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Computers and Robotics

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When one mentions the word technology, it invariably stirs up thoughts of science fiction-like electronic gadgets, spacecrafts, lasers, computers, and robots. If we hear talk of computers and robotics, our minds flash images of intricate computer consoles with flickering, multicolored lights and shiny, metallic, people-resembling machines with monotone voices.

Admittedly, these are rather narrow perceptions of what technology, computers, and robotics are all about. Yet, they indicate a mindset which has been instilled in us by the Madison Avenue and Hollywood approach so prevalent in our Western culture.

Technology in a broader and more realistic sense involves many areas including the natural, physical, and applied sciences as well as the social science. A useful definition of technology is one given by the well-known engineer and philosopher, Schuurman:

> Technology is the activity by which people, with the aid of tools, give form to nature for human ends.[1]

To be sure, this definition needs to be expanded if we want to understand clearly the "meaning" of technology. From this simple definition, however, it is apparent that technological design should be an integrating activity and involves much more than just producing specialized tools and machines. Good technical design of tools such as computers, chemical fertilizers, spelling checkers, pesticides, robots, computer-aided design systems, and Magic Window programs must be normed by the law of the inter-relatedness of the many and varied aspects of God's created order which they may touch or affect.

to do about it.

It is fair to warn you that the answers to the issues raised here will not come in a neat little solution package but will demand an ongoing struggle from all of us in the Christian community who take seriously our calling to be servants of the Most High God.

Why Computers Proliferate

Let us briefly consider some trends in the technology under scrutiny. Computers are becoming ever more pervasive in our society and in our personal everyday life. They come in all shapes and sizes. Literally

...it is crucial to understand that there is an intimate connection between people and technology. People do technology for people and other creatures in the service of God Almighty.

It is not the intent at this point to lay down a philosophical foundation for modern normative technology. In fact, God's Word for creation is our foundation. The task of exposing for us this foundation of normative technology was done by other papers in this series. But it is crucial to understand that there is an intimate connection between people and technology. People do technology for people and other creatures in the service of God Almighty.

Now we wish to zero in on that particular facet of technology which is manifested via modern computers and robotics and in this way try to be specific in our analysis of the challenges this area provides for us as Christians today. We must raise some honest questions about present technological developments and sensitize ourselves to the real issues which underlie and result from the use of computers and robotics. We must evaluate whether or not this technology, as we see it in action today, is obedient technology and if not, what we are prepared

millions of identical computers (microprocessors) are being incorporated each month into standard consumer items such as dishwashers, refrigerators, vacuum cleaners, power tools, automobiles, TV sets, furnaces, etc. Such computers are, in reality, pre-programmed automatic controllers of the same generic type but each with their own "personality." In fact, these appliances are all robots.

Why is this being done, since we already had all these appliances before the "micro-age"? Because the memory of a "smart" microcontroller can readily be re-programmed to completely change the operating characteristics of the appliance in which it is placed. A few simple examples may help. The speed and cycle duration of a food blender, or the angle and depth of cut of a "smart" tablesaw, or the maximum temperature of a steam iron are software instructions programmed into their identical microcomputer memories and are readily changed by the manufacturer.

For the manufacturer, this means the same computer circuit (chip) can be used to control a great variety of appliances with minimal added development cost. For the consumer it means more versatile, cost-effective and reliable appliances and machines. Here we observe the cost benefit of mass production and, at the same time, the customizing and, we hope, humanizing of the end product through simple changes in the computer program. This, in at least a narrow sense, changes the appliance's "knowledge."

It is presently possible to build such computers with the ability to change their own internal operating instructions and their database, and therefore their "personality" and knowledge, depending on certain external or internal events which they may be designed to monitor. For example, a "spelling checker," as part of a word processor, can learn new words and add them to its vocabulary. A personal robot can learn the location of walls and furniture in a house by trial and error or by artificial vision and avoid these obstacles in future walks through the house. Of course, it is still the original designer who controls what type of information a robot (articulated computer) can sense and how it will articulate its actions.

But what happens when a computer or a robot designs another advanced version of its own kind? Will this throttle our creativity and our freedom or will it cause it to soar to ever greater heights? If we are truly disclosing the meaning of reality with our advancing technology, we should expect ever greater insight and understanding rather than a narrowing of our horizons.

