

Entrepreneurial Innovation at Google

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To fully realize its innovation potential, Google encourages all of its employees to think and act like entrepreneurs.

Large organizations have enormous innovation potential at their disposal. However, the innovation actually realized in successful products and services is usually only a small fraction of that potential.

The amount and type of innovation a company achieves are directly related to the way it approaches, fosters, selects, and funds innovation efforts. To maximize innovation and avoid the dilemmas that mature companies face, Google complements the time-proven model of *top-down innovation* with its own brand of *entrepreneurial innovation*.

INNOVATION POTENTIAL

The concept of innovation potential is a critical, but often overlooked, element in the discussion of innovation; defining and understanding this potential is important because it is the source of all innovation within a company.

Resources

A company's innovation potential can be defined as the combination of its human, intellectual, physical, market, leveraged, and financial resources. Consider, for example, Google's assets.

Human. Google has more than 20,000 employees spread across several functions such as engineering, operations, marketing, and sales. In addition to expertise in their field, all Googlers bring to the company their individual passions and interests, which play a key role in driving innovation.

Intellectual. The company possesses significant know-how and intellectual property in many areas—most notably in crawling, storing, indexing, organizing, and searching data on a massive scale and with an extremely fast response time.

Physical. Google has a network of datacenters as well as a variety of custom, open source, and commercial hardware and software to harness this computing power and make it easily and seamlessly accessible to both customer-facing products and internal tools.

Market. Hundreds of millions of people use Google's products each day. These products generate revenue as well as goodwill that is useful to the company when it needs to try out, and get feedback on, its latest innovations.

Leveraged. Google fosters an ecosystem that allows other companies to prosper by providing additional value and content on top of its services. By lowering the impedance between itself and the outside community, Google facilitates a symbiotic relationship that enables and accelerates innovation for all.

Financial. The company has the ability to invest significant capital in many speculative projects and innovative ideas.

Example: Google Search

Google's Search platform, and the development of the infrastructure on which it runs, illustrates how the combination and interaction of all of these resources helped the company to grow and enabled—and sometimes forced—it to innovate.

In the beginning, passion for a better way to search the Internet led to Google's innovative PageRank algorithm.¹ The quality of PageRank results generated a lot of interest in, and millions of users for, Google in a very short time, requiring the company to scale its infrastructure as fast

as possible. To keep costs reasonable, Google built its servers in-house with cheap commodity parts and Velcro fasteners for fast swapping of components, and it operated these servers with open source software. At the time, this approach was considered highly novel. Google had to develop its own software layers to make its commodity servers work seamlessly and in a fault-tolerant way. This led to several additional innovations such as MapReduce,² the company's patented software framework to support distributed computing on large datasets on clusters of computers.

The highly scalable, distributed, and fault-tolerant hardware and software infrastructure and tools originally developed for Search, combined with access to a massive user base and a growing number of employees, made it possible for Google to conceive, launch, test, and rapidly scale many new products like Gmail, News, and Ads.

INNOVATION MODELS

As a company grows, its innovation potential grows along with it and, more often than not, so does its need for innovation. The amount and type of innovation that a company actually realizes are determined by its cultural, organizational, and technical beliefs and practices with respect to innovation, which can result in various models.

As Figure 1 shows, two different innovation models starting from exactly the same innovation potential will produce dramatically different subsets of actual innovation. While some models produce innovation that is closely aligned and easily integrated with existing technology and products, others lead to innovation in areas peripheral to the organization's current focus. Some models result in incremental innovations; others are highly disruptive.

The concepts of open and closed innovation developed by Henry Chesbrough³ are examples of such models. *Open innovation* involves ongoing collaboration with, and contributions to and from, people outside the company. In contrast, *closed innovation* is kept in-house and "under wraps" until the product hits the market. Not surprisingly, a company that favors open innovation will achieve very different results from one that favors its counterpart.

Google has many projects that follow either the open or closed model, and others that do not cleanly fit either stereotype. Android and Chrome OS are examples of permeable interfaces between Google and the outside community, and would be defined as open on the surface. However, both projects periodically "go dark" on the community to surprise the market. In a sense, they are both open and closed depending on business needs at any given time. Google Wave is a good example of closed innovation because it was developed without significant external influence.

