued. We will examine options for tools following a discussion of the types of tools and the framework of innovation possessed by individuals who consider themselves as innovators.

SURVEY OF STRUCTURED PROBLEM-SOLVING PREFERENCES

To support a better understanding of how innovators approach innovation practices and the use of tools for innovation, and to appreciate the actual innovation strategies used by a reasonable cross-section of the population, we employed a survey developed by Boyd and Goldenberg (2013) wherein certain beliefs and expectations around a structured innovation method were explored.

The subjects of the survey and research were drawn from the public but focused more specifically on demographic groups ranging from educators and administrators through individual businesses, public organizations, as well as business groups, community groups, and professional organizations interested in innovation. The anonymous survey was shared via social media and also through professional discussion boards geared towards these types of interest groups.

The survey asked questions regarding the beliefs toward innovation as well as specific practices used in innovation. McLaughlin and McLaughlin, 2020 evaluated two critical questions about beliefs toward structured innovation – whether creativity is innate and whether innovation can follow a structured path. Here, we turn to the latter category of questions that are the focus of ongoing pedagogical research because they provided insight into the potential challenges of teaching a method for innovation, structured or otherwise.

SURVEY STRUCTURE

This survey was structured as a binary system of responses which elicited clear preferences and allowed for the strongest conclusions in evaluating the results. The anticipated number of respondents was expected to provide a sufficient number of data points to observe spreads of opinion and mitigated the use of a Likert or other variable scale approaches.

Additional details of the survey are provided in McLaughlin & McLaughlin (2020). A full copy of the survey is provided in the Appendix.

Survey Questions of Interest

Of interest here are those questions that support insights into the mindset and the types of practices used for innovation, and specifically of ideation. Given the limited sample size, only complete question responses demonstrating the greatest dispersion, far exceeding sampling error or other inherent biases, were included in this analysis.

Referring to the survey questions in the Appendix, our focus is on questions 1, 2, 15, 9, and 12. These questions ask respondents to comment on the methods and types of ideation practices they prefer as well as the limitation frame around the ideation problem at hand – this last question being directly focused on the classic "Think outside the Box" admonition common in innovation discussions.

Presentation of Results

Table 1 presents the results of the survey for noted key questions.

For each pair of questions, the respondent is asked: "Place a check mark beside the statement you agree with most."

Table 1: Survey Response Summary

Question	Question Pair	Responses
1	A. Innovation occurs by adding features to a product.	102
	B. Innovation occurs by taking features out of a product.	20
2	A. Innovation is finding problems that are solved by hypothetical solutions.	26
	B. Innovation is finding solutions to difficult problems.	96
15	A. Innovation is an unstructured process.	96
	B. Innovation is a patterned, "templated" process.	26
9	*The glue on the back of Post-It® notes came from a mistake in making glues.* A. The Post-It Note is a good example of innovation because it was spontaneous.	93
	B. The Post-It Note is a bad example of innovation because it was spontaneous.	29
12	A. Constraints on resources like time and money drive innovation.	59
	B. Constraints on resources like time and money inhibit innovation.	63

n=122

Realignment of Results

There are survey responses that have been shown by Boyd (2015), and Boyd & Goldenberg (2013), to be aligned to a productive and structured process of innovation. These aligned responses are provided with the original survey, so we have assessed each question relative to that alignment and assigned percentages based on responses that are so aligned as a way to assess the beliefs of respondents relative to researched best practices. Using the alignment, we obtain Table 2 wherein the responses for each question pair are assessed.

Table 2: Aligned Survey Response Summary

Question	Aligned	Not Aligned	Percentage Aligned
1	20	102	16%
2	26	96	21%
15	26	96	21%
9	29	93	24%
12	59	63	48%

In reviewing the results, we take each question individually, as follows:

In Q1, only 16% of respondents chose subtraction as a preferred method to innovate over addition. Under structured innovation, we look for constraints to motivate natural creativity in all of us (Boyd, 2015; Boyd & Goldenberg, 2013; Goldenberg, Mazursky, Horowitz, & Levav 2003). Simply adding on a capability represents unlimited constraint. However, subtraction forces us to consider alternative ways to achieve the original functional goals of a product or service. Sometimes the alternative is simply a change in how the product or idea is used. Sometimes we must change or improve the kinds of technology being employed. Changing or improving technology is not considered as an "addition" in this context.

