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of A to T.

SEPR No. 76-

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SOCIO-ENGINEERING PROBLEMS REPORT NO. 76-

A series of manuscripts on the social relations of engineering and related philosophical questions dealing with the interaction of science and society. Distribution is limited to reviewers and discussion groups for criticism prior to consideration for possible publication.

"THE CONNECTION BETWEEN THE MAN-TO-COMPUTER  
RELATIONSHIP AND THE FUNCTIONING OF HUMAN  
CIVILIZATION"

(Three Eras: Force, Power, and Information)

Date:	11/26/63	11/27/63	1/20/64	2/21/64
Letter		SEPR 92	SEPR 92A	SEPR 76-
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## I. SCANNING PROBLEMS FROM THE LARGE RANGE DOWN TO LOWER LEVELS.

It is important to scan the world political and economic system starting from the largest area and working down to smaller units to see if there are problems for which this technology is useful, even if the market structure is not prepared to deal with the problem. (Note: See page 16 of Engelbart's SRI report:

"Existing, or near-future, technology could certainly provide our professional problem-solvers with the artifacts they need to have for duplicating and rearranging text before their eyes, quickly and with minimum of human effort. Even so apparently minor advance could yield total changes in an individual's repertoire hierarchy that would represent a great increase in over-all effectiveness. Normally the necessary equipment would enter the market slowly; changes from the expected would be small, people would change their ways of doing things a little at a time, and only gradually would their accumulated changes create markets for more radical versions of the equipment. Such an evolutionary process has been typical of the way our repertoire hierarchies have grown and formed.

But an active research effort, aimed at exploring and evaluating possible integrated changes throughout the repertoire hierarchy, could greatly accelerate this evolutionary process. The research effort could guide the product development of new artifacts toward taking long-range meaningful steps; simultaneously, competitively minded individuals who would respond to demonstrated methods for achieving greater personal effectiveness would create a market for the more radical equipment innovations. The guided evolutionary process could be expected to be considerably more rapid than the traditional one....." \*)

This process is illustrated by some diagrams in English Through Pictures Book 2 (§) In this same booklet we have illustrations showing the exponential rise of population, power output and other features which make our civilization more complex. W. Ross Ashby (#) has pointed out that man has built a civilization beyond our understanding and that it is getting out of hand.

\* D. C. Engelbart, "Augmenting Human Intellect: A Conceptual Framework" Stanford Research Institute, Report AFOSR-3223, October 1962

§ I.A. Richards and Christine Gibson, English Through Pictures Book 2, N.Y.: Washington Square Press (1961), p. 230.

# W. Ross Ashby, "Design for an Intelligence Amplifier," in Automata Studies, Princeton Univ. Press (1953)

2. SEPARATION OF "PHILOSOPHICAL ANALYSES" FROM "BUSINESS (OR ENGINEERING) ANALYSES."

I classify this report as a "philosophical" communication. I attempt to fit each letter or article I write into one of the three categories listed below:

- (a) Engineering Technical Communication: Articles dealing directly with the engineering work of the corporation for which I work are processed through the Publication Department of the corporation in accordance with Section 14 of "Canons of Ethics" (\*) of the National Society of Professional Engineers. Such communications dealing with technical work and cleared by the corporation would be issued from my engineering business address: Advanced Systems Development Division, International Business Machines Corporation, Monterey and Cottle Roads, San Jose, California, 95114. §
- (b) Philosophical Communications: Philosophical studies dealing with the interrelationship between science and society; the sciences and the humanities are issued solely upon my own responsibility without review by the corporation. Such communications are issued from the address of Socio-Engineering Problems Reports: P. O. Box 85, Campbell, California, 95008, and are edited to clearly have no identification with the corporation.
- (c) Community, Political and Religious Communications: Material dealing with local community problems or representing a particular political or religious viewpoint are issued from my residence address: 2346 Lansford Avenue, San Jose 25, California, 95125.

