Increasing the Odds of Maneuvering the Innovation Journey[1]

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Ever since the resource-based view of the firm (Barney, 1991; Peteraf, 1993) and the notion of dynamic capabilities (Teece, Pisano, & Shuen, 1997), unique resources that typically are generated through innovation have been at the heart of strategic management scholarship and practice. However, the strategic management research literature has largely focused on antecedent causal mechanisms of innovation, such as resource investments, intellectual property rights, contractual controls (Mitchell & Leiponen, 2014) and consequences of innovation (e.g., firm performance and competition). Largely absent has been research on the *process of innovation*, or the sequence of events and activities that unfold during the initiation, development, and implementation of inventive ideas (Garud, Tuertscher, &Van de Ven, 2013). While central to the field of strategic management, knowledge of the innovation process remains a "black box"

[1] The essay reflects the co-authors' different academic and managerial views. We worked together on several innovations studied at the 3M Company in the 1980's. During that time William Coyne was 3M's Group Vice President of Health Care and sponsored studies of several innovations at 3M. Andrew Van de Ven was research professor at the University of Minnesota, and directly involved in tracking the innovations at 3M with several PhD students (notably Raghu Garud and Douglas Polley). We appreciate the invitation from Jeffrey Reuer and Joseph Mahoney for the opportunity to write this joint academic-practitioner essay for *Strategic Management Review*. In doing so, Van de Ven covered the academic research literature, while Coyne provided "color commentary" by sharing his insights and experiences from his career of managing innovation.

The *SMR* editor suggested we add a footnote discussing the process of preparing this co-authored article. As a practitioner, Bill observed that, "through several months of discussions we were able to combine well researched and documented data with observational facts that support the former from a practitioners' point of view. I believe we came up with a more readable and actionable essay by reinforcing the message this way. We learned from each other through the dialogue." Andy agrees, saying that, "our discussions provided a wonderful way to connect the general case from afar (research data) with particular up-close instances and examples of Bill's observation and experiences. It seems to provide a good way to integrate academic theory and management practice." Bill responded, "Yes, definitely!"

(Vinokurova & Kapoor, 2020). Some studies have sought to understand the innovation process but scholars have not yet been able to identify a clear prototypical process for the management of innovation (Gupta, Tesluk, & Taylor, 2007). As a result, many questions pertaining to the strategic management of innovation are still little understood. It is essential to delve deeper into the 'black box' of innovative processes to understand both how they are initiated, developed, and implemented, and their implications for strategic management (Gallouj & Weinstein 1997).

The purpose of this essay is to present a prototypical process of innovation from the initiation to development to implementation of innovations over time, and to discuss their implications in terms of some key questions and propositions for strategic management. This prototype is based on empirical research observations of how the innovations journey typically unfolds, not on prescriptions of how it should unfold. We discuss the implications of these empirically grounded observations by raising some strategic management questions and proposing some answers for future theory and practice on the process of innovation.

The Typical Innovation Journey

> *Innovation … is anything but orderly. It is sensible, in that, our efforts are all directed at reaching our strategic goals, but the organization … and the process … and sometimes the people can be chaotic. We are managing in chaos, and this is the right way to manage if we want innovation.* (Coyne, 1996)

Schilling (2021) reports that this chaotic innovation process has been observed in many companies, including Google, Ericsson, and Xerox. Brown and Eisenhardt (1998) discuss strategy as structured chaos for competing on the edge. One of the key implications of chaos is that the innovation process cannot be controlled in the traditional managerial sense; but you can learn to maneuver the journey.

While innovations, by definition, are unique new ideas that are implemented, a growing number of studies are showing that the process of developing innovations from concept to

implementation follows a remarkably similar pattern. As Figure 1 illustrates, it begins with a random set of gestating events, shifts into a chaotic non-linear cycle of divergent and convergent development activities, and ends in an orderly sequence of implementation or termination steps. This pattern was empirically found in the development of a wide variety of new technologies, products, programs, and services in business, government, and non-profit organizations studied in the Minnesota Innovation Research Program (Van de Ven, Angle, & Poole, 1989; Van de Ven, Polley, Garud, & Venkataraman, 1999; 2008), and other studies.[2] See extensive reviews by Keupp, Palmié, & Gassmann (2012), Garud, Tuertscher, & Van de Ven (2013), and Woolley (2021). These studies challenge the commonplace view that the innovation journey consists of a linear sequence of stages, that managers can control the innovation process, and that they are responsible for innovation success. Instead, the findings suggest that innovation managers should be held accountable for increasing their odds of success by developing an organizational culture that enables innovation and by practicing skills in learning and leading the innovation journey (Visscher & de Waard-Nederhof, 2006).

-- Insert Figures 1 and 2 about here. --

Figure 2 illustrates a dozen characteristics that Van de Ven et al (1999; 2008) used to map their observations of the typical innovation journey during the initiation, development and termination periods. In the *initiation period*, a set of seemingly random coincidental events occur that set the stage for diverging into a new innovative direction. Some of these gestating events are sufficiently large to "shock" certain attentive entrepreneurs to launch an innovative venture by

[2] See, for examples, studies by Vinokurova and Kapoor (2010) at Xerox, breakthrough innovations in minicomputer, cement, and airline industries by Tushman and Anderson (1986), disruptive innovations in the hard disk drive industry by Christiansen (1997), in bio-pharmaceuticals by Dougherty (2016), nanotechnology by Woolley (2010), the U.S. auto industry by Abernathy and Clark (1985), and of the incandescent lightbulb, Ford's assembly line, and Reebok Pump athletic shoe by Hargadon (2003).

developing a proposal and obtaining funding for it. In the *development period*, soon after work begins in an initially planned convergent direction, the process proliferates into a divergent cycle of exploring new directions, changing goals, learning by discovery, pluralistic leadership, and building new relationships. Problems, mistakes, and resource constraints frequently occur during these divergent paths. They lead innovators into a convergent cycle of exploiting a given direction, learning by testing, executing relationships with unitary leadership, and goal consensus. This cycle of convergent behavior may diverge again with further exploration of a chosen direction and if additional resources permit. This innovation journey converges in the *implementation period*, or the divergent behavior is terminated when resources run out or when political opposition prevails to terminate the developmental effort.

