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ABSTRACT

A paper titled "Myopia, Cornucopia and Utopia" makes up the major portion of this Project Solo Newsletter. It emphasizes the danger involved in the belief that the larger the system the better, and points out that although the computer utilizes technology, the human with judgment utilizes the computer. Some details of the Project Solo system are also briefly discussed. (JY)

PROJECT SOLO

AN EXPERIMENT IN REGIONAL COMPUTING FOR SECONDARY SCHOOL SYSTEMS

National Science Foundation/University of Pittsburgh/Pittsburgh Public Schools

Newsletter No. 4 October 16, 1970

The Newsletter

We have been circulating information packets on Project SOLO from time to time in an effort to keep all participants as well as administrators in close touch with the many facets of the project. We will be doing this more frequently now that the project has moved into the classroom, passing along specific information on the progress of the computer augmented classes at Allderdice, Westinghouse, Peabody, and Fox Chapel. Samples of teacher au'hored modules, interesting student programs, new technical developments, special announcements, and various position papers, will be included in these mailings.

Accompanying each mailing will be a brief newsletter to identify the authors of enclosures, or to comment on the significance of their work. This particular newsletter has been called No. 4 for 1970. For your records, No. 1 refers to the paper "Some Principles for the Human Use of Computers in Education" together with the sample module VORTAC, No. 2 is the paper "Teacher-Student Authored CAI Using the NEWBASIC/CATALYST System", and No. 3 is the "Primer for the NEWBASIC/CATALYST System". Questions or comments on newsletter content should be addressed to our secretary, Mrs. Lois Rahuba, Computer Science Department, University of Pittsburgh, 800 Cathedral of Learning, Pittsburgh, Pa. 15213.

MYOPIA, CORNUCOPIA, and UTOPIA

The first enclosure with this newsletter is a paper by Dr. Richard Bellman which he delivered at Carnegie-Mellon University on October 7, 1970 as recipient of the annual Dickson Prize for outstanding scientific achievement. I believe that it provides a particularly good perspective for analyzing the kind of questions that come up with respect to computers and education. The underlined section on page 5 certainly deserves repeated emphasis.

I also found some aspects of Dr. Bellman's lecture irritating. Sweeping statements such as those on page 1 about "outmoded" educational systems and a curriculum that is "largely irrelevant", exhibit not only distressing inaccuracies, but employ the kind of simplistic theatrics that will never solve the problems decried. More on this below.

The Com-Share System

You will also find enclosed some material about the Com-Share computer network which Project SOLO is utilizing. Previous information sent you described the NEWBASIC/CATALYST system which was especially implemented for our project by Com-Share. What many people do not realize is that many other processors and features are available through the terminals in our schools, and that the students using these terminals have access to one of the most fascinating worlds of exploration ever devised by man. We intend capitalizing on this power later on in the project.

Information Systems and High School Mathematics

It is interesting to contrast the charge of irrelevance so often leveled at achools (as exemplified in the Bellman paper) with an application of one of the Com-Share system packages we have just started exploring.

As is well known, modern mathematics' syllabi emphasize Set Theory because of the intrinsic power found in such an abstraction. Most "applications" shown to students, however, fail to even begin to illustrate this power and students studying Set Theory might very well wonder what it has to do with their 'real world' existence. But suppose that a teacher worked with them in utilizing the CRS information retrieval system documented on page 1 of the Com-Share technical newsletter enclosed. I am willing to wager that the set-theoretic structure of this package, if properly used in connection with a class project in building a real retrieval system, could bring crackling vitality to this area of mathematics. The phrase properly used is important of course; in particular we must continue to give support to the excellent core of teachers growing out of Project SOLO. Attention to this point will continue to be one of our prime concerns. (We have just completed arrangements with Dr. Siegfried Treu of the National Bureau of Standards, who is an expert on information systems, to do some preliminary documentation of CRS application for us.)

Newsletter Authors

Newsletters will usually be the signed opinion of one person. This first issue came from the desk of the project director, but future issues will want to express a variety of viewpoints, including those of students. Send all material for inclusion to Lois.

Mailing List

The Project SOLO internal mailing list now has 37 names as listed below. If we should add or delete names, let us know.

