Letters

Omnibus Language Proposal

Most physical scientists, particularly graduate students, need the "dictionary-hunt" knowledge of two or three foreign languages, despite the contrary opinions and high costs cited by Nichols and Everson (Letters, 23 June). I have a suggestion that may seem bizarre at first; it is based on comments made by Fritz Zwicky at a symposium on Modern Methodology at Caltech recently. Briefly, Zwicky feels that languages can best be taught several at a time, as in his native Switzerland. He claims that in this manner, similarities and differences would stand out and be more easily remembered by students. Several of us urged him to prepare a textbook so that his idea could be tried, possibly in a special course for graduate students in the sciences.

No one seems to have given much thought to a course in "scientific languages," say, German, Russian, French, Italian and Spanish. A graduate student usually has had 2 years in one of these so that the comparative aspects of grammar would not be too difficult. As Zwicky points out, scientific terminology tends to be the same in most languages, and the student specializing in physics, for instance, is in any case helped by equations and diagrams. The purpose of such a course would be to give a student confidence in finding and reading articles in foreign journals about his own thesis topic, without spending the time to learn two or three languages thoroughly. The linguists will undoubtedly object to such shallow treatment, but they may be reassured that regular language courses will still be needed for other purposes, and that the five-language course may reduce the bored fringe of disinterested students in regular language classes. The major problem is who can teach such a course? (other than Zwicky)!

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Methanol: A New Fuel?

"Energy needs versus environmental pollution: a reconciliation?" (16 June, p. 1448) by Leon Green, Jr., proposed a system of energy generation based upon the use of ammonia as a fuel. The general thesis developed is attractive in that it provides for conversion of fossil fuels into a chemical fuel in such a way that waste products can be readily controlled and contained at the point of release. On the other hand, I think that Green's suggestions would have been much more practical if he had given consideration to the production of methanol rather than ammonia.

The chemical process used to convert fuel gas, petroleum fractions, or even coal to methanol is essentially the same as the process used for production of ammonia. In both, the original raw material is converted to a mixture of carbon monoxide and hydrogen which is then further processed to produce the desired final product. The efficiency of conversion is approximately the same in both cases, and a substantial fraction of the carbon originally present in the fossil fuel disappears from the system as carbon dioxide. In the case of ammonia, all of the carbon is separated in this manner; with methanol, about two-thirds is removed.

The cost of erected facilities for the production of ammonia or methanol are roughly comparable. Once very large plants are designed for producing methanol, the relative simplicity possible in handling the product as compared with the requirements for liquifying and pressurizing the ammonia product will probably result in an advantage in the overall investment cost. Methanol can be stored at atmospheric pressure under all normal conditions and can be readily shipped by pipeline, by normal tank car, or tank truck. Because of its very low freezing point and low viscosity, it can be used easily for all conventional fuel requirements.

It is interesting to note that, with some adjustment to the carburetor, methanol can be used as a fuel in ordinary internal combustion engines. It is a completely clean fuel requiring no additives, lead, or other constituents which tend to aggravate atmospheric pollution problems. Of course, it would be essential that the internal combustion engine be adjusted properly to avoid formation of oxygenated hydrocarbon compounds in the exhaust gases.

Of even more interest is the possibility of utilizing methanol directly as a fuel for a direct conversion fuel cell. Substantial work in this direction has been carried out at Institut Français du Pétrole where demonstration cells have already been built and operated for many thousands of hours. Use of methanol in this manner would permit a ready transition from hydrocarbon fuels inside of city areas with a gradual replacement of internal combustion engines by electric motors powered by fuel cells.

Production of methanol could be taken over completely by large energy companies currently refining petroleum and distributing hydrocarbon fuels. The investment required to produce enough methanol to replace all existing fuels would certainly be extremely high, but may not be out of proportion to that required for producing low-sulfur conventional fuels such as is being required by legislation currently being enacted throughout the country.

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Computer Science

Professors of computer science are often asked: "Is there such a thing as computer science, and if there is, what is it?" The questions have a simple answer:

Wherever there are phenomena, there can be a science to describe and explain those phenomena. Thus, the simplest (and correct) answer to "What is botany?" is, "Botany is the study of plants." And zoology is the study of animals, astronomy the study of stars, and so on. Phenomena breed sciences.

There are computers. Ergo, computer science is the study of computers. The phenomena surrounding computers are varied, complex, rich. It remains only to answer the objections posed by many skeptics.

Objection 1. Only natural phenomena breed sciences, but computers are artificial, hence are whatever they are made to be, hence obey no invariable laws, hence cannot be described and explained. *Answer.* 1. The objection is patently false, since computers and computer programs are being described and explained daily. 2. The objection would equally rule out of science large portions of organic chemistry (substitute "silicones" for "computers"), physics (substitute "superconductivity" for "computers"), and even zoology (substitute "hybrid corn" for "computers"). The objection would certainly rule out mathematics, but in any event its status as a natural science is idiosyncratic.

Objection 2. The term "computer" is not well defined, and its meaning will change with new developments, hence computer science does not have a well-defined subject matter. *Answer.* The phenomena of all sciences change over time; the process of understanding assures that this will be the case. Astronomy did not originally include the study of interstellar gases; physics did not include radioactivity; psychology did not include the study of animal behavior. Mathematics was once defined as the "science of quantity."

Objection 3. Computer science is the study of algorithms (or programs), not computers. *Answer.* 1. Showing deeper insight than they are sometimes credited with, the founders of the chief professional organization for computer science named it the Association for Computing Machinery. 2. In the definition, "computers" means "living computers"—the hardware, their programs or algorithms, and all that goes with them. Computer science is the study of the phenomena surrounding computers. "Computers plus algorithms," "living computers," or simply "computers" all come to the same thing—the same phenomena.

Objection 4. Computers, like thermometers, are instruments, not phenomena. Instruments lead away to their user sciences; the behaviors of instruments are subsumed as special topics in other sciences (not always the user sciences—electron microscopy belongs to physics, not biology). *Answer.* The computer is such a novel and complex instrument that its behavior is subsumed under no other science; its study does not lead away to user sciences, but to further study of computers. Hence, the computer is not just an instrument but a phenomenon as well, requiring description and explanation.

Objection 5. Computer science is a branch of electronics (or mathematics, psychology, and so forth). *Answer.* To study computers, one may need to study some or all of these. Phenomena define the focus of a science, not its boundaries. Many of the phenomena of computers are also phenomena of some other science. The existence of biochemistry denies neither the existence of biology nor of chemistry. But all of the phenomena of computers are not subsumed under any one existing science.

Objection 6. Computers belong to engineering, not science. *Answer.* They belong to both, like electricity (physics and electrical engineering) or plants (botany and agriculture). Time will tell what professional specialization is desirable between analysis and synthesis, and between the pure study of computers and their application.

Computer scientists will often join hands with colleagues from other disciplines in common endeavor. Mostly, computer scientists will study living computers with the same passion that others have studied plants, stars, glaciers, dyestuffs, and magnetism; and with the same confidence that intelligent, persistent curiosity will yield interesting and perhaps useful knowledge.

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"The Big Trouble with Scientific Writing . . ."

When I see articles, as I frequently do these days, exhorting authors to greater simplicity and clarity (*1*), I think of the first little scientific note I wrote, when I was an idealistic graduate student. I wrote it as simply and directly as I could. It began, "The big trouble with diffusion cloud chambers is low radiation resistance," and it went on in the same vein. My co-workers thought it needed a little more work. Secretly I did not agree, so I decided to attempt to make it into a parody of