In Q2, only 21% of respondents believed innovation was finding problems that are solved by hypothetical solutions over finding solutions to difficult problems. The former is a 'solution forward' strategy whereas the latter is a 'problem backward' strategy, both of which we address in the next section. While it may seem intuitive that we are looking for solutions to problems (problem backward), that constraint, i.e., that an innovator is trying to solve a problem instead of just trying to innovate (solution forward), can be limiting, as it imposes a value judgement too early in the creative process. Such a strategy is akin to a leader asking a team to provide creative solutions to a problem, but to only provide the solutions that have value, often without knowing how value is measured. Structured innovation seeks to first strategically create possible solutions, and then to evaluate whether they solve the problem, as a separate step in the innovation process (Ezzat et al., 2017).

In Q15, 21% of respondents believed innovation was a templated structured process. Research has shown that unstructured or random idea generation has a low probability of success because it does not take advantage of a successful starting point, the current almost-workable solution (Boyd, 2015; Boyd & Goldenberg, 2013; Goldenberg, Mazursky, Horowitz, & Levav 2003). A systematic, structured approach that follows patterns of historic success in innovation has been shown to both increase success probability and to provide traceable pathways to past ideas or successes (Blank & Newell, 2017). Being systematic improves success and learning at the same time.

In Q9, 24% of respondents believed that the accidental creation of the Post-It(r) note was a bad example of innovation. Random successes happen, and they can be very beneficial, but they are also rare and unreliable (Boyd & Goldenberg, 2013; Rietzschel et al., 2014). Further, as noted by Weisberg (1993, 2015, 2020), a novel idea generated without intent cannot be considered part of the class of creative ideas. A structured creativity or innovation process, instead, provides avenues for learning and testing pathways to solutions that help raise the probability of success in a more consistent, reliable manner.

In Q12, respondents were split in their belief as to whether constraints drive or inhibit innovation. Inevitably, solving a problem is about closing a gap between what we can do and what we want to do. As described above, creativity and the motivation to be creative arises from an open gap, not from a closed gap. In a structured innovation process, we actively introduce gaps to spur our natural, human

instincts toward finding solutions (Boyd, 2015; Boyd & Goldenberg, 2013). In this way, constraints help to drive innovation by creating those idea-provoking gaps.

In summation, the survey responses clearly show a specific perspective as to what constitutes an innovation practice. Respondents believe adding functionality to an existing product or service is creative, but subtracting is not. They indicate that ideation should focus on solving problems rather than generating hypothetical solutions first. They felt that unstructured ideation is preferred over ideation that follows a pattern. And that a serendipitous event was a good example of successful ideation. Taken together, these responses suggest a belief in unstructured, unfocused, random, and open-ended ideation practices. These responses also reinforce our prior findings.

Finally, respondents are split on whether individuals prefer an "unconstrained problem" as a path to innovative solutions, though this position is within the survey margin of error (approximately +/- 7%).

Example Textual Responses to the Survey

We asked respondents to provide an example of innovation and the following responses were consistent with the survey results. We offer commentary for each considering their alignment to structured innovation practices:

- "As a small software company, we would innovate by working closely with our customers, understanding their day-to-day problems and working with them to find solutions. Not sure if that is how you would classify innovation?" This is the classic 'problem backward' innovation strategy, and the 'working with them' step often involves substantial iteration and guesswork versus applying strategic processes for ideation.
- One respondent shared an experience leading strategy for a large corporate event with over 15,000 people: "The innovation was simple: transform the event from one focused on marketing to an event focused on sales, our customer needs and requirements from our exhibitors. We figured out what mattered to each audience and changed the program. It took two years and we increased attendance, revenue after the event, partner satisfaction and customer satisfaction." This is potentially the correct approach if a structured strategy for ideation is employed, unfortunately, without knowing more of the 2-year process of ideation that preceded the final solution, it is difficult to know.
- One participant believed "successful innovation often comes from a detailed understanding of the customer's needs. Of course, some are solutions to unknown needs; smart phones." First, detailed understanding is exactly the basis for generating quality, hypothetical solutions from a known point of idea development. The myth that smart phones were an unknown need belies every prior known example of people running to their desktop computers to answer email or search for information. Smartphones simply saved time and improved portability of that desktop computer, while building on the data connections already present in cell phones.

