SCIENCE

1 October 1976

Volume 194, No. 4260

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Western Electric Reports:

Rumpelstiltskin lives!

Rumpelstiltskin found his niche in fairy tales by spinning straw into gold. That once seemed only a little more challenging than the host of engineering problems the Bell System faced in developing a practical lightwave communications system. Problems like spinning "wires" of glass.

In lightwave communications, pulses of laser light are used to transmit millions of bits of information through hair-thin glass fibers. A bundle of such fibers not much thicker than a lamp cord can carry as many telephone conversations as a copper cable the thickness of your arm.

Bell Labs researchers came up with a recipe for glass fibers so transparent a light beam passing through 500 feet of the material would lose less intensity than in passing through a window pane. So repeaters could be economically spaced—about four miles apart.

But a way also had to be found to make the fiber at mass production speeds without deviating more than 1% in diameter.

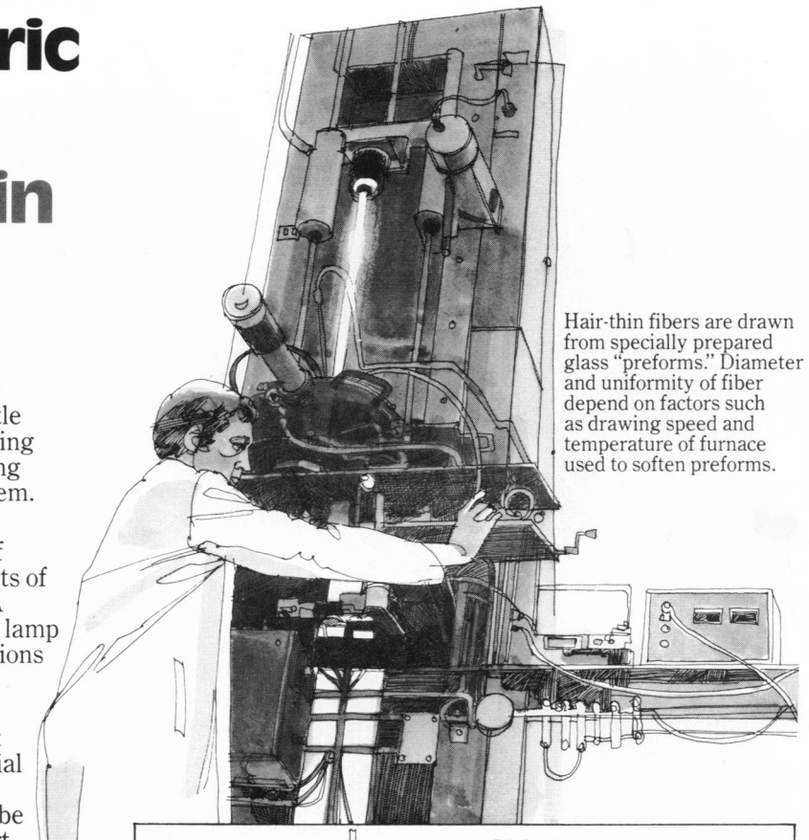
The people at Western Electric's Engineering Research Center in Princeton, N.J., tackled the problem while lightwave development continued at Bell Labs.

They discovered that laser light, shined on an optical fiber at an angle perpendicular to its axis, casts a characteristic light pattern. They were able to correlate this pattern to changes in the fiber's diameter. And to build an automatic feedback system into existing fiber drawing machines to control it.

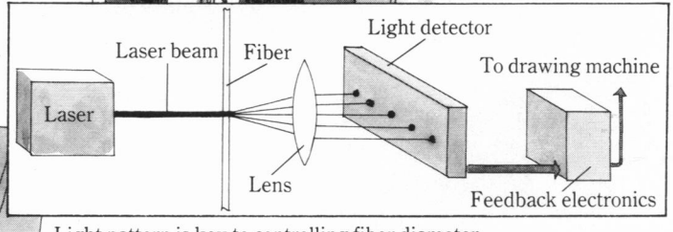
The result is ultrasmooth glass fiber with a diameter varying no more than thirty-millionths of an inch.

Bell System engineers have found practical ways to fashion the fibers into cables that can be pulled through underground ducts, and to splice them with negligible light loss in the real world of manholes and city streets.

Benefit: Today, an experimental lightwave system is being tested at a Bell Labs-Western Electric facility in Atlanta. In the early 1980's, lightwave communications will probably be used to relieve cable congestion between major telephone switching centers. And as it proves competitive with other technology, it will spread throughout the telephone network.



