THE INDUSTRIAL PHYSICIST

PUBLISHER
Randolph A. Nanna
Tel: 301-209-3102
rnanna@aip.org

ASSOCIATE PUBLISHER/EDITOR
Kenneth J. McNaughton
Tel: 301-209-3051
kmcnaugh@aip.org

ART DIRECTOR
Steven R. Black

SENIOR CONTRIBUTING EDITORS
Jennifer Ouellette
Patrick Young

CONTRIBUTING EDITORS
Jay C. Cherniak
Nancy Forbes
Eric J. Lerner

CIRCULATION DIRECTOR
Jeff Bebee

PUBLISHING ASSISTANT
Stephanie Jankowski

ADVISORY COMMITTEE
Richard E. Swanson (chair),
Larry E. Antonuk, Vincent M. Donnelly,
William H. Prest, Harold J. Reitsema,
Manik Talwani, Jennifer J. Zinck
Kenneth J. McNaughton (staff liaison)

ADVERTISING MANAGER
Abby Singer Klar

SENIOR PRODUCTION MANAGER
Christine DiPasca

SENIOR PRODUCTION ASSISTANT
Rita C. Wehrenberg

APPLICATION TIPS EDITOR
Jennifer L. Huergo

EDITORIAL OFFICES
One Physics Ellipse
College Park, MD 20740-3842
Tel: 301-209-3051
Fax: 301-209-0842
e-mail: tip@aip.org

ADVERTISING OFFICES
Tel: 800-247-2242

WORLD WIDE WEB
www.tipmagazine.com

AMERICAN INSTITUTE OF PHYSICS

EXECUTIVE DIRECTOR
Marc H. Brodsky

MEMBER SOCIETIES
The American Physical Society
Optical Society of America
Acoustical Society of America
The Society of Rheology
American Association of Physics Teachers
American Crystallographic Association
American Astronomical Society
American Association of Physicists in Medicine
American Vacuum Society
American Geophysical Union

OTHER MEMBER ORGANIZATIONS
Corporate Associates
Sigma Pi Sigma Physics Honor Society
Society of Physics Students

Not so smart?

I am somewhat disturbed by your article titled "Smart Ceramics Transform Structural Shapes" in the December 2001/January 2002 issue of *The Industrial Physicist*, pp. 10–11. Although it is good to let the scientific community know about piezoelectric applications for structural control, the National Technology Transfer Center should be well aware of the fact that packaged piezoceramic fibers and plate actuators were commercially available and applied to structural vibration and shape control well before NASA's claimed invention.

Continuum Photonics (which used to be called Continuum Control) Corp., in Billerica, Massachusetts, has been manufacturing piezoelectric transducer (PZT) fiber actuators, and ACX, Inc. (now a division of Cymer, Inc.), has been manufacturing PZT plate actuators for structural control applications. The photograph in the article, as a matter of fact, looks just like one of the Continuum products.

Now, I understand that the NASA actuator is made from diced PZT plate (thus a cross section of each fiber is square or rectangular rather than circular or oval as Continuum's fiber is), and that it also uses a patented process in manufacture. However, the principle is exactly the same, including the use of the interdigitated electrode configuration.

I have been involved in piezoceramic materials for more than 15 years and know well that the use of piezoelectric ceramic as an actuator requires a significant amount of reliability testing, especially when a high electric field is applied and the field within the ceramic is not uniform. Previous attempts I know of have been unable to overcome lifetime and reliability issues at the level required for commercial success.

As a government organization, shouldn't NASA be promoting and helping small industries with new ideas instead of competing with them? The NASA knowledge base on piezoelectric ceramics has been relatively weak in my opinion. Thus, it is dangerous to claim some of the properties without more extensive testing and scientific understanding.

Shoko Yoshikawa
Cambridge, Massachusetts
shoko62@hotmail.com

[*Author replies*: I understand your concerns about the article, and although the work at Continuum was not mentioned, I and the research team at NASA–Langley are well aware of it. My understanding is that the NASA–Langley team began its work primarily because it was not able to get a reliable supply of the material for its own work, and that NASA is currently pursuing a patent. NASA has no intention of competing with industry and hopes to license its improvements so that the technology will become widely available. At the moment, though, this is still a research effort, and NASA has not sold the material to anyone.

With regard to your comment that NASA "just" uses diced piezoceramic fibers, the published data seems to indicate that this results in significant improvements in cost and performance. As the article says, diced fibers are easier to handle, so that manufacturing cost and reliability are improved. There also seems to be a fair amount of evidence that diced fibers provide better electri-

BPA INTERNATIONAL® ***THE INDUSTRIAL PHYSICIST*** (ISSN 1082-1848; CODEN INPHFA), volume 8, number 1, **Subscriptions:** *The Industrial Physicist* is available free to qualified parties in the USA who complete, sign and return the qualification cards in each issue. Mail to *The Industrial Physicist*, P.O. Box 96000, Collingswood, NJ 08108, fax to 856-488-6188, or log onto www2.starrcorp.com/ipy. New subscriptions, renewals, address changes, and other subscription needs can be facilitated at this Web site. Questions? E-mail jbebee@aip.org**. Readers outside the USA** can receive the magazine at the following rates: members of AIP-related societies $57/year, all other individuals $66/year. **Libraries and institutions** in the USA pay $76/year, those outside the USA $106 (airfreight delivery only). **To order a paid subscription**, please send your request with name, address and payment—a check for $U.S. drawn on a U.S. bank, or credit card information (indicating VISA/MC/AMEX, credit card #, expiration date, name as it appears on the card, and billing address)—to AIP, Attn: TIP Payments, P.O. Box 503284, St. Louis, MO 63150-3284. **Back copies** are available for $20 each postage paid from the AIP office listed under "paid subscriptions," using the same pre-payment instructions.


