

ISSUE 82 SPRING 2016

In Search of Ingenuity

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BY ANDREW HARGADON

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Few people may recognize the name Norman Heatley. Even the Nobel Committee overlooked him when, in 1945, it awarded the Nobel Prize in Medicine jointly to Alexander Fleming of St. Mary's Hospital and Ernst Chain and Howard Florey of Oxford University for discovering the lifesaving antibiotic penicillin. But it was Heatley, working side by side with Chain and Florey, who devised the first methods for growing enough penicillin to study its chemical structure and activity, purifying it, and measuring its potency. Sir Henry Harris, who succeeded Florey as head of Oxford's Dunn School of Pathology, once summed up Heatley's role by saying, "Without Fleming, no Chain or Florey; without Florey, no Heatley; without Heatley, no penicillin."

Most of the credit and attention for breakthroughs typically goes to the individual with a grand vision, the genius whose exceptional creativity reshapes a company or even an industry. Heatley didn't have the sudden insight that sparked a big idea. Rather, he put into practice the hundreds of small insights necessary to make a big idea real, figuring out how to get things done against all odds — enabling a major scientific breakthrough in the worst of wartime Britain.

Heatley provides a critical lesson for companies: The pursuit of innovation doesn't depend on genius. Instead, it demands ingenuity — the ability to come up with solutions that are original and clever given the constraints that you and everyone else face. The lightbulb was a 40-year-old invention when Edison found a way to make it a commercial success. Google was not the first search engine. Amazon's Kindle followed a decade of electronic book readers. Apple's iPod was released five years after the first MP3 player hit the market. As technologies and markets converge, ideas appear to many people at the same time. At first, those ideas are out of reach, but gradually the gap between what's possible and what's practical gets smaller. Ingenuity enables a company to jump that gap before its competitors do.

A Life-Changing Mold

In 1928, when Alexander Fleming made his now-famous discovery, penicillin's potential to treat bacterial infections was already well known. Yet Fleming soon abandoned penicillin as too unstable for clinical use. He was not alone — the major pharmaceutical firms also thought penicillin was too expensive an effort for an outcome that was so uncertain. The challenge? Making penicillin required growing the penicillium mold, harvesting its secretions, and then isolating and stabilizing the active ingredient. The only profitable path, everyone assumed, was to develop a synthetic version. But because nobody knew what the active ingredient was or how to purify it, and even laboratory quantities were too costly to produce with existing technologies, the idea remained out of reach.

A decade later, advances in biochemistry gave Florey and his team hope they might succeed where so many others had failed. However, they quickly reached the same impasse. Without funding, progress depended on Heatley's ability to cobble together new production methods. Little by little, he began experimenting. First he created a quick and accurate way to test each batch's potency. Then he found the best medium for growing the mold (an early experiment with yeast from a local brewery cut the production time in half). Next he identified the most productive strains. And finally he found the best means of purifying the resulting "brew."

Heatley's small improvements may have lasted for only a week or so before being superseded by the next improvement. But each brought new ways of raising penicillin's yield and strength and, as often as not, new insights into its chemical nature. The team progressed on the shoulders of these many small insights, and the demand for penicillin climbed. The first test, on two mice, used up the entire supply. A few weeks later, they had enough to run tests on eight mice, then 24, and ultimately 50. Testing penicillin on the first human subject, a man suffering from sepsis, again used all the penicillin they had. The patient improved, but the team ran out of medicine before he could fully recover.

Through it all, Heatley kept improvising and improving his methods. But this was World War II, and materials and resources for even the most basic research practices were scarce. To build a contraption that cooled, mixed, dissolved, and extracted penicillin from harvested mold broth, he used

a discarded oak bookcase, glass tubing, pumps, laboratory bottles and tubes, an old doorbell, colored warning lights, copper coiling, and other plumbing pieces.

This makeshift factory produced enough penicillin to treat — and cure — five more patients, finally demonstrating penicillin's miraculous abilities. Armed with their samples, data, and methods, the team would soon gain the commitment of the U.S. government and the pharmaceutical industry to invest in commercial production. Within two years of Heatley's first efforts, monthly global production

how to realize them — at least not with the approaches they're used to. In other words, it's the *how* that matters, not the *what*.

