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Harnessing the Secret Structure of Innovation

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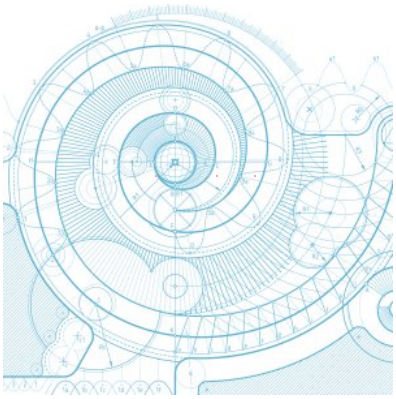
Innovation is often viewed as more art than science. But in reality, companies can improve their odds of sustained success by taking advantage of information about the unfolding innovation process.

In an era of low growth, companies need innovation more than ever. Leaders can draw on a large body of theory and precedent in pursuit of innovation, ranging from advice on choosing the right spaces to optimizing the product development process to establishing a culture of creativity.[1] In practice, though, innovation remains more of an art than a science.

But it doesn't need to be.

In our research, we made an exciting discovery.[2] Innovation, much like marketing and human resources, can be made less reliant on artful intuition by using information in new ways. But this requires a change in perspective: We need to view innovation not as the product of luck or extraordinary vision but as the result of a deliberate search process. This process exploits the underlying

structure of successful innovation to identify key information signals, which in turn can be harnessed to construct an advantaged innovation strategy.



Comparing Innovation Strategies

Let's illustrate the idea using Lego bricks. Think back to your childhood days. You're in a room with two of your friends, playing with a big box of Legos (say, the beloved "fire station" set). All three of you have the same goal in mind: building as many new toys as possible. As you play, each of you searches through the box and chooses the bricks you believe will help you reach this goal.

Let's now suppose each of you approaches this differently. Your friend Joey uses what we call an impatient strategy, carefully picking Lego men and their firefighting hats to immediately produce viable toys. You follow your intuition, picking random bricks that look intriguing. Meanwhile, your friend Jill chooses pieces such as axles, wheels, and small base plates that she noticed are common in more complex toys, even though she is not able to use them immediately to produce simpler toys. We call Jill's approach a patient strategy.

At the end of the afternoon, who will have developed the most new products? That is, who will have built the most new toys? Our simulations show that this depends on several factors. In the beginning, Joey will lead the way, surging ahead with his impatient strategy. But as the game progresses, fate will appear to shift. Jill's early moves will begin to seem serendipitous when she's able to assemble complex fire trucks from her choice of initially useless axles and wheels. It will appear that she was lucky, but we will soon see that she effectively harnessed serendipity.

What about you? Picking components randomly, you will have built the fewest toys. Your friends had an information-enabled strategy, while you relied only on intuition and chance.

What can we learn from this? If innovation is a search process, then your component choices today matter greatly in terms of the options they will open up to you tomorrow. Do you pick components that quickly form simple products and give you a return *now*, or do you choose the components that give you a higher *future* option value?

In our research, we analyzed the mathematics of innovation as a search process for viable product designs across a universe of components. We then tested our insights using historical data on innovations in four real environments. We ran simulations based on detailed data from four domains: software technologies, culinary arts, music, and language. (See "About the Research.") In the process, we made a surprising discovery. You can have an advantaged innovation strategy by using information about the unfolding

process of innovation. But there isn't one superior strategy. The optimal strategy is both time-dependent and space-dependent — there are many innovation spaces, each of which has its own characteristics. In innovation, as in business strategy, winning strategies depend on context.

About the Research

We analyzed innovation as a process of combining components to make new products. We used simulations based on historical data to study this process in four domains: software technologies, gastronomy, language, and music.[i]

In software, the products we studied were software programs and the components were development tools. We collected data for 1,200 software products made up of 1,000 development tools from StackShare, a website that catalogues tools used by technology companies.

