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several questions about what subject matter should be included in an undergraduate course on optics. We think that these questions have a broad meaning for the physics community that transcends interest in a book review and would like to comment on them.

Numerous surveys conducted by the AIP and others in recent years have shown that there are fewer opportunities along traditional career paths today than in the past. It follows that if the present generation of physicists continues to be trained according to traditional procedures, it will be trained for increasingly non-existent careers.

A realization of this problem has prompted a great deal of discussion of alternate careers in applied areas. We submit that if physicists are to pursue alternate careers the nature of their education and training must be changed so as to enhance the prospects of their successful pursuit of these alternate paths. This cannot be done as an afterthought while keeping the structure and content of our courses unchanged.

There is an adage to the effect that "Generals spend time between wars learning to fight the past war better." What we must avoid is physicists spending time between technological cycles learning to contribute better to the past cycle.

The reviewer concluded that our book would make a fine text in an applied-optics course, but that a number of topics found in a traditional optics course were not covered. That is precisely the point! A book or course cannot include all of the traditional material and have room for modern applications other than by adding a few footnotes here and there or a brief section at the end. To meet today's needs there should be an emphasis on newer topics.

In addition to the proper selection and emphasis of topics the manner of presenting the material is important. We think that optics should not be taught by the *deductive method*—writing down Maxwell's equations and deriving expressions from them. Students tend to become immersed in vector algebra and do not learn how to apply their knowledge. The subject should be taught by the *inductive method*—the key experiments that form the basis of what we know should be reviewed. The fundamental properties of light waves and their interaction with matter should be built up one by one by reference to phenomena. This approach, particularly when associated with a laboratory, helps students develop an intuition for phenomena and this makes it easier for them to apply their knowledge to real-world problems.

In today's world, not only courses in applied optics, but also the standard undergraduate course in optics should be taught along the lines outlined above.

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7/25/77

Commodity reserves

Recent letters have discussed known world reserves of several important energy-related commodities such as coal and uranium. The discussions often center on how long it will take for such reserves to be "used up," given various sets of assumptions. In this respect I thought your readers might be interested in the following table taken from the May 1977 issue of the Morgan Guaranty Survey.

This table shows that the known reserves of all but one of the eleven commodities listed actually *increased* in the period from 1950 to 1970, some by extraordinary amounts. Unfortunately coal and uranium are not listed. While it would be rash to conclude from this table that the more such commodities are used up, the more we still have, I think it is fair to say that predicting the "life expec-

Known world reserves—1950–1970

	1950	1970	Percent change
	Thousands of metric tons		
Iron	19 000 000	251 000 000	1 221
Manganese	500 000	635 000	27
Chromite	100 000	755 000	675
Tungsten	1 903	1 328	−30
Copper	100 000	279 000	179
Lead	40 000	86 000	115
Zinc	70 000	113 000	61
Tin	6 000	6 600	10
Bauxite	1 400 000	5 300 000	279
Potash	5 000 000	118 000 000	2 360
Phosphates	26 000 000	1 178 000 000	4 430

tancies" of any commodity is probably very difficult, to say the least. Perhaps it isn't even worth the effort. The basic problem in such predictions, I believe, lies in understanding what proven reserves actually are, namely "resources that can be economically mined at *current* prices and with *current* technology." Who among us would be willing to predict future prices and future technology with confidence?

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6/2/77

Electron microscopes

Sidney Abrahams and Jerome Cohen (November, page 34) urge the development of high-voltage scanning instruments as beneficial for materials research. They suggest the need for a national facility, or funding for developing techniques, theory and equipment.

It would appear that the National Institutes of Health, at least, agrees with Abrahams and Cohen, for we have been supporting, for the past five years, Elmar Zeitler's construction of a one-angstrom, one-million-volt instrument at the University of Chicago. In view of Abrahams's and Cohen's concern, I am surprised they are not aware of this (or, for that matter, of the fact that the Arizona State microscope is the work of *Alex* Strojnik and not Marija Strojnik).

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3/21/77

THE AUTHORS COMMENT: In reply to Eric Glass, we are aware of the developments in high-voltage electron microscopy at Arizona State University and the University of Chicago (see pages 41–42 of our article). We would like to correct our previous statement that the 500 kV electron microscope at Arizona State was built by Marija Strojnik: it was in fact designed and built by her father, Alex Strojnik. Our concern for funding a national high-voltage electron microscope facility is to make available user-oriented instrumentation with adequate services that many US scientists can exploit, rather than individual laboratory instruments. In addition, such a facility should include among its purposes development of the theory, techniques and design necessary for advancing the field. Further comments on the need for a national facility may be found in the article by J. M. Cowley and S. Iijima in the March issue (page 32).

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