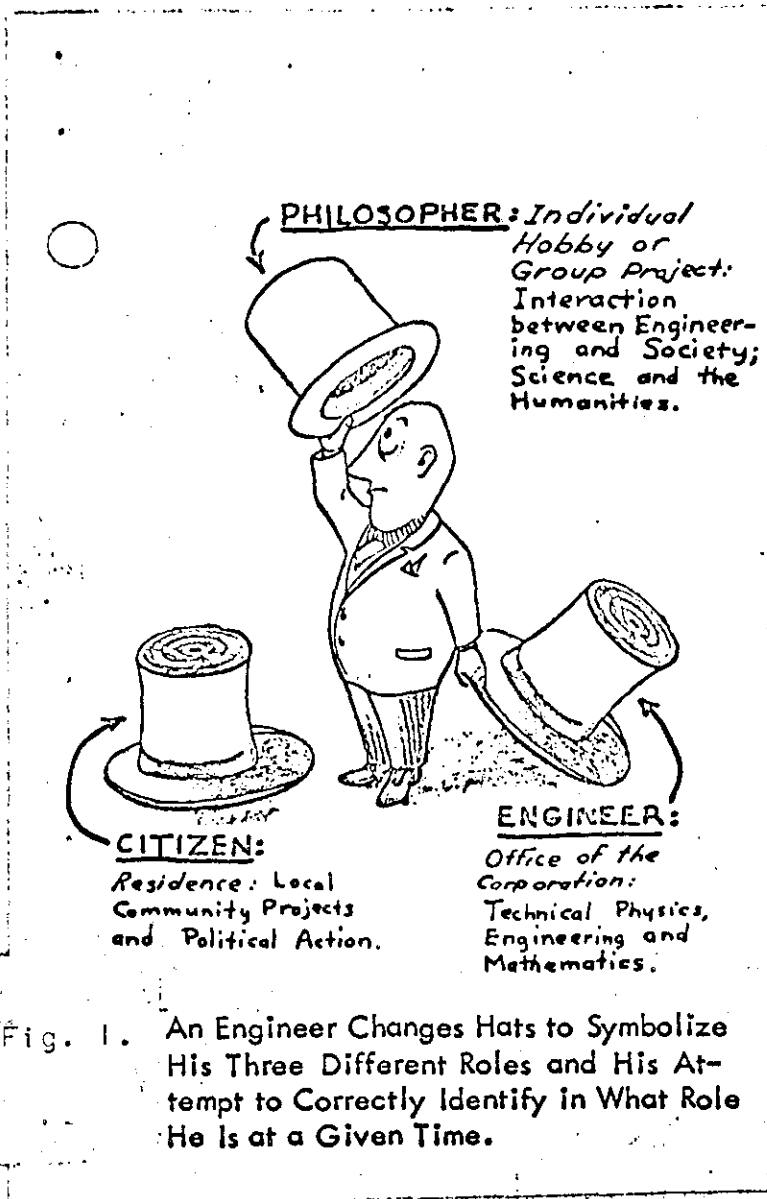
Frederick B. Wood

\*"Professional Policies" National Society of Professional Engineers, Washington, D. C. (1958), p. 48.

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§ New address: IBM - ASDD Lab., P.O. Box 66, Los Gatos, Calif. 95031

This separation is illustrated in Fig. 1. The close relationship of the separate parts can be deduced from SEPR No. 66, "Creativity Ethics, and Specialization in Engineering."



NOTE

The historical precedent for separating the philosophical part of a problem from the immediate remunerable parts of the parts of the problem-solving work goes back at least as far as Maimonides (1135-1204), who was physician to Saladin in Cairo during part of the Crusades, and at the same time he was seeking to harmonize Biblical and Rabbinic teaching with philosophy, and especially with the philosophy of Aristotle. The battles of the Crusades only made temporary adjustments in the state of human civilization, while the philosophical studies of Maimonides gave following Arabian, Jewish, and Christian scholars the tools with which to deal more effectively the philosophical problems facing human civilization as mankind moved into the next era of history. Maimonides was mindful of a Talmudic saying that "thou must not use the Torah as a spade to dig with." Some of the modern aspects of these questions are discussed by T.K. Quinn, a former Vice-President of General Electric Co., in a pamphlet, "The Individual in a Business Society," issued by the New York Society for Ethical Culture(1958).

