knowledge could become the means to international peace, the second general assembly of the International Association of Universities, held in Istanbul in September 1955, recommended the establishment of a balanced education which would leave no man of science without humanistic culture and allow no humanist to ignore the influence of science on human history. The surest bridge to mutual good will thus lies in our hands. As the nation with the greatest resources, it is for us to encourage this type of education here at home and abroad.

Where does the scientific approach to the formation of human character leave sectarian religion which many people now wish to impose on the public school curriculum? Modern science with its emphasis on selflessness, cooperation, humility and integrity is not hostile to religion, whether Christian or otherwise. In fact it transcends the dogmatic limitations of the various creeds and points the way to a higher universal God concept and a deeper sympathy for all human beings. It is the basis for a new concept of man and a new concept of society to which men of all religions can give assent.

S. E. TORSTEN LUND

A Probable Image of the Future

Astounding technological changes are noted by this author. Implicit in his study is the rapid acceleration in such changes. He indicates what various writers see ahead, with emphasis on our resources problem. He concludes with a question that indicates the dilemma of modern man and places tremendous responsibility upon schools and school people.

As Margaret Mead (10) has pointed out, many teachers reflect a world which no longer really exists, while our pupils will live their adult lives in a world greatly differing from even the present one. However, that segment of teacher population implied in EDUCATIONAL LEADERSHIP dares not live in the past; must strive constantly to understand the present; and ought to study the most probable images of the future.

We must start with some assumptions, the most important being absence of large scale nuclear and/or biological warfare; the continuance of the constantly accelerating pace of change brought about by large scale application of science and the resulting technology; the rapid spread of technology and industrialization to all parts of the world; and a continuation of efforts to build a functioning world-wide organization.

Acceleration of Change

Several years ago the writer (9) sketched man's increasing ability to transform his environment by the application of science. Illustrative examples were included; some rather imminent developments were suggested; a possible limitation set by available resources was indicated; and the inherent logic of tech-

S. E. TORSTEN LUND is associate professor of education, University of California, Berkeley. His essay, "Technology—Threat to Freedom," appeared in the ASCD booklet,* Education for American Freedom *(1954).

nology was pointed out as a real threat to man's individual freedom. In general, developments during the intervening short time span have shown the predictions to be conservative.

The demand for energy, mostly supplied by fossil fuels, goes on at a geometrically increasing rate. No new large-scale sources have been developed, though we now see the beginnings of the use of nuclear energy.

The development of machines continues unabated. A spectacular example, observed by us all, is that of earth moving machines. These have been allegorically portrayed by Artzybasheff on a recent cover of *Time* (6/24/57). It is safe to predict that machines will be built which can and will perform almost any manipulation or shaping man desires.

In the field of civilian transportation we now have more millions of even bigger energy-wasteful automobiles, festooned with scarce chrome, and upholstered with luxury materials found, a few years ago, only in homes of the wealthy. At the expense of fuel we have effortless powered steering, braking, window regulation, and seat adjustment. We have succeeded in so cluttering our arteries of transportation as to force us to build fantastically expensive multilane highways in our metropolitan areas. This appears to be a hopeless effort to prevent the eventual thrombosis of our cities' circulatory systems. This year we embark on a 15 year program to build a 50,000 mile, $100 billion superhighway system over the U.S.A. Incidentally, it took the Roman emperors 500 years to build a 50,000 mile roadway!

The speed of our aircraft has increased and within two years will jump from the present 350 to 550 mi/hr. The almost 60 per cent increase in speed means a fantastic increase in the complexity of air transportation. The near-free world of yesterday's airman will shortly be changed into entirely controlled air space and our aircraft will be under the constant surveillance of electronic dispatchers channelling each flight with reference to the current traffic. As usual, military air transport leads the way in speed and our new B58 has a "classified" cruising speed which most probably will exceed 1000 mi/hr. Flying west at the equator in that aircraft one can experience a perpetual noon-time, with the sun seemingly standing still—the world will have shrunk to a 12 hour size!