We now discuss key research findings during the initiation, development, and implementation periods of the innovation journey, and discuss their implications in terms of strategic management questions and proposed answers. These findings are more evident in radical than incremental innovations, in terms of the degree to which they represent a departure from existing practices (Schilling, 2013) or change the basis of market competition (Coyne, 1996). Radical innovations transform the way firms engage with the marketplace, and they require new technical skills and organizational competencies that are different from incremental innovations (Audretsch & Aldridge, 2008; Tiberius, Schwarzer, & Salvador, 2020).

Initiating Innovation through Organization Culture

> *Research finding: Innovations are not initiated on the spur of the moment, by a single dramatic incident, or by a single entrepreneur. An extended gestation period of seemingly random events occurs before innovations are initiated. Some trigger recognition of need for change; others awareness of technical possibilities. Some "shock" entrepreneurs to mobilize plans and resources for developing an innovation.*
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> *Strategic management question: In this context, what can organizations do to increase the chance of innovation?*

Proposed answer: Organizations with a corporate culture that enables and motivates chaotic divergent behaviors are more likely to develop a tradition of innovation than those that promote random or orderly behaviors.

The 3M Company is a good example of this proposition. Its management strategy emphasizes that creating an organizational culture for innovation is both possible and necessary for corporate growth and survival. Organization culture sets the stage for innovation by influencing the field of perception and imagination for actors to increase their likelihood for acts of insight to occur (Garud & Turunen, 2021). A tradition of innovation is the historical product of an accretion of past organizational innovation activities. Coyne (1996) presented six principles that he submits are responsible for creating a tradition of innovation in 3M's now 120-year history. Subsequent experiences at 3M and studies in other companies emphasize the critical roles of the CEO and top managers in addition to the innovators in building this innovation culture.

1. *Vision* -- Declare the importance of innovation; make it part of the company's self-image.

   > Our efforts to encourage and support innovation are proof that we really do intend to achieve our vision of ourselves … that we do intend to become what we want to be … as a business and as creative individuals.
   >
   > The CEO makes it clear through multiple channels of communication that the corporate vision/goal is clearly that the company be recognized by the customers as the most innovative supplier. It is important that the front-line employees recognize their role in making this happen.

2. *Foresight* -- Find out where technologies and markets are going. Identify articulated and unarticulated needs of customers.

   > To support foresight, the CEO realizes that in most cases, this comes from the technical community that can best understand the company's core competencies for radical innovations that change the basis of competition in the market.
   >
   > If you are working on a next-generation medical imaging device, you will probably talk to radiologists, but you might also sit down with people who enhance images from interplanetary space probes.

3. *Stretch goals* -- Set growth goals that stretch the organization to make quantum improvements. These goals cannot be achieved with incremental new products. While many projects are pursued, place your biggest bets on those that change the basis of competition and redefine the industry.

   > 3M has a number of stretch goals. One states that we will drive 30% of all sales from products introduced in the past four years. … To establish a sense of urgency, we have recently added another goal, which is that we want 10% of our sales to come from products that have been in the market for just one year. … Innovation is time sensitive … you need to move quickly.
   >
   > One important implication is that rigorous use of "stage-gate" systems (Cooper, 2011) can hamper innovation (Klingebiel & Esser, 2020; Schilling, 2013). The limitations of following the stage-gate model is particularly evident at gate 1 where breakthrough innovations have a high degree of uncertainty and teams are unable to document market

potential at this stage. New ideas, surprises, and discoveries and constructive responses occur continuously throughout the process of organizational innovation and change, not merely at the outset (Golden-Biddle, 2020).

Early and rapid market experiments and feedback are more likely to trigger radical innovations than periodic internal administrative stage-gate reviews of innovation. As one 3M executive advocated, "make a little, sell a little, and make a little more." Continuous feedback from the market to the development team is essential. This helps the team to recognize the unarticulated needs of the customer to frame the innovation's potential market.

4. *Empowerment* -- Hire good people and trust them, delegate responsibilities, provide slack resources, and get out of the way. Be tolerant of initiative and the mistakes that occur because of that initiative. Continually reference innovative product successes that came from employees experiencing individual initiatives.

   William McKnight [a former chairman of 3M] came up with one way to institutionalize a tolerance of individual effort. He said that all technical employees could devote 15% of their time to a project of their own invention. In other words, they could manage themselves for 15% of the time. … The number is not as important as the message, which is this: The system has some slack in it. If you have a good idea, and the commitment to squirrel away time to work on it and the raw nerve to skirt your lab manager's expressed desires, then go for it.

   Put another way, we want to institutionalize a bit of rebellion in our labs. We cannot have all our people off totally on their own … we do believe in discipline … but at the same time, 3M management encourages a healthy disrespect for 3M management. This is not the sort of thing we publicize in our annual report, but the stories we tell – with relish – are frequently about 3Mers who have circumvented their supervisors and succeeded.

   We also recognize that when you let people follow their own lead … not everyone winds up at the same place. You cannot ask people to have unique visions and march in lockstep. Some people are very precise, detail-oriented people… and others are fuzzy thinkers and visionaries … and this is exactly what we want.

5. *Communications* -- Open, extensive exchanges according to ground rules in forums for sharing ideas and where networking is each individual's responsibility. You need multiple methods for sharing information.