If your company is trying to drive its own breakthroughs, the trick is to find your Heatleys. Google has publicly acknowledged that when it hires graduates with the best GPAs, it sees little correlation with those who succeed most at work. Transcripts and test scores don't predict how people will face real-world challenges. Heatley had formal training in biology and biochemistry, but he also possessed technical skills in optics, glass- and metal-

do things around here." Imagine what would happen if you could identify them and empower them to innovate from the inside out.

"Do the Experiment"

Unfortunately, ingenuity often does not align with ordinary corporate practice. Innovation projects run a gauntlet of up-front analysis and committee approvals. The process is designed to map every step of the path forward, to justify large and long-term commitments. It reflects established companies' desire to know how they will get to the idea before they've even started. But ingenuity thrives on figuring out new ways to produce, distribute, support, and scale existing ideas. As those new ways emerge, they change your understanding of what's possible.

To find those new ways, you have to create the conditions in which your Heatleys can thrive. Encourage them to start experimenting. Experiments do more than test assumptions — they also force the connection between abstract possibilities and concrete realities. Whenever it came to talking about ideas, Heatley's boss Howard Florey was famously impatient: "Do the experiment" was his motto. When people are pushed to turn vague concepts into specific choices that can be built, tested, and improved, their ingenuity takes over.

Of course, funding experiments can backfire without a disciplined approach. Counterintuitively, the best experiments are often the cheapest. They don't require perfect conditions, they can be built quickly and with materials close at hand, and, should they fail to deliver, they can be improved and run again. Consider that Ernest Lawrence built the first subatomic

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soared from roughly 100 units to 100 million units. The drug was made widely available for military use; two years later, in 1944, it became available to the broader public.

Thanks to a concerted marketing campaign by St. Mary's Hospital, Fleming's "discovery" quickly became the public image of penicillin's origins. So much so that when the Nobel Committee considered awarding its 1945 prize in medicine to Fleming, scientists from across Europe and the United States urged them to also acknowledge the work of the Oxford scientists. Ultimately, Florey and Chain were honored, leaving out Norman Heatley.

Find Your Heatleys

The penicillin story makes clear that the need to come up with a new and brilliant idea is often overrated. The ideas are out there, and people can see them. They just can't see

working, plumbing, and carpentry, and a willingness to use these skills to quickly build and test new ways of getting things done given the available resources.

Your innovation team needs people who are makers as much as they are thinkers. These are people who, when faced with uncertainty, don't wait until they see a clear path and a right answer but who prefer to start doing — seeing what works and what doesn't. Moreover, innovation requires people with the confidence to know that they can find a way to cross any bridge when they get there — even if they have to build a new bridge to do it.

Look for people with an aptitude for ingenuity, and encourage and enable them not just to think differently, but to act differently. Some of them may already be in your organization, unrecognized, unnoticed, or bound by "the way we



particle accelerator in the late 1920s for \$25.

As a rule, always run the inexpensive experiment first, and then gradually increase the investment. Big companies have more resources and can afford to go straight for the big price tag, but that doesn't mean they should.

Finally, avoid making long-term funding commitments or basing milestones on outcomes that were set before the real work and learning began. Instead, fund projects with a series of tranced investments tied to specific learning goals over short periods. Base each new tranche on what the team has learned (and how that has changed the original plan). Doing so provides room for the trial-and-error nature of ingenuity and lets the team reevaluate goals based on what worked and what didn't.

Fostering ingenuity doesn't mean you should throw out your existing practices or deliberately starve

your project teams. Heatley and his colleagues at Oxford were working during a world war; chances are, your circumstances won't be as dire. But focusing on ingenuity does suggest a different way of thinking about innovation. When the right people are encouraged by supportive leaders to challenge constraints the rest of the company and market accept as a given, to focus their efforts on the how rather than the what, and to experiment early and often, you can set the best ideas free. +

Reprint No. 16102

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