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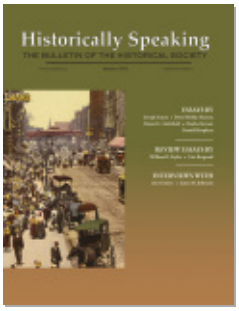

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The Idea Factory: An Interview with Jon Gertner

Conducted by Donald A. Yerxa

LAST YEAR, PENGUIN PRESS PUBLISHED JON GERTNER'S The Idea Factory: Bell Labs and the Great Age of American Innovation. *The birthplace of some of the 20th century's most influential technologies, Bell Labs has been called "America's greatest incubator of innovation."* The Idea Factory *is a thoroughly researched and accessibly written history of this remarkable institution. In December, senior editor Donald A. Yerxa interviewed Gertner, whose work has appeared in the* New York Times Magazine. *Gertner is editor-at-large for* Fast Company *magazine.*

Donald A. Yerxa: Would you provide our readers with a brief overview of Bell Labs?

Jon Gertner: Bell Labs—which was officially known as Bell Telephone Laboratories—was created in 1925 as the research and development arm of AT&T (American Telephone and Telegraph), the then-monopolistic U.S. phone company. AT&T was the largest company in the world at the time—the largest by assets, by stock market value, and by employees. It controlled all long distance service in the U.S. through its "long lines" department; it also controlled somewhere between 80-90% of the local telephone service in the U.S. through its ownership interests in twenty-three local operating companies (e.g., New York Telephone, Pacific Bell). Finally, it controlled the manufacturing and production aspects of U.S. telecommunications through its ownership of Western Electric, which made the products—phone handsets, phone poles, switching centers—that allowed the whole nationwide system to function. Bell Labs was really the brain behind AT&T's huge industrial and technological system. It was also where long-term plans were conceived for the future of global communications.

Submillimeter Line Astronomy Group Experiment, Bell Labs, 1979. Courtesy of NASA/Ames Research Center, archive.org.

Even at the start, Bell Labs was a fairly large organization of several thousand engineers. By the 1950s it had grown to roughly 10,000 people, about 15% of whom worked in research and the rest in development. Those in research were mainly Ph.Ds doing deep science; those in development were mainly engineers thinking about how to implement new technologies and how to respond to the near-term (or immediate) needs of the system. Maybe the easiest way to sum up the Labs' accomplishments is to note that the people working there, both in research and development, thought about their success not as a result of having great ideas, but as a result of solving great problems. And the phone company—an ever-expanding network of voice and data communication that was struggling to accommodate the future transmission and switching needs of the network—had an endless stream of problems. In one way or another, this "problem-rich environment" (as one former Labs scientist described it to me) led the Labs' technical staff to some of the greatest technological breakthroughs of the modern era.

Yerxa: Why was it called "the Idea Factory"?

Gertner: Though it serves as the title of my book, the folks at Bell Labs actually didn't call it that. So there's a bit of poetic license with that term. Usually, for those who worked there, it was simply called "The Labs." The title for the book came from a lovely piece of writing done by Arthur C. Clarke in the mid-1960s. Clarke wrote a nonfiction book about the history of overseas communications. His research involved spending a lot of time at Bell Labs, which had been the leading innovator in communications satellites. And in his book, in describing the Labs, Clarke wrote that it was "a factory for ideas." He was right.

Yerxa: What prompted you to write the book?

Gertner: A few reasons, actually. I've worked as a magazine journalist for the past twenty years, and I've been increasingly interested in writing about innovation and technology. I also grew up very near to Bell Labs' Murray Hill laboratory, the great facility where the transistor and the silicon solar cell were both invented. So I knew quite a lot about the place, and had long wondered if there was a way to write a history of it for a general—not technical—readership. But in addition, I hoped that a general history could address some of the deeper questions I'd been thinking about as a journalist: How does innovation happen? What causes it? How can we nurture it? And finally, what was Bell Labs doing that allowed its scientists and engineers to innovate with so much success over the course of many decades?

Yerxa: What made Bell Labs such a special place?

Gertner: A lot of things. Being attached to the largest company in the world gave Bell Labs a lot of funding and—as I mentioned—a lot of great problems to solve. The leadership of Bell Labs, moreover, which I discuss in great depth in the book, created a remarkable culture for research and engineering. Often, the leadership gave scientists tremendous autonomy and time, so if you wanted to study the deeper nature of silicon or plastics, or if you had some other field of interest that seemed to be of use in communications, you could usually make a good case for doing the work. In describing Bell Labs' success, I sometimes remark that it was successful not just because of the funding, and not just because of the talented people, but also because it was situated within an organization that had customers and manufacturing facilities, too. So there was a profound understanding not only of how technology was necessary to serve customers, but also of what kinds of technology could be manufactured for reasonable costs.