Survey Conclusions

Survey results suggest that the introduction and acceptance of structured innovation tools will depend significantly on building an appreciation of the benefits of using structured tools and ideation strategies toward the overall success of the project. Further, given that research shows that applying constraints aids in the production of ideas, work is also needed to strengthen the perceived value of applying constraints in innovation practices.

Before presenting recommendations and a general model for structured innovation, we will next briefly discuss strategies that are best aligned to a structured approach to ideation and ultimately innovation based on our literature review and the above survey results.

STRATEGIES FOR IDEATION

All innovation derives from the process of idea generation or ideation, but before delving into that subject, it is necessary to separate ideation from innovation. The latter being a judgement or assessment (whether something is innovative or not depends on many factors) long after the act of ideation and the former being a process, with an idea being the product of that process. There is no doubt, however, that ideation is an essential element of innovation. And while this discussion addresses the innovation mindset, it does not address the subjective assessment of whether something is or is not innovative. For the skills in innovation to be successfully developed, one only needs the desire, and thankfully, not the guarantee of success.

Additionally, it is important to note that the utilization of tools or defined processes for ideation have been shown to greatly improve the success of ideation, or as Goldenberg and Mazursky (1999), termed it, improving the "understanding and prediction of new product emergence." In their original research, they document that by following some basic ideation practices or "templates," the quality, measured in terms of quality and originality of ideation, could be improved by 80 to 111% for raw ideas and by 25 to 80% for the subset of top ideas. This is not to suggest that random processes are completely ineffective; however, the knowledge that one can improve their odds of a quality idea by the simple use of structured ideation methods templates should support their further use in a system of teachable, traceable methodologies (Blank & Newell, 2017; Boyd & Goldenberg, 2013; Rietzschel et al., 2014).

WORKABLE PRACTICES FOR IDEATION

So, what works? As we progress along a path to defining the factors motivating a desire to solve problems and thus forming a part of the mindset for innovation, one of the factors is a knowledge of HOW to solve problems. What are some reasonable steps to take toward generating ideas for potentially innovative solutions? And are there tools or best practices that guide us in developing the innovation mindset that led to training on innovation?

Sadly, one of the most common complaints of those involved in or asked for innovation is that they do not have a source for ideas. And this lack of knowing HOW to generate ideas can be a significant demotivator in following the innovation practices. Overcoming this complaint, especially with methods that have been shown to be successful, should be a significant benefit to building the innovation mindset.

Factors in an ideation tool aligned to supporting this motivation include ease of use, mental portability, transparency, and importantly, a favorable probability of success.

A DISCUSSION OF IDEATION METHODS

There are countless publications on the various methods and techniques of ideation practice ranging from the simple to the complex. This section is not intended to be an exhaustive survey, but rather a brief overview of the types of practices that have greatest relevance to building a toolbox that supports the innovative mindset. Many ideation tools come as part of larger innovation methods that define a broad pathway between problem and solution.

The innovation pathway, shown in Figure 4, can begin either with the problem and work back to a solution, or the reverse. The former can be considered as an inductive approach, starting with observations followed by hypotheses and theories that lead to a solution. The latter would be considered more as a deductive process wherein a theoretical approach is taken and then tested with data collection against actual experiences in the problem space.