### 3. HISTORICAL PERSPECTIVE.

A recent editorial in the Proceedings of the IEEE( $\phi$ ) ended with the sentence, "Are we dinosaurs or birds?" If we are not interested in dying out like dinosaurs, we must first develop some perspective of where we are in the history of human civilization. We must look for things more constructive than Toynbee's analyses the rise and fall of civilizations. Our civilization has the knowledge and the research tools to understand our problems and to propose solutions so that our civilization doesn't have to die out like the Roman Empire and other past civilizations.

To obtain a perspective of the state of our civilization, let us use a Gaussian Perspective similar to the Histomap, but extending into the future.( $\$$ )

In Fig. 2 human history is divided into three eras: Force, Power, and Information. The numbers on the past-future scale are years plus and minus from now. The time scale is derived

$\phi$  J.D. Ryder, "To Define Is To Limit," (editorial), Proc. IEEE. vol. 51, No. 9, Sept. 1963, p. 1175.

$\$$  This chart form is illustrated in a manuscript Socio-Engineering Problems Report No. 91, "Four Philosophical Tools for Improving Problems Concerning the Problems of Disarmament."

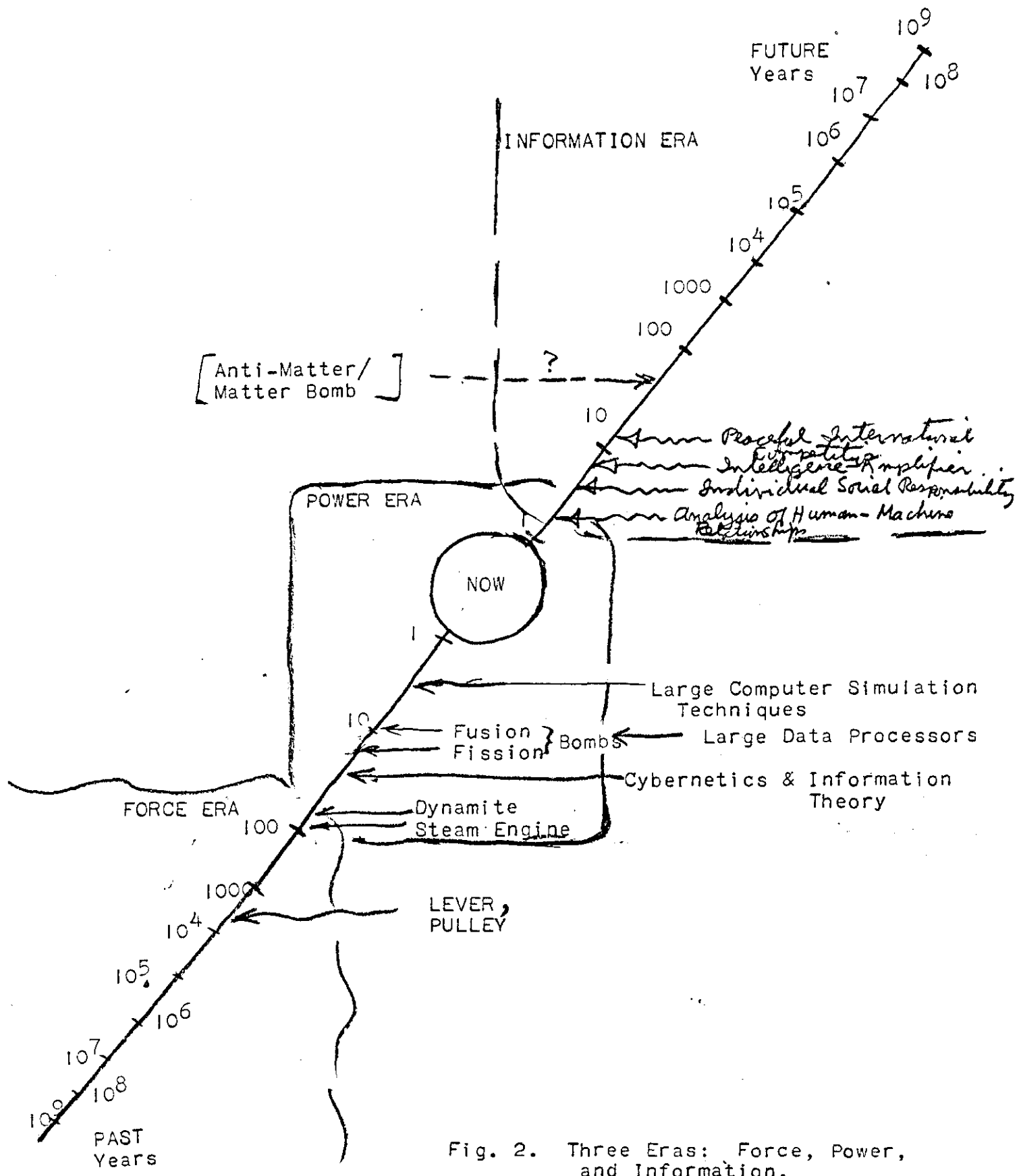


Fig. 2. Three Eras: Force, Power, and Information.

from a gaussian probability distribution similar to the gaussian probability paper printed by Codex Book Co. for extreme value probability curves. Norbert Wiener uses the terms power and control, where I use the terms power and information(%). I.e. the term "Information Era" is possibly more conducive to democratic concepts, Albert Schweitzer's concept of "Reverence for Life," and the maximizing of information or negative entropy.(§)

The past and future events marked in Fig. 2 are only approximately correct in location. Since future events cannot be accurately predicted, the relative order of future events should be taken as more significant than the actual times. For example it is necessary that civilization advance well into the "Information Era" before more countries reach the stage of development that could sustain manufacture of atomic bombs or hydrogen bombs. Also it is important that the four major steps into the Information Era, namely:

- Analysis of human-to-machine relationship,
- Development of Individual Social Responsibility,
- Design of Intelligence -Amplifiers,
- Organization of Peaceful Competition of Countries;

before man gets very far in developing the "anti-matter/matter annihilation bomb"

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% Norbert Wiener, "The Mathematics of Self-Organizing Systems," in Robert E. Machol and Paul Gray, Recent Developments in Information and Decision Processes. N.Y.: Macmillan Co. (1962) pp. 1-21.