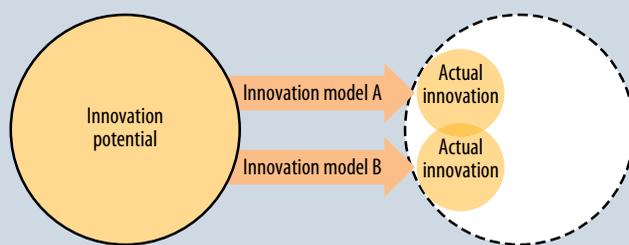


Figure 1. Starting from exactly the same innovation potential, two different innovation models, A and B, will produce dramatically different subsets of actual innovation.

TOP-DOWN INNOVATION

Arguably, nothing has more influence on a company's future than the innovation models it chooses to adopt. In addition to open and closed innovation, Google practices both top-down and entrepreneurial innovation.

Top-down innovation is the default model for most established organizations after they reach a certain size and maturity. It is characterized by several traits including

- the creation of one or more entities focused on research or advanced development—for example, Bell Labs, Xerox PARC, and Sun Microsystems Laboratories;
- recruitment of dedicated researchers, including many PhDs, to staff the research organization;
- a small number of ambitious and often expensive long-term projects that are usually chosen, or at least vetted, by the organization's top layers;
- formal and extensive research proposals, plans, and reviews; and
- a relatively closed and secretive environment, with limited sharing of resources and information with other parts of the company.

An example of top-down innovation at Google is its Translate technology. Language translation is widely acknowledged as a very difficult problem in computer science. Given Google's goal to organize the world's information, having an effective translation technology is critical to its mission and business. To address this problem, the company hired many leaders in the industry and gives them time to innovate at their own pace. Google integrates this group's innovations in its products as they become available—the company recently introduced a feature that lets Chat users who speak different languages send instant messages in real time.

Another notable example of top-down innovation at Google is the ambitious self-driving car project led by Stanford University's Sebastian Thrun, a pioneer researcher in this area and codeveloper of Street View.

Top-down innovation has produced groundbreaking results and is irreplaceable for innovation that requires long-term commitment, substantial investment, and significant domain expertise. However, it is unsuitable for pursuing innovation that requires limited time and resources and is best served by an open, lightweight approach.

ENTREPRENEURIAL INNOVATION

In *The Innovator's Dilemma*, Clayton M. Christensen⁴ described the challenges that established companies, especially industry leaders, face delivering breakthrough innovation. As a company grows in size and market stature, keeping existing products competitive and satisfying customers' needs with incremental features can easily consume all of its resources, leaving the door wide open for start-ups with disruptive offerings. The dilemma Christensen poses is more than just a possibility—it is the most likely outcome for most businesses.

The key role of managers at Google is to guide and connect, not control.

Google believes that the best way to stay on top of the market and remain competitive over the long term is to promote, foster, and invest in entrepreneurial innovation in all areas of the company. The ability to drive, and participate in, innovation is not limited to a select few PhDs working in designated research labs—it is open to all employees. Further, Google's entrepreneurial innovation model mimics, with some obvious and necessary limits, the experience that entrepreneurs would have in a start-up: fighting for funding and resources, dealing with competing products, and, if successful, earning significant financial rewards for their efforts.

Two core beliefs drive Google's approach to entrepreneurial innovation.

The business of Google is innovation. If you randomly ask 10 people what business Google is in, most will say Internet search and advertising. But if you ask Google's CEO, Eric Schmidt, or its founders, you will get different answers, such as "our business is innovation" or "we take our jobs to be innovators and we are failing if we are not innovating quickly enough."

While Google invests heavily in maintaining, supporting, and continually improving already established products such as Search, Ads, and Gmail, it realizes that to ensure long-term growth and success, it must also commit resources to innovation in several areas. Schmidt made that clear in 2009 when he said that "innovation is the technological precondition for growth."⁵

Expect innovation from every employee. Google strongly believes that innovation can come from any employee at any time. "We prefer [our engineers] to run rampant," Schmidt explained in 2005. "The cleverest ideas don't come from the leaders, but rather from the leaders listening and encouraging and kind of creating a discussion."⁶ In his 2009 commencement address at Carnegie Mellon University, Schmidt said, "You cannot plan innovation, you cannot plan invention. All you can do is try very hard to be in the right place and be ready."⁷

What does it mean to "try very hard to be in the right place and be ready," and what does that take? For Google, it means organizing the entire company to foster and support "unplanned" innovation and entrepreneurship.