Results of Computerization

On the one hand, computerization is leading to fearsome machines which can destroy or hurt, e.g., heat-seeking missiles or killer satellites, video machines and games which seem to enslave rather than serve. But a machine can equally well be designed to give a paraplegic the ability to walk by computerized, adaptive control of body muscles and nerves; to restore bladder control to paralysis victims by electrical stimulation; or to implant bionic ears to restore the hearing of those who have suffered injury to the inner ear.

What about the use of robots to handle useful but toxic chemicals, to make consistently good welds on automobile and tractor frames, to handle the routine tasks of picking items from shelves in large warehouses? Then there are the hundreds of computer systems which monitor the weather on this continent and bring us accurate predictions of pending tornadoes or snowstorms; and satellites, loaded with robotic equipment, scan our fields to predict crop yields, observe insect infestations, and monitor our lakes and streams for pollutants.

It is equally true, of course, that this same technology causes many problems. Benefits and risks seem to be complementary aspects of each technical advance, caused, no doubt, by our lack of insight into the true nature of things and creatures but also because of the antithesis present in this world. The inventor or designer's motivation can be to either serve the Creator by opening up creation's true meaning or to serve his own (or his corporation's) selfish interests and ambitions. The latter motive often results in either short or longterm harm to his fellowman, himself, and nature at large.

If, on the other hand, our motive is stewardly care, we must get away from the bad precedent of, for example, forcing insufficiently developed technological interfaces, such as computerized word processors, into the hands of our secretaries and administrators. It ought not to be necessary for a secretary to change drastically her or his abilities to type, file, and sort in order to use a more efficient, computerized machine.

Therefore, we need system analysts, programmers, and designers who can recognize the norms of the administrative field and

harness technological advances and tools to serve the administrators and not to stand in the way or frustrate. The tool must be customized to the need and not the other way around.

Our challenge then is not to ask, "What will future technology bring us?" but instead, "What should computers and robots do for mankind and otherkind?" Can we make robots into obedient servants of our Creator? We must use our God-given insight and the lessons learned from history to approach the answers to those questions.

Fifth Generation Computers

A few years ago, the Japanese startled the rest of the world with their "Fifth Generation Computer Project." In a nutshell, the Japanese want to leapfrog, or bypass, a whole generation of computer and artificial intelligence in development in order to deal more effectively with the social and economic problems which they anticipate facing in about a decade. Automation in the manufacturing industries in Japan is highly advanced and has resulted in tremendous gains in productivity. In spite of that fact, costs and prices in their service industries are rising rapidly and are at the point where the price of a good restaurant dinner equals the cost of four scientific calculators. Of course, the reason is that service industries are not readily automated even by our present advanced computer and robot technology. Hence the fifth generation computer project.

Via this effort, the Japanese and, somewhat belatedly, also the U.S.A. and Europe, are striving for more human-like (artificial intelligence) interfaces to partially remove the gross productivity imbalances between the service and manufacturing industries. The results of this massive and intense effort to invent new techniques and approaches will likely benefit many workers in labor-intensive fields. This will free more time for laborers to be creative image-bearers, which, in turn, raises another question, namely, how do we teach people to be more creative after we take away many of the menial tasks? Is it even a good idea to eliminate all such tasks? More about this later.

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It is interesting to note the four major goals of this Japanese project:

1. Enhancement of productivity in low-productivity areas.
2. Conservation of national resources and energy conversion.
3. Establishment of medical, educational, and other kinds of support systems for solving complex social problems, such as the transition to a society made up largely of the elderly.
4. Fostering of international cooperation through the machine translation of languages.[2]

Fifth generation computers are expected to be used by many different people in the 1990s. They will manipulate knowledge as well as raw data in the form of numbers, symbols, words, pictures, or human speech, where we narrowly define knowledge as information judged or organized in much the same way as we organize knowledge in our brains. As such, these new computers will be more than a direct extension of today's micro-computer technology. Applied artificial intelligence will play a key role. New parallel processing architectures and new design philosophies are required to make possible such a quantum jump in technology. Rather than do "number crunching," the new machines must be able to assess the meaning of information as well as understand and anticipate the problems that need to be solved.