   Cross-function and division forums and workshops are powerful engines for sharing expertise within organizations. Occasional one-two day meetings involving scientists with external experts from different organizations provide important opportunities to develop their strategy.

   When innovators communicate with each other, they can leverage their discoveries. This is critically important because it allows companies to get the maximum return on their substantial investments in new technologies. It also acts as a stimulus to further innovation. Indeed, the ability to combine and transfer technologies is as important as the original discovery of a technology.

A 2014 study by Boh, Evaristo, and Ouderkirk at 3M found that inventor's depth and breadth of expertise is influence by corporate culture. Specialists can expand their knowledge to become polymaths – by anchoring themselves in their core technologies and integrating these technologies with new areas, thus also learning about new technological domains. A corporate environment like 3M's can be conducive to cultivate generalists and polymaths, due to the diversity of business and the philosophy that the company, rather than individual business units, owns the technology. Breadth of expertise helps an inventor to generate many inventions, but depth of expertise helps an inventor to generate technically influential inventions. Both breadth and depth of expertise are required for an inventor to be successful and valued in a commercial corporation.

6. *Rewards, Recognition, and Resources*-- Emphasize individual recognition more than monetary rewards through peer recognition and by choice of managerial or technical promotion routes. "Innovation is an intensely human activity."

   The Carlton Society, the top technical award at 3M, is a good example. Each year, new members are chosen by their peers, a few are elevated by a committee of their peers, and then recognized by the CEO at an annual "Academy Award" type ceremony. This and other peer-recognized awards are powerful motivators for employees to contribute to corporate goals.

   Resource allocation is a moving target in organizations dedicated to innovation particularly larger companies that have many existing and successful product lines to resource. Breakthrough innovations cannot be predicted, but when found, need immediate reallocation of resources to be successful. Rigorous strategic planning does not easily allow this to happen (Johnston & Bate, 2013).

These six principles represent ways to increase the odds of organizational innovation in random or chaotic situations where innovation occurs by chance or luck. The six principles are directed at creating a low-dimensional corporate culture for innovation that relax the rigid structures and managerial controls prevalent in most organizations. However, they do not advocate high-dimensional random behavior. Instead, they represent pragmatic suggestions for developing a tradition of innovation by creating a corporate culture that enables and motivates chaotic behavior.

While chaos is commonly referred to as "a state of extreme confusion and disorder," we adopt the mathematical meaning of chaos as a state of bounded order and predictability of pattern, but not path (Dooley & Van de Ven (1999). As Nonaka (1990: 28) observes,

> Chaos refers not to a static state of disorder, but rather to the dynamic state of order without the periodicity and recursiveness of the emerging chaos theory (Prigogine & Stegners, 1984). "In real world practice, problems do not present themselves to

> the practitioner as givens. They must be constructed from the materials of problematic situations which are puzzling, troubling, and uncertain" (Schon, 1983: 40)… The process of generating innovation takes place through the use of chaos to internally give birth to new problems, a process through which knowledge and information are created through the use of redundancy. Unlike the problem solving or information processing model, the innovation generation process …is a "problem generating" or "information creating" model. From this viewpoint, innovation can be understood more dynamically, leading to the possibility that different and new patterns of managing the innovation process can be proposed.

The six principles are supported with an extensive body of management theory and research. They echo Angle and Van de Ven's (1989) conclusion, based on an extensive review of the literature, of the need to structure the organization's context to *enable* and *motivate* innovative behavior. This context includes leadership, resources, structure, and culture of the encompassing organization that innovation projects draw upon to diverge and converge into innovative behaviors. Studies show that the role of leadership provided by CEOs and top managers on organizational innovation is important (Burke, 2021; Sariol & Abebe, 2017; Yadav, Prabhu, & Chandy, 2007). Amabile (1988), Bartunek, Balogun, and Do (2011), and Stouten, Rousseau, and DeCremer (2018) and summarize a large body of research indicating that innovation is facilitated in organizations that provide a context that enables and motivates innovation; it does not occur where enabling or motivating conditions are absent (Ravasi & Schultz, 2021).

However, relatively little research has examined the influences of cultures on innovation in different societal or national contexts. Although work has mentioned the importance of cross-cultural differences (e.g., Erez, Van de Ven, & Leer, 2015), little work has examined its role. The cultural component of infrastructure has been undertheorized and work has yet to identify the infrastructure mechanisms that lead to a supportive culture. Lundvall and colleagues (2002) maintain that the time horizon of agents, trust, and predominant economic rationality are aspects of culture that are particularly important for innovation, but it is not clear how they influence innovation. A special issue on creativity by Morris and Leung (2010) points out that important

differences exist, such as power distance, and different meanings of idea novelty and usefulness in Eastern and Western cultures. In addition to definitions are questions about whether the antecedents and consequences of creativity and innovation are similar and different across cultural contexts (Erez et al, 2015).

Coercive or forced processes to build an organizational innovation culture are likely to fail, as shown by Conato, Ravasi, and Phillips (2013), which presents findings of a longitudinal study at 3M during the 1990's of coerced implementation of a six-sigma practice in the face of a low degree of fit between the practice and 3M's culture. Contrary to current predictions that a lack of cultural fit will eventually be resolved through adaptation of new practices, Conato et al. (2013), Ravasi and Schultz (2021), and Mantere and Wiedner (2021) discuss how changing an organization's culture or implementing a culturally dissonant practice entails ongoing processes of mutual adaptation in shared beliefs and behavioral patterns and social reconstructions of an organization's cultural repertoire by its members.

