Pro Rege

Volume 12 | Number 3 Article 4

March 1984

Computer Revolution: Another Human Extension

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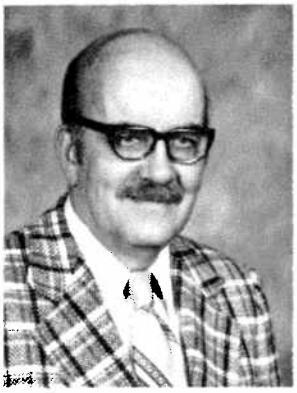

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Many social commentators have discussed the impact of the computer revolution on modern society. Most interpretations seem to be based on a humanistic view of humanity and history. I want to suggest how Christians might view the computer revolution. In doing so, I want to put the computer revolution into the larger context of the history of technical innovation, with special emphasis on the principal developments of the modern scientific era.

My investigation of the meaning of the computer revolution begins with the Biblical description of human beings and their achievements. According to the Bible, Adam and Eve were created in the image of God, not in the image of an animal, and so the human race has not evolved. But changes have occurred in human life. Those changes are not those which the evolutionist postulates, but rather the changes that cannot occur among animals.

Some of these uniquely human changes are of interest in examining the computer revolution. They are changes which occur because human societies, unlike groups of animals, accumulate knowledge from generation to generation. In short, human culture is possible. Since only human beings possess this culture-forming ability and only

human beings were created in the image of God, we can relate these two aspects of human beings. Human beings accumulate knowledge as various human cultures are formed *just because* they were created in the image of God. Of course, creation in the image of God implies much more than merely the ability to accumulate knowledge. But as the human race accumulates knowledge, it grows in the understanding and the use of creation. This growth does not make the human race morally better as time passes; on the contrary, human beings continually make use of these developments in their rebellion against God. We should understand the nature of this growth.

I would like to work out this thesis concerning growth by discussing the formation of culture, starting with the Biblical account of its beginnings.

We know very little about the abilities Adam and Eve had before they fell into sin. But the abilities of the earliest fallen human beings must have been extremely limited. According to Genesis 4, some of them began to work metals. These first tools must have been very simple. Others learned the first principles of agriculture.

As an aid in demonstrating that these changes in the life of the human race may be considered to be changes in individual persons, I shall introduce the concept of the "extension of the human being." When the hand of a human being first used a tool to do that which the hand could not do alone, the tool became the extension of the human being. When a human being gained control over a field or a flock, the field or the flock became —again, because the human being controlled it—an extension of the human being. The "extension of the human being" idea held for the horseback rider, the charioteer, the soldier armed with clubs and arrows—in fact, it has held for all the technical innovations of history.

This history of technology consists of more than a chronological list of innovations and how they have increased the ability people possess to do such things as mine metals, travel, transport materials, produce crops, build houses, and make machines. Such achievements represent power; if a list of such achievements were the whole story, human beings would be little more than machines, continually exerting more power as the years pass.

But human beings are not machines. According to the account in Genesis, the early workers of metal also made musical instruments. When these instruments were played, music was created. As technological improvements continued to appear, people could develop an increasing number of abilities and skills. The potential of human beings is exhibited not only by the tools and machines which are extensions of their hands, but also by their violin sonatas, the skills of athletes, and the intellectual prowess of the most sophisticated mathematicians.

Both the person who possesses the unusual ability and the person who admires that ability are created in the image of God. This admiration is not surprising, since we are all part of the same creation. We are thrilled when we see an outfielder make a running, leaping catch; words cannot describe our emotions when we hear certain music, such as the Trout quintet or a Brandenburg concerto. We might have a similar experience when we encounter a particularly satisfying mathematical demonstration.

Practically all of these achievements are possible only because human beings can accumulate knowledge and experience. Such an idea is obvious in technological development; it is also true in other human experiences. Artists of all kinds learn from the cultures which preceded theirs, and quite often, as in athletics and music, developments are possible only after technological advances have been made. Sophisticated modern mathematicians could not produce their results if the Greeks had not done their work.

Therefore, human history demonstrates that God has continually led people to learn more of creation. He has led people to understand how to use creation, and the result

is that every facet of human life is affected by this understanding. Human interaction with creation changes every part of human life. Everything in the human environment and experience—including thought, artistic expression, personal interaction, and work—constantly changes.

Quite possibly we would not recognize the earliest fallen human beings if we met them. They surely would not know what to make of us. But it is not only cultural advances which would separate us. Sin has also been accumulating over the years. Furthermore, the accumulated sin is not merely something added to our cultural advances, as if it could be scraped off the top, enabling us to inspect the pure, advanced culture underneath. Sin permeates every cultural achievement. Sin is present in the pistol of the hit man, in the pure reason of the Greeks, and any impure motives of Christian artists and intellectuals.

