adequate training of scientists and engineers, there will be increasing and more traumatic social, psychological, economic, and political needs that must be met. To provide adequate training of personnel to meet such needs, the educational system must undergo basic changes, in substance and method, at various levels. Another aspect of the problem is the lag between the national educational establishment and the rapidly expanding field of future studies. A wealth of knowledge about probable future trends and alternatives, in all aspects of society, has been accumulating rapidly in recent years, by which training institutions could be guided in measuring up to changing conditions and demands.

A third feature that must be addressed relates to the inner space of man. The startling findings of scientific research in recent years, at the frontiers of physics, chemistry, biology, psychology, physiology, neurology, and other fields, have been converging in such a manner as to create a revolutionary concept of human nature and its world. The traditional image of man and his perception of reality, to which the educational system has been anchored, is steadily fading away. A new image is arising with outstanding components, such as human potential for creative unfolding is infinite; the child is born with an innate biological pattern that should be the primary guide for its education and development; the structure and functions of the brain (or rather brains) are revealed and understood as never before, opening the door for new insights into human perception, motivation, emotion, memory, learning, consciousness, and self-awareness; and new and baffling dimensions of reality are encountered in the realm of subatomic physics.

The crucial question that concerned leaders of thought and policy must answer is how to bring this emergent, revolutionary image of man and his world into the heart of the educational method at all levels.

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In his editorial of 14 September, Abelson calls for better career guidance of able youths. In the Study of Mathematically Precocious Youth (SMPY) at the Johns Hopkins University, we have worked out and tried what is called the 4D (Discovery, Description, Development, and Dissemination) model with more than 10,000 mathematically gifted junior high school students (chiefly seventh graders). We believe it provides the guidance and educational flexibility needed.

The first step is to locate intellectually talented youths who attend school in a seven-state area (Maryland, the political entities that touch it, and New Jersey), chiefly by means of an annual talent search. Any seventh grader, or a youth in a higher grade who is of seventh-grade age, who scores in the top 3 percent on national norms for the mathematical, verbal, or total composite score of a school-administered standardized achievement-test battery such as the Iowa Test of Basic Skills may register for the talent search with our Office of Talent Identification and Development (OTID) and take the College Board's Scholastic Aptitude Test (SAT) in the nationwide January administration. The key concept is that this three-part (verbal, mathematical, and English composition) SAT is difficult enough to assess the mental power and precocity of these youths, most of whom are four or five school grades below the last 2 years of senior high school, when the test is usually given. We consider that a participant in the talent search reasons exceptionally well mathematically if he or she scores at least 500 on the SAT, which is above the average of college-bound 12th-grade males and roughly the upper 1 percent of 11- to 12-year-old boys. About one-fourth of the males and one-eighth of the females in the talent search do this well. Comparable criteria are 430 for the verbal SAT and 43 for the Test of Standard Written English, on the latter of which SMPY's girls exceed the boys.

Although the SAT is invaluable for identifying highly able youths, even with three scores it has little *diagnostic* power. The high scorers need to be further studied with tests difficult enough to determine their specific knowledge and aptitudes. For example, how well do they score on the College Board's Mathematics I and II achievement tests or the mathematics test of the American College Testing (ACT) Program? How much general science do they know, as evaluated by the ACT-Natural Science Reading test, the college level of Educational Testing Service's Sequential Tests of Educational Progress (STEP) in Science, or the College Board's Physics achievement test? How much Algebra I can they do, even before taking the course? How apt are they in mechanical reasoning (for example, as measured by one of the Psychological Corporation's tests), spatial relationships, nonverbal reasoning (we like the 36-item, difficult Raven Progressive Matrices Test), and so forth? What are their vocational interests, attitudes, and values? How extroverted or introverted is

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each of them? How neurotic? (We do not, however, probe deeply into personalities or seek personal problems unless already obvious.) What factors in their homes, including the educational attitudes of parents, are likely to affect the use of their intellectual talents? Also, of course, talents for the various performing arts are important, though SMPY and OTID are not well equipped to assess them.

Identifying the youths and studying their characteristics will usually be nonproductive, however, unless from that point on they are helped educationally in major ways. SMPY's specialty is the area of mathematics; students are instructed in fast-paced special classes from Algebra I through the first year of college calculus. Virtual miracles of acceleration can be accomplished in this individualized manner, such as an 11-year-old youth's scoring extremely high on the college-level Advanced Placement Program examinations in Calculus BC, Physics C1 (Mechanics), and Physics C2 (Electricity and Magnetism). Quite a few eighth and ninth graders can readily complete the first year of college calculus well, as judged by this calculus exam. Some youths we have helped went on to receive their baccalaureates at ages as young as 15 and their master's degrees at 17. Within a few years a number of them seem likely to earn Ph.D.'s from top-level universities many years sooner than the age 30 or so that is average for most scientific fields. The increase in person-years of expertise should be invaluable to the individuals themselves and also to society.

Further information about SMPY's pioneering can be found in five books already published by the Johns Hopkins University Press or in press there: *Mathematical Talent* (1974), *Intellectual Talent* (1976), *The Gifted and the Creative* (1977), *Educating the Gifted: Acceleration and Enrichment* (1979), and *Women and the Mathematical Mystique* (in press). Also, reprints of certain relevant articles are available from SMPY. We do not discuss here the newly created OTID role in verbal areas. Inquiries about that and the 1980 talent search should be addressed to OTID director George.

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