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§ The use of the word "control" in B. F. Skinner's papers on "Behavior Control" frightens people, giving them an impression of control by a dictator. When the same concepts of feedback control circuits are used with a concept of maximizing individual creativity through some biological process similar to maximizing negative entropy, therapy oriented people like Carl Rogers see the usefulness of behavior control concepts for the benefit of mankind

4. THE FOUR ERAS OF CIVILIZATION (IN MAN'S APPLICATION OF THE FORCES OF NATURE)

The three eras shown in Fig. 2 plus a transition era between the Power Era and the Information Era are discussed below:

(i) FORCE ERA.

Man had his own strength plus the possibility of adding others to his work crews as members of his team or as slaves. Man invented the lever and pulley to permit him to exert a greater force than his own strength at the expense of moving the object through a shorter distance in a given time.

(2) POWER ERA

Man invented devices which could couple onto natural thermodynamic processes which increased entropy. In this way man derived power orders of magnitude greater than his own power as a by-product of natural processes. The first economic system of this era, i.e., the capitalist system is designed so that economic work is done by coupling the operations to another natural process, namely the desire of human beings for more goods or money. However this system keeps getting into conflict with philosophers due to the contradictions between maximizing profits and ethical teachings of religious leaders.

The historical ways by which these conflicts have been creatively resolved in American business is discussed in a series of articles in the Harvard Business Review. (#)

# HBR (1952) esp. article by Kenneth Boulding.



There appears to be a more fundamental change occurring in connection with the problems of our civilization shifting from power production problems to information processing problems. It is interesting to note that the founders of the consumer cooperative movement thought the contribution of their system was to introduce a time lag in parts of the economic system to allow for the inadequate information processing capabilities of the earlier forms of the capitalist system.

### (3) TRANSITION ERA

This transition era has sometimes been referred to as the "Noösphere" by Soviet Scientist N. I. Vernadsky (\*) and by the Priest Anthropologist Teilhard de Chardin(‡).

**Hypothesis: The stability and adaptability of a social organization (country) is a function of its attainment of the ideal political idea distribution statistics based upon the variance being proportional to the per capita power production.**

Some curves of electric energy production and population graphs are plotted in Fig. 3 to use in testing the plausibility of the above hypothesis. Ideal values of the variance are used with arbitrarily assumed political idea scales. Three selected countries are replotted in Fig. 4 to show guesses of the ideal and real distributions.

