INTRODUCTION

Thank you, Bob [Eshun]

Looking across the audience, I am reminded of when I was in graduate school at the University of California at Berkeley. It was while I was at Berkeley, 37 years ago this month, that I began my career in computers. It has been a rewarding career—one that has brought excitement, challenge and fun.

So, it is truly a pleasure to be here at the University of Minnesota and have this opportunity to talk with you about computers in the 1990s.

In preparing my remarks for today, I reviewed some predictions made about the 1980s.

U.S. News & World Report had this to say about the '80s: "Tax cuts will be possible without big deficits."

In a September 1980 article, Forbes magazine asked rhetorically: "Is American Telephone & Telegraph about to be broken into several parts?" Forbes' answer to that question was an unequivocal "No".

The boldest prediction about the '80s was made in the book, Here Comes Tomorrow!, published in 1966 by Dow Jones & Company. The book unskeptically reported a prediction that sometime in the '80s, men would land on Mars, but stay only 10 to 20 days.
Well, the only prediction I am going to make is a sure bet: the technological changes that reshaped the computer industry in the last half of the '80s will continue into the '90s. Other than that, I'm going to avoid predictions and instead give you an historical perspective of computers that may help you better understand where computers are today and where they are headed in the coming decade.

I've entitled my remarks, *The Coming of the Third Generation*. Now, some of you may be questioning my ability to count because it's been almost 10 years since the drum-beating began about the imminent arrival of the fifth generation of computers. It's still going on. In fact, last October the Saint Paul Pioneer Press published an article headlined: *Fifth generation of computers is readied*.

What exactly are these so-called "generations" of computers that people talk about?

The first of these generations was based on vacuum tube technology. The second, on discrete solid state technology. The third, on the integrated circuit. The fourth, on Large Scale Integration. The fifth is a mixed bag of advanced circuitry and new architecture and software embodying so-called "artificial intelligence". This is clearly a technologist's view of things.

A societal view would be quite different--and much more realistic. It would define a "generation" of computers more by their role in society than by the technology of their innards. Not surprisingly, the time span of such a computer generation is roughly 20 years--about the same as that of a human generation.

In fact, the arrival of computers in society in the late 1940s can be viewed as another wave of immigrants analogous to those human waves that arrived in America from Europe in the latter part of the 19th and the early part of the 20th centuries. The process of assimilating those human immigrants into American society parallels very closely the process by which computers have been and are being integrated into our daily lives.
THE FIRST GENERATION

Similar to the great waves of human migration, the computer "immigrants" were preceded by early "explorers"--the calculating devices of ancient history, the inventions of Charles Babbage in the 19th Century, the pathfinding of Alan Turing in the 1930s, and so on. But the first true wave of immigration, as so often happened with its human counterpart, came in the wake of great social upheaval--in this instance, World War II.

Out of the turmoil of that conflict, there arose a restlessness. First in a trickle and then in large numbers the computer immigrants came, seeking change and opportunity. The typical computer immigrant arrived on the shores of society just as its human counterpart did--a thing of basic skills, little sophistication, and with a tremendous language barrier between it and the place where it took up residence.

Society, on the other hand, was busy with other matters and mostly ignored the newcomer. In certain computer ghettos, such as California, there was some concern as it proliferated. But, in general, the new immigrant was only tolerated. Meanwhile, it went about its cumbersome, sweatshop kind of work solving equations for physicists and stamping out payrolls, while being made the butt of "ethnic" type jokes. Unable to communicate, it stayed tightly cloistered in ethnic neighborhoods called computer rooms.

Teaching this immigrant new skills was a slow and arduous task. By and large, it was so busy earning its keep that only in off hours--after sometimes working 140-hour weeks, pausing only for brief "health" checks--was there time to improve its basic skills. Pidgin English dialects came into use. Although most were quite arcane and had strange names and sounds such as FORTRAN, COBOL and ALGOL, some degree of communication began to take place.

