Purposive Systems

Proceedings of the First Annual Symposium of the American Society for Cybernetics

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TO FRANK FREMONT-SMITH

Preface

The proceedings of a symposium and the "Proceedings" of the same symposium are, alas, two quite different things. This is, perhaps, most clearly felt by those who share the pleasure and the burden of translating the spirit, the intellectual climate, and the hard-core content of the actual event into its representation, strung out in printer's ink over thin pages squeezed between two hard covers.

Can one reconstruct the event from its representation? Perhaps for those who participated in the First Annual Symposium of the American Society for Cybernetics the reading of the papers in this collection will conjure up charming and unforgettable moments of this symposium, as, for example, when Warren McCulloch, ASC President, in introducing Frederick Seitz, the President of the National Academy of Sciences, produced from his unfathomable breast pocket a bottle of *Chateau Lafitte,* vintage 1962, and presented it to "the connoisseur of science and other good things in life"; or when Margaret Mead told how a quarter of a century ago she got so excited in one of the early conferences which later shaped "cybernetics" that she broke one of her teeth without noticing it; or when Nicolai Amosov was so besieged by newsmen that two of them mistook one another for Amosov, until they congratulated each other on the facility of their American idiom.

Such *anekdota* of symposia proceedings have usually no place in the "Proceedings," but there was a flavor to this first symposium of the cybernetics society that does not transpire through the printed papers alone. It was a touching mixture of sentiment, remembrance of old friends and days of fermentation of ideas and discoveries, of the pioneers meeting the young who

were full of enthusiasm to expand the field into new and adventurous lines of thought, and of heated discussions of plans for the future of cybernetics.

For those who were not able to attend this meeting and who can only see it through the keyhole of the papers collected in this volume, these small sidelines may serve as clues for the quick shift of mood in the papers, ranging from reminiscences to terse statements of fact and theory, or from discussions of computer hardware to philosophical contemplations and semantic clarifications.

Unfortunately, not all who contributed to the success of this symposium could be represented by their papers in this volume, if it was to appear within a period that would not push into obsolescence fresh ideas that germinate new avenues of thought in this quickly growing interdisciplinary field. Even more unusual hues would have been added to this cybernetic palette if we had been able to include the address by the Honorable James E. Webb, Administrator of the National Aeronautics and Space Administration, who spoke to the society after the banquet and who gave a fascinating description of the cybernetics of a large and effective research and development organization within a sociopolitical system such as NASA is operating within the United States Government; the speech by Seymour Papert who stole the show with his proof of "Why Machines Can't Think," if the paradigm for "thinking" is placed in the collective mind of the Daughters of the American Revolution; and the paper by J. C. R. Licklider who confessed quite personal relationships with his machines.

However, we are grateful to all who contributed to this symposium, to those who found the time and put in the effort to prepare and to present their papers, to those who contributed to this volume, and we express our thanks to the National Science Foundation which made this symposium possible in the first place and to the National Bureau of Standards which opened its superb facilities to the purpose of this meeting.

In concluding, I wish to let my deeply felt gratitude be known to all who so untiringly and enthusiastically contributed to the preparation of this volume by transforming within about seven

weeks barely legible copies of the manuscripts that were mostly in "tapese"—a partly understood languagette spoken by magnetic tapes—into publishable articles that could go to the printer. I am deeply indebted to my coeditors, all graduate students at the University of Illinois and members of the Biological Computer Laboratory; to the secretarial staff, particularly to Miss Janet Ficken, Mrs. Patricia Smith, and Mrs. Jane Spears who typed and retyped n-th order drafts; and last, but not least, to my wife who—until the wee hours of the morning—never tired of discovering the subtleties of a thought in the coarse grain of a rough draft and bringing them to light.

A salute is due to the publishers who left no stone unturned to give this volume an unusual priority in its production schedule and a pleasant appearance.

If, however, shortcomings in exposition and errors in representation should remain, it is not these friends who have so generously given their time and efforts but I alone who have to bear the blame.