I think if there's an X factor, that might be it: if Bell Labs had existed as a stand-alone laboratory, it would not have succeeded. But being part

of the phone company gave it a rich ecosystem within which to grow and flourish.

Finally, I think one aspect of this place cannot be overlooked. As a monopoly, Bell Labs did not have to meet quarterly earnings targets, the way companies do today. It had the unique luxury of planning and thinking for the long term.

Yerxa: What were some of the most significant technological innovations to come out of Bell Labs?

Gertner: The list is quite long. But at the top would have to be the transistor, the building block of all digital products, which came out of the Labs in the late 1940s and was arguably the greatest invention of the 20th century. That little invention heralded an era of miniaturization; there are now billions of transistors on the processor chips that power our computers and smartphones. And there were lots of other great innovations, too. Bell Labs was where the theory of the laser arose, and where many of the early laser models were built. The theory of digital communications came out of Bell Labs. And so did communications satellites. The UNIX operating system for computers and the C programming language came out of the Labs' computer science department in the late 1960s. Also, the idea for cellular telephone systems began at Bell Labs. Then there were a number of ideas that were theoretical or were not tied to particular products or processes—radio astronomy, for instance, which began at Bell Labs in 1931 based on an idea of Karl Jansky's.

Yerxa: Please comment on the commitment to basic, "unfettered" research at Bell Labs as opposed to its functioning as a basic industrial lab.

Gertner: Well, I think the notion of what an industrial lab should be has changed quite a bit over the years. The work has moved away from fundamental, "basic" research, which is done more at universities, toward engineering and commercializing products. But what you had at Bell Labs in its heyday—especially in the research department—were scientists and mathematicians who were encouraged to follow their deep curiosity and see where it led them, even if the journey took years. They pursued mathematical theories of communication, for instance, or they investigated the hidden properties of new materials, such as semiconductors. They were always asked to work on projects that had some relevance to human communications, a broad mandate that could include pretty much anything. While they were asked to demonstrate progress in what they were working on, often that progress was not measured in, say, marketable products or revenue, but in publications. So really they were being asked to do many of the things a university researcher might do, except they didn't have to apply to a federal agency for funding, they didn't have to grade papers, and they didn't have to teach classes. Also, they had as colleagues some of the greatest minds of their era. Not a bad combination.

I've said before that Bell Labs was akin to a huge engineering facility with a factory in the basement and an ivory tower in the upper stories. Maybe that's not the best metaphor, but I think it was true to a great extent. I also think the fact that it had all these components—research, engineering, and manufacturing—integrated together helped produce excellence from all parts of the organization.

> One tremendous shortcoming of the modern American corporation is its inability to fund and nurture breakthrough technologies that might take decades to come to market.

Yerxa: You structure the narrative around key figures at Bell Labs over the decades. Would you give thumbnail sketches of a few of them? Were there any characteristics, biographical or temperamental, common to these key scientists?

Gertner: In many respects, Mervin Kelly was the boss and great visionary of Bell Labs—a trained physicist whose ability to manage talent and structure a complex and sprawling research organization helped create the Labs' success. Kelly hired many of the great scientists at the Labs including William Shockley, the brilliant and controversial physicist who helped invent the transistor. Shockley oversaw the team that had the transistor breakthrough, and then, in a break with Bell Labs tradition, where a supervisor was forbidden from competing with those under him, he came up with a better transistor design.

Claude Shannon was quite different. In some respects, he fits our archetypal notion of a true genius: solitary, abstracted, and able to see the future with uncanny precision. Shannon formulated some of the early rules of digital communications and was a trailblazer in seeing computers as ultimately becoming intelligent machines. Shannon was the first person to train a computer to play chess. At the same time, he was working in robotics in an era where few people were doing that.

The Labs was big enough to suit people of different temperaments and backgrounds, so I don't really think there was one kind of typical researcher. Some staff members came from families of means, whereas others, like Kelly, were raised in very humble circumstances. What's more, Kelly was an incredibly driven, type-A personality, as was Shockley. But Shannon was very dreamy, and quite inclined to spend his day at the Labs playing chess or building gadgets. What mattered there was how smart you were, and how quick. In that respect, it was a meritocracy.