Over a period of 25 years following World War II, this tide of immigration grew. It attracted new and more powerful immigrants, all of them sensing opportunity and seeking to make their mark. Many were quickly snuffed out in the accident-prone world of industrial America. Some survived and prospered.
All-in-all, these new immigrants were a rough-hewn crew. But like their early human counterparts, they increased the wealth of their industrial masters, and of the whole economy. They were a new and vital source of energy and productivity. But the computers were also an alien lot—unintegrated and certainly incapable of serving any broad spectrum of economic need. These computer immigrants were, in short, the cheap manual laborers of the new information age.

**THE SECOND GENERATION**

By the late 1960s and early 1970s, the offspring of the first generation began to make their presence felt. Building on the economic and intellectual foundation of their forebears, this second generation escaped the sweatshops of numerical calculus and clerical processes. Its members have won a secure place in society by applying a dazzling array of capabilities.

The more mobile of the new generation have moved out of the computer room ghetto and learned how to perform services in the general worksites of society. They work side-by-side with engineers. They have entered small businesses. They perform routine chores for air travelers. A few have even made it into the profession of teaching. Slowly, then, the offspring of the immigrants have made their way into society.

But as a whole, the second generation is somewhat torn—eager to explore the new opportunities now open to it, yet still clinging to the old ways of the first generation.

Language continues to be a problem. While some can converse to a degree in the language of their adopted environment, most are more comfortable with their native tongue. Some computers and their programmer friends still hanker for the ethnic cabals of old and decry the defection from the old ways. And, if you'll grant me just a bit more poetic license, members of the first generation just shake their disk heads in bewilderment over the doings of their offspring.
No one observing the people experience in dealing with today's technology could conceivably use a term like "fourth generation" (much less fifth) to describe the current state of affairs.

In a recent article on the lack of meaningful interation of technology into society, U.S.A. Today reported that of the 20 million households that have personal computers, 22 percent use them once or twice a month or less. Even VCR's are too complex for many people to use properly. John Allen Paulos, author of Innumeracy - a best seller about math illiteracy -- recently appeared on the David Letterman show. Twenty of his friends offered to tape the show on their VCR's. "Two actually managed to do it," Paulos says. "Half [of the rest] taped the wrong station; the other half taped static."

As far as computers themselves are concerned -- consider this: "windowing software" and the ability to use a "mouse" to select options within an application are almost the defacto definition of "user friendliness." Without question, the most widely used application is the "spread sheet," -- about the most rudimentary human task you can imagine in our "information age."

As I said, no serious person could refer to that as a fourth, much less the fifth, generation state of affairs.

However, despite the fact that computer technology is still so primitive in its ability to integrate with the average person's daily tasks, the second generation has made its mark and paved the way for the third. With the arrival of the 1990s, the third generation soon will be fully with us.

THE THIRD GENERATION

The third generation will be better educated and more "affluent" than its predecessors, based on a spectrum of technology its "grandparents" couldn't imagine. It will be literate, articulate and completely integrated with its human partners. It will be capable of taking its place in every arena of human endeavor -- not only accepted but sought after.
Actually, the first of the third generation has probably already arrived—Steve Jobs' Next computer. I don't intend to undertake a discussion of the wonders or weaknesses of Next -- or any other brand name for that matter. The key point is this: Next is intended to make it easy for users to build applications for the computer to serve their particular needs. That's far more profound than just making the computer “user friendly.” Obviously there still will be mass market applications such as spread sheet systems. But the computer can only become fully integrated with its human counterpart when economically as well as technologically it is possible individually for people to share and enhance their human expertise through use of the computer.

The third generation also is ready to make its mark in manufacturing plants. Let me read you two excerpts from a New York Times article last month on the clothing industry's harnessing of computers to standard industrial sewing machines to produce a larger variety of clothing more quickly and cheaply.

The first excerpt: "While some industrial sewing machines already come equipped with computer chips, many of these machines are still used for only one task."

The second excerpt: "By reprogramming the machines, engineers have converted an old straight assembly line into a more versatile line with many subassembly stations. Each computerized piece of equipment can work at a number of tasks instead of one."