In spite of the influence of sin on culture, God has not left himself without witness in creation. He witnesses to us not only in the change of season, but also in what he has led us to achieve. In doing so, he presents us with a glimpse of what we could be. After all, there is in principle no limitation on the number of skills or abilities which one person may possess. One person could have the intellectual ability of an Einstein, the athletic skills of Olympic gold medalists in every sport, the voice of a Pavarotti, the musical genius of a Toscanini or a Beethoven, and the literary abilities of a Solzhenitsyn or a Shakespeare. Contemplating this magnificent composite person provides only a glimpse of what God created when he created the human race. Although we do not know what we will be like when our sanctification is complete and we enjoy a perfect life with our Lord, we do know that what we will be able to develop into will not be less than this composite person. We will be fully human.

The Computer Revolution

The computer has come into the kind of world just described. The computer is an extension of a human being because it enhances human abilities in a very large number of fields. What a person can accomplish because of the computer is now so much greater than it was that it is difficult to describe the situation.

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Even so, it is important to grasp what has happened. To obtain a limited picture of the situation, consider the amount of information the modern "supercomputer" can hold in memory and process. Take, for example, an eighteen-digit number, such as 864,984,293,754,201,278. When you know this number, you possess a certain amount of information. The computer can store such information; other information it might store are words or other symbols. The supercomputer will be able to hold in memory information equivalent to 32 million such numbers *and* it will be able to process all this information in about two-tenths of a second. Comparing this ability

with that of an unaided person will help you to begin to grasp how much the human being is extended when this immense capability is applied to human tasks.

Lesser versions of the computer are also being applied to our tasks. As a consequence of all these efforts, virtually nothing in our society has been left untouched. Because of the computer, manufacturing, mass transportation, broadcasting, and uses of the telephone are far different from what they were a few years ago. Business, farm, school, and other organizational records are kept with computers. Today's financial institutions keep their records and transfer funds using computers.

In addition, there has been a complete transformation of military organizations. Mailing lists, including those of newspaper and magazine subscribers, are computerized. Weather satellites and weather forecasting would be impossible without computers; in fact, without computers we would have no satellites or space probes of any kind. Computers are changing medical diagnosis and treatment. Sometimes scientific information is so voluminous (astronomical and weather information are but two examples) that it cannot be analyzed without the aid of a computer.

Such a list of computer applications emphasizes the technical side of our lives. The effect of the computer on other human activities is great, but not always so obvious. Word processors are only beginning to exhibit their effect on writing and literature. The invention of digital recording is only one way in which the recording and broadcasting of music has been altered by the advent of computers. Since computerization will improve all manufacturing operations, better musical instruments will be produced. Theatrical productions are of much higher quality now that it is possible to block and to plan stage settings using computer programs.

With most of the uses of the computer which have just been listed, the computer merely improves upon what people were doing before. Even though this improvement is often dramatic, the human activity concerned has not *completely* changed. We are presently at the stage we once were when we removed the horse from the horse-drawn carriage and replaced it with an engine without doing much to the carriage itself. It seems that the computer impact on our culture is miniscule compared to what it can become. Because of the computer, human life will have been extended farther than ever before. The computer revolution, occurring within a few decades, may be the largest cultural change the human race has ever known in a similar period of time.

Sinful people misuse these developments so that they would, except for the restraints which God puts on them, wreck our society. Even so, it is not true that because of the horrible effects of sin we can find none of the Lord's doing in developments such as the computer revolution. Every cultural advance exhibits a small part of what human beings could be if they were not sinful. Every cultural advance points to the kind of development we will know when our life is perfect. At present, we see through a glass darkly, to be sure; but we do not fail to see through the glass at all.

Computer Crime

God the Father honored human beings when he created them in his own image and God the Son dignified this image in the Incarnation. One of the worst sins is to believe that a human being, the crown of creation, is something less than the image of God. But many thinkers look upon a person as a machine, not the image of God, and they anticipate the time when the computer will constitute the brain of that machine. In a time when there is much talk about computer crime, this particular denial of God's work is the greatest computer crime of all.

Such a low view of humanity might arise because of the belief that human beings have evolved from the animal state. In that view, the human being is an evolving machine

whose parts consist of reacting chemicals. Human behavior becomes predictable and controllable. This is "reductionism"; a human being is "reduced" to a set of chemical and physical processes. Since chemical and physical processes can be interpreted mathematically and since the computer can carry out mathematical operations very efficiently, the reductionist sees—in principle, at least—no reason why a mechanical person, with a computer brain, cannot be created. Of course, computer scientists are usually concerned with realizable goals and not with such science fiction versions of artificial intelligence. But the scientific community has nevertheless erred in this matter: it has not claimed unequivocally that these science fiction predictions are wrong in principle. (In this kind of intellectual climate the term "computer language" is unfortunate because it implies that a human language and a computer language are comparable, whereas our linguistic ability is actually unique: neither a machine which we make nor an animal possesses this ability.)

mathematics, it might seem that attempts to use the computer to predict social behavior are doomed to failure. In order to understand that some such predictions are valid, the concept of "model" must be understood.