H. V. F.

Foreword

THE CHALLENGE

The great pamphleteer of the American Revolution, Thomas Paine, used as his opening words in *Common Sense,* the tract which became, so to speak, the little red book of that revolution: "These are the times that try men's souls." Doubtless there was to him something highly unique about the period in which he lived and, indeed, there were quite unique features to it. For that was the time in which, at long last, the egalitarian movement swept upon the world stage in a way that was to endure.

It was not the first time that this movement had appeared on the horizon. There had been, for example, the great peasant revolts of the Middle Ages, but they had always been put down. Now, at last, there was to be a new chapter in the history of man in which any individual could expect to develop and act upon his talents.

It is, perhaps, worth noting as an aside that the factors which made that period of the 18th century so distinguished were, at least in part, the result of technical advances. The unusual situation at Lexington and Concord, in which a group of farmers could rout a professional army, would not have been possible before the invention of gunpowder. Thus the circumstances which made the events of Paine's days possible are linked to what has been a continuing revolution, influenced by changes in technology in which there are two very prominent trends, either one of which we may look upon today as "the challenge."

The first of the trends is a gradual but continuous shrinking of the globe through the development of better means of communication. The members of the human family have been drawn

closer and closer together over the millenia and have gained more awareness and understanding of one another for better or worse. We are all increasingly conscious of dwindling distances in these days in which we have planetary communication on a microsecond scale and jet airliners which can almost keep up with the sun. Behind all of this is the ever-increasing transfer of technology onto a common scientific base. That transition began in full force early in the last century with the emergence of the science of chemistry as an indispensable technological tool. The events of World War II and the role that scientists played in it brought the meaning of the new age home with great clarity. Looking ahead, we can foresee the time in the very near future when essentially all men will live on the basis of a common fund of knowledge, a fund which is now highly operative in the Atlantic community, Latin America, Eastern Europe, and Japan. Before the end of the century, it will be effective in most of Asia. We do not know how long it will take before Africa participates fully in this common technological culture, but one would imagine that a century is on the long side if Africa can achieve reasonable political stability.

The second trend which has been in force over the ages, and which I believe is particularly relevant to the work of this society, has to do with the ever-growing complexity of the problems we face. This complexity strikes us with force on all sides today in much the way that Tom Paine recognized that unusual events were a matter of course in his day.

I believe that this trend toward complexity is essentially a permanent feature of the evolution of man and is something that he should accept and try to understand very thoroughly now that he cannot fail to note that it has him in its grip. Reduced to its simplest form, one can, perhaps, express the underlying principles of the trend in the following way: Each technological success we enjoy as a result of overcoming problems and difficulties automatically engenders a new series of problems more complex than the ones faced originally. The new problems in turn can be solved only by the evolution of a more complex form of technology. In describing the situation in these terms, one is reminded of an aspect of Freud's account of dream analysis.

He discovered in the course of analyzing his own dreams that, as he gained success in the process, the dreams became more and more complex so that increasing amounts of ingenuity were required for the analysis. It was as if his subconscious mind sought to elude the attacks of his conscious mind upon it.

Let me illustrate the principle in a simple way. As our Stone Age ancestors developed tools, they found that they could improve their lot enormously through ingenuity and innovation. In this process, they invented spears, traps, bows, and arrows, as well as systems for storing food. In other words, they learned to use technology to extend their capacities as food-gatherers. In so doing, however, they promptly ran into new problems because they also had to extend their range of exploration to wider and wider geographical areas because of the speed with which they exhausted older food-gathering areas. This problem was solved in part by turning to agronomy, which made it possible to utilize a given land area far more effectively. On the other hand, agronomy made man an acquisitor so that he began to have extensive property to maintain. Moreover, he became very sensitive to local conditions, such as soil exhaustion and the diseases of plants and animals on which he depended.

Some of the new problems were resolved in turn by moving into the great river valleys where man had renewable soil and continual access to water. But here, too, he ran into new and more complex problems, for the great river valleys were subject to periodic floods. In brief, he found it necessary to reorganize his society. Whereas almost all members carried the same burden in the food-gathering and early agronomical stage, the river valley civilization compelled man to develop extensive specialization if he was to master the new problems.