Google puts these beliefs into practice through

- a flat, data-driven organizational structure;
- a "20 percent time" policy;
- open and powerful development environments;
- services and tools to help launch, test, and get user feedback as early as possible; and
- generous rewards and recognition for successful innovation.

Each of these efforts requires significant commitment, investment, and participation by almost every company group and project. As practiced at Google, entrepreneurial innovation is not a matter of simply making a few tweaks and adjustments here and there; it is woven into the very fabric of the company, coloring every activity.

FLAT ORGANIZATIONAL STRUCTURE

The most immediately visible evidence of Google's policy of entrepreneurial innovation is its organizational structure and associated management philosophy.

On the surface, Google is organized and managed like most other companies. It has different groups—for example, engineering, finance, human resources, operations, product management, and sales—and within each group are vice presidents, directors, managers, project leads, and so on. But that is where the similarities end.

One of the first things people new to Google notice is its very flat management hierarchy. While the company has a traditional job ladder with familiar titles, it has always tried to keep the ratio of engineers and other individual contributors to managers as high as possible. It is not unusual for 30 to 40 people to report directly to a manager, or even to a director or VP. In addition, the key role of managers at Google is to guide and connect, not control. As one senior executive put it, "I am a very expensive e-mail router." While no two groups or managers are exactly alike, titles and seniority do not carry as much weight at Google as they do at most companies, especially when it comes to making product decisions and launching or assigning activities.

The most notable effect of Google's flat management hierarchy is that, at any given time, there is a certain amount of chaos. But the company is not only comfortable with this, it sees some chaos as a necessary ingredient for innovation. Shona Brown, Google's senior VP of business operations and coauthor, with Kathleen Eisenhardt, of *Competing on the Edge: Strategy as Structured Chaos* (Harvard Business School Press, 1998), summarized this philosophy in a 2006 *Fortune* interview: "The company's goal is to determine precisely the amount of management it needs—and then use a little bit less. ... If I ever come into the office and I feel comfortable, if I don't feel a little nervous about some crazy stuff going on, then we've taken it too far."⁸

While Google's organizational structure can result in, for example, project duplication, it also increases the number of projects and accelerates their time to market. By "letting more flowers bloom," the company can collect more feedback on what customers consider valuable.

TWENTY PERCENT TIME

Another notable aspect of Google's culture derived from its core beliefs is its well-known 20 percent time policy, which allows engineers to invest roughly a day each week pursuing projects outside their official area of responsibility.

The most important thing about 20 percent time is not how long employees are allowed to spend on side projects, but that Google encourages them to think and be entrepreneurial. There is no formal accounting of time spent—some people use more, others less. Googlers engrossed in their primary responsibilities may not be inclined to work on anything else right then; others may choose to spend approximately a day each week on a side project or accumulate their 20 percent time over several months and then spend several weeks in a row on the project.

Google employees working on 20 percent projects often join forces and create the internal equivalent of a small start-up, recruiting their first "employees" from the company ranks. As in the real world of start-ups, most 20 percent projects do not make it to the next level. But the few that achieve critical mass eventually lose their 20 percent status and become official Google projects—the equivalent of a start-up getting venture capital funding. We estimate that about half of Google's products, including Gmail and News, started out as 20 percent projects.

POWERFUL DEVELOPMENT ENVIRONMENTS

One advantage that entrepreneurs outside Google do not have is access to its unparalleled computing resources and the ability to use and leverage all of its code. Unlike other organizations of comparable size, at Google thousands of engineers share a single, gigantic code base. This

means that someone working on Maps can see, use, and even modify the code developed by colleagues working on Ads, Gmail, or Calendar—and vice versa. The lack of "code silos" enables all kinds of code reuse, mashups, and product cross-pollination that inspire innovation.