A model of a system to be studied is a description of the system which includes the factors which will determine the behavior of the system. To illustrate, suppose a particular system is a group of people. If we can describe this group as half male and half female, this description can be for certain purposes our model of the system. This model provides, for example, the prediction that no more than half of the group will ever give birth to children.

Naturally, models are usually much more sophisticated, and it is not surprising that advanced mathematics is often involved. It is possible to construct and use complex mathematical models without computers; with computers, however, much more complex modelling is possible. One kind of group behavior which can be predicted even though it involves many factors and large numbers of people is the voting behavior of

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Computer Modelling

Some uses and predictions of uses of the computer seem at first glance to be reductionistic but actually are not. For example, since human social behavior depends upon human qualities which cannot be reduced to the group. Thus, a warning against reductionism cannot be universally applied to systems involving people. What *is* true is that workers who do not see the error in reductionism are likely to favor using computer analysis in lieu of all other kinds of social analysis.

Another reason some workers assume that the computer can be used for any kind of social analysis is the success associated with the use of the computer in working with models of systems simpler than those involving people. The computer has given significant aid in analyzing models of ecological systems, demonstrating, for example, which new equilibrium state is achieved when one component is varied. Also, modelling of chemical and physical systems, inherently simpler than modelling involving living things, has often been successful. Enough is known about the properties of atoms and molecules to make possible the construction of models which are very complicated but not too complicated for modern computers. For example, in order to synthesize a chemical compound, such as a medicinal drug, many chemical reactions or steps must be carried out. At each step along the route the experimenter may have to choose which of several possible steps is the best next step to take. Consequently, there are a large number of conceivable paths between the starting materials to the desired product. Almost all the paths will be very inefficient. The testing of a large number of possible paths is not feasible in the laboratory; it is feasible, however, to test these paths using the computer if the system is properly modelled.

Thus, computer modelling can be a weapon in the hands of the unbeliever who is determined to show that a person is a machine, not an image of God. But computer modelling can also be one more extension of human beings, giving us one more glimpse of what they can be.

The Computer, One More Sensational Development

What is there about the computer which makes it a *sensational* development? The computer has an impact on a wide variety of fields. But *why* does it have this impact? I shall discuss the reason for its staggering impact and then, in terms of certain "extremes" in creation, relate this development to other modern sensational developments.

The computer carries out many processes analogous to the thought processes of a person. The innovation is this: the computer functions at infinitely greater speed. The computer is not revolutionary merely because it can store a large amount of information; after all, we have been able to store similar amounts of information in libraries for a long time. With the computer the difference is that we have unbelievably rapid access to this information and we can process this information at speeds never known before.

I want to discuss the reason for this speed and the meaning which that speed has for us as we consider the larger picture.

The reason for the speed lies in the fundamental difference between the computer and other means of making automatic calculations and storing information. In the ordinary sense of the term, there are no moving parts in a computer. On the other hand, in mechanical calculators, which preceded the computer, there are moving parts. Gears and levers, which have mass, must move as calculations are carried out. Other calculators which were used are based on the same principle. The same is true for other means of storing information.

Although there is no moving part in the computer, the electrical impulse, which possesses no mass, does move. The question of whether or not the entity which moves possesses mass is critical. The electrical impulse, which is the propagation of the electric field, moves with the speed of light. The speed of light and of electric field propagation is 300,000 kilometers (186,000 miles) per second in a vacuum; the speed through matter is somewhat less. (The speed of light and the speed of electric field propagation are the same because light is the propagation of an electromagnetic field, and for fundamental reasons all field propagation speeds are the same.) But even though an object possessing mass, such as an airplane or a bullet, moves with the speed of

sound, a speed we ordinarily consider very great, such a speed is only about one-millionth of the speed of field propagation.

This factor of one million would be about the difference between the speed of a modern computer and the speed of a "computer" based on parts moving with the speed of sound. But if we were to slow down our computers by a factor of one million, they would of course not be computers in the usual sense: one cannot think of a use of the modern computer which would still be a use in such a slowed-down instrument.

What has happened, therefore, in the development of the computer is that the Lord has led us to utilize in one more way the very great speeds associated with field propagation. Until the middle of the nineteenth century the only uses of this great speed were associated with light. But at that time the telegraph was invented; within a few decades the telephone appeared; then came radio and still later television and many other inventions depending upon field propagation. In all of these cases, the great speed of field propagation is critical. With each, the speed of field propagation made it possible for persons to extend themselves. Thus, although a person can send a message by letter, the situation is different in a fundamental sense if the same message is sent by telegraph, telephone, radio, or television.

