

ON THE FUTURE COMPUTER ERA: MODIFICATION OF THE  
AMERICAN CHARACTER AND THE ROLE OF THE ENGINEER  
OR  
A LITTLE CAUTION IN THE HASTE TO NUMBER

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THE ISSUE

The development of interconnected, computer-based information holds seeds of major changes in the American character within the next few decades.

It behooves the individual systems designer to understand some of the "second-order" effects of today's system-design decisions upon tomorrow. The isolated effects of each individual system are of minor importance in themselves, but the composite effect on society is greater than the sum of the parts. This major force is affecting value structure and changing the basic quality of life. Tomorrow, by definition, cannot be like today. The role of the technologist in choosing what to do or what not to do may have a greater effect in determining the nature of the changes than we technologists often are willing to acknowledge. A key concern is that the sensitive nature of this unasked-for responsibility is yet to be widely appreciated by those to whom it has been granted.

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### THE AMERICAN CHARACTER IN THE PAST

DeTocqueville, describing the American frontier of the 1830s, was struck by the freedom of Americans to come and go as they pleased without documents. He recorded the effects of an open frontier which bred people whose optimistic outlook was entirely different from that which he had encountered in Europe. For the first time he met citizens who felt their only limitation to wealth and happiness lay within themselves. If one did not like his station in life, he had only himself to blame. Here was the freedom to pick up, move into the frontier, and create an entirely new life.

Such descriptions of the American frontier character make it clear that ours was an unusually fortunate condition--a rarity. The many countries of the world that have or have had a geographically open frontier lack the cultural, legal, or religious freedom--all requirements for the geographic mobility upon which social mobility hinges.

### THE CHANGE: RECORD KEEPING

We have come a long way from the day of the frontier ethic. In the process of building more complex social institutions to better serve groups of individuals, we are (and perhaps unnecessarily) eroding mechanisms conducive to social mobility.

We like to think that every man can accomplish as much as his own efforts will allow. The only constraint that exists in our folklore is lack of enterprise, never the limitation of past failures.

Better record keeping may be forcing us to move away from the value structure deTocqueville described to that of a new nation, where the name of the game is too often "keeping your nose clean" or "not getting involved."

Let us consider the role of record keeping in society and how it may be creating this changing attitude.

### DEVELOPMENTS IN RECORD KEEPING

The information explosion did not start with the computer. The improved mail service of the 1840s sometimes helped uncover the mistakes of a man's past. In the middle of the 19th century, national commerce required credit information about people whom shippers of goods would never meet; and the institution of Dun & Bradstreet was formed to fulfill this legitimate need. The telegraph increased the speed of this information flow in the 1850s; the telephone and rapid, national, rail-mail service were major breakthroughs in the developing information technology; the underseas cables in the 1860s extended instantaneous communication to verify the backgrounds of those who came from the Old World. The typewriter and carbon paper cut the cost of information duplication--and then came the Xerox machine.

The computer is but another in a long series of technological improvements to information flow. However, it promises to have even greater impact in changing our value structure than all these earlier improvements combined.

### THE CLERK MENTALITY

In a complex society we must fracture intellectual tasks into a series of routine steps to utilize personnel of lesser experience and intelligence. We are all familiar with the bureaucrat who never lets common sense interfere with what he is doing. He goes only by the "rule book." Large companies and Government agencies have successfully created people totally incapable of reaching a decision unless the situation is spelled out in a rule book. If their rule book does not cover the situation, their only response is to send you to see someone else--in some cases, just anyone else. A common complaint against the computer is that it increases the number of places and situations where we are subjected to the indignities of such mentalities. While

annoying, there are other more serious charges that society can hold against the misuse of the computer.

#### FILES VS. THINKING

The computer allows one to wade through very large masses of information, selectively extracting items of interest. Information from files is necessary or at least helpful in reaching major decisions. We would be foolish to totally pass up the wonderful features of modern information technology merely because it can be misused. However, we must face the growing tendency to use records in lieu of thinking to reach decisions, without considering the consequences of everyone's doing the same thing. This tendency derives from two sources: the desire not to have to think and the desire to take selfish advantage of whatever information is of individual value and to ignore the prospect of damage to society as a whole. Imagine this as resembling air pollution caused by the internal combustion engine. With one or a few cars there is no problem; but when many cars congregate in a city, all belching exhaust, it becomes another matter. We begin to appreciate the full noxious consequences of socially undesirable concatenation of many individually tolerable generators of pollutants.