NASA Langley Research Center

cal contact, so that the voltage–strain relationship is better in the NASA composite than in Continuum's product.

If you have further questions about this work, I encourage you to read the SPIE reference mentioned in the article or contact Keats Wilkie (w.k.wilkie@larc.nasa.gov), the lead investigator on this project at NASA.

Ted Lynch]

Diced fibers were invented and reported in my thesis work in 1995. NASA–Langley based its actuator almost exactly on the materials, geometry, and fabrication approach published in my work as well as on unpublished reports and meetings I conducted that their representatives attended. There is no support to the claim that diced square fibers are "easier to handle, so that manufacturing cost and reliability are improved." Take it from a company that has commercialized the technology and integrated it into demanding consumer products (such as sporting goods)—diced fibers have poor economies of scale and offer no advantages for reliability (or performance; a Continuum product with similar geometry has similar performance).

In my opinion, to label the NASA–Langley work an invention is an overstatement. It is simply a different approach to manufacturing (we have worked on many), riding on the coattails of work that is the culmination of millions of dollars of research and countless man-years of effort (at both MIT and Continuum). Since the MIT/Continuum work was pioneering in this field, it surprises me that no one contacted us to discuss it.

Aaron A. Bent
President
Continuum Photonics
Billerica, Massachusetts
www.continuumphotonics.com

Ted Lynch, in his reply, addresses the major technical points raised by Yoshikawa and Bent quite well. In fact, both Yoshikawa's and Bent's prior work in this area is cited and acknowledged extensively in my referenced SPIE publication on the NASA macrofiber composite (MFC) manufacturing process and device. As for "NASA competing with small business," the Langley work that led to the MFC actuators was undertaken specifically and exclusively to meet NASA mission requirements—in particular, those related to the active twist rotor effort. As a NASA research center, we do not perform our work to compete with commercial product developers. The resulting NASA device proved to be extremely useful for a wide range of applications, both government and commercial, and has therefore been commercialized by NASA with private industry partners.

W. Keats Wilkie
NASA Langley Research Center
w.k.wilkie@larc.nasa.gov

Lift-off

I have been following the maglev story (April/May, pp. 20–24) and follow-up letters with great interest. This topic has been a fascination of mine since I read about the idea in Robert Heinlein's science fiction stories from the 1950s. The ideas for long-range transport and space launch are certainly of interest. But I am bothered by the social engineering that is suggested by the authors and many of the follow-up letter writers. Islands of high-density high-rise habitation connected by a web of high-speed maglev tunnels and surrounded by a sea of "green space" may be a utopian dream for some, but it is the worst kind of Orwellian nightmare to me.

Suburban living is popular because it gives people an area with a level of privacy and autonomy that is not available to the high-density denizen. I live in a rural area and like the fact that my nearest neighbor is half a kilometer away through the trees. I doubt that I will ever be ready to give up my lifestyle and voluntarily move into a high-density high-rise with half a million of my closest friends. Nor will I voluntarily give up my access to personal transportation that is under my control rather than that of some central computer. And while you can find people willing to live in high-density surroundings, I believe you will find a good number who enjoy their suburban or rural life and would give it up only if forced, which seems to me the only way to implement the utopian dream. Forcing people to conform to such a master plan is simply immoral, even if it is possible.

I am concerned about the environment—I live in the middle of it much more than most people. That's why my house was built with insulated concrete walls, a half meter of insulation in the ceiling, and a ground-source heat pump that uses a fraction of the energy of other methods. I also carpool to work and would gladly give up my internal-combustion-powered vehicle for an electric- or fuel-cell vehicle if it provided me the convenience and efficiency of the internal-combustion power plant. Given the current technology, especially of diesel engines, I don't consider this likely.

Humanity's advances have been, for the most part, voluntary. And the countries, such as the United States, that allow the greatest personal freedom of action have done more to improve the lot of a wider group of people than all the social engineering and five-year programs ever devised. So maglev may indeed be in our future, but let's not have it shoved down our throats.

Scott McKinster
Polaris Industries
Salol, Minnesota
scott.mckinster@polarisind.com

[*Authors reply*: We are reminded of the caustic book *Coercive Utopians* (R. Isaac and E. Isaac; Regnery, Chicago, 1983) and share Mr. McKinster's taste for liberty. Nevertheless, what looks voluntary to an individual may look automatic to the system. A gas molecule may "feel" free, while the collective behavior of the gas is strictly determined. Similarly, the evolution of the transport system follows a tight script, although individual consumers may experience choice. As our physicist colleague Wolf

Haefele enjoyed saying, "Don't forget the system. It won't forget you."