Since the speed of field propagation is vastly greater than any other speed in our experience, we might call this speed an "extreme" in creation. Many modern extensions of human beings depend upon our ability to utilize this extreme. These extensions had to await earlier developments and could not have occurred before modern times. It was not even possible to make a good estimate of the speed of light until the seventeenth century.

Let us now examine some of the other aspects of modern science with respect to extremes. Until early in the nineteenth century, the smallest objects known were those which could be seen with the aid of an optical microscope, an instrument which decreased by factor of several hundred the size of the particle which could be seen. At that time good evidence for the existence of atoms appeared; later, particles much smaller than atoms, the components of atomic nuclei and electrons, were discovered. All of these particles are extremely small. To illustrate, suppose the unaided human eye can see particles one one-thousandth of a centimeter (about four ten-thousandths of an inch) in diameter; then the smallest particles we know, the components of atomic nuclei and electrons, are less than one ten-billionth the size of particles we can see. What is critical for the present argument is that as chemistry and physics advance, we can manipulate these very small particles. This manipulation is another example of a utilization of an extreme, in this case small size, which extends human capability.

Another extreme discovered in the modern scientific era is the amount of energy which we can manipulate. Not very long ago the largest amount of energy we could manipulate was associated with large conventional bombs. But with the advent of atomic bombs, hydrogen bombs, and nuclear energy for the production of public power, the change in the amount of energy we can release—a human extension associated with fearful responsibility, with the potential for incalculable good or harm for the entire planet—is greater by a factor between one million and ten million, the exact number depending upon the system used.

There is another kind of knowledge of extremes which does not have practical ramifications and therefore does not represent an extension of the person in the same sense as used in the discussion up to this point. But we are to praise God; and as we learn of extremes in his creation, we acquire greater ability to praise him. Two such extremes are relevant to our discussion.

As described earlier, knowledge of small size is both important and useful. Great size is also important. Just because we have been able to understand and use small sizes and

rapid field propagation, we have been able to make a minimum estimate of the size of the universe. We now know that there is matter at least 100,000 billion billion kilometers (about 60,000 billion billion miles) distant. The creation of the human race was the climax of the creation of *this* magnificent universe.

The other extreme which we do not utilize in the ordinary sense but which causes us to stand in awe of what God has done is the age of the universe. Modern estimates of the age of the universe center around 19 billion years. The size and the age of the universe are both much greater than was once thought. Although God has always required us to praise him for his creation, we are because of our modern knowledge even more than in earlier times without excuse. Christ redeems *this* creation of incomprehensibly great size and age.

What Does the Existence of Extremes Mean?

What do these various extremes—the speed of field propagation, the size of the smallest particles, the amount of energy we can obtain, and the size and the age of the universe—have in common?

In every instance, the extreme is amazing because it is so far from our "ordinary" experience. If we consider again what the earliest fallen people knew and could use, we realize that they knew how to use only objects which approximated the size of their bodies. Considerable human extension would have to occur before people could know about and direct the use of electrons, or before they could have knowledge of the universe. Think of the distance between the metal workers of Genesis 4 and the builders of supercomputers.

These extremes are considerable extremes just because the objects or the speeds considered are very small or very large *with respect to* the size or the maximum speed of the body of a person. The age of the universe is taken to be very great because its age is very great with respect to the lifetime of a person. Nuclear energy, either in a bomb or in a reactor, is immeasurably large with respect to the amount of energy a person uses or produces in a lifetime.

Thus, the concept of the extension of the person in our day is closely related to the discovery of extremes. Perhaps that was always the case: the steam engine made it possible for a person to move much more rapidly than if a horse were used; energy could be released much more rapidly with dynamite than with coal, etc. But there are theoretical reasons to claim that some of the new extremes cannot be exceeded. Thus, according to modern physical conclusions nothing can move more rapidly than field propagation. Some theoretical considerations suggest that particles which have the highest energies yet produced in laboratories may be the ultimate in particles: the question of finding more fundamental, smaller particles with greater energy may have no meaning. Similarly, a certain line of reasoning suggests that we may not be able to establish a greater minimum size of the universe.

But we do not know what the Lord will lead us to discover. What we do know is what has happened. When we ask what has led to the most dramatic extension of the person, we discover that an understanding of the extremes in creation has contributed the most. Have we sufficiently utilized our understanding of known extremes? Surely not; we can expect, for example, many more uses of rapid field propagation. Perhaps developments as revolutionary as the computer await us. Are there more extremes besides great and small size, field propagation, age, and amount of energy? If so, these new extremes would open up entirely new frontiers. We do not know if such extremes exist; but it certainly seems that there are not many. In any case, our unfolding knowledge and our capacity to use this knowledge will continue to be guided by God. He decides how much our capacity will increase before Christ returns and how much it will increase afterward.