Innovation Development Period

> *Research findings: The development period of an innovation is a highly ambiguous uncertain journey in which entrepreneurs, with financial support from investors, undertake a sequence of events over an extended time-period to transform a novel idea into an implemented reality. Several years of intensive investment and effort are often required to develop an innovation to the point where its ultimate results can be determined.*
>
> *This journey is exacerbated by the chaotic complexity of the development period, in which activities proliferate from a simple unitary process into expanding, divergent, and parallel progressions of ideas and activities. Some of these activities are related through a division of labor among functions and interdependent paths of activities, but many appear to be unrelated in any noticeable form of functional interdependence. Many ideas and action paths perceived as being interdependent at one time are often reframed, reinvented, or discarded at another time as the innovation idea or circumstances change and as different people fluidly engage and disengage in the developmental process. Setbacks, problems, and mistakes frequently occur along these developmental paths, but they seldom trigger corrective actions; instead, they are treated as unforeseen challenges to surmount.*

So also, innovation goals and outcome criteria shift many times along the way and appear to reflect the most recent and pressing concerns capturing the attention of entrepreneurs and resource allocators at the time in the innovation journey.

Strategic management question: What guides the innovation journey?

Proposed answer: Learning by discovery, pluralistic leadership, and networking by "running in packs" increase the odds of maneuvering the innovation journey.

Learning by Discovery. These research findings call for an expanded definition of learning that examines not only how action-outcome (or cause-and-effect) relationships develop, but also how prerequisite knowledge of alternative actions, outcomes, and contexts emerge. This expanded definition distinguishes learning by *discovery* from learning by *testing*. Learning by discovery in chaotic conditions is an expanding and diverging process of discovering and creating possible action alternatives, outcome preferences, and contextual settings. Learning by testing during more stable periodic conditions is a narrowing and converging process of testing which actions are related to what outcomes. Moreover, since learning by discovery is a precondition for learning by testing, it is important to examine how transitions occur between chaotic and orderly learning patterns.

The following visual image of a rugged landscape captures key elements of the initial developmental process.

> We want to cross the dark valley to reach the peak on the other side. A broad goal galvanizes us to action. To reach the other side we must explore the valley at the same time we are constructing a path to the other side. We use our collective and individual skills by dividing-up and sending scouts to pick specific paths from among the visible details of the valley (i.e. game paths, open versus thickly wooded areas, caves and canyons, etc.). Some are detoured in the maze of a cave; some get chased up a tree by wild beasts, others become preoccupied with cataloguing the vegetation along the trails, while others discover that the peak on the other side consists of a mountain range with many peaks. As we move forward and exert efforts in clearing our paths, we discover more about the terrain as well as ourselves. We become good at trail blazing, at learning what we like and dislike, but not necessarily at knowing where we will end up. If we get too tired, we stumble. Thus, we learn to eat and rest periodically. This is certainly trial and error

> learning, but it is unlikely that it will manifest itself as major changes in the direction of the innovation. (Polley & Van de Ven, 1996: 880).

Further investigation of processes of learning by discovery and transitions to learning by testing is warranted. If the innovation journey is to be explained as a learning process, the origination of novelty should begin with profound ignorance not only with respect to what actions people can take but also what outcomes they desire and the institutional context in which they will operate. The idea that preferences are not in existence *a priori* should motivate further study about how preferences are created and discovered in situations of high ambiguity (Alvarez & Porac, 2020; Rindova & Courtney, 2020). It also calls for a need to revise theories of planned change from predetermined ends to the emergence of in-process improvisation and learning of possibilities and opportunities as they arise (Berglund, Bousfiha, & Mansoori, 2020; Sarasvathy & Venkaaraman, 2021). Actions taken without clearly understanding the range of possible outcomes is likely to be critical to the early development of truly innovative ideas. As Griffin and Grote (2020) discuss, while uncertainty is largely considered an aversive state to avoid, this overlooks opportunities that arise by creating uncertainty.

Pluralistic Leadership. Top managers and investors, like their innovation teams, cast about for inspiration to interpret and make sense of their innovation journeys. However, unlike the innovation units who rally behind the charismatic vision and persistence of their entrepreneurs, in their resource allocation committee meetings 3M top managers adopted pluralistic roles (such as an innovation entrepreneur, sponsor/mentor, critic, and institutional leader) that serve as checks and balances on each other in making innovation investment decisions.

These pluralistic leadership roles provide the key ingredients for a new perspective on strategic decision making in highly uncertain situations. We propose that during ambiguous and divergent innovation development periods, organizational learning and adaptability are enhanced

when a balance is achieved among diverse, opposing, and conflicting, views among innovation leaders. The existence of consensus and support among top managers to a single strategic vision appears neither empirically correct nor effective during ambiguous periods of innovation. Instead, these periods require a pluralistic structure and process of leadership that incorporates the requisite variety of diverse perspectives necessary to make uncertain and ambiguous innovation decisions. While a homogeneous structure of power and leadership may be efficient for exploiting a given course of action, it tends to squelch consideration of diverse and opposing viewpoints inherent in ambiguous tasks. Thus, pluralistic leadership increases the chances for technological foresights and decreases the likelihood of oversights (Garud, Nayyar, & Shapira, 1997).

This change occurs because the dimensions of leadership needs to match the dimensions of the task. Unidimensional leadership of multidimensional tasks results in myopic behavior and blind-sided outcomes. An organization's capacity to innovate increases when diverse views and pluralistic leadership roles are valued and balanced. An elite structure squelches diversity and increases myopia. Since few individuals have the breadth for leading complex innovation tasks, sharing pluralistic leadership roles among trusting managers increases the likelihood of successfully maneuvering the innovation journey.