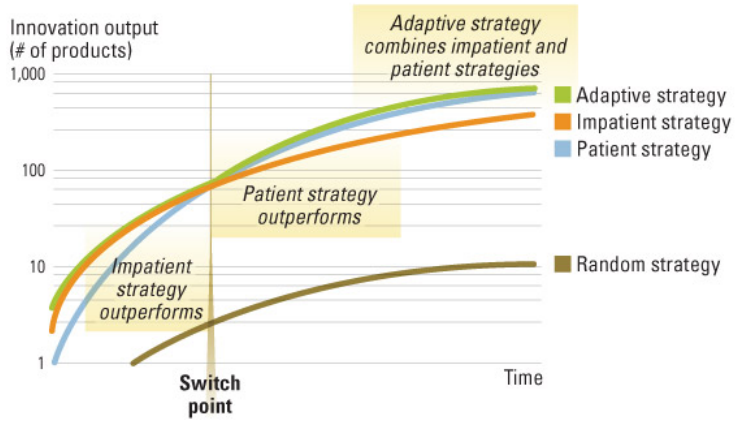
In gastronomy, the products we examined were recipes and the components were ingredients. We collected data for 58,000 recipes made from 381 ingredients from the recipe websites allrecipes.com, epicurious.com, and menupan.com.

In language, the products we studied were words and the components were letters. We used as our data the words in the official word list for Scrabble tournaments and the 26 letters in the English alphabet.

In music, the products we studied were jazz bands of the early 20th century and the components were musicians. We collected data for 1,000 bands made up of 4,700 musicians from the Red Hot Jazz archive, a website that catalogues pre-1930 jazz bands.

Our research demonstrates three crucial insights. (See "Information-Enabled Innovation Strategies Perform Better.") First, information-enabled strategies outperform strategies that do not use the information generated by the search process. Second, in an earlier phase of the development of the innovation space, an impatient strategy outperforms; in later stages, a patient strategy does. Critically, third, it is possible to have an *adaptive* strategy, one that changes as a market develops and that outperforms in all phases of the market's development. Developing an adaptive strategy requires you, in effect, to know when to switch from Joey's approach to Jill's. The switching point is knowable and occurs when the complexity of products starts to level off after increasing.

Information-Enabled Innovation Strategies Perform Better



Our analysis indicates that strategies that take into account information about the unfolding innovation process tend to outperform random innovation strategies that don't use such information. We also found that, in the early phase of the development of an innovation space, an *impatient* strategy outperforms; in later stages, a *patient* strategy does. Finally, it is possible to have an *adaptive* strategy — one that switches from impatient to patient as an innovation space develops and that outperforms in all phases of the space's development.

Source: BCG Henderson Institute and London Institute

Applying the Insight

From our findings, we distilled a five-step process for constructing an information-advantaged innovation strategy.

Step 1. Choose your space: Where to play?

The features of your innovation space matter, so it's important to make a deliberate choice about where you want to compete. Interestingly, it's not enough to analyze markets or anticipate customers' needs. To innovate successfully, you also need to understand the structure of your innovation space.

Start by taking a snapshot of key competing products and their components. How complex are the products, and do you have access to the components? As a rule of thumb, choose spaces where product complexity is still low and where you have access to the most prevalent components. By focusing on immature spaces, you can get ahead of competitors by first employing a rapid-yield, impatient strategy and then later switching to a more patient strategy with delayed rewards. Uber Technologies Inc. provides a good example. The company entered the embryonic peer-to-peer ride-sharing space three years after it was founded in 2009 as a limousine commissioning company. Uber chose its space wisely: The ride-sharing

industry was immature, product complexity was low, and the necessary components were easily accessible. The impatient strategy was to get to market quickly with a ride-sharing app. There is also now what appears to be a patient strategy at work at Uber — self-driving technology with a much higher level of complexity and a much longer gestation period.

Step 2. Select your strategy: How to play?

Next, do something counterintuitive: Look backward, not forward. Measure the evolution of complexity in the innovation space you have chosen by analyzing the distribution of product sizes in terms of the number of unique components in products. If complexity is low and stable, it's an indication that the space is still in its infancy. Here, choose an impatient strategy. If complexity is high, then the space is maturing and a patient strategy will be the best approach. The complexity of a space is thus a crucial signal to orient your innovation strategy.