H. Bower, J. Burke, S. Cho, R. Confer, S. Dubinsky, M. Duda, R. Gillespie, G. Grass, C. Hayes, M. Himmler, R. Kavanagh, L. Kishkunas, J. Klein, D. Kubiak, M. Kunkle, M. Levy, D. McMillin, J. Meldon, M. Molyneaux, W. Mong, J. Novak, J. Olson, J. Perz, C. Porter, J. Richards, F. Rifugiato, J. Roush, B. Rubin, R. Scott, D. Semans, M. Shore, J. Snoke, O. Taulbee, H. Teal, M. Valenti, T. Vasser, P. Williams

Address by Dr. Richard Bellman, Oct. 7, 1970

MYOPIA, CORNUCOPIA AND UTOPIA

We are citizens of a large and successful society. Consider, for example, the following statistics. We tolerate one-half million serious auto accidents a year plus 60,000 fatalities; we support an 80 billion dollar a year military establishment of our own in addition to subsidizing those of Cambodia, Thailand, the Phillipines, South Korea, South Vietnam and North Vietnam, (albeit involuntarily and indirectly), and others; we can allocate 40 billion dollars to a TV spectacular on the moon using a hand-held camera. This is impressive evidence of success.

Lately, however, we have been experiencing some troubles. It is clear that all of our society's systems are becoming strained, some more disturbingly than others. Lead poisoning, mercury poisoning, DDT and smog are taxing our ecological systems. The medical systems stagger along, overloaded and understaffed. Only because ten to twenty million of our population are as yet uninformed of their rights to medical care can it be maintained at all. The educational system is outmoded; the schools are overcrowded and the curriculum is largely irrelevant. A riot is at least interesting to students who are bored. Our principal social machines, the cities, are distressingly ineffective.

It appears then as if we had Pay Television all along without the American public being aware of it. This emphasis upon television was particularly surprising in view of our myopia as far as national goals were concerned.

Are we really successful? Until the present, we have taken it for granted that size <u>was</u> success. The message was in the garbage. We assumed that large systems were intrinsically

superior and would automatically function more effectively than small systems. No one even asked whether a large system was basically desirable, or feasible. Resources, space and time were apparently unlimited. Technology would reign supreme and solve all problems that arose.

It is this that I wish to discuss today. Such questions began to come under serious scrutiny shortly after Wor' War II. Technology had indeed made the nation great in many different ways. It had given us abundance, prosperity and freedom. In particular, it had turned the tide against the formidable armies of Fascism. Suddenly, however, it transformed into a monster. We didn't seem to know how to switch the machine off. The threat of automation in various industries like the steel and the automobile industries became very real.

Extrapolation to other industries and other types of jobs created the image of a bleak and tedious future with no significant place for man. Predictions of four-day and three-day work weeks were followed by those of two-day and even no-day work weeks. Newspapers and magazines were replete with relentless foreboding, Puritan displeasure and the spectre of compulsory leisure.

Then appeared an extraordinary machine, the computer, which worsened the situation. Ordinary machines had supplanted man's muscle; the new machine dethroned his brain. The computer was to the spinning jenny as Freud was to Darwin. Enthusiasts wrote about thinking machines that would become world chess champions, compose music and, worst of all in some circles, prove mathematical theorems.

All of this combined to conjure up a nightmarish 1984, a world devoid of human control and indifferent to human values, a

world governed by computers. It was, and is, a terrifying picture. Fortunately, most of these ideas are nonsense and in fundamental ways all are wrong. Let me explain.

To begin with, I wish to recall some simple and basic properties of the digital computer. It can store and retrieve numbers, it can carry out data processing involving arithmetic and it can follow instructions to perform long sequences of these operations. It never gets bored and, at least as far as the Credit Card companies are concerned, it never, never makes a mistake.

This device that can carry out the elementary arithmetic operations of addition and multiplication billions of times faster than ever before possible, has irrevocably changed the nature of mathematics and thus of the physical and social sciences. Yet the revolutionary effect of the computer on both calculation and concept remains a secret to most mathematicians in colleges and universities. Indeed, most of the courses in all subjects in the colleges, and naturally the high schools, remain precisely what they would have been had the computer never happened. Distressing as the situation is, it is not surprising to those of us with some knowledge of the history of science and education. That this unfortunate lack of interaction with current mathematics, science, technology, life, and philosophy results predictably in alienating and embittering students hardly needs stating.