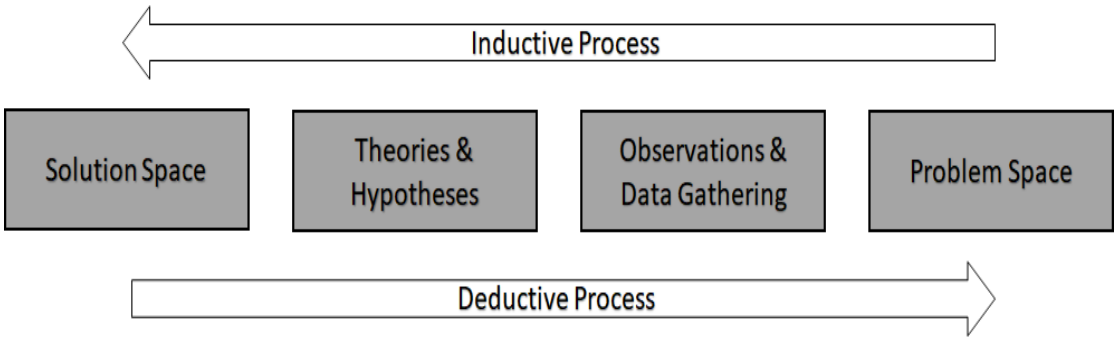

Figure 4: The Innovation Pathway

The inductive process is well documented as the "Jobs to be Done" approach by Christensen et al. (2020) and popularized by Ulwick (2016). The deductive process is equally well documented as the scientific method, a centuries-old approach popularized by Eric Ries (2011).

In evaluating creativity, Weisberg (1993, 2020) analyzed James Watt's invention of the steam engine, Eli Whitney's cotton gin, the Wright Brothers' flying machine, and Picasso's *Guernica.* He concludes that "creative thinking in invention begins with what is already known", and that great creative works are invariably incremental accomplishments. And when problems require additional solutions where direct or near direct solutions are not available, the process of analogy is applied, often looking to nature for solutions.

Thus, it is our hypothesis that all effective innovative methods are systematic, while the direction of movement may differ, there is a consistency in that, at the conclusion, the method follows a process that is consistently deductive in nature, meaning that a change is made to a known product, process, or service that addresses (actually or hypothetically) a problem in the problem space. Further, a systematic innovation process is more successful precisely because it follows this deductive process.

In Figure 5, we present a general structure for the methods of idea-centered, deductive innovation and showing examples of different techniques applied at the various connection points across the universe. For purposes of evaluating or identifying ideation methods, we have broken up the universe into distinct segments reflective of a core or generic "idea" (e.g., a product or service), the localized "system" of rules and environmental factors in which that idea exists and functions, and the collection of these localized systems into a "world" of overlapping and non-overlapping systems that give rise to larger concepts of interconnectedness.

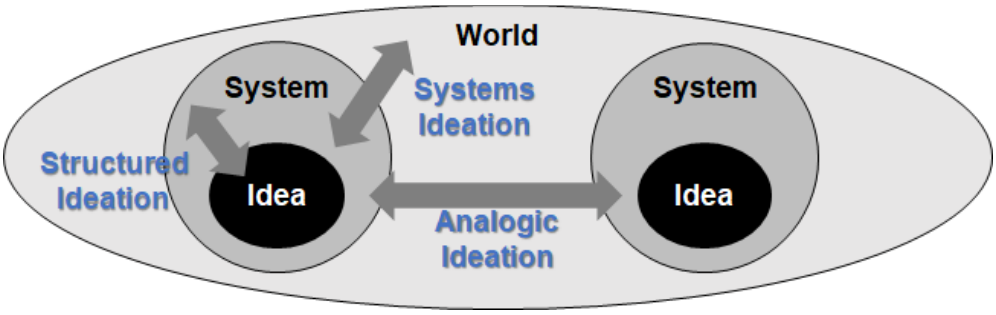

Figure 5: The Universe of Ideation Environments

At the base of the structure, an idea exists conceptually by itself, performing a function within its own system and environment. Specific changes, which we identify as structured ideation, can be made to that idea that adapt it to the changing needs of the system – these changes occurring naturally or systematically seeded. Methods that exhibit this structured ideation would be Systematic Inventive Thinking (SIT) (Boyd & Goldenberg, 2013), its parent TRIZ (Altshuller, 1984), or its partner

MATCEMIB (Valentine et al., 2018). These methods are applied directly as changes to the idea at hand and are then assessed within the policies and environments of its local system. Additional examples include almost any modification to a design to accommodate changing customer needs, regulations, environmental factors, supporting technologies, and the like.