Majchrzak, Malhotra, and Zallg (2020) show that the timing of pluralistic leadership roles is important. Critical or paradoxical comments are needed early in the innovation development process by groups in a scientific community, when they lead to novel acceptable solutions, whereas overlapping suggestions without paradoxical or dialectical comments tend to be reframed as incremental ideas. Majschrzak et al (2020) also found that positive and negative feedback encourages community participants on their own and without external governance intervention, to engage in actions that eventually lead to accepted solutions.

Networking by running in packs. There is now a stream of research that corroborates the importance of the flow of knowledge across networks (Ahuja, 2000; Garud et al., 2013; Gulati, Nohria, & Zaheer, 2000; Hansen, 1999; Podolny, 2001). We propose that entrepreneurs who run in packs will be more successful than those that go it alone to develop and commercialize many innovations. Running in packs means that entrepreneurs cooperate (Bengtsson, Johansson, Nasholm, & Raza-Ullah, 2013), i.e., simultaneously cooperate and compete with others as they develop and commercialize their innovations. Running in packs is analogous to bicycle racers who cue their pace to one another and take turns breaking wind resistance until the ending sprint. Running in packs is the central dynamic among actors engaged in building an industrial ecosystem or infrastructure that no organization can accomplish individually, but that all actors rely upon to reduce their time, cost, and risk of innovation (Dougherty & Dunne, 2011; Van de Ven et al. 1999; Woolley, 2021).

In addition to proprietary research and development, manufacturing, marketing, and distribution functions by private entrepreneurial firms to commercialize their innovation for profit, an innovation ecosystem includes collective resources (intellectual, financial and technological endowments), institutional standards and legitimacy, and educated consumers. The creation of this infrastructure is well beyond the reach of any individual firm, thereby requiring the involvement of many public- and private-sector organizations such as universities (as sources of ideas), training facilities (for human resources), and financial institutions that perform critical functions to develop and implement an innovation (to generate the liquidity required for innovations to flourish).

A number of researchers have used and extended this macro infrastructure to examine technological fields (Garud & Karnoe, 2003), new business startups (Aldrich & Fiol, 1994), the American film industry (Mezias & Kuperman, 2001), flat panel display technologies (Murtha,

Lenway, & Hart, 2001), microprocessors (Wade, 1995; 1996), nanotechnology (Woolley, 2007; 2010; 2014; 2017), semiconductor lithography equipment industry (Adner & Kapoor, 2010), the complex ATLAS technological system (Tuertscher, Garud, & Kumaraswamy, 2014), and other studies reviewed in Woolley (2021). As Powell (1998) maintained, the organizational field of an emerging industry is not only multi-disciplinary but also multi-institutional. This study noted that all the necessary skills and organizational capabilities are not readily found under a single firm's roof, and that technological process goes hand-in-hand with the evolution of the industry and its supporting institutions. However, Saxenian (1999) cautions that industrial development of technological innovations is a messy process that does not follow a predetermined paradigm

These infrastructure considerations have led to a realization that new ideas, especially disruptive ones (Christensen, 1997), must consider existing arrangements (Glasmeier, 1991) as captured in the notion of transilience – the capacity of an innovation to influence the established systems of production and marketing (Abernathy & Clark, 1985; Garud, et al, 2013). The paradox here is that the innovation requires the support of the very constituents that are disrupted, and so must be grafted onto already functioning ecosystems. This process is not a discrete event, but one that requires transformation of the infrastructure over an extended time-period. For instance, in the emergence of wind turbines, actors in Denmark progressively scaled up their design by steadily transforming the competencies that lay distributed all across the Danish business ecosystem in an overall collective act of bricolage (Garud & Karnoe, 2003). In contrast, actors in the United States attempted to introduce a breakthrough wind-turbine design based on formal theoretical modeling to leap frog existing designs. This approach did not trigger the transformational processes that unfolded in Denmark. Eventually, the firms in the United States succumbed to their Danish competitors.

An important caveat for a firm trying to go it alone to be the first mover is that it may have to expend considerable resources to create or transform an ecosystem only to set the stage for fast followers to reap the benefits (Anderson & Tushman, 1990; Teece, 1987). This happened during the emergence of cochlear implants; 3M primarily developed and transformed elements of the industry infrastructure in order to facilitate the development of cochlear implants, but 3M's efforts benefited rivals such as Cochlear Corporation, whose multi-channel device design eventually became the dominant standard (Van de Ven et al, 1999). A study of the development of GAAs integrated circuits in the US and Japan found a similar result (Rappa, 1989).

In short, no single actor has the resources or competence to build and control an innovation ecosystem or infrastructure, but each plays a key role. Organizations that network by "running in packs" will be more successful than those that "go it alone."

Innovation Implementation Period

> *Research Finding: Innovations commonly encounter "naysayers," and end when they are either terminated or implemented by integrating the "new" with the "old" arrangements.*
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> *Strategic management question: What attributions should be used to evaluate the performance of innovators?*
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> *Proposed answer*: Instead of assuming that innovators can control innovation outcomes, we propose they be held accountable for practicing skills that increase the odds of innovation success.

A common characteristic of successfully implemented radical innovations is that their innovators were reprimanded, demoted, and told to stop developing their innovations.

- Witness, for example, a technical employee in 3M's commercial tape business 60 years ago who was experimenting with large pieces of sterile adhesive films to be used in surgery to seal the incision site and prevent bacteria entering the wound. He was able to generate some sales but not enough to satisfy his boss. He was told to stop but before he did, he generated a big order from the military and was allowed to continue. That innovator, Lew Lehr, built a billion-dollar healthcare business for 3M and eventually became CEO of 3M.

- The discovery of mRNA for the CoVid-19 vaccine follows a similar pattern. Katalin Karikó, after being dismissed and demoted at the University of Pennsylvania in 1990s, co-discovered a hybrid mRNA in 1995 that became the leading technology for the Covid vaccine. The problem at the time was that synthetic RNA was vulnerable to the body's natural defenses of destroying it before reaching its target cells. Karikó was convinced it was one she could work around. Few shared her confidence. "Every night I was working: grant, grant, grant," Karikó remembered, referring to her efforts to obtain funding. "And it came back always no, no, no."