During the last 2,000 years, Northern European man not only developed his own agrarian revolution in the regions north of the Alps where he learned to deal with the conditions of a temperate climate, but he also gained enough impetus in the process to generate the industrial revolution by pushing specialization far beyond the dreams of the river valley people—a specialization of which Adam Smith spoke so glowingly 200 years ago in his *Wealth of Nations*. Unfortunately, the industrial

revolution produced the great urban problems of which we are now so conscious.

The transition of the industrial revolution to a scientific base, which began early in the last century, as I mentioned earlier, has followed a similar course. Consider, for example, the field of medicine. The advances in dietary knowledge, immunology, and antibiotics have led to a vast improvement in public health. On the other hand, they have also induced the population explosion and made it necessary for us to take the control of population into our own hands. Moreover, as old antibiotics lose their effectiveness, we are compelled to race ahead in order to find new ones.

Still further, since man must die of something, diseases which were once fairly obscure are now the predominate ones, particularly in the more advanced societies. The practice of medicine becomes more and more complicated and requires evermore sophisticated knowledge and technology.

The problems of communication and transportation show the operation of the same factors. Automobile transportation, which 50 years ago seemed to be an unmitigated asset, now creates as many problems as it solves.

I have perhaps emphasized the issue enough to make it clear. We are on something of the nature of an endless belt or escalator on which the view gets more and more interesting as we move; yet, we must work in an evermore complex way to maintain our benefits.

As I look about in the era into which we are now moving, I must confess that I see some very frightening vistas. There is, for example, the reemergence of genocide as a force in human society. World War II provided a sufficiently horrible demonstration of this to give us pause; however, it seems to crop up in even more recent conflicts such as the Chinese conquest of Tibet and African civil conflicts.

Fully as disturbing is the persistent voice emanating from some segments of society expressing opposition to innovation. I know no way in which our society could destroy itself more effectively than by turning away from innovation.

The concept that social suicide can occur through the death of innovation is by no means an abstraction. One need only

follow the course of Roman history. Initially, the Romans were among the most practically innovative of all peoples who had ever lived. The great profusion of their aqueducts, fortifications, amphitheaters, and monuments which can be found from Spain to Ankara and from the heart of the Sahara to northern England gives one some inkling of the innovative genius of Roman leadership. There came a time in their history, however, when innovation was denigrated and most of the operations of society were turned over to a slave population which could scarcely be expected to do its best to preserve the system.

There are disturbing indications in our own society, and not least in that in the United States, that those in positions of power and influence are not entirely unwilling to downgrade the importance of the work of the scientist, the engineer, and the technician. In fact, the word "technician" now begins to carry a connotation of disparagement with it. Although I see nothing on the horizon that will prevent us from surviving for one generation, it is not difficult to predict what the outcome would be if the trend were to continue unimpeded for four or five generations.

Even if we succeed in inducing our society to reaffirm the importance of innovation, there still remains the danger that we will be overwhelmed by the sheer complexity of the problems which lie ahead. It is here, it seems to me, that the field of cybernetics, or what one might call the cybernetic revolution, offers mankind significant hope on two scores. First, we may be able to gain better control of the factors involved in sustaining our society through more efficient acquisition, processing, analysis, and utilization of the information needed. Second, we may be able to use expertly trained individuals much more effectively.

Perhaps most indicative of this hope is the very rapid growth in the capacity of computers which we are witnessing at the present time. If the present geometrical rate of improvement of the capacity continues for another 30 years or so, and there is no serious reason to doubt that it will, the implications will become staggering, provided society takes advantage of the potential benefits.

Many individuals have noted a percentage decline in the number of students going into the physical sciences and en-

gineering. In fact, the number of students in professional physics seems to be declining on even an absolute basis in the United States at the moment. Is it too much to hope that the cybernetic revolution will make this trend far less dangerous to our society than it might otherwise be by making it possible to use the time and capacity of the expert more effectively?

In conclusion, I would like to congratulate the people who have created the cybernetics society in order to give fuller purpose to the potentiality of the new revolution. It requires little wisdom to realize that the fruits of this work will extend far beyond the boundaries of a single professional group.

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*The papers presented by Dr. Licklider and Dr. Papert were unavailable for publication in this volume.