Of course, systems often exist outside of each other, and it is possible to derive approaches for changes drawn from those other systems to apply to the idea at hand. Thus, analogic or analogous ideation, the adaptation of a concept into an alternative context, gives rise to the computer software model of the human brain – two ideas existing in largely disconnected systems (one biological and one electromechanical). Analogic thinking has given rise to a wide range of design changes and as noted by Weisberg (1993) is often the change source of last resort after other research is conducted.

Finally, all systems exist within a much larger system of systems whereby a change to an idea may influence how that local system interacts with the world of systems. An example is how the internet transformed global communication policies, formal and informal. Ideation driven by the considerations of how an idea might produce or respond to changes across the interconnected system of systems constitutes the concept of systems ideation or systems thinking, to use the popular vernacular.

A key consideration for these methods is that the ideas generated by them are substantially predictable and extensible from prior problem solutions. Ideation follows identifiable paths, and it is 'intent' or goal-direction that moves an idea through the transformative process of ideation. And as noted by Weisberg (1993), the lack of goal-direction of serendipitous or random outcomes disqualifies a change method as creativity or ideation in any form.

What is clear in any system of innovation, as illustrated by the numerous cases in Weisberg (1993) and many other texts, is that keen observation, research, record-keeping, reflection, and experimentation are required, not to mention tremendous persistence, for innovation to be successful, and these elements are all present in the innovation process, regardless of how an idea or solution is generated. Continuing briefly, even the most impactful scientific discoveries have relied on a series of continuous, not disjointed or discontinuous, efforts to examine, alter, remold, and re-analyze old theories to accommodate new facts or interpretations of data.

In summary, while it cannot be denied that random successes occur, serendipity happens, but to rely on it, in the face of the alternative probability of success through direct, systematic, and focused "hard work" does a disservice to the process of teaching innovation. We can neither teach the blinding flash of insight nor rely on it. In fact, Danek and Flanagin (2019) stated "a feature of insight is that it occurs rarely, making it a difficult process to study systematically" (p. 61). For these reasons, the process of training innovators cannot present innovation as any process that involves random chance or a belief in innate, miraculous abilities.

A Model of Innovation

Bringing the pieces of creativity and innovation together, we present a closed model for the innovation process that allows us to examine the framework of the innovation mindset. Figure 6 depicts the various elements, beginning at the core with a natural or seeded problem or constraint, addressing that problem through the innate abilities for ideation combined with a reservoir of knowledge and expertise. Provided there is sufficient motivation, ideas generate naturally and can be judged against perceived resources and risks before deciding whether a solution exists or whether to try again. The environment that supports the desire to try again is critical in building persistence and thus maintaining motivation to continue the process until a solution is found.