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\* N.I. Vernadsky, American Scientist, vol. 33, no. 1, p. 10ff., Jan 1945 (trans. of 1943 paper).

‡ Teilhard de Chardin, The Phenomenon of Man. Harper Torchbook Edition (1961), trans from French (1955). Also article in W. L. Thomas, Jr. & others, Man's Role in Changing the Face of the Earth, Univ. of Chicago Press (1956). See also Marcel GoTay, "The Biomorph Development of Electronics," Proc. I.R.E., vol. 50, no. 5, May 1962, pp. 628-631.

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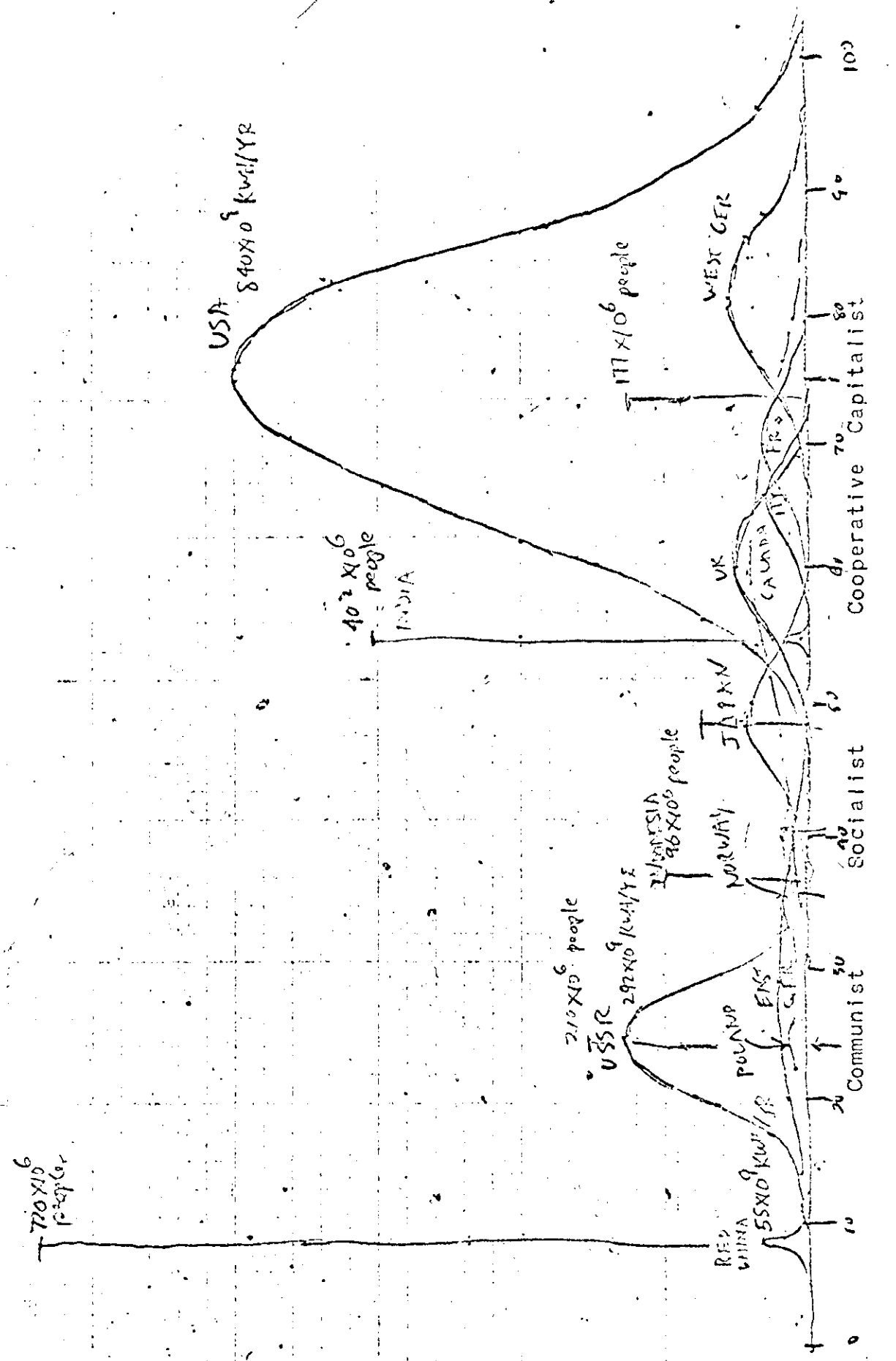