  By 1995, after six years on the faculty at the University of Pennsylvania, Karikó got demoted from a full professor path for no money coming in to support her work on mRNA. "I thought of going somewhere else, or doing something else," Karikó said. But in time better experiments came together. After a decade Karikó and her longtime collaborator at Penn — Drew Weissman, an immunologist with a medical degree — discovered a hybrid mRNA that could sneak its way into cells without alerting the body's defenses. This discovery is the basis of the Covid-19 vaccine developed and distributed by Moderna and Pfizer.

As these two examples suggest, many innovations are cancelled too early. While management can terminate an innovation, it is better to allow inventors to find out for themselves if their innovation does not work. This is particularly evident when the inventor can find help from five or more peer colleagues. It also suggests that when management says no, the inventor should run around to find someone who says "yes." This assumes, of course that inventors are resourceful and resilient individuals who are expected to not just follow organizational rules.

The examples also suggest that the eventual success of an innovation is also influenced by its temporal duration (Gersick, 1988; Hernes & Pulk, 2021; Nissen, Arbouw, & Commandeur, 1995; Schmenner, 1988). Initial investments at the start-up of an innovation represent an initial stock of assets that provides an innovation team a "honeymoon" period to perform its work. These assets reduce the risk of terminating the innovation during its honeymoon period when setbacks arise and when initial outcomes are judged unfavourable. The likelihood of replenishing these assets is highly influenced by the duration of the developmental process. Interest and commitment wane with time. Thus, after the honeymoon period, innovations terminate at disproportionately

higher rates, in proportion to the time needed for their implementation (Schoonhoven & Romanelli, 2001; Van de Ven, 2014).

Innovations are also terminated when resources run out. While obvious, this observation is fundamentally important in explaining (a) the tendency, throughout the developmental period, toward "sugar-coated" administrative reviews and impression management by entrepreneurs relative to resource controllers; and (b) the conflict that is structurally inherent in the roles of innovation entrepreneurs and top managers or investors.

Top managers or investors have two somewhat antithetical roles in an innovation: support and coaching on the one hand, and resource allocation on the other. If they are primarily viewed as resource controllers, instead of supportive coaches, innovation entrepreneurs have strong motivations to engage in impression management and to "sugar-coat" information, thus denying upper managers and investors the factual information they need to make sound decisions.

In their oversight capacity, top managers and investors periodically review the progress of their innovations and make attributions about the causes of performance outcomes of their innovations. Mitchell, Green, and Wood (1981) and Angle and Van de Ven (1989) observed that these attributions were often misdirected and significantly influenced the behavior and careers of innovation participants. For example, the unsuccessful product takeoff in one innovation was attributed to problems of "management implementation." Consequently, the innovation team manager was replaced. However, the facts in the case indicated that many factors that led to failure were beyond the control of the innovation entrepreneur or participants. The evidence indicated that attributing failure to mismanagement was incorrect and resulted in making entrepreneurs the scapegoats for events beyond their reasonable control. Among all the cases studied by Van de Ven et al (1989), in no instance where innovations judged as failures by top managers were the

innovation entrepreneurs offered another opportunity to manage a subsequent innovation. Such attributions reinforced top managers' beliefs that managing innovation is fundamentally a control problem, when it should be viewed as one of orchestrating a highly complex, uncertain, and probabilistic process.

A number of practical consequences follow if innovation success is recognized to be a probabilistic process. First, innovation success or failure would more often be attributed to factors beyond the control of innovators. This, in turn, will decrease the likelihood that the careers of innovation participants will be stigmatized if their innovation fails, and increase the likelihood that they will be given another chance to manage future innovations. After all, one cannot become a master or professional at anything if only one trial is permitted. Repeated trials over many innovations are essential for learning to occur, and for applying these learning experiences to subsequent innovations. For example, a company like 3M undertakes hundreds of innovations in its R&D laboratories at any given time. Auditing and applying learning experiences from one project to the next accumulates a learning organization that significantly increases its odds of innovation success. It is primarily through repeated trials and the accumulation of learning experiences across these trials that an organization can build an inventory of competence and progressively increase its odds of innovation success.

Concluding Discussion

This essay discussed some strategic management questions and propositions on managing the innovation process. They are based on longitudinal research findings and experiences in managing the initiation, development, and implementation periods of the innovation journey. In response to these questions, we suggested the following propositions for future theory and practice:

- Given the research finding that innovations begin in seemingly random events, the strategic management question is what can organizations do to increase their chance of innovation? We proposed that organization culture sets the stage for the likelihood of innovation. Specifically, *organizations with a corporate culture that enables and motivates chaotic divergent behaviors are more likely to develop a tradition of innovation than those that promote either random or orderly behaviors*. Indeed, we propose that innovation culture is critical for attaining long-term corporate growth and profit goals.
- During the chaotic and highly ambiguous period of innovation development when no observable outcomes or artifacts are available, what guides the innovation journey? We proposed that *organizations can increase their odds of maneuvering the innovation journey by:*

    1. *learning by discovery (as opposed to learning by testing),*
    2. *pluralistic leadership (as opposed to centralized unitary leadership), and*
    3. *networking cooperative and competing relationships by "running in packs" (as opposed to "going it alone") to develop the innovation ecosystem.*

- The research findings that innovations commonly encounter "naysayers" and end when they are either terminated or implemented, call into question the attributions strategic managers use to judge stochastic innovative outcomes. *Instead of assuming that innovators can control innovation outcomes, we propose they be held accountable for practicing skills for maneuvering the innovation journey.*

These propositions, of course, require further development and testing. Nevertheless, if they are substantiated in subsequent research, they have important implications for future theory and practice. A key implication is that *entrepreneurs and managers cannot control innovation success, only its odds by developing and practicing skills for traversing the obstacles encountered in divergent and convergent cycles of the journey.* A useful analogy may be to imagine that the innovation journey is like an uncharted river.