Let us return to the computer and systems. Using its ability to perform large-scale mathematical calculations, huge engineering systems of all types can be designed and operated. Let me cite hydroelectric systems, irrigation systems and garbage disposal systems.

What about administering social systems, such as medical systems on educational systems? A large system of any type requires extensive data-handling. Data must be stored and retrieved for decision-making. Computers are absolutely essential for our contemporary society.

But - the essential point is that they are not sufficient. To handle human, problems, they must be used by human beings.

To establish this point, let us recall that a physical system is specified by numbers. These numbers are transformed into other numbers by "laws of nature," equations which perform the transformation. Finally, the performance of the system can be evaluated in terms of numbers. Hence, the utility of the computer.

Social systems, however, stoutly resist quantification. In systems involving people, we find that we cannot describe too closely, that we cannot predict accurately and that goals cannot be specified with precision. We cannot speak meaningfully of efficiency and optimality in social systems. We can only think rationally of feasible systems.

Real systems then are fuzzy systems; objects and goals alike are perceived through a haze. Since a digital computer requires an arithmetic input, it cannot be used by itself to operate a fuzzy system. The fundamental difficulty is that a computer has no judgment, no intuition. To operate the fuzzy systems of a society populated by individualistic human beings, each unique, each with different ambitions and requirements, we need devices that can break rules if necessary, cut red tape in an emergency, improvise and, in general, cope. Fortunately, these surprising devices exist. They are human beings.

That large systems require extensive use of computers to augment human abilities in vital areas of data processing must be stressed. In these areas there is no substitute for the computer. It provides the data vital for human decision-making with the necessary speed. We thus must contemplate man-machine systems with a crucial division of responsibility. The computer utilizes technology; the human with judgment utilizes the computer.

Since the human mind can focus on only a relatively small number of problems at any time, it follows that large human systems must be composed of networks of small systems. This is a basic decentralization essential for educational and medical systems as well as for all other social systems. These networks will be patched together with human operators and supervisors and by human communication. Computers can only work effectively in social systems when their inputs and outputs are closely monitored by humans.

Even with a structure of this type, it turns out for many reasons that it is impossible to operate a large system efficiently. An inherent characteristic of every large system is a certain amount of confusion. This is not necessarily a severe problem. The objective in operating a large system is not so much to avoid confusion as to provide systematic mechanisms for preventing minor disturbances from becoming major disturbances - a control process.

This type of control will require many people in different positions at different levels. People will remain as lubricants of every social system, preventing the mechanisms from becoming clogges. Only they can tend to human needs and preserve human values.

An understanding of this situation will help dispel the bugaboos of automation and compulsory leisure. We actually don't have enough workers for the personal services required in health, education and welfare and for the maintenance of a comfortable and civilized society. To meet this need for workers with judgment we will make fruitful use of the elderly. Once again, in the society of the future, experience and maturity will be invaluable social assets.

We are becoming too sophisticated, too aware of the complexities and irrationalities of human nature to plan for ideal societies. But, we can plan for desirable societies which for the first time in history are feasible. We can improve existing society in some obvious ways. Certain factors may not guarantee human happiness, but they are necessary for a decent life. Among these are food, clothing and shelter, education and medical care, and, above all, human dignity, a sense of opportunity and a sense of fulfillment.

With the aid of modern science and technology, we can provide all of this. We live, after all, on a giant cornucopia. In many ways it is an easy world. It is an abundant world. Our problems are those of allocating existing goods and services to meet the basic needs of people. If we meet the needs of others, we automatically meet our own needs. It becomes clearer all the time that pragmatism dictates the actions of idealism.

The operation of large-scale educational and medical systems is a formidable task requiring, for reasons sketched above and many not mentioned, a combination of imagination, intelligence and effort. But a nation that can spend 40 billion dollars to send three men to the moon can, if it wishes, put stars in the eyes of children and hope in the hearts of all men.

Dignity, opportunity and fulfillment will be provided automatically by jobs, important jobs required to keep the systems of society functioning.

Is this Utopia? Perhaps so, perhaps not. Utopia is of course nowhere and no time. It is not a state, but a process, an adaptive control process. It is not an act of being, but an act of becoming. We may find that the road to utopia is utopia.