Fig. 3 Population Distributions & Ideal Electric Power Distribution

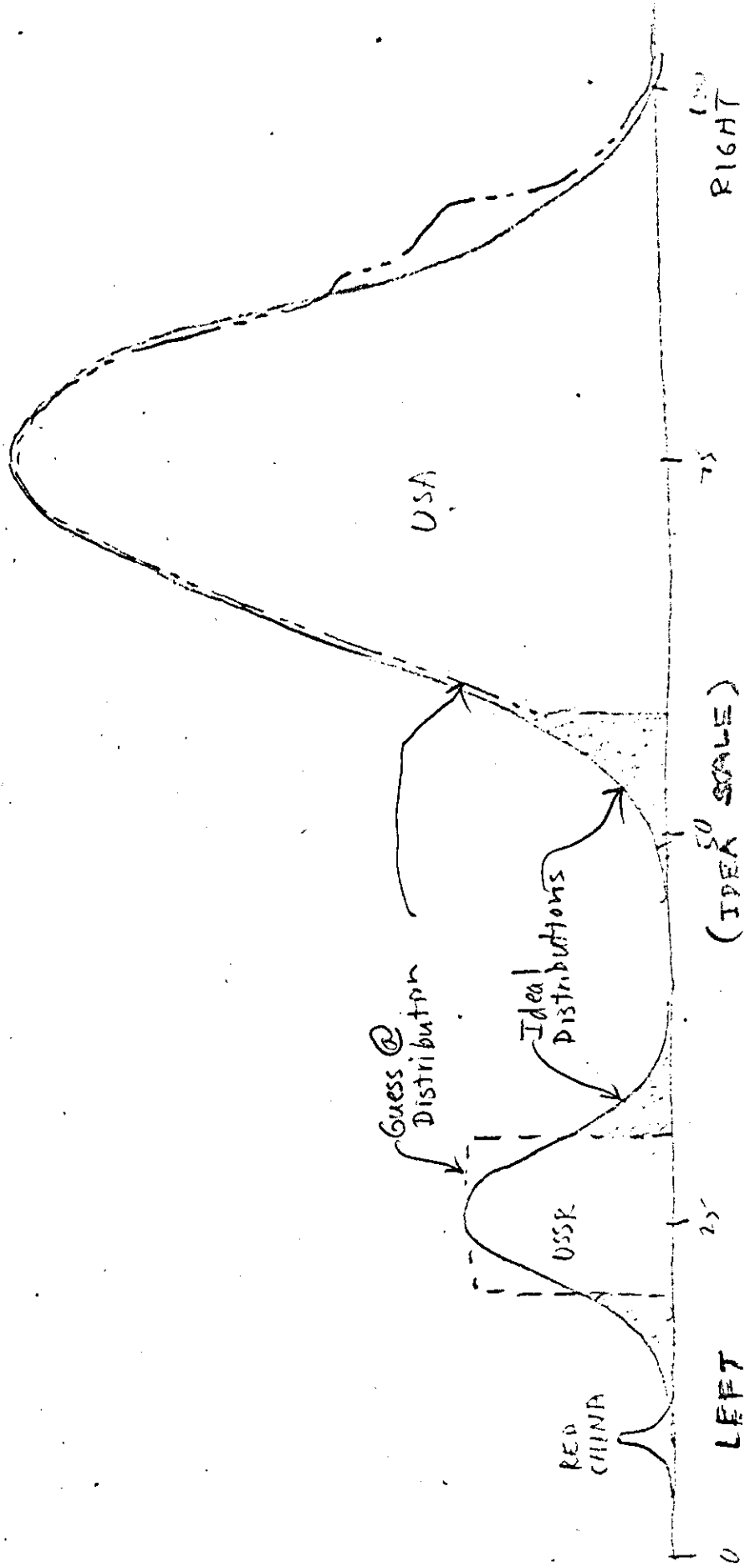


Fig. 4. Examples of Guess-For-Real Distributions

(4) INFORMATION ERA.