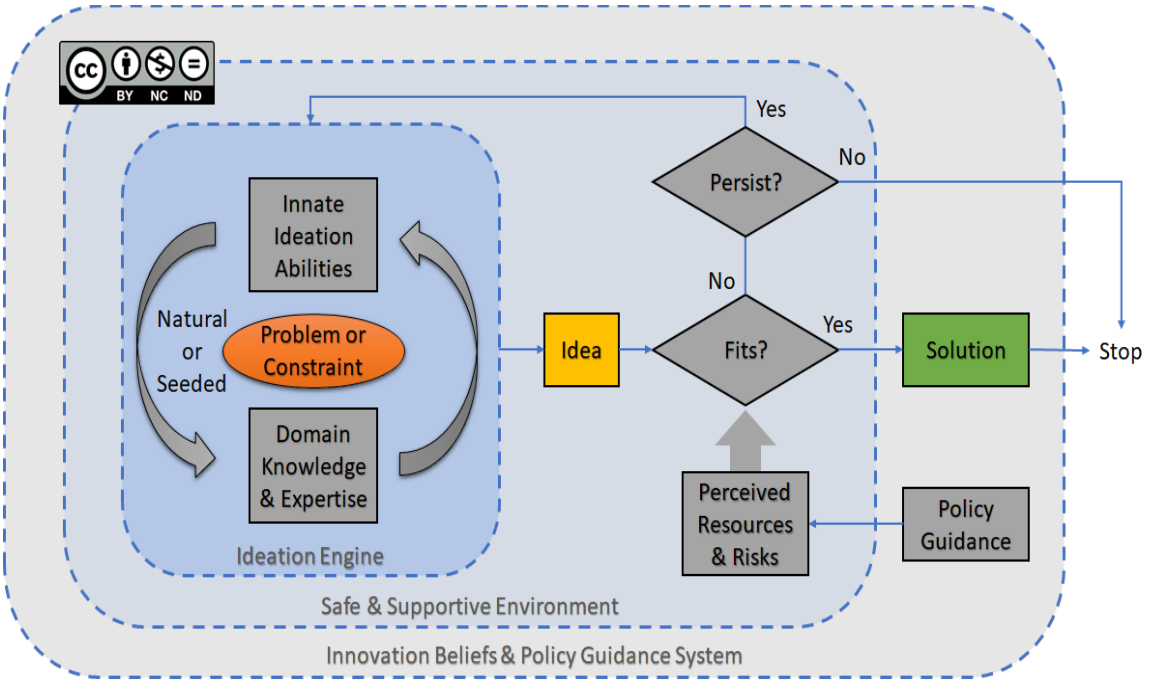

Figure 6: An Innovation Process Model

The only critical beliefs required for this process to work is a belief that there indeed is a process, and that ideation can be seeded through systematic or structured means. There is, of course, a nod to the global environment that can and often does provide guidance into the types of solutions that are acceptable or encouraged. The simplest policy example is not to invent things that harm other systems, intentionally or unintentionally. A better example is to build a framework that guides innovation toward a growth strategy for the world of systems discussed previously.

Examining the Innovation Mindset

Having now explored creativity and genius, surveyed innovators for their approach to ideation, discussed a small sampling of useful, productive ideation methods or templates, and organized and presented these concepts in a single, closed innovation process; we turn to the larger, encompassing desire of a more complete belief system or mindset for innovation.

With just these two concepts: 1) that innovation and creativity are not borne out of thin air or the result of innate genius, and 2) that we can stimulate our innate and practical processes for creativity through proper application of problem introduction; we ask ourselves why individuals fail to see innovation as a skill.

McLaughlin and McLaughlin (2020) found there is a strong disconnect between beliefs and practices in innovation. We have hypothesized that this disconnect has the effect of limiting interest in learning the methods of sound innovation practice under the logic that: If innovation is a random success born out of some innate ability, why work to cultivate the skill? If the innovation community is to drive effective, and hopefully lifelong, capability for innovation, it is essential that we align these beliefs around expectations of success.

As depicted in Figure 7, if the general practice of innovation is broken down by belief systems between practices aligned to structured methodology and practices based on innate ability, research indicates that predictable outcomes are highly correlated to applying measurable, clearly defined, systematic, and planned application of innovation practices as a learned skill. (Boyd & Goldenberg, 2013; Rietzschel et al., 2014)

