commercially available, and human clinical trials are under way at multiple sites in the US.

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The article by Gail ter Haar presents an excellent review of the history and current status of acoustic surgery, and describes the renewed interest and newest applications of high-intensity focused ultrasound (HIFU). Unfortunately, ter Haar neglects to mention outstanding contributions, dating back more than 30 years, from a group at the Indiana University School of Medicine in Indianapolis.

In 1970, researcher Frank Fry and neurosurgeon Robert Heimburger began treating terminally ill brain-cancer patients with Fry's HIFU device, which was coupled with a highly accurate B-mode imaging system.[1] Fry and Heimburger continued to improve the HIFU technology. Then, in consultation with Indiana's department of urology, Fry and I developed a prostate ablation device[2] that combined both imaging and HIFU treatment within a single ceramic crystal, thus eliminating transducer alignment complications. This device was approved in the US and Europe in 1992 for treatment of benign prostatic hyperplasia,[3] and has been used by my company to treat BPH patients for several years. Unlike the "disappointing" results ter Haar mentions, multisite phase-III clinical trials demonstrate that HIFU treatment is safe and effective, improves peak urinary flow, reduces symptom scores, and improves quality of life.

References

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2. R. Bihrle, R. S. Foster, N. T. Sanghvi, J. P. Donohue, P. J. Hood, *J. Urol.* **151**, 1271 (1993).
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Ter Haar replies: The comments made by Kirby Vosburgh and Narendra Sanghvi are well taken. In a brief overview, it is impossible to mention all the contributors to this field. A review article can only be a personal judgement regarding the major milestones in a technique's development. The researchers in Indiana have certainly made significant contributions, but so too, for example, did Padmaker Lele at MIT, John Pond at Guy's Hospital, London, and, more recently, Dominic Cathignol's group in Lyon, France. There was simply not the space to detail these contributions, nor those of many other notable researchers.

I did not mean to understate the role of magnetic resonance imaging in acoustic surgery; I recognize and am excited by its considerable potential. The ability to image 1–2°C temperature rises, while useful, must not be overstated, because without good understanding it may lead to mispositioning of the high-power focus. The strength of MRI-guided acoustic surgery lies in its ability to overlay, on an anatomical image, the distribution of thermal dose achieved, thus allowing an essentially real-time assessment of the treatment. Ultrasound techniques do not yet provide such information, but may in the future. Undoubtedly there will be clinical applications—for example, in the brain—for which MRI will be the best way to monitor treatments, but for many others, diagnostic ultrasound will prove to be more appropriate. Certainly, because of the expense of, and limited access to, MR scanners, acoustic surgery that is ultrasound guided will be available to more patients worldwide.

Clinical interest in acoustic surgery is expanding rapidly; concurrently, many commercial enterprises are appearing, some farther down the road to regulatory approval and commercialization than others. The devices mentioned by Vosburgh and Sanghvi are just two of several currently in clinical trial. I considered it beyond the scope of the article to review the information available from these sources.

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Bell Labs Had Role in EDFA Development

The interesting recent article on Bell Labs, Lucent Technologies (Physics Today, October 2001, page 26), omitted an important detail. Although the article lists some of Bell Labs' major achievements, including optical solitons, it does not mention erbium-doped fiber amplifiers (EDFAs). Despite their usefulness in improving our understanding of fiber nonlinearities and of new ways to exploit them, solitons have had only a limited impact on optical communications applications. EDFAs, however, have been key to enabling wavelength-division multiplexing technologies, broadband optical networks, and terabits-per-second terrestrial and undersea communications.

EDFAs were developed simultaneously at Southampton University and at Bell Labs, according to Herwig Kogelnik.[1] His testimony is authoritative because he directed one of the two Bell Labs facilities in Crawford Hill, New Jersey, where the group of early EDFA investigators worked (1986–1990). The Crawford Hill investigations and demonstrations led to a rapid technology transfer to the Labs' submarine-link department in Holmdel, New Jersey, and to several other development sites thereafter. (Research on solitons also benefited greatly from the transfer!) That transfer was the culmination of 20 years of fiber-optic research at Bell Labs and probably represents one of the company's greatest success stories.