Hair-thin fibers are drawn from specially prepared glass "preforms." Diameter and uniformity of fiber depend on factors such as drawing speed and temperature of furnace used to soften preforms.

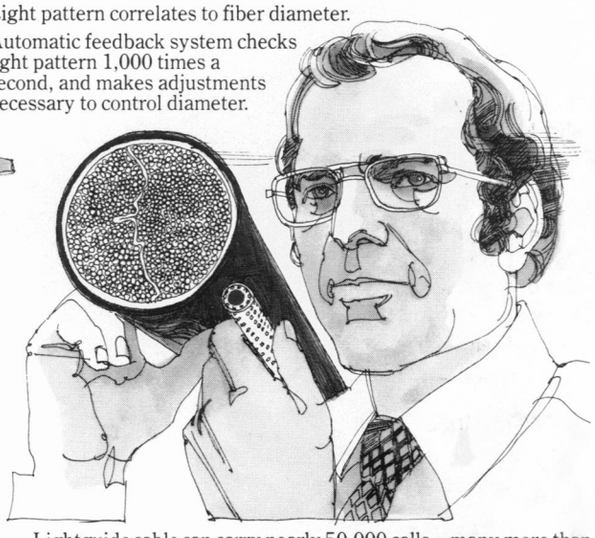


Light pattern is key to controlling fiber diameter.

a) Laser light is shined perpendicular to fiber.

b) Light pattern correlates to fiber diameter.

c) Automatic feedback system checks light pattern 1,000 times a second, and makes adjustments necessary to control diameter.



Lightguide cable can carry nearly 50,000 calls—many more than larger copper cable. Imagine the space that saves underground.

Western Electric

For years I suffered terribly from

LETHOLOGICA

until a nice doctor friend prescribed

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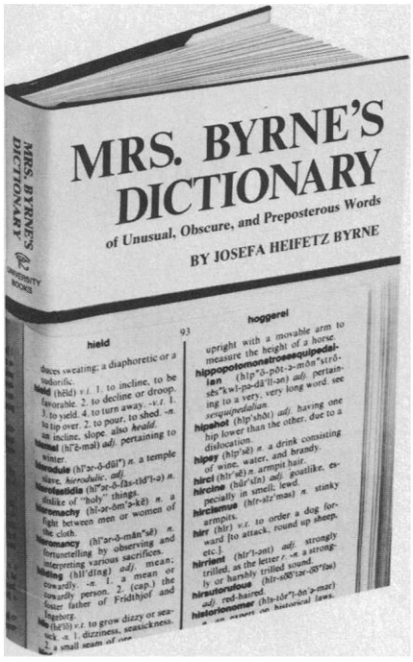

Yes, for years I couldn't remember the right words. People I considered complete idiots were finishing my sentences for me. I was leaving blanks in my love letters and suicide notes. I found how bleak the future was when I tried a little cephalonamancy (fortunetelling by boiling an ass head), and tyromancy (fortunetelling by watching cheese coagulate).

I went from doctor to doctor looking for help, finally becoming a confirmed iatrapistiac (one having little faith in doctors), especially when one suggested I needed a hepaticocholangiocholecystenterostomy (look it up).

Then I found *Mrs. Byrne's Dictionary*. Now I can be unusual, obscure and preposterous by turns. Now I don't need an unabridged to go along with my collegiate. For entertainment now, I browse instead of groak (watching people silently while they eat, hoping they'll ask you to join them). I don't care anymore that we have a kakistocracy (government or rule by the worst).

Mrs. Byrne's Dictionary by Josefa Heifetz is better than omphaloskepsis!

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SCIENCE

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COVER

Color mosaic of Viking 1 Orbiter pictures. Fifteen frames taken through three color filters (violet, green, and red) were reconstituted by the U. S. Geological Survey, Flagstaff, Arizona. The scene covers approximately 1800 by 2000 kilometers and contains part of the "Grand Canyon of Mars" (*Vallis Marineris*). The Viking 1 landing site is north of the scene. See page 97.

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To understand their argument we must consider it in detail.

Feldman and Lewontin begin by terming the analysis of variance a local perturbation analysis, as indeed it is under certain assumptions (and geometry and the natural sciences likewise). Then they introduce broad heritability, which can be determined only from the study of identical twins reared apart in random environments, provided that gene-environment covariance and differential effects of prenatal environment are negligible. Since in practice broad heritability is not estimable, flogging it seems unnecessary. They next conclude that "statistical inference about the heritability of traits that are phenotypically plastic is invalid." What does this mean when heritability is the complement of plasticity? They cite approvingly two comments by Moran on genotype-environment covariance, both of which were subsequently corrected (*1*). A valid treatment of gene-environment covariance was introduced more than half a century ago by Wright and later refined (*2*).