In any case, our outlook of increased mobility *and* bigger cities maximally frees those who want to live like Robinson Crusoe by sparing land for them. Were the 7 million residents of New York City each to enjoy the 3-acre zoning of rich U.S. suburbs, they would occupy about 33,000 square miles, more than the area of Maine. Were each of today's 100 million U.S. households to enjoy the square kilometer that Mr. McKinster enjoys, they would require about 38 million square miles, 10 times the land area of the United States. Unless a world of 10 billion people is densely urbanized, it will spare no land for nature. City dwellers are true greens.

Jesse Ausubel and Cesare Marchetti]

Optics career

I thank you for the "professional biography" you wrote for *The Industrial Physicist* (December 2001/January 2002, pp. 26–29). I enjoyed the article immensely and was able to relate well despite our differences in age and in work and management experience. It's amazing to see how so many technical challenges boil down to interpersonal ones.

As a side note, I think I met you, and perhaps even interviewed with you, while visiting the Rockwell Science Center in 1991 after being laid off from Space Systems in Downey (SSD). I came in with a background in optics, although with less than 2 years of experience at SSD, and probably not enough practical experience to be of value to the Science Center. I am sure that tens of thousands, if not hundreds of thousands, of people have been displaced since 1990 from the aerospace giants into smaller commercial entities. And, of course, there has been a growing trend during the past 10 years for smaller companies to be absorbed into larger corporations. Such is the case here at Honeywell, much to the frustration of many. I am not sure what a "model" acquisition is, but I have not experienced it to date. I hope there will be a renewal of investment back into the "R" in R&D in the technology sector. Your summary, "Lessons learned," should be bulletin-board material in every engineering organization.

Jeff Blitstein
Honeywell
Folsom, California
JBlitstein@GetIntellisense.com

[*Author replies*: Thank you for your kind words. You are one of many people who have written me about the similarities between their experiences and mine.

Regarding your comment about there being less "R" in R&D, it is sadly true of the Science Center, which is now Rockwell Science Corporation, an independent spin-off from Rockwell, with outside investors and some employee stock ownership. It is now pushing to produce and sell devices, and there is much less of "the vision thing" than before (and it was disappearing then too).

Jeff Schoenwald]

Renewables

I recently came across your article "Where is Energy Going?" in the February 2000 issue of *The Industrial Physicist*. There is an important, yet underappreciated, role for renewable sources, particularly solar and photovoltaic (PV), in the energy framework that you so cogently describe. This arises from two peculiar properties of solar/PV, namely, that the generating units are nearly completely modular (economies of scale are relatively unimportant), and that they can be used not only at the sources but also at the ends of the electricity network. (One might reply that fossil fuels could also be used in a distributed fashion, but as you rightly point out, their disadvantages (urban pollution, bulkiness, and transport difficulties) have long since proven dissuasive in practice.) These advantages imply that distributed generation of solar/PV can be an important complement to the nuclear/hydrogen paradigm that you predict.

The real value of solar/PV is that it allows the electricity grid to operate in two directions. With reverse metering, excess electricity generated by solar/PV at the ends of the capillaries (urban rooftops, remote sites, etc.) can be fed back into the grid, essentially allowing the grid to operate as a giant bat-

tery. This is a supreme advantage of the electricity grid, one that is not properly appreciated by many environmental activists who advocate "off-the-grid" lifestyles in an attempt to support renewables.

Although the amounts of energy generated in this fashion are small compared with the demands we will have to satisfy in the 21st century, the excess energy produced in this way will come at just the right time—on hot summer days, when the electricity demand loads are at their highest. These demand maxima determine the dimensions of the delivery infrastructure, tying up lots of capital in capacity that may be used only a couple of times a year. What would be the cost savings in downsizing new infrastructure if end-of-capillary solar/PV could substantially reduce the demand spikes that occur each summer?

William A. Eisenstein
Department of Landscape Architecture
and Environmental Planning
University of California at Berkeley
weisenst@uclink4.berkeley.edu

[*Author replies*: As an urbanist, you might find much of interest at our Web site, including our papers about mobility (http://phe.rockefeller.edu). As a Californian, you deeply appreciate the importance of power reliability and quality. Marchetti and I have pondered ways to achieve them, and we conclude, like you, that a great deal can be gained by a distributed backup or peaking strategy. However, our solution, the Splicer, runs on natural gas or electricity. Look at the section on the Splicer in the latter part of the paper titled "Elektron, Electrical Systems in Retrospect and Prospect" (http://phe.rockefeller.edu/Daedalus/Elektron/; *Daedalus 125* (3), Summer 1996, 139–169). A backup system that is intermittent and requires a lot of maintenance, as so-called renewables do, seems a dreamy luxury.

Jesse Ausubel] Ω

Mail letters to The Editor, *The Industrial Physicist*, One Physics Ellipse, College Park, MD 20740-3842; fax (301-209-0842); e-mail (tip@aip.org); or respond from our Web site (www.tipmagazine.com, click "Write to the Editor").