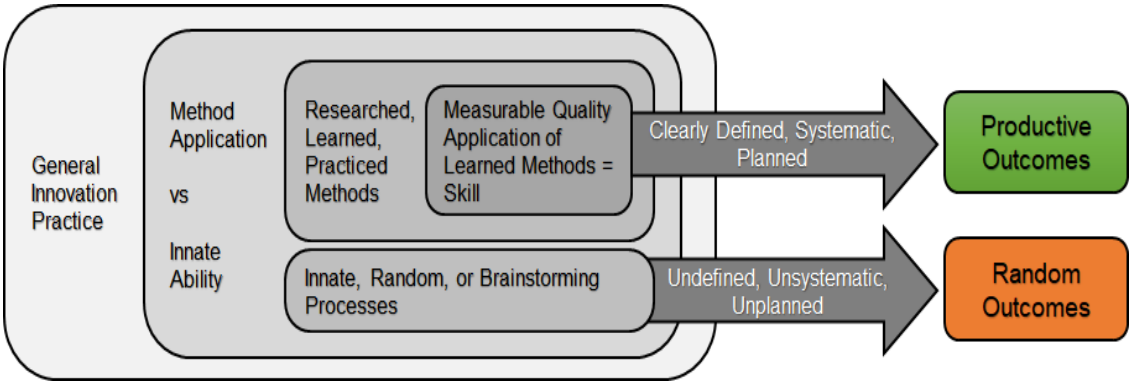

Figure 7: Practices of Innovation Linked to Outcomes

Belief systems have arisen in populations that, so far, favor the random success principles. Whether this is because most innovations appear, after lengthy processes of incremental refinement, to have arisen magically, or whether too little emphasis has been given to promoting and educating on practices of innovation is not fully known. Leaving the question of why populations have developed this split belief system in the innovation process for future research, we will focus on the separate and more important need to define the mindset surrounding productive innovation so that proper steps may be taken to implement new or improved training techniques for the innovation practice which is founded in an innovation mindset.

Building an Innovation Mindset

A broad definition of the critical elements of a mindset include:

> *...the confluence of our beliefs, feelings, values and attitudes, which guide our decisions, behavior and actions in the world. It is precisely the deep-seated dependence we have on our mindsets, which can open or close the possibilities we see in life and work, that make transformation so difficult (Paxton & Van Stralen, 2015, p. 13).*

Accordingly, Ness (2015) stated, "habitual thought patterns involve deeply held framed expectations." To build an innovation mindset, one must believe that innovation is not an innate ability but is a skill that can be learned and developed. Here, we can focus specifically on the Growth Mindset as described by Dweck (2007), which begins with an appreciation that personal growth is not innate and benefits from the development of skills aligned to goals and aspirations. Individuals with a growth mindset tend to seek challenges, are less averse to failing, more appreciative of learning from failure, and resilient to setbacks (Chao et al., 2017).

In addition, Ng (2018) describes how a growth mindset impacts human motivation and this mindset supports that learning is desired and possible and drives individuals to "engage in a task for inherent satisfaction (p. 2)." Li and Bates (2019) stated that "growth mindset theory predicts whether children believe that basic ability can be greatly changed or is fixed and hard to change causes differences in attainment and response to failure in an educational setting (p. 1641)." This combination of growth mindset and intrinsic motivation can drive individuals to pursue creativity and innovation and especially when they are in an environment where they feel safe and supported. Shen et al. (2018) concur that "psychological safety plays an important role in nurturing creativity and convergent thinking in particular" (p. 230).

Because having a growth mindset can determine whether someone believes they have basic abilities to do something or to learn something, it is critical to develop this mindset early and consistently throughout life. Having tools for the successful implementation of innovation practices builds confidence in supporting that growth mindset and the sooner we can introduce these tools, the sooner we can build an innovation mindset. Niehoff (2019) pointed out that mindset is a culture and that "institutional mindsets will need reprogramming to produce new environments and learning communities that are innovative and creative" (p. 36).

If forming a habit around innovation mindset involves knowing what to do, how to do, why to do, and so on, there is an organized set of factors that make up this mindset. Cherry (2010) notes specifically that there should be emotional, behavioral, and cognitive components to any mindset, reflective of feelings, actions, and prior knowledge. As part of the cognitive element, there must be prior knowledge of an environment that supports cultivating that mindset. Thus, there should be basic elements for a complete innovation mindset. And to reiterate, these are the factors we believe are necessary in building an innovation mindset:

- [Cognitive] Belief that one is in an environment that promotes a growth mindset (belief that personal growth can be developed from skill and practice)
- [Cognitive] A belief that innovation is a skill and can be learned and developed
- [Cognitive] A belief that constraint promotes the generation of ideas
- [Behavioral] The use of specific tools for structured ideation
- [Emotional] Belief that one is in an environment that is safe, supportive, and non-judgmental
- [Emotional] A personal intrinsic or environmental extrinsic (enlightened self-interest) motivation driving desire to engage in a task for inherent or organizational satisfaction, also known as persistence or grit.