How can you extract this signal from the data in your space? Reassuringly, many innovators already have the tools to do so: Companies routinely reengineer competitors' products, analyze the patent landscape, and conduct interviews with technology experts to guide their operational decisions. We believe innovators can and should also use the same tools and information to guide their strategy by methodically measuring the evolution of product complexity in their space. This requires developing a taxonomy of components by sampling competitors' products and dissecting not only physical components but also intangible ones like process innovations or business model choices. While we are not aware of any company that is yet explicitly doing this, we do see that many startups implicitly follow this logic by shifting from an impatient minimum viable product logic to a more patient innovation strategy centered on more complex designs once cash flow and funding have been secured and the space begins to mature.

Step 3. Apply your strategy: How to execute?

Next, execute your chosen innovation strategy. If you follow an impatient approach, your objective is to adopt or develop components that enable you to bring relatively simple products to market quickly. Ask yourself how you can be first, increasing your research and development (R&D) speed and decreasing time to market. A minimum viable product approach, which favors simplicity and speed, embodies such a strategy.

However, if the characteristics of your chosen innovation space imply that a patient strategy is more appropriate, a minimum viable product approach isn't the best; instead, your objective should be to maximize future innovation options. Large technology companies such as Apple Inc. and Samsung Group implicitly do this. They research and patent widely, but then often take years to integrate their innovations into new products — not because they are slow to innovate but precisely because they are playing a patient innovation game.

Can companies follow both a patient and an impatient approach in different parts of their business? They can — but it's a very hard thing to do well. General Electric Co., for example, has developed and widely implemented a program called FastWorks, which is essentially a capability to build and scale minimum viable products in rapid iteration cycles. However, GE also appears to be keeping its more traditional, patient innovation approach in place — in other words, it's ambidextrous with respect to innovation.[3] But few companies have GE's range of capabilities, so proceed with caution if pursuing such a strategy.

Step 4. Sense shifts and adapt: How to extract a switch signal?

Next, let's remind ourselves that the best strategy is space- and time-dependent. This means you not only need to monitor the complexity of your innovation space but also must compete on access to information in order to detect valuable strategy-switching signals earlier than competitors. What acts as a switch signal? In our research, we found that a flattening in the increase of product complexity is a reliable signal that it is time to switch from an impatient innovation strategy to a patient one.

Licensing partnerships and technology acquisitions can be valuable to surface this signal. Most innovators use them to broaden their access to components in order to innovate faster. Equally important, however, is that such tactics can also provide innovators with broader information about the evolution of complexity in the space — and thus give them an information advantage in extracting a switch signal. A related tactic is the creation and orchestration of developer ecosystems (like those created by content managing platform Box Inc., open-source computing company Red Hat Inc., Apple, and others). These ecosystems are, in essence, managed innovation spaces where the orchestrator not only gains access to components and innovations developed by others but also has a unique gateway to extensive information on the space.

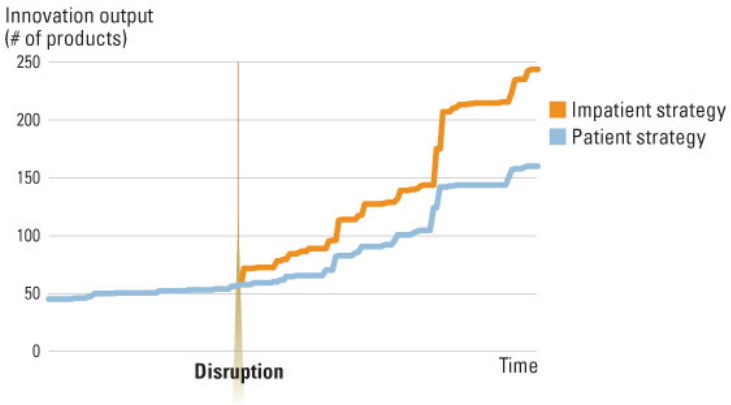
Step 5. Brace for disruptions: How to reset the clock?

The promise of an information-enabled innovation strategy extends to disruption. Disruption, as seen through the lens of our model, is an event that suddenly resets and resimplifies an innovation space by lowering product complexity. We observe such events when two previously unconnected innovation spaces merge, giving rise to myriad new product innovations with reduced complexity. This implies that disruptions don't just happen — they are created by innovators at the edge of a space who build simpler products that leverage components from a different space. A classic example is the disruption of the music media industry by edge players in peer-to-peer file sharing (such as Napster, in its initial incarnation) and research organizations developing new music encoding standards (like the Munich, Germany-based

research organization Fraunhofer-Gesellschaft, which was the main developer of MP3 technology for digital audio). While we cannot claim that we can predict such disruptions (yet), our analytical approach allows innovators to spot such events and interpret them as early warning signals.