For my contribution to this early work, I received, jointly with the University of Southampton's David N. Payne, the 1998 Benjamin Franklin Medal in Engineering. Yet, for unexplained reasons, Bell Labs never claimed its contribution to the invention and early development of EDFAs, despite their tremendous impact on technology and business. Such an anomaly, or memory erasure, shows that historical accuracy, even in famed institutions, can become secondary to internal rivalries ("not started in my department") or marketing simplifications ("EDFAs have always been there"). True, practically all the early EDFA investigators have left the Labs, and the submarine group established its own company. But could this evolution justify censorship in Bell Labs' history? The Labs should be proud of having been on the forefront of another technology revolution, thanks to the vision and risk-taking stance of both investigators and managers of Crawford Hill.

I recommend the National Academy of Sciences Web site, http://www4.nationalacademies.org/beyond/beyonddiscovery.nsf, which lists, under the Modern Communications menu item, pages titled "Basic Research Remains Vital" and "The Development of Lasers and Fiber-Optics—A Chronology of Selected Events." Those state that Southampton University and Bell Labs discovered and developed "practical and effective" EDFAs.

Reference

1. N. Savage, *IEEE Spectrum* **38** (June 2001), p. 43.

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More Heat Over Greenhouse Gases

The article "Warming Oceans Appear Linked to Atmospheric Greenhouse Gases" (PHYSICS TODAY, June 2001, page 19) prompted a comment from Robert C. Whitten (PHYSICS TODAY, December 2001, page 12). He stated "how the mean atmospheric temperature can remain essentially constant while warming the oceans is never explained." In her response to Whitten, Barbara Goss Levi tells us that "additional greenhouse gases added to Earth's atmosphere absorb infrared radiation emitted by Earth's surface and reradiate part of it to the surface. This radiation can warm the surface directly without warming the atmosphere first." This reasoning is flawed for two reasons.

First, that the additional greenhouse gases absorb additional radiation from Earth's surface implies that warming will obviously occur where the additional gases are located, assuming they are at a lower temperature than Earth's surface. This assumption will normally be satisfied. Indeed, the original article by Levi states, "If the trapped infrared radiation is heating the atmosphere, we might expect it to be warming the world's oceans as well." While this statement is correct, the response to Whitten contradicts it.

Second, if we were to accept the erroneous explanation that reradiation from the greenhouse gases warmed only the ocean surface, then we would have difficulty explaining why this warmer ocean did not transfer some of the added heat to the surface air layer in contact with the ocean, thereby warming the atmosphere. It is well known that air passing over the ocean rapidly reaches thermal equilibrium with the water surface, and surface air temperatures normally maintain a value very nearly that of the ocean surface. This warming of the surface air would, in turn, be distributed upward, probably in a period of days, certainly not years, resulting in a mean temperature above what it would be without the greenhouse gases. Thus, in either scenario, a net warming of the troposphere would result. We thus conclude that there is no way that the ocean surface can warm without a resulting warming of the overlying atmosphere.

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In the December issue of PHYSICS TODAY (page 12), Robert Whitten takes Barbara Goss Levi to task concerning her article about greenhouse gases. However, I am not convinced that Levi's response gets to the nub of the problem. Whitten's question about "how the mean atmospheric temperature can remain essentially constant while warming the oceans," touches on some very basic physics. The question can best be addressed in the context of a simplified, globally-averaged model of Earth's atmosphere that one finds in texts on meteorology and climate. See, for example, chapter 1 of J. T. Houghton's *The Physics of Atmospheres* (Cambridge U. Press, 1986), in which Earth is treated as a "gray" spherical body with uniform radiant properties, immersed in a beam of solar plane waves.

First, the mean planetary radiant temperature of about 255 K must remain approximately constant, independent of any altered greenhouse emissions, if one assumes that the planetary reflection coefficient, emissivity coefficient, and solar constant all remain unchanged. (These assumptions can be relaxed, but that would only cloud the issue). This model reflects the steady state achieved in the power balance between the constant incoming shortwave radiation from the Sun and the constant outgoing long-wave infrared terrestrial radiation. A temperature of 255 K corresponds to a height of some 5 km in the atmosphere; but