# Aerogels

Congratulations on your excellent article by David Pope, "NASA Puts the Heat on Aerogels" (9/97, p. 13). I find the information in *The Industrial Physicist* to be extremely timely and informative, bringing together top consultants, leading-edge vendors, and pioneering information managers to show how technology is transforming businesses today and may transform yours tomorrow. *The Industrial Physicist* is for people on the front line of information technology management. Keep up the good work.

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Greater Austin Chamber of Commerce
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## Design of experiments

I read your informative article on the design of experiments in the September 1997 issue of *The Industrial Physicist*. Congratulations on an article well written, addressing a very useful topic for many engineers in our industry (semiconductor).

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The subject of my research is the polishing of ceramics by chemical methods that use different solutions and particular polishing pressures, speeds, and polishing pad hardnesses, to name just a few key factors. The polishing process is very sensitive to numerous parameters and their mutual interactions, which makes it difficult to elucidate major factors by a trial-and-error method of experimentation. Once I finished reading your article, I realized that design of experiments (DOE) software must be the only solution to the optimization of the polishing process. I would like to ask a couple of questions. The list of the software vendors is quite long, so what principles should be employed to decide which software to use? In my case, there are not only mixtures of materials, but also a variety of different mechanical and chemical properties of materials involved in the polishing process. My questions are: (1) Are there different algorithms of DOE that are implemented by different vendors, or do all use essentially the same statistical algorithm? (2) Are there any limitations on the number of variables that DOE software will support for calculations?

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[Author replies: First, I'd guess that most vendors will provide the standard algorithms for DOE. Some may suggest a variant called Taguchi design, which I advise you to avoid, because it's not always optimal statistically. Also, beware of vendors who offer a bewildering array of statistical functions of which DOE may be only a small part. You may find these software programs to be very difficult to learn and use. Look for packages that are devoted to DOE.

My answer to your second question is: not really. It's more a matter of how many you can physically handle. With the two-level factorial approach, you can do as many as 31 factors in 32 runs, but a more typical DOE will be 4-7 factors in 16 runs. Figure 2 of the article (and the associated text) will give you a range of options for full and fractional factorials.

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My primary dissatisfaction with *The Industrial Physicist* is the lack of any technical detail regarding the topic of the articles. I am not suggesting detail to the level of a scientific journal or *Physics Today*, but some detail about what makes the subject matter important and how it works. For example, I was interested in the Design of Experiments article but got little from it besides an appreciation of its use by corporations. I would like to read about the methodology of DOE programs and the differences among the available products. Also, some gritty truth about where DOE programs fail or become suspicious. Please accept these comments as an effort to help you develop the best magazine possible. I would like to reevaluate *The Industrial Physicist* if you make some of these changes.

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## Deming

Your article in the September issue of *The Industrial Physicist* about the principles of W. E. Deming's management ideas (p. 46) was very intriguing. As I have never heard about this before, I would like to ask you to give me a few references with which I could start exploring this subject in more depth. As a soon-to-be physics Ph.D. who is thinking about a nonacademic career, I feel that this would be very valuable.

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[Author replies: I recommend as a starting point the following texts:

1. W. E. Deming, *The New Economics for Industry, Government, Education,* MIT Center for Advanced Educational Services, Cambridge, MA (1993).

2. W. E. Deming, *Out of the Crisis*, MIT Center for Advanced Educational Services, Cambridge, MA (1986).

3. P. Senge, *The Fifth Discipline: The Art and Practice of the Learning Organization*, Doubleday, New York, NY (1990). Although Senge does not address Dr. Deming or his principles per se, this text provides a wonderful treatment of systems theory and thinking.

If you're interested in seeing how Deming's principles can be applied to education, you may want to look at my own recent text, *The New Philosophy for K-12 Education: A Deming Framework for Transforming America's Schools*, ASQ Quality Press, Milwaukee, WI (1996).

## Letters

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I try very hard to help my students learn chemistry and physics. Part of my job is to turn in grades at the end of the semester. How can I determine student performance when there are so many variables?

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[Author replies: Here are three possible approaches that come to mind.

1. For all students whose scores on your assessments are different, but not significantly different, submit a grade of A. For any students who fall outside the system on the high side (i.e., have significantly high scores), submit an A+. For students who fall outside the system on the low side (have significantly low scores), provide special help and, for the time being, submit a grade of I (incomplete).

2. A more common approach among faculty trying to apply Deming's principles in their classrooms is the following. Clearly define and communicate the course objectives or requirements at the beginning of the semester. For all students who fulfill those requirements, submit a B at the end of the semester. For all students who go above and beyond those requirements (for example, they may conduct, write up, and submit three or four extra lab projects), submit an A. For those students who fail to complete all the core objectives, submit an I (incomplete).

3. Finally, you may consider the grading system Dr. Deming used during his decades of service on the faculty at New York University. He told all his students at the beginning of each semester that their final grade would be an A. "Come here to learn, not to get a grade," he'd say. Having removed the extrinsic grade as a concern among his students, he was able to concentrate—and help them concentrate—on learning.

James Leonard] Ω