American business has progressed beyond the point where narrow, self-serving, public-be-damned actions can be justified. But not all of business is equally enlightened. Let us consider a few examples where whole industries ignore their responsibility. The examples used are but examples, not an all-inclusive indictment. The extension of this list is, as the engineering texts say, left as an exercise for the student.

### EXAMPLES

Several examples follow where better information processing is used to further the interests of a single organization, even though such use could extract an incommensurate, invisible, and unappreciated price from society. Consider the insurance industry, one of the earliest heavy users of computers. It is automating records so that it can rapidly run through its insurees, or potential insurees, consider a range of factors, and decide which are the "worst risks."

The basic concept of insurance is socially desirable. It permits large numbers of individuals to average out the possibility of rare catastrophes. It allows the individual economic security without placing demands upon Government. If our insurance systems did not exist, the Government (in our current national mood) probably would have to provide these services by default.\*

In Los Angeles there is a large area called Watts (renamed by the press with what was the name of a single small neighborhood). Watts is a poorer section of the city. In 1965 it produced a well-publicized and innovative riot which seems to be setting the style for the future. This was not a race riot in the usual sense. One oft-quoted observer of the phenomenon, Moynihan, described it as a crowd bent more on merchandising than on civil rights. As a result of this riot, insurance rates for existing policies were recomputed. Insurance companies stopped issuing fire and burglary insurance to new businesses within this area. It is in the best immediate interest of each independent insurance company to do so. By rapidly identifying potentially high-risk neighborhoods and removing them from

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\* In many cases of default, insurance is already supplied by Government. California State Disability Insurance stands testimony to the failure of private business to maintain its initiative.

their rolls, the insurance company eventually can provide lower insurance costs to the better risks with a more favorable loss experience. But the "second-order" effect was that a whole section of the city was unable to readily obtain insurance. This was one of the first factors documented to explain the absence of redevelopment in Watts. Part of the social price was increased Government intervention, as this inability to obtain fire insurance rapidly became a political issue. Under duress by the State Insurance Commissioner, most insurance companies banded together to share the load in an "assigned risk" pool. However, burglary insurance is yet to receive equal attention. In an area desperate for more effective retailing, new business is driven away and even old business is discouraged from rebuilding. This lack of adequate burglary insurance is one more destabilizing force in a situation that is already too inflammatory for comfort and potentially dangerous to national stability.

Is this a case where what is best for each insurance company is not best for industry and society in the long run? The ever-increasing ability to rapidly shuffle individuals into narrower and narrower groups, automatically excluding the bottom group from protection against catastrophes, has many major, obviously anti-social implications.\*

#### MAKING UNEMPLOYABLES

Another example is employment. Once you hired a man on the basis of what you thought of him. You were prepared

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\* Just after I wrote these words, my parents in Philadelphia received word that the company that had provided them with fire insurance for 25 years--without any loss--had cancelled their policy. No reason was given or felt necessary. My parents find their new, middle-class negro neighbors good neighbors. They do wish, however, that they did not have to pay this penalty for choosing not to join the crowd fleeing to the still segregated suburbs.

to fire him the moment you saw he would not work out. Remember the day when engineers without degrees were common? And how many of them were better than we, their degree-holding juniors? Today, in California, we block entry into our profession for any who have not spent a due number of years at an accredited institution. Of course, a paper degree never made an engineer, but it does eliminate the necessity for the personnel manager to be able to think. All he need do is examine a few boxes on a form and he reaches a decision as to whether a man is a good engineer and how much he should be paid. Look at the roster of old engineers--the Edisons and almost Edisons--of the last few decades who were "degreeless," and would not be hired by any large company today if youths. How many potentially valuable men are we throwing into the ash can in the process of simplifying the personnel manager's job?