OVERCOMING CHALLENGES

Instilling the innovation mindset into learners – learners of all ages – requires overcoming critical gaps between how innovation is perceived and how it is practiced. Leaders may appreciate the need for supportive environments, but they must also inform future innovators on the core practices of innovation and ideation. Organizations can support this mindset by fostering a climate that equips "developing leaders" with skills such as flexibility and adaptability (Palazzeschi et al., 2018). These developing leaders and future innovators must be given both the problem and the tools to solve that problem effectively. Carnevale et al. (2017) found in their research that managers play a critical role when it comes to motivating employees in sharing creative ideas, innovative thinking, and sharing their voice. For this reason, organizations can develop their leaders' interpersonal skills so they can foster an environment where ideas are shared, and creativity and innovation are encouraged. Leaders play a key role in creating this climate which is consistent with leader member exchange research (Carnevale et al., 2017). And May (2020) described the importance of providing career-connected learning experiences and collaborating with the community and businesses to shape education and training needs, which create fertile environments for building innovation skills through early exposure to past innovations and helping to build knowledge and persistence.

At this point, we have documented that creativity and innovation are not innate abilities, but instead are learnable and developable skills. We have shown via survey results that even innovators do not appreciate that ideation, a key element of innovation, is based on tools and practices that inherently take advantage of innate human abilities. We have presented a closed process for innovation and proposed a set of necessary conditions for the innovation mindset as well as examples of structured ideation tools supportive of implementing the process.

We are left with the great challenge of understanding why many have not come to see that innovation is a structured process and how to engage learners in forming their own innovation mindset. We

have offered ideas in the form of necessary conditions for innovation that guide trainers/educators/leaders on how they might begin to approach this challenge.

Our global challenges for basic necessities, stewardship of our natural environment, as well as the creation of jobs and opportunities for a growing population demand greater emphasis on the innovation mindset. Like the air we breathe and the sea that surrounds the fish, we often fail to comprehend its existence. With the right lenses, we can see the elements of innovation that exist around us all the time. It is our hope that building the skills for innovation practice gives people the lens through which to see the innovation and innovation practices around them; thus, revealing the framework that establishes an innovation mindset, and shifting practices away from beliefs in happenstance and random genius.

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APPENDIX – SURVEY

[The following survey questions are from the published survey by Boyd and Goldenberg (https://www.insidetheboxinnovation.com/wp-content/uploads/files/are-you-an-innovator-quiz.pdf)] The italicized line was added to provide additional context for the question for those not familiar with the history of Post-It® notes.

ARE YOU AN INNOVATOR?

Place a check mark beside the statement you agree with most.

1. A. Innovation occurs by adding features to a product.
   B. Innovation occurs by taking features out of a product.
2. A. Innovation is finding problems that are solved by hypothetical solutions.
   B. Innovation is finding solutions to difficult problems.
3. A. I am more likely to innovate when I work alone.
   B. I am more likely to innovate when I work in a group.
4. A. Innovation is more about creating novel ideas.
   B. Innovation is more about selecting the best ideas.
5. A. When I innovate, I "brainstorm" ideas out of my head.
   B. When I innovate, I follow a series of steps to find ideas.
6. A. Innovating is predictable and not risky.
   B. Innovating is unpredictable and risky.
7. A. The ability to innovate is a gift that you are born with.
   B. The ability to innovate is a skill that you can learn.
8. A. I prefer ambiguity when pondering new ideas.
   B. I prefer clarity when pondering new ideas.
9. *The glue on the back of Post-It® notes came from a mistake in making glues.*
   A. The Post-It Note is a good example of innovation because it was spontaneous.
   B. The Post-It Note is a bad example of innovation because it was spontaneous.
10. A. I feel responsible for innovating new ideas.
    B. I feel others are responsible for innovating new ideas.
11. A. Innovating is a random, improvisational, back-and-forth experience.
    B. Innovating is a systematic, linear experience.
12. A. Constraints on resources like time and money drive innovation.
    B. Constraints on resources like time and money inhibit innovation.
13. A. Homogeneous groups are more likely to innovate.
    B. Diverse groups are more likely to innovate.
14. A. Innovation can be scheduled. It can occur anytime I want.
    B. Innovation cannot be scheduled. It occurs randomly.
15. A. Innovation is an unstructured process.
    B. Innovation is a patterned, "templated" process.

Additional demographic and open-ended questions included in the survey were:

- Your approximate years of professional experience.
- Your role in innovation for your organization.
- Tell us a non-proprietary story about a successful innovation. What was unique about it?
- Any other thoughts on innovation strategy that you'd like to share?

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