In short, the objective is to invent and develop new computer technology that can perform more human-like intellectual functions such as inference, association, and learning, and accomplish non-numeric pro-

cessing of text, speech, and patterns. The Japanese timetable to achieve these goals is 1991 and now, three years into the project, they are right on target!

There is no doubt that by 1991, technology will have wrought many substantial changes to our work and life style. Hundreds of thousands of new robots, some with great capabilities, will have taken their place among us. The question to us is, operating from punched card programs, but nevertheless automatic and robot-like in their operation. This also emphasizes the fact that, as long as machines look like machines, we may be very impressed by their power and capability but we accept rather readily that they, designed and fabricated by people with the help of other machines, are just cold steel, plastic, and silicon!

Our narrow, popular conception of robots is that they must look at least somewhat like people and articulate themselves like people, for example, through speech, arm movements, and walking.

will we actively propose and pursue biblical norms to channel these developments or will we let the secular mind lead us ever further from our creation mandate?

About Robotics and Artificial Intelligence

What makes a robot a robot? A robot can be defined as an "articulated computer." Our narrow, popular conception of robots is that they must look at least somewhat like people and articulate themselves like people, for example, through speech, arm movements, and walking. On the other hand, an automatic train speeding down a Tokyo track at 200 mph is also a robot. It is well to broaden our perspective of robots since it will help to remove from our minds some of the wrong connotations that the modern "personal" robot seems to bring with it.

Some not so obvious examples of robots are computer controlled milling machines, microwave ovens, and record players. Even the old Dutch street organs and once-famous player pianos could be classified as articulated electro-mechanical computers,

Yet, the moment a machine is given the ability to talk to us, move toward us, and raise its mechanical hand to greet us, we regard the machine more as a person-like thing and somehow our attitudes and feelings toward it change. A machine's exterior human resemblance and behavior touches our emotional senses and arouses in our minds emotions of awe, excitement, fear, and even of kinship. Some would say, "But that's only natural!"

Still, very little seems to be known about this man-machine relationship; it offers great opportunities for Christian psychologists and social scientists to make their contribution to this area.

How intelligent are today's robots or computers? The verdict has to be this: not very intelligent at all! The speed of a computer's ability to calculate is often mistaken for intelligence. As it is, even insects demonstrate levels of intelligence higher than any computer has ever attained, even though the insect uses only very slow neural processing. Speed alone does not solve all complex problems. Completely different ways of building

computers, that is, new computer architectures, need to be devised to stimulate intelligent behavior.

Visual perception in a human, for example, is a highly sophisticated ability. When one stops to think of how complex a process vision is, one can only conclude that it is astonishing that we have the ability to see at all. Our visual capability is a marvelous tribute to our powerful Creator. Often we are tempted to draw an analogy between the computer and the human brain but this can be very misleading. Present day computers mainly process information one item at a time, but the brain, even though its signals move slower than those in modern computers, can process millions of information items seemingly at the same time. In writing about the brain's ability to recognize patterns, Crick says: "human beings can recognize patterns in ways no contemporary computer can begin to approach.[3]

Expert Systems

However, in research labs around the world, tremendous strides are being made in the area of artificial intelligence, AI for short. As an example, the very computers used to develop AI systems have been designed largely by other computers. Artificial intelligence is difficult to define but it includes the ability to reason, anticipate, make logical inferences, and understand speech. A machine with such intelligence does not exist, at least, not yet! But machines called "expert systems" do exist and are being created today. These seem to be very human-like in their capability to diagnose and analyze.

Expert systems are computers programmed to have access to a large database of information about a particular subject and possess the ability to sift through and analyze the facts given to it by a user of such a system. By the way, a very valuable aspect of expert systems is that they will preserve knowledge long after the original human expert has gone. AI researchers determine how medical, legal, management, and technical experts reach their conclusions based on years of accumulated experience. The expert's knowledge is then encoded in the machine via thousands of if-then rules. This procedure is known as knowledge engineering. The expert system can then answer diagnostic type questions very accurately and very completely.