> Most people cling to the riverbank, afraid to let go and risk being carried along by the river's current. At a certain point, some people are willing to jump in and trust that they can maneuver the river. While going with the flow of the river, they begin to look ahead and guide their course onward, deciding where the course looks best, steering around boulders and snags, and choosing which of the many channels and branches of the river they prefer to follow. Because some have developed skills and practiced traversing various river currents, falls, and obstacles, they maneuver the river better than others who have not learned to swim. While this increases their odds of success, no one controls the river. (Polley & Van de Ven, 1996)

This analogy is helpful to make a few concluding observations. First, like a river, the journey cannot be controlled, but managers and entrepreneurs can develop and practice skills to increase their odds of maneuvering the journey through stretches of divergent and convergent waters. In divergent waters, the river branches and expands in multiple dimensions and flows in chaotic or random patterns. Maneuvering these stretches entails divergent search, learning by discovery, pluralistic leadership, and running in packs with others to create new relationships and institutions for collective survival. Occasionally the river converges in a particular direction, and flows in a more orderly periodic pattern. Many familiar principles of rational management are useful for maneuvering and exploiting these stretches, including implementing strategic goals, trial-and-error learning, unitary leadership, and executing agreements within established institutions for competitive advantage.

Maneuvering transitions between divergent and convergent flows are problematic for two reasons. First, just when people gain some comfort and skill in going with a convergent flow, the innovation river may transition again into a divergent pattern that requires very different managerial skills. As a result, maneuvering the entire innovation journey requires developing ambidextrous management skills. Second, like a river, the paths of these transitions are often unpredictable and beyond the control of those floating down the uncharted river. However, unlike a river, innovation leaders can intervene and place boundaries on divergent and convergent patterns with their resource investments, organizational structuring, and selecting participants who have practiced and honed their skills in maneuvering the obstacles in the innovation journey.

Empirical findings of chaotic processes during the innovation journey also requires us to reconceptualize the process of innovation and what methods we use to explain it. Empirical observations suggest that the process of innovation cannot be reduced to a simple sequence of

stages or phases as most models in the literature suggest. Chaos tells us that the process consists of a nonlinear dynamic system, which is neither stable and predictable nor stochastic and random (Cheng & Van de Ven, 1996). Chaos reduces and sharpens the range of plausible explanations by identifying when and what dimensions of the innovation process are orderly, random, and chaotic. Once we know this, then researchers have a better idea of what methods to apply to understand the dynamics. As Morrison (1991) discusses, (1) use stochastic methods and statistics to explain random processes; (2) use linear deterministic representations to explain periodic cycles or stable equilibria; and (3) use nonlinear dynamic modelling to explain chaotic processes.

We close by noting that the characteristics of the innovation journey described above are more pronounced or more complex for innovations of greater novelty, size, and duration. Researchers have found the innovation process to be more disorderly for technically complex innovations than they are for technically simple innovations (Poole et al., 2000). Relationships between innovation processes and outcomes may be much weaker for highly novel radical innovations than they are for less novel incremental innovations in the short term, but may create more value to a company in the long term. Some organizations appear more successful in developing certain types of innovation. Tushman and Anderson (1986) found that competence-destroying technologies tend to be initiated by new entrants, while competence-enhancing innovations are undertaken by existing established organizations in the product market. Some organizations that value and reward individualism may have an advantage in radical innovation, while a more collectivist system may do better at an incremental one (Katz, 2004). Some innovations are largely developed and protected with property rights within a corporation, while others emerge in more open ecosystems that entail less firm-centric hierarchy and more "running in packs," with conflict and coopetition among public and private firms over value creation and

sharing of property rights, However, across these organizational differences, studies show that temporal transitions from innovation invention to development and implementation often entail shifts from radical to incremental and from divergent to convergent thinking (Poole et al., 2000). As innovations become institutionalized, they become more structured and stabilized in their patterns and less differentiated from other organizational arrangements.

We may never find one best way to innovate because there are myriad forms and kinds of innovations. However, we suggest that the current essay has provided new insights that merit future research and practice on managing the innovation journey. In particular, we emphasized that organizational culture, as we proposed, increases the likelihood of innovations and guides processes of organizational learning, leading, and networking during the initiation, development, and implementation of innovation journeys. Indeed, organizational culture sets the stage for innovators to develop and practice the skills needed to traverse uncertain and uncontrollable obstacles encountered in divergent and convergent cycles of the journey.