This depressing loss of a scarce national resource extracts two prices: the immediate loss to the nation and the personal loss to the individual which is an even greater loss to the nation. When a person is mentally conditioned not to try to do more merely because he is unable to obtain formal certification of competence (a mere piece of paper), a man has been destroyed. Causing a man to lose his self-esteem is among the most serious breeches of good manners. When society as a whole is guilty, it should expect anti-social behavior from those who feel unpardonably wronged.

But let's get back to some less abstract examples. Even a person's minor health problems may make him unemployable in this new world. For example, if a person has ever had an ailment which makes him a member of that class determined by the insurance companies as exhibiting reduced life expectancy, he will often be ineligible for employment. The employment application form is probably second only to the income tax form in creating liars from law-abiding citizens. What is a man to do if he has a

family to support and has a rheumatic heart condition? The company that asks questions about health in its application form is within its rights, and such questions do work to the immediate advantage of the company, but our applicant knows that he will probably be turned down if he answers the question honestly. He is forced to lie or to work at less than full capability. The most extreme choice is to become a ward of the state.

A few decades ago lying about one's age, health, and training was fair even for an engineer filling out employment applications. With World War II and the post-war, military security-clearance system, we have evolved to an almost universal business ethic where each company will reveal to any other company personal personnel information in its files. A waving of the flag is generally required to get schools to open all their records to prospective employers. Police departments are usually obliging when asked to recite the failures of the citizens in their town, if asked in the right manner or via commercial private detective channels.

#### USE OF RECORDS IN THE FUTURE

As our computers become more powerful, they will be able to slice the population into infinitesimal groupings and filter out the people who are higher risks than the average. They can be automatically excluded from coverage if we program our computer to maximize profits by minimizing risks.

In the past, we have been able to handle only gross records. A person's medical record was scattered in many places. If a person started in a school and flunked out, he could try his luck at another school. His early failure would not show on the application form and no one would be the wiser, unless he achieved success or notoriety, by which time the results would be irrelevant.

With the computer and more centralized storage of information, much finer-grained information is being exchanged. The picture of man gained from his physical record can be more complete than ever before, but we must distinguish between a *picture* of man and man, for we can only paint a highly distorted pictorial record. It is information that can be reduced to *nice clean numbers*: IQ scores, grades in school, height, weight, salary, standardized job-description numbers, list of ailments, list of infractions of the law, list of periods of unemployment, list of credit dealings, the inevitable accidental error or two in the file--and lastly, for flavor, possibly a malicious personal reference.

#### THE NEW CHARACTER OF THE CITIZEN

From the earliest age the new child of America will probably be counseled to: "This above all--play it cool; keep your nose clean; don't take chances; do what you're told; don't argue with authority. And remember: nothing you do will ever be forgotten and anything can be held against you." Those able to walk this thin rope will exhibit less tendency to overtly buck the system. Those who have fallen from the rope, either accidentally or deliberately, will find society not to their liking and won't have much to lose in open hostility. These will be the alienated citizens of tomorrow. In between will be the citizen who does not support his government in his heart and who, if he can get away with it, will not hesitate to harm it. Great pressure will be placed on American citizens to transform them from free spirits who do not fear living their lives as men (with the assurance that if one fails one can always try again) into a new nation of tightrope walkers.

In 1967 The President's Crime Commission Report stated that there is a 90 percent probability--extrapolating

current crime figures--that a Negro child born today in urban areas will have a brush with the law more serious than a traffic violation. The figure is 40 percent for urban areas as a whole, both Negro and White. If society brands a man a criminal, it reduces his interest in maintaining the stability of that society.

Since it only describes the extremes, this bleak picture may be an exaggeration. Life is not like this. In painting a picture of where we are going, it is easy to dramatize by overstatement. But it is clear that the American character is changing from the frontier man of old. It is plausible that physical records play a major role in the transformation and that new changes in the information-processing art can profoundly accelerate this transformation. It is clear that we are dealing with one of the key forces for changing the character of our future society.

#### THE ROLE OF THE ENGINEER

Let us shift gears and ask ourselves as technologists what special obligations we have to society in the coming "high-information era." This is not an easy question to answer. The major professional societies of engineers have never spelled out a collective responsibility for the profession which transcended the social depth of a statement of true belief in Maxwell's equations.