One of the fastest changing fields is that covered by the generalized term "communication" (21). Direct dialing telephony now has been extended to much of the U.S., and awaits only the laying of a coaxial cable to reach Hawaii. The unruly "line-of-sight" electro-magnetic waves will soon be curved around the earth, possibly by means of "pipes," to make world-wide T.V. broadcasting chains a reality. Two new air navigation systems have gone into operation—one, the inertial system which is entirely independent of any exterior communication except for the earth's gravitational force. The other, based on Doppler's principle, feels itself along the earth's surface by bouncing a signal from aircraft to earth and return. A computer analyzes the return to calculate track, speed and direction. Finally, there have been further developments in our electronic computers. The earlier analogue

computers are apparently to be almost displaced by the more compact, speedier and more versatile digital computers. Our mathematicians and communications experts are rapidly learning how to analzye our tasks and code them into the binary system which these electronic brains "understand" and obey. As rapidly as we have entered the age of automation we are only in its early stages. One large banking chain is now in the process of converting its daily check clearing activities into an automated system in which improved versions of "Erma" will carry out the whole procedure, including the preparation and possibly mailing of the monthly statement to each depositor. We can assume that the entire system of bank clearinghouses will eventually be operated by "super Ermas," consisting of a complex of automated computers, magnetic memory banks, and high speed sorters and printers, all watched over by a few highly expert persons who keep the various units electronically healthy.

The future of the electronic computer is not limited to mere computation. Already developments indicate that it may be designed so as to exercise discrimination and interpretation on a level which simulates the operation of the human brain. The development of a mathematical theory of communication by Shannon (14), Wiener (21), and others makes probable the use of electronic devices which can translate one language into another. Will they eventually be able to translate poetry?

Technology goes on with an ever increasing rate of development, but we see little concern on the part of most people, even on the part of most "educated" persons, as to how this technology is going to affect us all. True, it is becoming increasingly difficult for any one to understand the complexity of our world. Technology demands an ever increasing specialization, which has already reached the stage where even the specialists find it extremely difficult to communicate with each other. We desperately need great synthesizers who can translate our technology and its probable social consequences into language we can all understand. We see some attempts to break down barriers to communication, especially on the part of top echelon thinkers. Thus we did have an international meeting on Peaceful Uses of Atomic Energy. This year sees the start of the 18 month International Geophysical Year during which the savants of more than 60 nations will cooperate in an all-out effort to render more precise our understanding of many aspects of our earth and even the universe. For us, as teachers, an even more exciting example is the recent symposium of scholars reported in *Man's Role in Changing the Face of the Earth* (18).

A Study Program

After examining a sampling of publications which deal with the future, the writer of this article suggests that teacher-readers embark on a study program including, as a start, the sources listed in the bibliography. The following thumbnail sketch may whet your appetite.

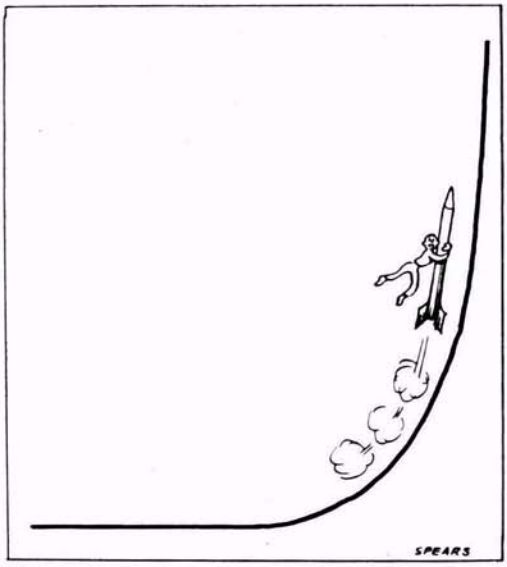
The most impressive fact in our reading has been the documentation of the *constantly increasing rate* at which change takes place. In fact, the symbol for the 20th Century might well be an exponential curve, with man zooming up the steeply ascending portion of that curve. When plotted, such items as human population growth, production, consumption of coal, oil, gas, various metals, water, etc., etc., all tend to assume the shape of a curve which approxi-

mates that of growth of invested principal when compound interest is applied. Even a cursory examination of such a curve suggests that long time continuation along the present dizzy inclines is improbable.

In all attempts to foresee the future, some assumption is made with respect to future population growth. It is well documented that recent growth of human population has attained a rate which will result in a population explosion. The ancient limiters of population growth, disease and famine, have been greatly reduced in effectiveness without a compensating change in human birth rates. For some time the population of the U.S. has grown at the rate of approximately 1.5 per cent per year (compounded), and there are no signs of a decrease. There is almost unanimous judgment that some control of population growth will become necessary, though it is recognized that effective control may take several generations. Failure to check the present explosive growth can only mean a future in which the resource base will be insufficient to support the resulting mass of humanity at an optimum standard of living.[1] Most writers on the future assume that such rapid population growth will continue for some time and in turn they foresee many problems, some of which we will note.

