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Methodology and Theory at the Frontier

The advance of science is much like a game of leapfrog in which there are alternating hurdles of theory and experiment. A new theory frequently leads to a new technology, which generates new data. This progress results in dichotomies between the new data and the current theory, leading to the demand for better theory. For example, as atomic spectroscopy improved in accuracy, it revealed flaws in atomic theory, which directly caused the succession from the Thompson atom to the Bohr atom. The deciphering of the genetic code in molecular biology led to the ability to engineer DNA, but only after two new technologies—sequencing and cloning—had been developed. If sequencing had not been accompanied by the ability to produce large quantities of DNA, sequencing efforts would have been severely curtailed. Conversely, the manipulation of DNA by restriction enzymes would have been very limited without the ability to sequence. In combination, these technologies made genetic engineering not only possible, but also extraordinarily easy to perform.

Another aspect of new technology is its cross-disciplinary character. Sometimes an innovation contributes to the development of all fields of science, as did the computer. Chemists are benefiting from the NMR of physicists, and neuroscientists from the nuclear devices of PET scans. Neurobiologists are locating areas of the brain and identifying them with specific cognitive processes; they are aided by advanced instruments that use chemical and physical techniques. The lever arm of scientists has been extended enormously by new tools that simply did not exist even 5 years ago. It is inspiring to realize that today's college student can determine in hours the structure of molecules that the greatest organic chemists of the past would have taken years to solve.

To help accelerate the interaction of techniques with theory, the AAAS is sponsoring a new type of yearly meeting entitled Science Innovation, whose preliminary program appears on pages 1727 to 1736 in this issue of *Science*. This new broad-scale meeting is itself an innovation that provides a catalyst between theory and experiment, emphasizing techniques and principles that transcend disciplinary lines. The program features outstanding practitioners in the theory and techniques of modern science. Theorists can bring a shopping list of techniques they would like to see developed. Experimentalists who have developed techniques can extol the virtues of their methods and get ideas as to how they can be expanded in scope, versatility, and speed. A new potential for collaboration should appeal not only to those actually developing techniques, but also to those who want to harness new techniques to explore their ideas and solve their research problems. The use of tutorials in the morning and workshops in the afternoon allows scientists to expand to new areas and consolidate their information by interactions with those having hands-on expertise in the technique.

Future Science Innovation meetings undoubtedly will evolve to optimize the interaction of theory and experiment. The instruments for new technologies in research usually develop into medical or consumer products. In the interim, scientists can have great fun in their wonderful toy stores of glistening new instruments. A good machine can enormously increase the potentials of science, and the extraordinary symbiosis between theory and experiment enhanced by instruments has made modern scientists more productive than their predecessors. This productivity has led to the gigantic fattening of journals and the proliferation of new ones. It is conceivable that, in the near future, the biologist's "one gene, one enzyme" will be expanded to "one gene, one journal." The equivalent flowering of physics, chemistry, and related disciplines may result in "one byte, one instrument." The new reality is that scientists who desire to be on the cutting edge must keep apace of techniques in other disciplines as well as in their own fields. Meetings provide a key resource, distilling from the plethora of published developments those that are crucial for discussion and exploration. In the past, most scientists attended focused meetings within their own disciplines to get the most bang for a buck. Scientists of the future must parlay their meeting currency in order to buy techniques across the spectrum of science—to expand their problem-solving skills beyond the immediate horizons and participate in the revolution of technology that will most assuredly follow.—DANIEL E. KOSHLAND, JR.