These two excerpts capture the essence of the difference between second and third generation technology. In the older system, computers (microprocessors) can only perform predetermined tasks (i.e. applications). In the second instance, the computer task becomes much more dynamically determined. The production supervisor can use the machines much more as he would a team of people with various skills.
The New York Times article goes on to say that engineers envision a large assembly line making several kinds of garments directed by a single computer system. Each operator will see on a computer screen the pieces of fabric next to arrive and get instructions on how they are to be sewn. The computer will then direct the actual sewing operation.

Here we have almost a role reversal in which the knowledge available within the computer enhances the performance of its human co-worker.

This third-generation technology will require operators more skilled than present workers. At the very least, operators will have to be able to read and take direction from a computer screen. The third generation also will result in fewer workers--about 20 percent less in some clothing manufacturing plants.

The transition to a fully integrated third generation has profound implications--more so than all computer history to date.

**JOB CREATION**

As the trend in the clothing industry indicates, one implication is jobs.

No topic is of greater interest or importance in the 1990s than that of job creation. Computers, or more generally microelectronics, have a complex and seemingly paradoxical relationship to this issue of jobs. Microelectronics is the only salvation for manufacturing industries but at the same time it inexorably accentuates and accelerates the movement of these industries from labor intensity to capital intensity. In effect, high technology preserves the economic benefit of basic industries while limiting them as a source of job creation.
The past few years have made it very apparent that the computer, microelectronic, and high technology industries cannot create the necessary jobs for those displaced from older manufacturing industries. In fact, the main issue for high technology companies these days is the reduction of labor intensive processes.

The other day I was looking over a list of some 50 U.S. computer companies. Virtually every one of the companies has experienced one or more of the following over the last five years: major divestiture, merger, bankruptcy, strategic alliance necessitated by competitive pressures or at the very least asset write-offs and workforce reductions.

The current issue of Corporate Report Minnesota depicts the local computer scene as, if anything, even more chaotic than the national scene. Edge Computer, a workstation manufacturer, moved to Arizona before it dissolved. Stearns Computer, a manufacturer of word processors, went bankrupt. CPT Corporation is fighting to survive. The mainstays of the Minnesota computer community haven't fared any better. Control Data closed its ETA supercomputer subsidiary. Honeywell sold its computer business. Unisys has cut back its activity in Minnesota. Cray Research is going through the toughest period in its history.

There are two factors driving the changes taking place in the computer industry. They are the underpinning of the new third generation. One is a familiar source of change -- basic technology. The other change is the advent of portable standard software systems such as UNIX and C. Industry standard operating systems came into our world with the introduction of MS-DOS for the personal computer. But only with the growing acceptance of UNIX has the citadel of the mini-computer and mainframe proprietary software systems come under siege. And this is a source of change more powerful than anything we've previously experienced.

I won't dwell on the basic technology part. The facts are impressive, almost incredible, with regard to the rate of change. But we've always had such performance comparisons in the computer industry. In earlier times, however, the economies of new technology utilization were totally different from what they have now become.
Until very recently, each computer vendor had a proprietary and unique operating system. This system and its associated data management software are essentially the computer's "interface" to society, i.e., to the application, or said most simply: to the work being done. Not only, then, was the nature of this societal interface arcane in the extreme, there were so many different ones that users became the captive of their vendor.

The cost to the user of forsaking one proprietary software system for another was prohibitive. Thus the citadel of the vendor's installed base was not only secure, it expanded only at a pace the vendor could afford to introduce new applications or increased performance. UNIX and other industry standard software are changing that. Application vendors will build for standards systems rather than for proprietary systems. As a result, vendors of computer platforms must look beyond their own proprietary systems software for the account control and value-added that brings profits. Beyond that, standard software systems reduce enormously the cost to the user of migrating to more cost-effective hardware. This both opens the market to new vendors and shortens the product cycle for introduction of new hardware platforms.

