experience has been that joint sponsorship of university research by industry and government agencies works well and can satisfy the missions of all three entities. Indeed, it is not difficult to find common ground between the research-program focus of our consortium and that of government research agencies.

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Butler replies: Michael Riordan correctly points out that AT&T could, as a monopoly, justify funding basic research at Bell Labs, something it could no longer do after its breakup. Although the results of that research did have enormous impact on modern life, Stephen Adams and I discovered, while writing *Manufacturing the Future: A History of Western Electric* (Cambridge University Press, 1998), that the impact was frequently delayed. Monopolies could fund basic research as good corporate citizens, in part because they could spread out the deployment of results to ensure adequate returns on disruptive innovations. As a monopoly, AT&T often waited to introduce the innovations created at Bell Labs. In the 1950s the average product life cycle at AT&T was on the order of 20 years. Under competitive pressures after 1984, that life cycle, we were told, shrank by 1996 to about six months and sometimes pushed to three months.

After 1996 Bell Labs, as a part of Lucent Technologies, might immediately develop innovations it created, but it lacked the funds to maintain the level of research it had under the AT&T monopoly. After the loss of monopoly status, competition pushed innovations into the marketplace at a far faster rate, but those innovations became increasingly incremental rather than transforming the technology.

Larry Sumney and Ralph Cavin reflect the views of the one industry that our study found to have successfully resolved the tensions in the research nexus involving industry, government, and academia. Research sponsored by microchip industry consortia is industry driven rather than government or university driven and is largely limited to "precompetitive" research—that is, research to improve the products of the industry as a whole without giving advantage to any single corporation or group of corporations. Microchip industry consortia have resolved the intellectual-property tensions between corporate interests and universities by requiring a royalty-free license to members for any research funded by the consortium. A university, however, retains the right to sell that intellectual property to those outside the consortium. Whether or not industry-wide, consortium-led research would work in all high-tech industries remains to be seen. However, Semiconductor Research Corp and other microchip industry consortia provide a good model for one way to resolve the tensions frequently underlying government-driven university and industry collaborations.

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Newcomb looked to astronomy's future

Among the comments we received in response to our article "Simon Newcomb, America's First Great Astronomer" (PHYSICS TODAY, February 2009, page 46) are a number of inquiries about an often repeated quotation attributed to Simon Newcomb: "As far as astronomy is concerned, it must be confessed that we do appear to be fast reaching the limits of our knowledge." An internet search brings up hundreds of sites that present this quotation as an example of how short-sighted, and wrong, even the most renowned scientists, inventors, and other learned people can be. But few sites include a proper reference to the quotation, let alone put it into context.

Newcomb first made the comment as part of a speech titled "The Place of Astronomy Among the Sciences,"[1] which he presented at the dedication of a new astronomical observatory at Syracuse University in New York on 18 November 1887. A more complete quotation is, "It would be too much to say with confidence that the age of great discoveries in any branch of science has passed by: yet, so far as astronomy is concerned, it must be confessed that we do appear to be fast reaching the limits of our knowledge. True, there is still a great deal to learn."

Newcomb was talking about the "old astronomy" that focused almost entirely on cataloging celestial objects—stars, planets, moons, asteroids, comets—and computing their motions. In the same talk he also said that "all the geometry and astronomy, all the phenomena of the motions of the heavenly bodies are already reduced to one general law." He was referring to Newton's universal law of gravitation, which he then accepted without reservation. As we pointed out in our article, and in more detail in our book,[2] Newcomb later began to question Newtonian physics as he struggled with the discrepancies in the motions of Mercury. Ultimately, his findings provided an immediate test of Einstein's theory of general relativity.

It is important to realize that Newcomb was not including "new astronomy," generally referred to today as astrophysics, in his assessment of the outlook for future discoveries about the universe. Just two paragraphs later in the printed version of his talk, he explicitly refers to the "new science of physical astronomy," states that "the study of the stellar spectrum is a worthy one," and mentions his curiosity about whether the spectrum of Sirius will change as the star goes through various stages of its life.

Newcomb's interest in learning about the universe never waned, and he argued strongly for the pure pursuit of knowledge, saying that it seemed almost as if the secrets of nature would be revealed "only to those who investigate from a love of nature herself."

References

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