Allowing thousands of developers to work concurrently on hundreds of projects in an open development environment of this magnitude and diversity—Google supports several programming languages and frameworks—requires a massive investment in tools and computing power. Predictably, most commercial or open source software development and testing tools were never meant to scale to Google's requirements in terms of size, diversity, and speed. To address this problem, the company had no choice but to think like entrepreneurs and innovators.



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Several years ago, a few Googlers got together and created the Engineering Productivity organization to design and implement the tools, infrastructure, and services required to support the company's uniquely demanding development environment. The "customers" of Engineering Productivity are the thousands of Google developers; the following statistics indicate the scale and speed of development that this organization has made possible:

- 6,000 developers in more than 40 offices,
- 2,000 projects under active development,
- 100,000 builds each day,
- 150 million test case executions each day,
- 20+ code changes per minute,
- 50 percent of code changes every month, and
- a single monolithic code tree with mixed-language code.

Google's very-large-scale development and testing tools are among its most valuable assets—and they significantly accelerate the company's ability to experiment and innovate.

LAUNCH, TEST, AND FEEDBACK TOOLS

Startups can move fast and take the kind of risks that their bigger counterparts are unable or unwilling to take. It is difficult to be entrepreneurial if launching a new product takes months or years instead of weeks. To foster innovation, Google has a "launch early and iterate" philosophy. How early? One of the company's rules of thumb is: "If you

are not embarrassed by your first launch, you have not launched early enough.”

In addition, Google makes internal entrepreneurs’ new ideas accessible to thousands of coworkers and millions of external users who are ready and willing to try out applications and tell the company what they think of them. Two early-access programs, Internal Labs and Labs, provide innovators with progressive market exposure and visibility.

As the name suggests, only Googlers have access to Internal Labs. This gives innovators an opportunity to obtain feedback from 20,000 people on a proposed application, when expectations are low. Among the categories of Internal Labs applications is one called “R.I.P.,” the final resting place for innovation not considered worth pursuing. Most applications end up here, which shows that Internal Labs is effective at helping employees test ideas and fail fast.

To foster innovation, Google has a “launch early and iterate” philosophy.

Innovators who are ready to share early versions of their innovation with external users can take advantage of Google Labs. As described in its FAQ (www.googlelabs.com/faq):

Google Labs is a playground where our more adventurous users can play around with prototypes of some of our wild and crazy ideas and offer feedback directly to the engineers who developed them. Please note that Labs is the first phase in a lengthy product development process and none of this stuff is guaranteed to make it onto Google.com. While some of our crazy ideas might grow into the next Gmail or iGoogle, others might turn out to be, well, just plain crazy. ...

Google engineers and researchers are always looking for a way to show off their pet projects, and Google Labs seemed like a great way for them to get feedback without forcing every new feature on all of our users. So, please follow the “Details and Feedback” link under each experiment and post a comment to let them know what you think of how they’ve been spending their time—and be frank. It doesn’t help anyone if a bad idea is encouraged to spread like a noxious weed.

Note the emphasis on getting honest user feedback. While Google Labs provides employees an opportunity to showcase their innovation with the rest of the world, its primary function is not self-promotion but weeding out bad ideas.

Some established products have their own version of Google Labs where users can experiment with new features. Product-specific labs, along with their taglines, include

- Calendar Labs: Latest ideas from the Calendar team,
- Gmail Labs: Dozens of Gmail experiments,
- Google Maps Labs: Experimental Maps features,
- Search Experiments: Alternate search views and more, and
- YouTube TestTube: YouTube’s ideas incubator.

The importance of these labs in the context of innovation and entrepreneurship at Google cannot be overemphasized. The expression “say it with numbers” is an integral part of the company’s DNA. When it comes to deciding whether to invest in new ideas, there is no more compelling set of numbers than the actual usage data obtained from labs launches.

REWARDING SUCCESSFUL INNOVATION

One major motivator for entrepreneurs is the prospect of substantial financial rewards if their start-up is successful. While for many Googlers the main incentive for innovation is seeing their idea become reality and reach millions of users, employees who take innovation from idea to successful product receive both monetary and honorary recognition.

