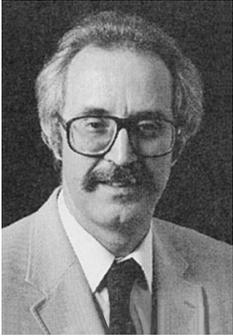


## EDITORIAL



**Edward R. Dougherty**  
Editor

The University of Rochester administration has recently announced that it will close graduate programs in a number of departments, two of these being mathematics and chemical engineering. While at first this might appear to most people as simply one major research university deciding to restructure itself into a not-so-major university, for those of us in the imaging community there is much more at stake. Because it is home to both Kodak and Xerox, Rochester is one of the major imaging centers in the world, and therefore the future of imaging is closely tied to significant imaging events in Rochester. And there can be little doubt that suspension of graduate research and teaching in two key foundational imaging disciplines is not insignificant, especially when no other programs exist in the area to take their place.

Even if we ignore silver halide imaging and restrict our focus to digital imaging, chemical engineering plays a

role in imaging materials, toners, and numerous other staples of digital imaging. The case for mathematics is even more compelling when it comes to digital imaging, which happens to encompass the stated visions for both Kodak and Xerox. Nevertheless, the University of Rochester administration has decided to eliminate graduate-level mathematics.

When processed, either digitally, optically, or chemically, an image is modeled as a two-dimensional random process, one of the most complicated mathematical entities. To seriously model image processes and filters, one needs a serious mathematical education—and not just in one or two areas of mathematics. In fact, the application areas of mathematics in imaging science span mathematics itself: probability theory, mathematical statistics, topology, logic, numerical analysis, computational complexity, measure theory, linear algebra, functional analysis, nonlinear optimization, generalized function theory, potential theory, analytic function theory, partial differential equations, differential geometry, lattice theory, group theory, and integral equations. I could go on but I think the point should be clear. Indeed, in my own research I have applied almost all of the aforementioned mathematical disciplines. I have been able to do this for a single reason: I was educated by world-class research mathematicians.

Perhaps the decision makers at the University of Rochester are not aware of the centrality of mathematics within physical science. This is not evident in contemporary introductory textbooks, many of which actually form false impressions in the minds of students. But the matter is well understood among scientists. Simply put, there is no scientific phenomenology without mathematics. Put more substantially by the physicist Sir James Jeans:

*The final truth about a phenomenon resides in the mathematical description of it; so long as there is no imperfection in this, our knowledge of the phenomenon is complete. We go be-*

*yond mathematical formula at our own risk . . . . The making of models or pictures to explain mathematical formulae and the phenomena they describe is not a step towards, but a step away from, reality; it is like making graven images of a spirit.*

The relevance of Sir James' statement is nowhere more evident than in image processing. One need only think of the attempts to trivialize the Wiener-Kolmogorov filter theory or the Karhunen-Loeve representation theory and the misunderstanding such attempts have generated.

The situation at the University of Rochester has already drawn national attention relevant to the quality of education it portends. I recently received a statement from the American Mathematical Society (AMS) concerning termination of the graduate program in mathematics at the University of Rochester. The AMS has sent a fact-finding committee to meet with both the university administration and the Mathematics Department. The statement provides an excellent summary of the need for first-rate mathematical education and the salient role of mathematics in science. The AMS states:

*Mathematics is the language without which all science and technology . . . would be in a primitive state . . . . This is the subject which the University of Rochester proposes to purchase, like a commodity, at the cheapest available price for resale to its students.*

Relative to imaging education, the problem in Rochester may be more stark than whether or not students are to get the best instruction. Will there, in fact, be any courses available at all? The kind of mathematics graduate courses necessary for contemporary research in image processing might simply cease to exist in the city of Kodak and Xerox. They are not offered by the Rochester Institute of Technology and now it appears they will not be offered by the University of Rochester. Let me quote from an editorial in the *Democrat and Chronicle* (Rochester's

major newspaper) written by Neil A. Frankel, manager of the Advanced Components Laboratory in Xerox's Joseph C. Wilson Research Center for Research and Technology:

*I would also like to know how the university can explain to Kodak and Xerox, whose founding families donated much of the existing endowment, why the elimination of graduate-level mathematics and chemical engineering is "good" for these companies and for the community. I can't imagine any conceivable way that this case could be made in a convincing way, not even by the spin doctors who are in charge of the university's current public relations campaign.*

It could be argued by the University of Rochester administration that the re-

search of the Mathematics Department is not directly related to imaging. But here I make two points. First, fundamental mathematical understanding of image processing requires sound mathematical training at the graduate level, and this can only be imparted in the various mathematical disciplines by world-class experts in the disciplines. Second, it is the university's choice that mathematical imaging is not a major activity of the Mathematics Department. Given the existing expertise at the University of Rochester, it would take only a few additional outstanding faculty to establish a world-class program in mathematical imaging to serve the community. Would this not be bet-

ter than abandoning a core imaging discipline?

Because it is the function of a society to serve the needs of both its members and its profession, I take this opportunity to offer my services to University of Rochester President Jackson. If he so desires, I will help to organize an international committee from among the world's leading imaging mathematicians to develop a strategic plan for mathematical education and research in imaging. Such a plan could preserve the traditional integrity of the academy while at the same time serving the long-term needs of the imaging industry in both Rochester and the United States.