A disruption always requires innovators to reset their innovation strategy and to return to an impatient approach. We modeled different responses to disruption in the technology space and found that companies that successfully reset their strategy have an innovation output that's about 50% higher than companies that don't. (See "Navigating a Disruption.") Switching back to impatient behavior is easier said than done, because it requires a switch in all aspects of the innovation approach.

Navigating a Disruption



Our analysis suggests that the best response to a disruption is to switch from a patient to an impatient innovation strategy. Doing so successfully results in an innovation output that's roughly 50% higher than the output obtained by sticking with a patient strategy after a disruption.

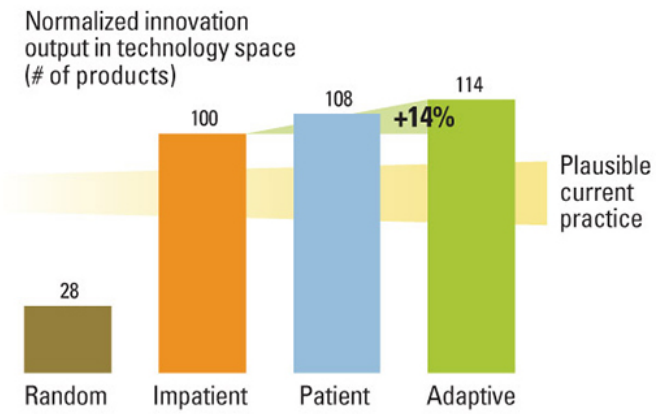
Source: BCG Henderson Institute and London Institute

An Advantaged Innovation Strategy

Can you have an innovation strategy that is inherently advantaged? Our research suggests it is possible. In fact, an innovator following this new information-enabled approach will — to its competitors and the public — appear to be minting its own luck. Such an innovator will typically outperform others that do not use information in the same way. (See "Adaptive Innovation Strategy Provides the Largest Payoff.")

Adaptive Innovation Strategy Provides the Largest Payoff

Note two levels of outperformance: Information-enabled strategies collectively outperform random strategies, and among information-enabled strategies, adaptive strategies outperform in the long run.



Source: BCG Henderson Institute and London Institute

Aspiring innovators seeking to adopt an information-enabled innovation strategy should take these five imperatives to heart:

- Reframe innovation as an information-enabled search process.
- Collect information on components and innovations to characterize the space.
- Analyze the maturity of the space, and adapt your strategy accordingly.
- Build an information advantage to innovate your approach to innovation itself.
- Respond to or create disruption by adapting your managerial approach.

Interestingly, this perspective on innovation has implications for other domains of problem-solving. In a world where many simple problems have been solved, we are increasingly left with more complex ones for which impatient, linear problem-solving approaches offer little value. Our progress and prosperity will depend increasingly on solving hard problems that require less direct and more patient strategies. Whether addressing the challenges of innovation or issues of a broader societal nature, holding a patient line can be hard and risky. But a structured approach to problem solving as we describe in this article, guided by the right signals, will lead us more predictably to powerful solutions.

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1. See, for example, W.C. Kim and R. Mauborgne, “Blue Ocean Strategy: How to Create Uncontested Market Space and Make the Competition Irrelevant,” expanded edition (Boston, Massachusetts: Harvard Business Review Press, 2015) on choosing spaces; B. Brown and S. Anthony, “How P&G Tripled Its Innovation Success Rate,” Harvard Business Review 89, no. 6 (June 2011): 64-72, on product development; or L. de Brabandere and A. Iny, “Thinking in New Boxes: A New Paradigm for Business Creativity” (New York: Random House, 2013) on creativity in business.

2. See T.M.A. Fink, M. Reeves, R. Palma and R.S. Farr, “Serendipity and Strategy in Rapid Innovation,” March 2017, https://arxiv.org.

3. M. Little, “Innovation and What’s Next,” webcast presentation, Sept. 15, 2014, www.ge.com.

i. Details of some of our analyses can be found in Fink et al., “Serendipity and Strategy in Rapid Innovation.”