The Google Founders’ Award, launched in 2004 to reward outstanding entrepreneurial achievement, can amount to millions of dollars. The approximately two dozen recipients of the first award shared around \$12 million worth of stock. As in a real start-up, the shares were divided in proportion to recipients’ contributions; the core contributors received awards of \$1 million or more. Google cofounder Sergey Brin explained that the award was largely created “to give people incentives to apply for jobs at Google even after the promise of getting rich from the company’s initial public offering last August had passed.”⁹

Google offers many other incentives and awards that recognize and reward internal entrepreneurship. However, because only a fraction of innovation succeeds, how the company deals with failure is just as important as the way it deals with success.

In the “outside world,” entrepreneurial success—in the form of venture capital funding, acquisition, or an initial public offering—is the result of actual market success. Likewise for Google innovation, user adoption, not opinion, largely determines a project’s future. A good example of this is the genesis—and termination—of Google Wave.

Wave began as an idea to create a new paradigm for online collaboration, with the ambitious goal of augmenting and possibly replacing e-mail. Its creators pitched the idea to Google executives, who funded it much like a venture capital firm would a start-up. Wave received luxuries not normally accorded to in-house projects including near isolation (in Sydney, Australia) to allow for greater independence, plentiful resources, and a long runway. However,

Wave failed to reach and maintain a specific number of active users by a given time and was cancelled.

While Wave's end result was disappointing, it demonstrates the effectiveness of Google's entrepreneurial innovation model. The application was given sufficient time and room to flourish and only terminated when it became evident that it was not popular enough to justify the further commitment of resources. And the effort was not wasted: many of Wave's breakthrough ideas and technology are finding their way into other Google products.

Trying something new and not succeeding is an inescapable and important part of the innovation process. Google knows that if it never fails, then it is probably not being as innovative as it needs to be. When a project fails to meet expectations, the company acknowledges it, learns whatever lessons it can, and moves on to something different.

Putting Google's entrepreneurial innovation model into practice requires significant commitment, investment, and participation from all functions and areas of the company. For example, the annual cost of 20 percent time alone is hundreds of millions of dollars. Overall, however, the ongoing stream of cutting-edge projects and features that directly result from entrepreneurial innovation amply demonstrate that the model is working.

Quantifying the costs and benefits more precisely might be possible, but it would be difficult—and perhaps pointless. Entrepreneurial innovation is so tightly woven into everything Google does that is hard to imagine the company without it. **C**

References

1. L. Page et al., *The PageRank Citation Ranking: Bringing Order to the Web*, tech. report, Stanford Univ. InfoLab, 1998; <http://ilpubs.stanford.edu:8090/422/1/1999-66.pdf>.
2. J. Dean and S. Ghemawat, "MapReduce: Simplified Data Processing on Large Clusters," *Proc. 6th Symp. Operating System Design and Implementation (OSDI 04)*, Usenix Assoc., 2004, pp. 137-150; <http://labs.google.com/papers/mapreduce.html>.
3. H. Chesbrough, *Open Innovation: The New Imperative for Creating and Profiting from Technology*, Harvard Business School Press, 2003.
4. C.M. Christensen, *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*, Harvard Business School Press, 1997.
5. A. Eustace, "Investing in Innovation at Google," *The Official Google Blog*, 2 Nov. 2009; <http://googleblog.blogspot.com/2009/11/investing-in-innovation-at-google.html>.
6. R. McMillan, "Loosen the Reins, Says Google CEO," *InfoWorld*, 19 May 2005; www.infoworld.com/t/platforms/loosen-reins-says-google-ceo-123.
7. E. Schmidt, Carnegie Mellon Univ. 112th commencement speech keynote, 17 May 2009; www.cmu.edu/cmufont/homepage/images/extras/transcripts/ericsschmidtcommencementkeynote.pdf.
8. A. Lashinsky, "Chaos by Design," *Fortune*, 2 Oct. 2006; http://money.cnn.com/magazines/fortune/fortune_archive/2006/10/02/8387489/index.htm.
9. K. Hafner, "New Incentive for Google Employees: Awards Worth Millions," *The New York Times*, 1 Feb. 2005; www.nytimes.com/2005/02/01/technology/01google.html.

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