I take greatest exception to the section of the article in which the authors advocate a purely empirical method of calculating the risk of genetic disease, thereby attacking a promising development in genetic counseling—the use of genetic models. Most genetic disease is of complex etiology. Until recently, recurrence of such conditions could be estimated only by empirical calculation of risks. This method depends on no detailed genetic analysis, considers only the child immediately following the proband, and pools families of different composition, ignoring normal siblings, more remote relatives, sex, age, quantitative information, and etiological heterogeneity. The dictionary definition of "empiric" is "one who deviates from the rules of science or accepted practice; one who relies upon practical experience alone, disregarding all theoretical and philosophic considerations; hence a quack, a charlatan"—the very apotheosis of local perturbation.

Hemophilia illustrates the way in which the empirical calculation of risks can be first a step forward, then backward. Almost 2000 years ago the Talmud used empirical risk calculation: later-born sons of a woman who had lost two boys due to bleeding were not to be circumcized, nor were the sons of her sisters; but paternal half-sibs were treated as normal individuals. While remarkably accurate for its day, this is less predictive than the determination of genetic risks based on detection of carrier women, which does not require the signal of two prior deaths. Faults of empirical risk calculation are rectified in complex segregation analysis, which gives specific and precise estimates of genetic risks (*3*). One of the required parameters is heritability. Feldman and Lewontin's statement that "confusing risks can be calculated separately for various ages, socioeconomic classes, cultural patterns, and the like," does not convey to the reader that affection of family members is the central factor in genetic counseling. The counselor who follows the advice of Feldman and Lewontin and prefers the empirical calculation of risks to the more complete specification provided by genetic analysis is giving his patient second-rate service.

After this fallacy, so damaging to medical genetics, discussion of gene-environment interaction and intergroup differences is anticlimactic. Interaction diminishes family resemblance and need not concern those whose task is to explain resemblance, not dissimilarity. The heritability of group differences cannot be predicted from intragroup heritability, but no geneticist supposes that it could.

Feldman and Lewontin have generalized their attack on a particular psychologist to include a significant part of science. They are concerned about possible abuse of genetics by nongeneticists, forgetting how often dire prophecies are dispelled by investigation (*4*). The evil they fear thrives in the obscurity they cultivate. Their clumsy harrying of biometrical genetics is entirely unbecoming and does only senseless harm to the cause of science and humanity (*5*).

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References

1. R. G. Holroyd, *Ann. Hum. Genet.* **38**, 379 (1975).
2. S. Wright, *Genetics* **6**, 111 (1921); *J. Am. Stat. Assoc. Suppl. 26* (1931), p. 155; D. C. Rao, N. E. Morton, S. Yee, *Am. J. Hum. Genet.* **26**, 331 (1974).
3. N. E. Morton and C. J. MacLean, *Am. J. Hum. Genet.* **26**, 489 (1974).
4. N. E. Morton, C. S. Chung, M. P. Mi, *Genetics of Interracial Crosses in Hawaii* (Karger, Basel, 1967).
5. DeW. Stetten, Jr., *Genetics* **81**, 415 (1975).

In contrast to Feldman and Lewontin, we welcome the recent swing of psychology from the environmental excesses of the past to a more balanced view of the biological bases of behavior (*1*). Behavioral genetics is but one part of a zeitgeist that is bridging the gap between the study of behavior and the study of biology, a movement that includes both sociobiology and psychobiology (*2*).

Contrary to the impression that Feldman and Lewontin create, it is not difficult to find examples of the usefulness of

genetic analyses in the study of complexly determined behavior. Psychopathology is an obvious example. Before the mid-1960's, psychologists continued to look for environmental causes of schizophrenia and other psychoses. In 1966, a single behavioral genetic study turned the field around. Heston (*3*) studied the adopted offspring of 47 schizophrenic women and compared them to a matched control group of adopted children whose biological parents had no known psychopathology. Of the adopted children with a schizophrenic heritage, five were diagnosed as schizophrenic; none of the control children was schizophrenic. Regardless of whether one likes the concept of heritability, this behavior is clearly influenced by genetic factors. That is a fundamental piece of knowledge. Behavioral genetic studies have also led to important discoveries concerning the manic-depressive psychoses (*4*).