In a research report last year analysts, John Levinson and Andrew Krawitt [Kraw-it] of Goldman-Sachs made the following statement: ".... within 2 to 3 years, we foresee micro/standards-based products as representing the vast majority of mid-range and high end [computer] systems purchased for new applications. "They go on to say that, "... making money in this new world is very different from the business of making money in the old world."

I might add that it will not only be "much different," it will also be much more difficult. Revenue for large computers is expected to increase at a 2 percent rate between now and 1994. In contrast, the revenue growth in 1985 was 9 percent and at the beginning of the 80's was 12-15%.

Medium-sized computers had a 20 percent growth rate in 1985; over the next four years, that figure likely will be around 8 percent. Only small computers are projected to grow at the rates typical five years ago--15 percent.
The next few years will see the computer industry adjusting both to third-generation technology as well as the realities of global competition. As young businessmen entering this world, it strikes me as the most positive of situations. I've found that it is in times of change and uncertainty that opportunity is the greatest. Certainly, third generation computers offer many exciting challenges in the area of job creation.

The appropriate application of new technologies, including computers, will allow us to attack basic unmet economic needs such as environmental problems; more available and affordable education and training; more affordable health care; energy; and quality. In meeting these needs, we can create new jobs. So again, the appropriate perspective--a third generation perspective--is one that concentrates on the application of the tool rather than a fascination with the foibles much less the technologies of the tool itself.

I should elaborate briefly on “quality.” Quality, or more accurately Total Quality Management, is really a topic in and of itself. But I cannot pass the subject without noting the four basic concepts embraced by TQMP. They are: 1) a focus on processes; 2) measurement; 3) continuous improvement of processes rather than final goals or specifications; 4) empowerment of people. Unless and until you know and have practiced these concepts, your MBA is about as useful to you as an automobile without an engine. But, as I say, that's another subject.

INTERDEPENDENT INDEPENDENCE

Another important implication of the transition to third-generation computers is that it makes possible a non-pathological solution to the state of "interdependent independence" in which society finds itself.
For more than 50 years—from Wendell Wilkie's *One World* to Toffler's *Third Wave*—we have been reminded by writers of every ilk of growing worldwide interdependence. This force has been growing, pressing and shaping the world around us. The social and political changes in Eastern Europe and the Soviet Union are the latest examples. As human interdependence has grown, the counter-balancing force of individuality has also grown. Consider energy and food—the very basics of existence. There is practically no nation on earth self-sufficient in both these necessities. And, yet, we have not seen larger and larger conglomerations of people into nations. Quite the contrary. Forty-five years ago, at the end of World War II, there were 79 independent nations. Today, there are 176. And the cry for “independence” increases daily -- from the Baltic to the Caspian Sea.

As trend-watcher John Naisbitt has pointed out: "An extraordinary thing happened in the late 1960s-- the U.S. gave up the myth of the melting pot. For years we had taught our children...that America was a great melting pot, as if we were all put in a giant blender and homogenized into Americans. Now we have given up that myth and recognize that it is our ethnic diversity [our individuality] that has made us such a vital, creative country." In fact, last week a federal judge in Arizona declared unconstitutional the state's amendment mandating English the language "of all government functions and actions."
So, one of the challenges in the 1990s is to structure ourselves to deal with this "interdependent independence" that will be necessary for 21st century existence.

The technologies of communications and third-generation computers provide us the opportunity to pursue individuality to a degree not possible before. At the same time, they allow us to share and access the experience and knowledge of others. Most important, they provide the only analytical resource capable of dealing with the incredible environmental, economic and other structural interdependencies of the world.

CONCLUSION

Again, the transition to a fully integrated third generation has more profound implications than all computer history to date. It will be a challenging, exciting, potentially rewarding new era.

Henry Ford said, and I quote: "A generation ago there were a thousand men to every opportunity, while today there are a thousand opportunities to every man." Ford made that statement in 1927. I don't really know about then. But I do know about now. The Third Computer Generation will open up more opportunities than ever before. Not to every man and woman, perhaps, but without question, to those who are prepared. Whether you are or not is up to you.