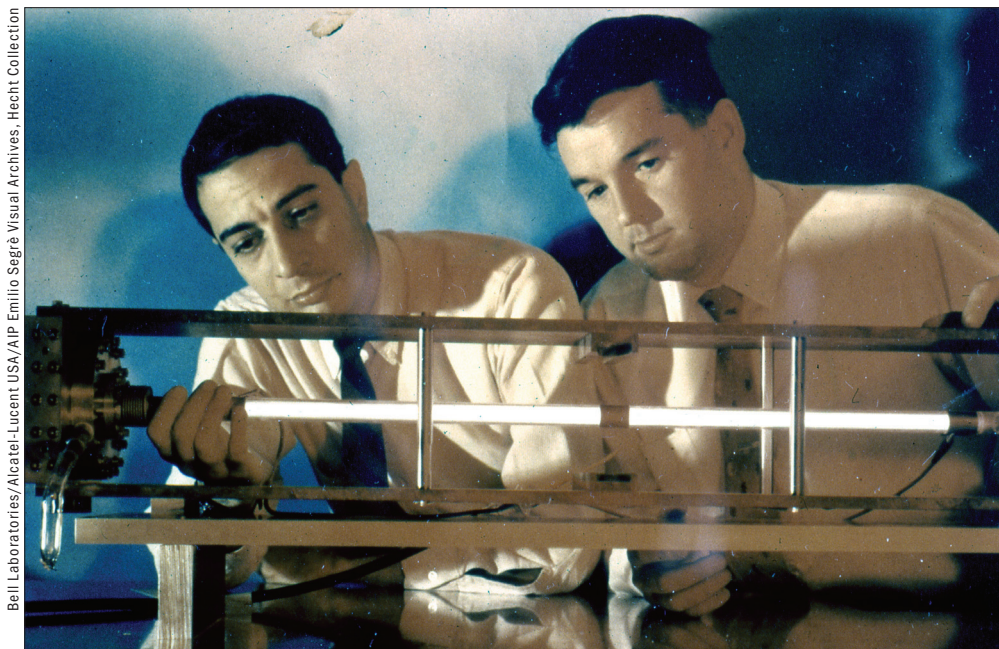


Andrew Gelman

What made Bell Labs special?



Bell Laboratories/Alcatel-Lucent USA/AIP Emilio Segrè Visual Archives, Hecht Collection

Innovation central
Ali Javan (left) and Donald R Herriott work with a helium-neon optical gas maser at Bell Labs in 1961.

The Idea Factory: Bell Labs and the Great Age of American Innovation
Jon Gertner
2012 Penguin Press
£18.71/\$29.95hb
432pp

Bell Labs was a legendary place, an industrial lab in the outer suburbs of New York where thousands of scientists, working nine to five, changed the world's technological history. Their inventions included the transistor, cellular communication networks and the theory of information, but amazingly, these were only a few of the major contributions to applied science and engineering that occurred in this set of famously close-packed labs. Year after year, Bell Labs scientists refined existing products and developed entirely new technologies. Those of us who spend time programming are familiar with Bell Labs as the home of C, Unix and the statistical package S (forerunner of the current open-source standard, R). And perhaps the most celebrated Bell Labs achievement in pure science was the 1963 discovery of cosmic microwave background radiation by Arno Penzias and Robert Wilson.

Coming up with the occasional breakthrough is one thing, but reliably producing innovation – that's something special. It gets even cooler when you realize that so much was done at Bell Labs, and for so long, that the aforementioned discovery of Big Bang radiation – along with C, Unix, S and various fundamental, Nobel-prize-winning contributions to physics – go unmentioned in a new history of the labs called *The*

Idea Factory. I say this not at all as a criticism of its author, the journalist Jon Gertner; rather, there was just so much going on at Bell that it cannot all fit in one volume.

Perhaps the most impressive part of the Bell Labs story is the workaday nature of its successes. Apart from Claude Shannon, inventor of information theory, the labs had no transcendent geniuses. True, William Shockley was a notable figure and, sure, John Bardeen is the only person to have received two Nobel prizes in physics. But they were not legendary minds on the scale of Fermi, Feynman or Von Neumann. Hence the fascination of Bell Labs as an idea factory where the institution gets as much credit as the scientists for the discoveries they made.

So what made Bell Labs special? To start with, it was well run, with managers who typically had strong technical track records of their own, appreciated scientific work and paid their staff enough to live comfortably – but not so much that they could just take their millions and quit. And as Gertner shows, Bell did benefit from some special circumstances. Monopoly profits meant the company could afford to hire top scientists and engineers, and with university jobs not paying very well and few get-rich-quick opportunities such as we have seen in Silicon Val-

ley in recent years, the high pay and excellent working conditions at Bell Labs attracted many who might look elsewhere today.

Second, there was nothing to do at the labs all day but work. I have known lots of middle-aged professors who don't spend much time teaching but don't do any research either. At Bell Labs it was harder to be deadwood. Located as it was in the middle of nowhere, the Murray Hill campus was not a place to relax, and if you were going into the lab every weekday anyhow, you might as well work – there was nothing better to do. Several researchers, including Shannon and Shockley, had sharp mid-career productivity declines – but *after* they left Murray Hill.

In my own experience working at Bell Labs for three summers during the 1980s, I vividly recall a general feeling of comfort and well-being, along with the low-level intensity that comes from working eight-hour days, week after week after week. I did the research underlying my most-cited paper while working in complete freedom for six weeks at Bell Labs during the summer after completing my PhD. So maybe being stuck in the lab until 5 p.m. every day isn't such a bad thing – though it might be impossible to replicate this sort of distraction-free workplace in the Internet era.