Hypotheses: The political-economic system having the highest chance of surviving will be that operating on the principle of "maximizing negative entropy," i.e., maximizing entropy in the stochastic sense. It may be possible to find conditions meeting the above where large sectors of the economy can be left functioning in the same capitalist, cooperative, and socialist forms of the present era.

The intelligence-amplifier of Ashby is needed to find what systems come near the conditions of maximizing negative entropy. Present high-speed digital computers and programming systems provide the basic technology from which the intelligence-amplifier could be developed. However the human intelligence to<sup>be</sup> amplified requires an internal biological feedback loop to provide a control based on "reverence for life" (equivalent to maximizing negative entropy). C. R. Rogers reports that human beings have such a "biological computer" within their brain that can be allowed to develop through psychotherapy or similar processes. This "biological computer" enhances the individual and leads the individual to make decisions beneficial to mankind (provided he can acquire the facts and select a reasonable number of alternatives to consider)--equivalent to max-

imizing negentropy. The weakest link in the system is the human -to-machine relationship. A better "impedance match" between humans and computers is needed. (This is a task for the computer industry.)

This era changes the coupling of the economic system from a physical thermodynamic system to a biological life process.

#### 5. THE NEED FOR AN INTELLIGENCE AMPLIFIER.

The problems of the social and economic world have reached a complexity that appears to require men of higher intelligence to solve the problems of our civilization. The chances of individuals being born with I.Q.'s of 150 are about one in  $10^6$ , and for 200 are about one in  $10^8$ . We cannot wait for people with extra high I.Q.'s to come on the scene. We must direct our efforts toward the development of what we might call an "intelligence-amplifier," using the terminology of W. Ross Ashby (§), analogous to the power amplifiers like the steam engine which started the industrial revolution.

The object is to design a machine or computing system or to program an existing computer so that, if we select certain criterion such as the economic system must have less than 100,000 persons unemployed; less than 10 murders per week, etc., then the machine

§ W. Ross Ashby, "Design for an Intelligence-Amplifier," Automata Studies, Princeton Univ. Press(1956), pp. 215-234.

will select and print out the specifications for such an economic system, provided the proper data has been supplied by the human operator.

A special class of the "intelligence-amplifiers" namely the type to help the top experts work on-line with a computer to make economic models, design buildings, edit text, and a host of other applications are being proposed, designed, and experimented with at SRI, SDC, MIT, CEIR, and elsewhere. Corresponding projects for use in national economic planning are planned in the U.S.S.R.

From the viewpoint of maintaining democratic government or from the viewpoint of maximizing negative entropy, there shortcomings in the special class of "intelligence-amplifiers" presently being developed. The development of a kind of elite class of problem-solvers is predicted from the present organization of effort and trend of development. This trend has been more explicitly stated by Dr. Donald Michael:

"In twenty years, other things being equal..... the research realm of the scientists, the problems of government, and the interplay between them will be beyond the ken even of our college graduates..... There will be a small, almost separate, society of people in rapport with the advanced computers. These cyberneticians will have established a relationship with their machines that cannot be shared with the average man any more than the average man today can understand the problems of molecular biology, nuclear physics, or neuropsychiatry. Indeed many scholars will not have the capacity to share their knowledge of feeling about this new man-machine relationship....."

A few years ago the author of this section felt that the way to solve this problem was to develop remote scientific computing as a way to bring the capability of the large computing center to every engineer and scientist in the U.S.A. This would decentralize the

distribution of scientific-computer programmers to reduce the chance the know-how of scientific computing and economic modelling being concentrated in a small elite group . It is now felt that a better way to insure a distribution of computer know-how is to develop programming aids and programming teaching machines aimed at making every congressman and state legislator a potential computer programmer.

The concept of "impedance matching" between man and computer has been discussed by A. Opler. (\*)

\* A. Opler, "On The Impedance Matching Problems of Systems That Include Men and Computers," in Systems: Research and Design, edited by Donald P. Eckman, N.Y.: Wiley (1961), pp. 118-123.