In addition to asserting that heritability does not advance either cures or counseling, Feldman and Lewontin reiterate the common knowledge that heritability estimates are limited to the population sampled and that genotype-environment interaction and correlation may be important. These points are misinterpreted by Feldman and Lewontin to mean that quantitative genetic analyses are, therefore, of no use. The conclusion does not follow (*5*). The very purpose of quantitative genetic studies is to *describe* genetic variability *in a specific population* and to ascribe that variability to environmental differences and genetic differences in that population (*6*). The question of generalizing to other samples and other times can only be answered empirically (the evidence with respect to cognitive abilities suggests considerable generalizability). Feldman and Lewontin seem to be more concerned with the question of *what could be* rather than *what is*. That is a legitimate concern, of course, but it should not be the basis for a critique of quantitative genetic analysis.

One aspect of their article that was most disturbing to us was its polemical nature. Feldman and Lewontin imply that the motivation of geneticists is eugenic and that they are the dupes of politicians who "use genetic misinformation to rationalize a politically determined policy." Rather than attempting to discredit research in behavioral genetics, the authors could better serve science by encouraging the search for specific genotype-environment interactions or genotype-environment correlations that they assume to be so important.

In addition to these general issues, it is necessary to address one technical point

concerning Feldman and Lewontin's discussion of the relationship between within-group heritability (h^2_W) and between-group heritability (h^2_B), which they also use to symbolize heritability in the broad sense). Although not cited by Feldman and Lewontin, h^2_B was first expressed as a function of h^2_W (their equation 3) by DeFries (*7*). DeFries made two points: (i) There *is* a mathematical relationship between h^2_B and h^2_W, contrary to what Lewontin (*8*) had previously asserted; and (ii) nevertheless, high h^2_W by no means implies high h^2_B. Feldman and Lewontin agree with the second point, but they state that the first point is "entirely spurious" because equation 3 does not describe a "causal relationship." Surely they cannot mean that all noncausal mathematical relationships are entirely spurious (*9*).

Although we disagree with many of the assertions contained in their article, we share Feldman and Lewontin's interest in reliable data on adoptions. We believe that well-designed adoption studies can provide the best information about the relative importance of heredity as a cause of individual differences in human behavior, as well as the first solid information concerning the importance of genotype-environment correlations and interactions (*5*).

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References and Notes

1. See, for example, the 1975 presidential address of the American Psychological Association [D. T. Campbell, *Am. Psychol.* **30**, 12 (Dec. 1975)].
2. E. O. Wilson's highly touted tome, *Sociobiology: The New Synthesis* (Harvard Univ. Press, Cambridge, Mass., 1975), is one example of this trend.
3. L. L. Heston, *Br. J. Psychiat.* **112**, 819 (1966).
4. J. Angst and C. Perris, *Int. J. Ment. Health* **1**, 145 (1972); J. Mendlewicz and J. L. Fleiss, *Biol. Psychiatr.* **9**, 3 (1975).
5. For a discussion of the possible effects of genotype-environment interaction and correlation on quantitative genetic analyses and the use of adoption data to assess these effects, see R. Plomin, J. C. DeFries, J. C. Loehlin, *Psychol. Bull.*, in press.
6. J. L. Lush, in *Thirty-Third Annual Proceedings of the American Society of Animal Production* (1940).
7. J. C. DeFries, in *Genetics, Environment, and Behavior*, L. Ehrman, G. S. Omenn, F. Caspari, Eds. (Academic Press, New York, 1972), pp. 5–16.
8. R. C. Lewontin, *Bull. At. Sci.* **26**, 2 (March 1970).
9. Causality of the intraclass genetic correlation (r) and h^2_B is irrelevant to the existence of a relationship between h^2_B and h^2_W. Nonetheless, the assertion that r "is dependent on h^2_B and not vice versa" is wrong. J. C. Loehlin, G. Lindzey, and J. N. Spuhler [in *Race Differences in Intelligence* (Freeman, San Francisco, 1975), pp. 290–291] have rephrased DeFries' argument in terms of four quantities to be estimated: (A) genetic variance between groups, (B) genetic variance within groups, (C) environmental variance between groups, and (D) environmental variance within groups. It can be stated that $r = A/(A+B)$ and $h^2_B = A/(A+C)$. Thus, the two parameters are essentially coordinate in status.