In its heyday from the 1940s to the 1970s, a Bell Labs job was said to be just like working at a research university, except the pay was better, the equipment was more up-to-date, the machine shop was available for all your needs and you didn't have to spend time teaching or applying for research grants. At a university, research grants can be distorting – and mediocre researchers who happen to be good at getting them can stay on and on and on. At Bell, the financial motive was not grants but contributing to the company's product lines. This seems reasonable to me, both because telephone service is a public good and because, as Gertner notes, the challenges of improving phone service motivated technical advances that benefited other areas as well. Although not mentioned in the book, Penzias and Wilson's discovery is a good exam-

ple, since it came as part of an effort to get cleaner telephone signals. There is, however, an irony here: as Gertner points out, Bell Labs scientists spent decades scrubbing the noise out of local and long-distance telephone calls, but the modern era of cell phones reveals that most customers prize convenience and connectivity ahead of sound quality.

In his concluding chapter, Gertner gives what I see as his book's overriding message. "It is now received wisdom that innovation and competitiveness are closely linked," he writes. "But Bell Labs' history demonstrates that the truth is actually far more complicated...creative environments

that foster a rich exchange of ideas are far more important in eliciting new insights than are the forces of competition." Although competition has been "superb" at bringing "incremental and appealing improvements", Gertner argues, "that does not mean it has been good at prompting huge advances (such as those at Bell Labs, as well as those that allowed for the creation of the Internet, for instance, or even earlier, antibiotics)". This all sounds reasonable.

Gertner concludes that modern corporate labs do not allow the same combination of freedom and long-term thinking associated with Bell's glory days. But perhaps, rather than

asking where the next Bell Labs will come from, we as a society should be looking to create and support the next Massachusetts Institute of Technology. Gertner includes a tantalizing story of a proposal in the 1960s to create "Summit University," a research institute in New Jersey that would have been closely connected to Bell and several other nearby industrial labs. The project was not carried out because the estimated \$16m cost was deemed too high. In retrospect that decision seems unfortunate.

Andrew Gelman is a professor of statistics at Columbia University, US, e-mail gelman@stat.columbia.edu

Tim Maudlin

The why and how of it all

Patrick George/Ikon Images/SuperStock



Zilch, zero, nada

Scientists and philosophers on the concept of "nothing".

Why Does the World Exist? An Existential Detective Story

Jim Holt

2012 W W Norton
\$27.95hb 320pp

A Universe from Nothing: Why There is Something Rather than Nothing

Lawrence Krauss

2012 The Free Press
£17.99/\$24.99hb
256pp

"Nothing" is a tricky concept. Consider Descartes' peculiar argument against the possibility of a vacuum: "If someone asks what would happen if God were to take away every single body contained in a vessel, without allowing any other body to take the place of what had been removed, the answer must be that the sides of the vessel would, in that case, have to be in contact. For when there is nothing between two bodies, they must necessarily touch each other." Descartes, like many others, has confused the concept of a vacuum with that of *nothing*: a vacuum is empty space, but the empty space in the bell jar is still *something*. It has properties such as size and shape even if it fails to contain matter.

The distinction between a vacuum

and nothing plays a central role in both Jim Holt's *Why Does the World Exist? An Existential Detective Story* and Lawrence Krauss's *A Universe From Nothing: Why There is Something Rather than Nothing*. By their titles, one might expect Krauss's book to answer Holt's question. But both authors tend to run together two distinct questions. One – Holt's main quarry – is "Why is there something rather than nothing?" In Krauss's book, the question that predominates is "How can something come from nothing?"

The predilection to regard these two questions as equivalent is puzzling, for no-one would confuse the question "Why is the universe matter rather than antimatter?" with the question "How can matter come from antimatter?". The fact that "nothing" means different things in the two questions makes the muddle more severe. The nothing in Holt's question is a state of universal and total absence: no matter, no fields, no laws, no space, no time, *ever*. The nothing in Krauss's question is a different beast: for most of his book, "nothing" means a vacuum state in some physical theory.

Holt is a journalist with a background in philosophy, and his question is philosophical, so he consults philosophers. Adolf Grünbaum argues that there is no problem: the felt need for an explanation arises from an unjustifiable conviction that nothingness is somehow more probable or expectable than the existence of something. Absent any principle

for preferring nothing over something, no explanation is required. Holt finds no flaw in Grünbaum's argument, but it still does not *feel* right to him, so he presses on with other philosophers, physicists, theologians and even the novelist John Updike. It makes for an amusing and stimulating, if somewhat picaresque, tale; one recurring motif is that Holt imbibes significant quantities of alcohol while his interlocutors prefer caffeinated beverages.

Holt's other interviewees include the theologian Richard Swinburne, who opines that the physical world exists because God made it and punts on the question of why God exists. Philosopher Derek Parfit focuses on the form that an explanation might take, considering how some property of the universe might account for its existence. Parfit calls such a property a "selector". For the speculative cosmologist John Leslie, the selector is goodness: Leslie suggests that the universe exists because it is good, and hence *ought* to exist. One might also imagine other properties playing the explanatory role, such as simplicity or variety, but Parfit's idea is that if there is a selector, we can get evidence for what it is by seeing which property (if any) the universe maximally exemplifies. This idea leads Holt, by a somewhat convoluted argument, to suggest that the relevant property might be mediocrity.

The physicists that Holt consults tend to be more on Grünbaum's side. Steven Weinberg and David Deutsch both recognize the hopelessness of