Presently, experimental machines of this type have been developed for the medical professions, and, in the near future, patients can dial up such a "computer doctor" for a remote medical checkup. Remember, that consumers can already buy electronic pulse, blood pressure, and heart monitors which can be connected to our telephone system to pass on their data to the "expert." Even a bionic nose, capable of distinguishing subtle differences in fragrance, has been developed in England. Technology is changing the computer from a very fast calculating machine to a device which can see, feel, smell, hear, speak, and move much like a human does.

What Makes Man "Man"?

If in a few short years, we can't tell a machine from a man by the way it talks, walks, and behaves, what is it then that makes man different from a robot? As Allen Emerson and Cheryl Forbes argue in their paper on "Living in a World with Thinking Machines"[6],

> If machines can reason, what does that do to our definitions, our fundamental presuppositions about life?...Man is not unique among creation any longer...Computers, coupled with genetic engineering and robotics, make possible the creation of new and the manipulation of old life forms, a domain we once thought belonged to God alone.

A tremendous and awesome challenge is before us. Our theologians, linquists, and philosophers must answer anew the questions: who is man? what is the nature of man? who is God? what does language mean? what is the place of salvation? We need to clarify and promote the biblical view of man as God's image-bearer, and what that really means, despite the stiff opposition we'll meet among those who would reduce man to a mere rational machine. It will also require a re-evaluation of what we mean by work. What about our God-given task of subduing the earth and ruling over creation? These questions, and others you may add, take on new importance in view of the fifth generation technology which dawns.

It is also possible that we may need to conclude that there are certain things which technology can do but which are immoral and anti-normative. Then too, against all opposition, we must say so.

Automation and Unemployment

"So," you say, "what about the bad side-effects of robots which through automation cause unemployment and recession?" However, is automation the real cause of unemployment or is it we who have ignored the norms of creaturely service? A few quotes from a reporter's interview with Schuurman may help at this point.

> Typical of all recessions is the fact that certain norms were always ignored. ...the unemployment we experience is really a judgment on the way we understand or fail to understand our mandate. Man has been called to work. Yet, most of creation's potential has not been developed.[4]

Our "call to work" is properly interpreted as "a freedom to work." Too often we see work as just "technical and productive" work. There is nothing wrong with technical work as such but we need to define our calling to work more broadly as Christians. Since it is exactly the technical work which can be readily automated with today's computers and robots, we claim that technology, which frees us from specialized repetitive work tasks, causes unemployment. Yet many other forms of work such as creative work remain undone. Again quoting Schuurman:

> Whenever technical work becomes automated, there is tremendous opportunity for creative work. However, having never learned what creativity entails, the unemployed person suddenly feels he has nothing to do. This may never be the case with a Christian.[4]

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Recall our earlier reference to the question, "How do we teach people to be more creative?" We need to teach that creativity includes inventing new and better ways of doing things, new ways of helping our neighbor, increasing our understanding of nature, of other creatures, of ecology, of linguistics. And is it not possible that unemployment will cause a renewed interest in the creative arts or modern artisanship using the new technological tools and instruments? Computerized art is only one example of this trend having started already. The independent crafts and trades could once again flourish, thus countering the leveling effect which mass production has on our creativity.

Do you feel that the above answers are still too technological or economical? Then listen to Schuurman again. "We have not been sufficiently economical or sufficiently technical because all of our economics and technology have been predicated on the (one-sided) ethic of production."... In other words, we demand production for the sake of production. Schuurman goes on to say,

> Can't we see that productive work must be used to feed the hungry and clothe the poor? Thus far we have failed miserably. We are not sufficiently technical; that is, we do not have the spiritual inclination to make maximum use of technical potential.[4]

To get out of this rut, we need to see the great variety of work that we do, regardless of its type or end results, as characterized by service to God, our fellowman, and all creation. "For a Christian then, work of any kind is identical, not as it is worked out to production but to service."[4]

Besides the many creative work opportunities made available to us by technology, the Christian also has to consider the potential for social work, parenting, charitable work, faith work. The gospel of cosmic redemption needs to be preached.