Feldman and Lewontin conclude their consideration of eugenics with the statement, "In our opinion, geneticists ought to dissociate themselves utterly from eugenics because they can only give legitimacy (even if unwilling legitimacy) to pernicious social actions." This statement contains the implication that scientists might properly withhold scientific views that are judged to have undesirable social consequences. In the past, this opinion would have had interesting consequences. Recall, for example, the social impact of Darwin's theory of natural selection. The "social Darwinists," led by the most influential sociologist of the time, Herbert Spencer, reinterpreted the concept of fitness to imply that the poor were unfit, the rich fit. The theory of natural selection, thus popularized and (mis)interpreted, provided a rationale for exploitative, laissez-faire capitalism. Darwin thus gave legitimacy, presumably unwilling, to a social theory that we, at least, would consider "pernicious." Ought he to have desisted for that reason?

Eugenics, of course, is not in itself a purely scientific issue; however, its scientific component is not negligible, as attested by the paragraph in Feldman and Lewontin's article that precedes the above quotation. But other geneticists, notably H. J. Muller and his followers, might assess the scientific issues somewhat differently. Scientific advocates of eugenics have the same right, and even obligation, to express their views as do Feldman and Lewontin.

Maintenance of open discussion of scientific issues impinging on sensitive social issues is doubly important because, whereas scientific conclusions are at least in principle demonstrable, the judgment of which social consequences are desirable and which "pernicious" is intrinsically subjective. No person has a right to legislate such social attitudes for others, much less for a whole scientific community.

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Jensen first claims that our references to his work are inaccurate or misleading. But he does not offer a single example. It is therefore difficult to take this blanket condemnation seriously. The references he offers, far from answering our objections, more usually repeat the errors we discuss. He devotes most of his letter to a theoretical point on which he has not previously written in any detail. Population geneticists will quickly see that

this is an area to which Jensen appears not to have given much previous thought. His remarks concern the issue of the change in genetic variance under natural selection. Our claim was that, since the additive part of the genetic variance for IQ would decrease toward zero under natural selection (in the absence of mutation) while other parts need not, it might be possible to infer how much selection has gone on. Jensen seems to be under the misapprehension that the mere presence of nonadditive genetic variance is a demonstration of the previous action of natural selection. R. A. Fisher has speculated (*1*) that for certain phenotypes the degree of dominance itself may be under the influence of natural selection, but this evolutionary modification of dominance should by no means be taken as a rule (*2*), nor does it mean that the existence of dominance must imply the previous action of natural selection. On the contrary most models of enzyme action lead directly to dominance as a consequence of the nonlinearity of enzyme-product relations. Thus Jensen is incorrect in claiming that the presence of dominance indicates past selection.

Jensen apparently does not understand that natural selection destroys all variance unless there is some sort of stable polymorphic equilibrium. In the latter case, some gene frequencies will be held at intermediate equilibria, with the consequence that there is no additive variance on the fitness scale (*3*), while additive variance may persist on the phenotype scale. If Jensen wants to maintain that the additive variance for IQ is present in the face of natural selection, he should also maintain that the relevant genes are maintained at intermediate equilibrium by some sort of balancing selection. In the face of this it would be most difficult for him to maintain his previous position on "dysgenic" trends.

Another elementary misconception is exhibited in Jensen's statement that the presence of dominance variance can be inferred from the difference between h^2_B and h^2_N. This is incorrect, since h^2_B includes contributions from the genotype by environment interaction variance, epistatic variance, and other terms, as well as the dominance variance (*4*). The other terms would have to be shown to be negligible before the difference in heritabilities could be attributed to dominance variance.

Jensen concludes his analysis of the selection problem with the statement, "We would not expect extremely high correlation of human intelligence with fitness." It appears that, in his confusion over the fundamental theorem of natural selection, he has overlooked his earlier statement that we were wrong in claiming that IQ has not been under intense selection for very long.

At the conclusion of his letter, Jensen implies that he accepts the validity of the studies on identical twins reared apart. This is, of course, very much in line with his 1969 point of view (*5*). But it is quite inconsistent with his more recent writing (*6*), in which he has rejected a large part of the data he originally used.

Jensen devotes his comments to a segment occupying about 7 percent of our article. He ignores our discussion of between-group differences, a topic upon which he has written extensively in the social science literature, as well as our numerous other criticisms of his use of heritability.