Continued urbanization is foreseen as the only means by which the vast number of future human beings can be kept alive on the basis of any acceptable human standard. As noted in detail by Seidenberg (13), this also means a constantly increasing rate of "organization" and an accompanying decrease in individual freedom. It is obvious that enormously complex problems of circulation must be solved, such as those involving water, food, wastes, and the transportation of goods and people.

[1] For a highly optimistic forecast see the Kiplinger magazine, *Changing Times*, June 1957.



An exponential curve—possible symbol for the 20th Century?

In every discussion of the future, as one problem after another is raised and possible solutions suggested, two items always rank top priority—first, that of necessary materials, such as metals, coal, oil, wood, fiber, water, etc. It has been pointed out that at the *current rate* we process over 20 tons of material per year for every man, woman and child in the U.S.! In the meantime in the U.S., and also in the rest of the world, the consumption of materials increases geometrically. Hence we know we are facing a growing materials shortage. Already some metals such as copper, lead and tin are growing scarce. For others, such as iron, we are having to process refractory, low-yield ores as well as import ore from other countries. One writer has pointed out that while many countries today are

Illustration by HAROLD W. SPEARS, superintendent of schools, Public Schools, San Francisco, California.

"have not" nations, all of them are "need more" nations. True, there are ample supplies of most materials, provided we can pay the very high cost necessary to process lower and yet lower grade sources. Incidentally, the glib promise of synthetic substitutes is questionable, since, at present, the most important synthetics have their origin in such materials as wood, coal, or, for the most part, petroleum.

A second top priority is that of energy. As the various writers consider possible ways out of an impending materials shortage and point to new or different sources, there is always the assumption of sufficient energy to accomplish the preparation. Of all growth rates, during recent decades, that of energy consumption is among the steepest in its increase. In recent history man has turned to fossil fuels, first coal and later oil and gas, to energize his many operations. Now almost all authorities agree that the end of our petroleum reserves is in sight. Even coal, especially coking coal, apparently will not last as long as many of the fairly recent estimates suggested. A significant illustration of the nature of an exponential curve is found in oil consumption when one writer (2) points out that, if present trends in increased rate of oil consumption are projected, the difference in time of peak production between the lowest reasonable estimate of the U.S. petroleum reserves and the highest, is but a matter of about 6 years! All writers assume that atomic energy will be called on to carry an increasing share of energy loads—foreseen even by pre-atomic bomb writer Stapledon (16) —even though many grave technical difficulties remain to be solved, not the least being that of disposal of the "hot" ash. Every possible source of future energy is now being carefully studied and reevaluated, including wind, tides, solar energy (both direct and indirect), hydro power, etc. At present there is a faint hope that nuclear fusion (related to that powering the hydrogen bomb) *may* be brought under control to save an energy hungry world. Nevertheless, it seems reasonable to assume that, in the U.S., our present energy squandering way of life will shortly have to be revised to a more Spartan level.

In this country at least we face an increasing shortage of water. Here again we have an example of the exponential curve, since increased consumption rates are proportionately much greater than our population increase would suggest. Even in water surplus sections of the U.S. there is a growing concern for adequate supplies of water suitable as to purity and temperature, and over water we will fight some of our most bitter political battles—as is already evident in the Far West. The desalination of ocean waters and purification of brackish water, the re-cycling of water, use of re-claimed water from sewage, and the transportation of water over longer and longer distances, all will be brought to bear on this problem, but always accompanied by greatly increased cost.

Less attention has been given the growing contamination of our atmosphere, the only source of air, which is necessary for all life. It is worth noting that the atmosphere is one natural resource which cannot be the monopoly of any one nation but belongs to *all* equally. There is, therefore, a deeply moral question involved when our industrial operations, our urban centers, and the world's military establishments convert the atmosphere into a gigantic sewer by the injection of untreated noxious gases, fumes, smoke, fissionable atomic debris (10), etc.

"The most valuable contribution this kind of article can make," according to its author, "is to arouse questioning and controversy. It is of utmost importance for us, as educators, to become concerned with the alternatives implicit in our immediate future."

There is a growing realization that a highly inter-related and interdependent industrial society is peculiarly vulnerable to disruption—as contrasted with the simpler, more self-sufficient non-industrial societies, for there are many points at which a blockage can bring the whole system to a standstill. As pointed out by many thinkers, this property of industrial society almost guarantees that steady growth of organization is an inherent property of industrialization with attendant increase in centralization in our social, political and economic affairs. This inherent characteristic of a technology dominated world when extrapolated into the future can provide, as it has in many writings (7), fearsome pictures of a future eventually devoid of individual freedom. There may even be a "point of no return" beyond which such outcome is inevitable.