Innovation and creativity have to be stimulated among us if we are ever to break the shackles of our narrow, materialistic, technique-oriented thinking. Of all people, we as Christian community should be at the forefront of developing technology. Not to buy ourselves more technological trinkets and toys, but to make maximum use of the technical potential to create for us the time and resources we need to feed the hungry, clothe the poor, establish justice, fight disease, and spread the Gospel. We need to be innovative in revealing God's full glory in created reality in order that we may prepare ourselves for that day when our Master will return. We are the ones who need to demonstrate to the world that there is a better way.

To be sure, sin will distort our best and well-meant efforts, but God's Kingdom has overcome the power of sin and so we must provide the Kingdom perspective. God will surely bless it.

We urgently need more and better "tool" programs for our computers so that we can indeed make computers into obedient servants.

What are we saying then? That we need many more Christian engineers, psychologists, philosophers, linguists, musicians, businessmen, and scientists? Yes, but more than that, we need to promote the Christian concepts of work, creativity, and technology in our classrooms, from our pulpits, in our business dealings, and set living examples of what "serving technology"

can and must be.

Does this mean, for example, that everyone of our students should be computer literate, in the sense as Kay defines it? Absolutely not! According to Kay, "Computer literacy is a contact with the activity of computing deep enough to make the computational equivalent of reading and writing fluent and enjoyable (a romance with the material is involved)."[5]

Computers will be as pervasive in the near future as electric motors are now. Yet, we accept having and using dozens of electric, motorized tools and appliances without knowing exactly how it is that electricity is converted to mechanical action. We use such products of technology as extensions and tools in a rather natural way, following simple actions and procedures such as the throwing of a switch. Ask a secretary using an electric typewriter (motor driven) or a carpenter using a skillsaw (also motor driven), "Are you 'electric motor literate'?" and their response will likely be, "Pardon me?" To be sure, it is the wrong question to ask.

Therefore, we should not expect computer literacy from everyone. What we should expect is that a person has a good appreciation of how to use computers and their programs to help get a task done more creatively or efficiently. It also means that such a person is conversant with the "good" software that may be available to accomplish the tasks he has to do.

We urgently need more and better "tool" programs for our computers so that we can indeed make computers into obedient servants. Are we going to wait for the big software houses to give us what they think we need? Let us teach our students to be more creative in the way they can interface with technological tools such as computers and robots to address problems in sociology, physics, economics, politics, history, and education. Let us teach them to make efficient use of such tools and then help them to use their extra free time for more creative tasks.

Certainly, within this college, we can make a beginning on this if we mean what we say in our statement of purpose. Each department ought to teach its students how to obey and to formulate norms that fit our biblical perspective. The engineering, social science, agriculture, linguistics, psychology, communication, and theology departments all need to pay heed to the challenges placed before us.

We must learn to apply technology to extend ourselves to be better able to serve. Are we dreaming out loud when we say these things? No! Can we turn the tide of materialism, selfishness, and technological slavery? The answer is an unequivocal yes! Let us join hands and minds with other Christians and work and pray that the Lord of creation will enable us to rightly discern how we should use our talents and gifts to make technology serve the creator and His creation. This paper has raised many questions, posed a number of challenges and a few possible starting points for finding answers. Now it is up to you to talk over the issues raised with your colleagues and friends and to act, in faith, to begin a reformation in technology. We can't afford to wait for someone else to do it for us. Admit that we are frail and weak but then remember too that God's power is made most evident through weakness.

Soli Deo Gloria!

Endnotes

[1]Schuurman, E., *Technology and the Future*, Wedge Publishing Foundation, Toronto, p. 5, 1980.

[2]Tohru Moto-oka, "The Fifth Generation: A Quantum Jump in Friendliness," *IEEE Spectrum*, p.46, Nov. 1983.

[3]Crick, F.H.C., "Thinking about the Brain," *Scientific American*, vol 241, no. 3, pp 219-232, Sept. 1979.

[4]Schuurman, E., "Technology and Work," *Christian Renewal* (interview), pp 4-5, Feb. 6, 1984.

[5]Kay, A., "Computer Software," *Scientific American*, vol 251, no. 3, pp 52-59, Sept. 1, 1984.