Havender, on the other hand, addresses a potpourri of Jensen's previous notions. He commences with his evaluation of what Jensen really means when he says "Compensatory education has been tried and it apparently has failed" (*5*) or when he entitles an article "The differences are real" (*7*). Havender's claim is that Jensen really meant *some forms of* "compensatory education" and *a few* "differences." If, in fact, this is what Jensen had in mind (and we find it difficult to extract this interpretation from the written words), then what has heritability to do with the problem? Havender would have us believe that Jensen's motive in promoting the importance of heritability of IQ has been to demonstrate the need for "novel types of intervention."

In fact Jensen has used the estimated heritability of IQ in white populations to justify his assumption of genetic differences for IQ between blacks and whites. As we have tried to point out in our article and elsewhere, both arguments are logically incorrect; h^2_B provides no information on the possible effect of intervention, nor on between-group differences.

As to whether our figures 1 and 2 are bizarre, it is sufficient to draw the reader's attention to the literature in population genetics on norms of reaction (*8*). Havender's claim that adoption studies show that IQ is not strongly affected by the environment is incorrect (*9*). The problem is how reliable such studies are, whatever their conclusion (*10*).

Havender, continuing the tradition of Jensen and his followers, fails to acknowledge that no information concerning group differences can be extracted from within-group heritability. If he

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A New Window on Our Planet

Space research is yielding an increasing body of new knowledge and practical applications. Conspicuous examples are the results from the Vikings and the success of communications satellites. Yet an important multidisciplinary, multinational series of global studies is receiving little notice. The enterprise was born 23 July 1972 with the launching of the first Earth Resources Technology Satellite (ERTS-1) by the National Aeronautics and Space Administration. Since that time, most of the solid earth has been imaged, much of it repeatedly, and scientists and engineers have been exploiting the data. Some of their findings are displayed in a recently published professional paper* of the U.S. Geological Survey which contains about 90 articles on eight major topics, including applications to cartography, geology and geophysics, water resources, land-use mapping and planning, environmental monitoring, conservation, and oceanography.

Utilization of data from ERTS-1 has been widespread. Some 100 nations are participating. Application to cartography and geology and geophysics are numerous. This was evident at the International Geological Congress in Sydney, Australia, during August 1976.

ERTS-1 is in a near-polar orbit about 918 kilometers above the earth. It circles the earth every 103 minutes and views each area of the earth every 18 days. ERTS-1 obtains images in four bands of the spectrum—0.5 to 0.6, 0.6 to 0.7, 0.7 to 0.8, and 0.8 to 1.1 micrometers. Data from the images can be combined to produce false-color pictures or can be analyzed by computer.

A particular advantage of ERTS-1 is the periodic coverage. Images obtained at different times can be compared and short-term or long-term changes evaluated. For example, variations in the chlorophyll content of fields can be detected. Healthy plants contain more chlorophyll than sickly ones. Thus, information on crop prospects can be garnered. The images also show the extent of forests. By comparing winter and summer data, the abundance of deciduous trees can be established. Yet another example is in management of water resources. In many areas of the world, regulation of reservoirs fed by melting snow is vital. By studying successive ERTS images and related ground data, better management is possible.

Longer-term periodic coverage may prove to be particularly important. One of the chapters of the USGS professional paper is devoted to the mapping of Antarctica, especially its coastal areas. The images will be part of a historical record which will show changes in the size, shape, and position of such features as ice shelves, glaciers, and ice tongues. With continuing monitoring of such features, ERTS-1 or its successors may well provide the first substantive indication of global climatic changes.

Another important advantage of the ERTS system stems from the height at which the satellite moves. Thus, an image covers an area of 34,000 km^2, about 1000 times that covered in an aerial photograph from a high-flying plane. In consequence, large-scale features of the earth have been identified that had previously gone unnoticed. Of particular importance to economic geology is the discovery of large-scale linear and curvilinear features.

Scanning the articles in the USGS publication, one can find evidence that the ERTS-1 venture is more than a simple exercise in photography whose potential will be quickly exhausted. It is clear that in 4 years scientists and engineers have found many other uses for the data. Moreover, with experience the power of the applications has increased. For example, images obtained from rocky terrain tend to appear as only slightly varied shades of gray. However, with electronic data processing, it becomes possible to identify the delicate shades as different rock formations.

The scientists using the ERTS-1 images are enthusiastic. Many feel that such satellites will be of great help to all nations in coping with natural resource and environmental problems, and that the ERTS data could not have become available at a more propitious time.—PHILIP H. ABELSON

*R. S. Williams, Jr., and W. D. Carter, Eds., "ERTS-1: A new window on our planet," *U.S. Geol. Surv. Prof. Pap. 929*. (Government Printing Office, Washington, D.C. 1976). Paper, $13.

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