It is also obvious that in the future, even more so than is true in the immediate past, man must appreciate his basic dependence upon his physical environment, for with all his inventive prowess it still remains true that he cannot, for any length of time, exceed the carrying capacity of his physical environment. Call this conservation-mindedness or what you will, there is here implied an important ethic, for as Sears (18, p. 481) says, "Whether we consider ethics to be enlightened self-interest, the greatest good for the greatest number, ultimate good rather than present benefit, or Schweitzer's reverence for life, man's obligation toward environment is equally clear."

The Most Critical Factor

Space limitations prohibit any real considerations of the educational implications of this brief picture of the look ahead. However, it is significant that though many of our basic resources appear to be headed toward a short supply, even in the immediate future, it is obvious to anyone reading these various prognostications that the most critical factor of all will be man himself. The real limiting factor is man's capacity to so manage his various enterprises that he can continue to live in human decency and dignity.

As we have noted, change appears, at least in the short run, to parallel an exponential curve. It is therefore the responsibility of man's educational institutions to provide a constantly increasing number of well educated and wise individuals who can understand our complex world, who have a valid ethic which will guide them in choosing future alternatives, and who can sucessfully communicate their understanding and their guidance to mass man.

It is here we are directly and immediately concerned, for it is through our schools that society must prepare its children, and even its adults, to live in the coming, complex world. Unless we can meet these problems, we may well be "painting ourselves into a corner."

Readings on the Future

Assuming you have read such imaginative works as: Orwell's *1984*, Vonnegut's *Player Piano*, and Huxley's *Brave New World*, browse in the following, especially those marked with (*).

1. Asinov, Isaac. "Profession" in *Astounding Science Fiction*, July 1957. p. 8-56.

*2. Brown, Harrison; James Benner; and John Weir. *The Next Hundred Years*. New York: The Viking Press, 1957. 193 p.

3. DARWIN, SIR CHARLES G. *The Next Million Years.* New York: Doubleday & Company, 1953. 210 p.

4. DAVIS, KINGSLEY. "The Unpredicted Pattern of Population Change." *The Annals of the American Academy of Political and Social Science,* May 1956.

°5. DRUCKER, PETER. *America's Next Twenty Years.* New York: Harper & Bros., 1955. 306 p.

6. ERNST, MORRIS L. *Utopia 1976.* New York: Rinehart & Co., 1955. 306 p.

7. GERBER, RICHARD. *Utopian Fantasy.* London: Routledge & Kegan Paul, Ltd., 1955. 157 p.

8. LATIL, PIERRE DE. *Thinking by Machine.* New York: Houghton Mifflin Co., 1957. 368 p.

9. LUND, S. E. TORSTEN. "Technology—Threat to Freedom" in *Education for American Freedom.* Washington, D. C.: Association for Supervision and Curriculum Development, 1954.

10. MEAD, MARGARET. *School in American Culture.* Cambridge: Harvard University Press, 1951. 41 p.

°11. MEIER, RICHARD L. *Science and Economic Development—New Patterns of Living.* New York: Technology Press, M.I.T., and John Wiley & Son, 1956. 246 p.

°12. SAX, KARL. *Standing Room Only—The Challenge of Over-Population.* Boston: Beacon Press, 1955. 201 p.

°13. SEIDENBERG, RODERICK. *Posthistoric Man.* Chapel Hill: University of North Carolina Press, 1950. 238 p.

14. SHANNON, CLAUDE E., and WARREN WEAVER. *The Mathematical Theory of Communication.* Urbana: University of Illinois Press, 1949. 117 p.

15. SHUTE, NEVIL. *On the Beach.* New York: William Morrow & Co., Inc., 1957. 320 p.

°16. STAPLEDON, W. OLAF. *First and Last Man.* New York: Jonathan Cape and Harrison Smith, 1931. 371 p.

17. STEWART, GEORGE R. *Earth Abides.* Toronto: Random House, 1949. 373 p.

°18. THOMAS, WILLIAM L., Editor. *Man's Role in Changing the Face of the Earth.* Chicago: University of Chicago Press, 1956. 1193 p.

19. THOMSON, SIR GEORGE. *The Foreseeable Future.* London: Cambridge University Press, 1955. 166 p.

20. UBBELOHDE, A. R. *Man and Energy.* New York: George Braziller, Inc., 1955. 237 p.

°21. WIENER, NORBERT. *The Human Use of Human Beings.* Garden City: Doubleday Anchor Books, Doubleday & Co., Inc., 1956. 199 p.