Career exploration

I would like to thank you for the work you and your staff have done on the new publication *The Industrial Physicist*. As a high-school physics teacher for over 25 years, I have seen many bright students with the imagination and the insight to be physicists. Commonly, however, these students were redirected into other related college majors (medicine, engineering, computing, and business, to name a few) because of the real or perceived lack of true jobs for the physics major upon graduation.

For years, my readily available literature base of applications for such students was my monthly *Physics Today* or *Physical Review Letters*. From these publications, a 17- or 18-year-old sees our specialty as remote and potentially unproductive. Your publication has brought a new level of interest and readability to career exploration for my brightest students. I thank you for this, and I believe it can only help bring more talented people to universities seeking that deeper view of nature that physicists enjoy.

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Industrial ecology

It requires a change in mind-set to recognize that waste streams offer opportunities to recapture valuable minerals and are not exclusively liabilities ("Industrial Ecology at the Crossroads," 12/97, pp. 24-26). Reverse osmosis offers a way to concentrate dilute streams that can broaden the range of possibilities. When I worked at DuPont, we were developing hollow fibers for desalination, and I always thought industrial uses would ultimately be more important than desalination. My impression is that this is a market still waiting to happen, but I might be out of touch because I haven't worked in this area in a long time.

Some of our first sales were to industry. A metal plater in Chicago was about to be shut down because of heavy metals in the effluent. The company installed reverse-osmosis units in desperation and then found that the concentrate could be dumped back into the plating bath to save on raw materials. Moreover, the water from the permeator was purer than city water and could be used as a final rinse. Materials savings alone paid for the installation in about three months. Another important use was water treatment for chip making. Pretreating rinse water removed organics and improved yield significantly. Also, fiber finishes can be recovered from waste streams and used as fuel.

But we failed at acid mine drainage. The water was cleaned up nicely, but iron-fixing bacteria loved the environment. All the fibers were encased in iron within a week. Likewise with caustic separation for the paper industry. Very high molecular weight hemicellulose caused blinding and premature loss of efficiency. As an aside, this project gives another example of the usefulness of physics training. Early in the project, we were stymied by reverse-osmosis tests that provided no clear direction. To give us some direction until the permeator group could understand the problem with their units, I developed a simple test using osmosis. It predicted both the water transmission rate and salt rejection accurately and could be run by our lab technician in about 30 minutes. Surprisingly, another critical parameter is the diameter of the hollow core. Again we developed a simple test by measuring nitrogen flow rate down the fiber. We could see at a glance if any fibers were blocked, and it gave an accurate measure of the diameter. With quick and accurate assessments, we were able to make rapid improvements in fiber quality in this very complex product.

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Grading advice

I was surprised by your grading advice in the letters to the editor in December's issue of *The Industrial Physicist*. Until I saw your comments, I'd only been dimly aware of how much grade inflation had encroached on university education. I work in a high-tech profession (space suits), where I see increasing numbers of poorly qualified, poorly motivated new graduates who cannot think through problems by themselves. Industry's response to this pool of mediocre talent is to lower its expectations and treat these technical people as an expendable resource, certainly not to be rewarded with the compensation and career opportunities that previous generations of engineers and scientists enjoyed.

Universities seem to try hard to indoctrinate their students in the popular concept of teamwork (considered important in these days of lazy, ill-prepared employees) and to promulgate the politically correct notion that criticism of personal performance is bad. This is the message I get from your comments regarding Dr. Deming's all-A grading philosophy. I contrast this with the scenario when I went to college some 30 years ago. One-quarter of my freshman engineering class didn't come back for the second semester. Half weren't back for the sophomore year. Most of those absent had come to the conclusion that study was too hard and they either could not or were not willing to do the solitary study. Of the more than 200 who started with me in aerospace engineering, only 16 finished with a diploma in that field.

One of my calculus professors was nicknamed "Cube Root Kent" because he was said to pass only the cube root of his class. Of course, this was not literally true; he only failed around 50 percent. Most of my professors graded on a bell curve, with the middle being a C. We were on a 3-point grading system, where a D carried the same weight as an F as far as grade points were concerned. After the first two weeks of a semester, there was no such thing as dropping a course. If you dropped, you got an F. Final grades were posted outside the classroom alongside each student's name (not just an impersonal and anonymous student number as is the case today). Most professors took the roll, and cutting class just wasn't tolerated. Nobody had TV, telephones, pets, or air conditioning in their rooms, and because of the lack of social activities there was nothing to do in our spare time but study. This system produced a generation of scientists and engineers who had self-confidence born from conquering failures. We came out of

school with personal initiative and determination—something today's graduates lack.

Your ideas about freely awarding high grades, essentially just for doing the class work or maybe just for being in class, are misguided. I doubt Dr. Deming was correct when he maintained that learning and making a grade are very different things. If today they are different, then perhaps we should reexamine our schools and our teachers.

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[Author replies: I appreciated your description of your experience in your aerospace engineering studies in college. It was not unlike my own experience in my mechanical engineering studies at around the same time. Needless to say, I remember very little of the content that was stressed on the numerous (and always graded) tests during that program. What gets me by is the process of learning that I learned from my parents and from far too few of my teachers.

Dr. Deming never proposed an all-A grading philosophy. Equally incorrect is your suggestion that I recommend "freely awarding high grades, essentially just for doing the class work or maybe just for being in class."

Dr. Deming tried to teach us two points:

1. It is impossible to measure student effort and achievement separately from other components of the system. Students alone do not produce test scores (or lab project results and so on). Other factors affecting test scores include the text, professor, technology, the test itself, and many other variables. Your college's 3-point grading system assigned grades to the students alone, thereby violating everything your physics professors taught you about systems theory.

2. When analyzing test scores (and other outcomes), the question is not, "Are the outcomes (or students or professors or vendors) different?" The question is, "Are they significantly different?" If test scores are not significantly different, then those students should not be ranked or graded differently. On the other hand, if scores are significantly different, those students should be ranked, graded, or otherwise treated differently. Once again, your college's 3-point grading system and your professors who "graded on a bell curve" were irrational, violating everything your statistics professors taught you about the normal, Poisson, binomial, and other models of random variation.

The grade inflation that is rampant throughout K-12 and higher education today is in no way reflective of the demanding and vigorous process of learning that Dr. Deming advocated.

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