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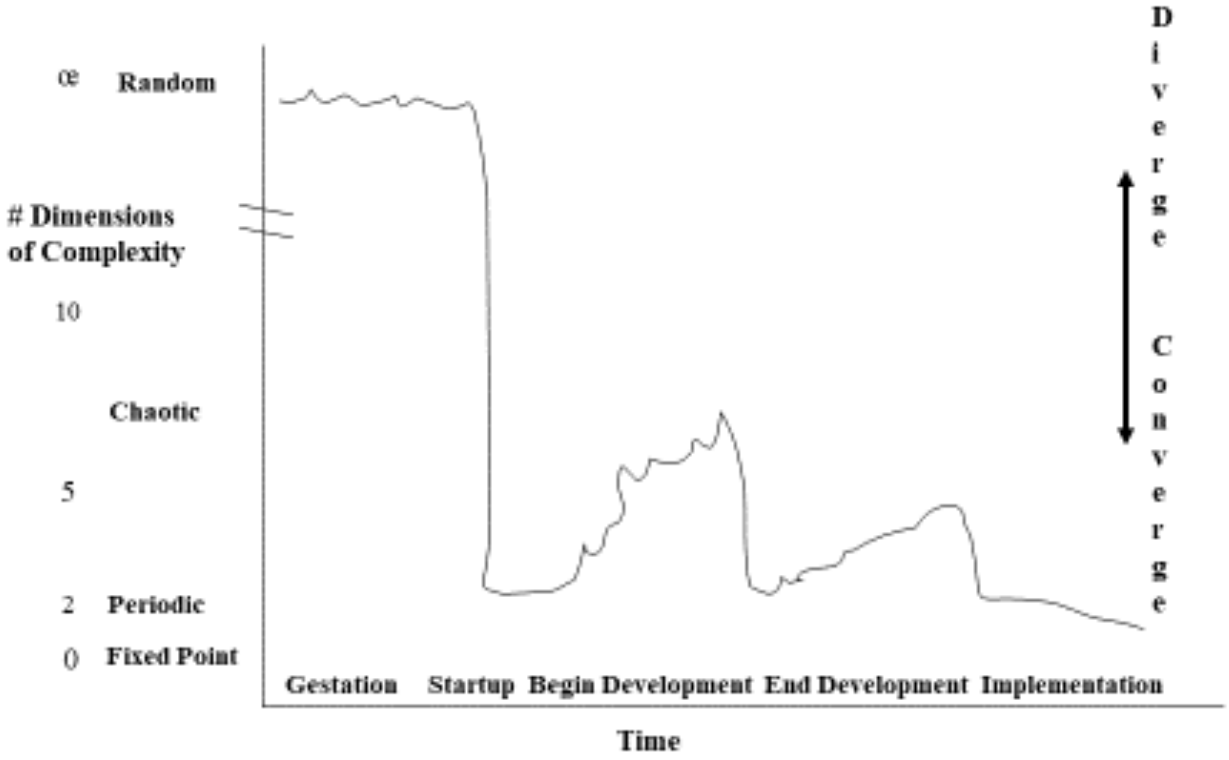
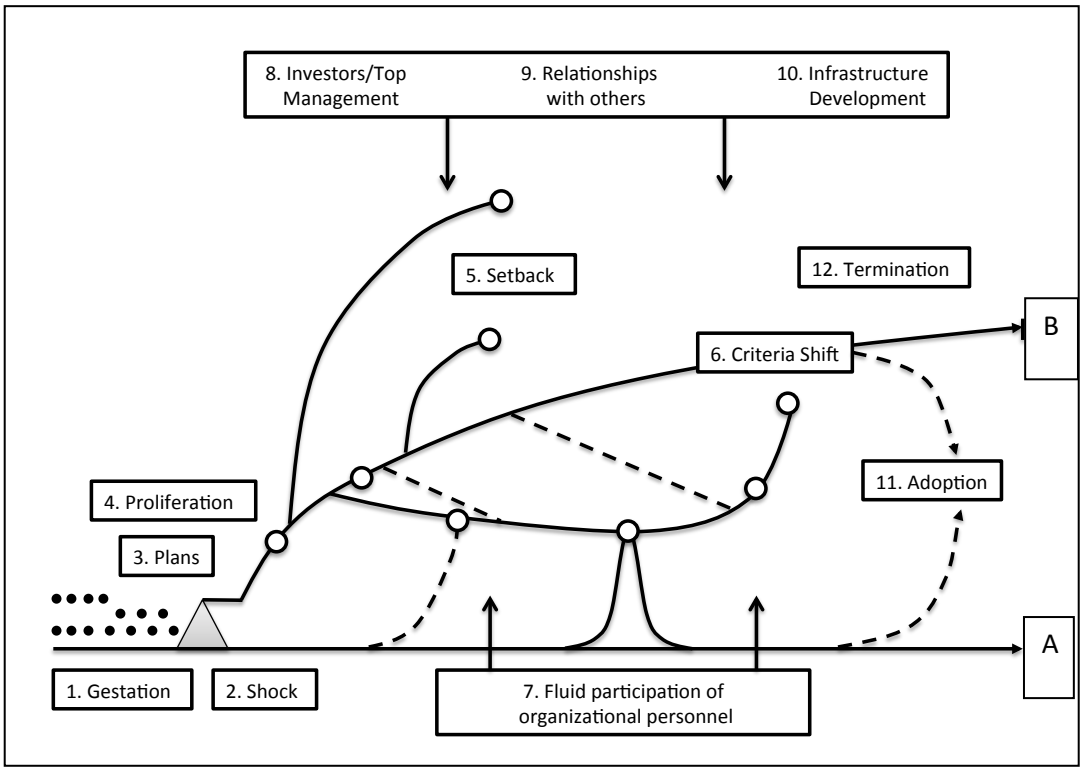
Figure 1. Random, Chaotic, and Periodic Dimensions in the Innovation Journey



Source: Van de Ven, Polley, Garud, & Venkataraman (1999: 2008) p. 196.

Figure 2: Common Characteristics of an Innovation Journey



Source: Van de Ven et al. (1999)

Note: In this Figure, the progression of events moving to A represents ongoing organizational activities, whereas the progression of events toward B represents the direction of an innovation journey that unfolds through three broad periods. MIRP researchers found a dozen common characteristics that occurred during the initiation stage (dealing with innovation gestation, shock, plans), the development stage (proliferation, setbacks, shifting assessments, fluid participation of organizational personnel, relationships with investors/top managers and others, infrastructure development), and the implementation stage (adoption by integrating the new into the old, and termination) (Van de Ven, et al. 1999).