Yerxa: Would you speak to Kelly's understanding of innovation? How successful were his efforts to systematize innovation at the Labs? And how adaptable was his formula of innovation in the latter decades of the 20th century?

Gertner: Kelly was very successful at creating a structure for Bell Labs that transformed it into what he called "an institute of creative technology." It's a bit difficult to quickly sum up the workflow within an organization of 10,000 people. (And after Kelly retired, Bell Labs grew even larger, reaching a peak of about 25,000 people in the early 1980s). Still, I think there were several principles at work here that paid off. Kelly created a well-funded organization that found a remarkable balance between its long-term planning (in research) and near-term engineering (in development). He accentuated the connection to manufacturing by siting Bell Labs' facilities at Western Electric factories, which helped his staff focus on the practical nature of their work. And perhaps most important, Kelly made sure that his scientists and engineers could exchange ideas and knowledge freely in large laboratories constructed in a way that encouraged interaction.

I think some of Kelly's principles are still useful—for instance, that new ideas arise at the interface of disciplines, such as metallurgy and physics, or that brilliant researchers need time and funding and autonomy to produce breakthroughs, which cannot be scheduled by the calendar. But I also think the sheer scale of Kelly's Bell Labs proved *sui generis*, a result of the remarkable funding stream provided by its parent corporation. Even at big companies like IBM that today still maintain great industrial labs, the research focus is more product-oriented and geared toward the near-term innovation.

There's one other thing worth saying. In an era before Silicon Valley, it was much easier for Kelly to get the talent in one place—his place. No one was making a billion dollars starting companies in California. So Kelly lured engineers and scientists to Bell Labs with the implicit promise that they would have a hand in creating the future. They made a good living. But, as Claude Shannon said, they came for the adventure, not the money. A unique time and situation made Kelly's vision possible, much the same way a unique time and situation made the Apollo-era NASA possible. That doesn't mean that the principles or processes used by those organizations lack relevance. But I think it does mean that they can't easily be recreated.

Yerxa: You suggest that "in any company's greatest achievements one might, with clarity

of hindsight, locate the beginning of its own demise" (186). What led to the demise of Bell Labs?

Gertner: The ostensible reason was the breakup of the AT&T monopoly, following several years of federal litigation in the early 1980s. After that, all the local operating companies—the "Baby Bells," as they were known, such as New York Telephone or Southwestern Bell—were separated from the mother ship, which was reduced to a combination of AT&T long lines, Western Electric, and Bell Labs. But what happened in that breakup was that AT&T's revenue decreased by about half, and also that it lost its connection with phone subscribers (i.e., consumers). That proved debilitating.

These were the immediate reasons for Bell Labs' long and slow demise, but there were deeper forces at work. The breakup of AT&T followed several decades of increasing competition in the telecommunications sector, whereby a number of new companies—MCI, to name just one—began marketing technologies originally created by Bell Labs. In effect, these new competitors were giving consumers new and often cheaper alternatives. The end of the old AT&T, and the end of the old Bell Labs, was the eventual result of this competitive tidal wave.

Yerxa: Is what you call the "great age of American innovation" behind us?

Gertner: I hope not. I don't think that Bell Labs was necessarily the apex of America's innovative era, but it did usher in the remarkable era where we now reside. I tend to believe that we still live in an age of wonder, built in large part on the foundational advances at this one laboratory. I also think that our engineers continue to create miraculous technologies. My worry is that this doesn't necessarily serve all of society's needs. For instance, I worry that we aren't solving some of our biggest problems—finding affordable sources of clean energy, for instance—quickly enough or with enough single-minded determination.

This leads to a related point. There is no question that monopolies like AT&T, which ran Bell Labs, had grave shortcomings: customers could often pay too much for service, and these utilities sometimes stifled the rate at which new technologies filtered down to consumers. But we should likewise ask whether something very valuable was lost with the demise of Bell Labs. These days, we seem too ready to accept a categorical belief that private enterprise is better at innovating than these fusty old organizations. But that just isn't true. One tremendous shortcoming of the modern American corporation is its inability to fund and nurture breakthrough technologies that might take decades to come to market. They just can't take the long-term risks that a place like Bell Labs could take. And startups can't do that either. Now, I suppose you can make the case that incremental innovation—great new smartphones, for instance—result from marketplace competition, but we shouldn't cling to a misplaced belief that breakthrough innovations like the transistor or the laser or even the Internet arise from this marketplace competition. Rather, the biggest and most disruptive innovations usually arise from a rich exchange of ideas among bright people who work in close proximity solving complex problems. And right there, you have a very good working definition of what Bell Labs was.