The effects of the computer are factors that describe qualities of life, not merely quantities of goods. The new criteria for optimization are complex and multidimensional and do not lend themselves to quantization. Good engineers have never been afraid of fuzzy numbers. A problem that cannot be completely quantified is not unsolvable.

The engineering profession historically bridges two worlds: the quantitative and the non-quantitative; the realm of the scientific and the realm of the practical.

The engineering discipline best serves when one uses quantitative methods only where applicable and is unafraid to use common sense and experience where only judgment applies. However, I am afraid that engineering as a profession today is too much concerned with minimizing costs or maximizing dollar performance of subsystems to think of the larger issues and of more complex criteria. As a profession, we retain a unique ability and, hence, have had thrust upon us a new responsibility to point out the misapplication of the quantitative methodology.

#### THE CHANGES IN THAT ROLE

It may be appropriate that our profession, not normally given to introspection, start to examine its own role to better appreciate the contribution we might make. I believe those who understand future technology have an obligation to act at least as an early warning system to the rest of society.

Engineering is beginning to evolve from the often narrow, single-product-oriented business service it provided a few decades ago. The engineer of old was a technological innovator--a garage tinkerer-plus-draftsman not afraid to use mathematics. He knew that mathematics was a limited tool and restricted its use to instances where it could be justified in building a better product. In those days we wanted better numerical tools to extend the range of quantitative solution. We were reluctant to trust so much to that vague magical skill called "engineering judgment" that went with gray hair.

Then along came the computer and the scope of useful application of quantitative methods expanded far beyond our early hopes.

Engineering education also responded. Quantitative courses, always preferred by the unimaginative teacher because they were easier to grade, drove out the non-quantitative ones in a Gresham's Law manner. The new curriculum

for an engineer is almost indistinguishable from that of the applied mathematician in the non-engineering school. A stiff dose of physics and mathematics is blended with a token taste of the humanities so the graduate engineer's language will not be entirely a string of numeric quantities separated by some grunts.

#### THE ENGINEER AND THE COMPUTER

Thanks to the powerful tools that our new breed of engineers have inherited, many of the challenging engineering-design problems of old have given way to a simple "turn-the-crank" process. Select a library program for designing a transformer, insert the desired parameters, push the buttons, and out comes a neatly typed recipe.

In the past, we were always leery of trusting the "handbook engineer" with anything important--you know, the non-thinking fellow who just looked up answers in the nearest chart, whether applicable or not. Our objection was that he rarely knew what the tables meant or what assumptions they contained. We have been able to extend the domain of "handbook-engineer thinking" immeasurably with the computer. Now handbooks of almost infinite length, in the form of computer programs, are coming into existence. Furthermore, it is so difficult to audit computer programs for reasonableness that we don't.

Unfortunately, our extended power to quantify is allowing the creation of a new "infinite-page-handbook" mentality while also expanding the range of issues some engineers are willing to tackle. Additionally, others with mathematical training are falling into the same mold, and a disconcertingly large group is being created which feels that all the world's problems are solvable with quantitative techniques--just find the right computer program and plug in the numbers.

THE BOUNDARY LINE

We need to probe the boundary line between legitimate social use of the computer and where the methods and capabilities of the new information technology have been oversold and allowed to displace common sense. Restated as a question: "Are our analytical tools weaker than we would like the public to believe? Are we misleading those who sit in awe of the gods called science and technology?" Most importantly, what harm is being done by an unthinking rush to number and what can we do about it? I don't have the answers; I can only raise the questions and hope that we all will work toward a larger dialogue explicating the substantive issues in detail. This is not a short-term problem, but it is important to start discussion now because of the swift pace of the information technology. The discussion pivots on what is regarded today as the "second-order" effects of trying to optimize solutions by, in effect, limiting the number of variables to facilitate putting the problem on the computer. For example, the programmer of a computer responsible for making better decisions for an insurance company should not avoid considering the secondary problems, such as creating a growing portion of society for which the other portions have little use. The blocking of subsectors of our society from affluence by misuse of information is a new, potentially divisible force. Such alternating forces may have been tolerable in a previous era. We are rapidly becoming a too highly interconnected society to withstand major disruption by a small number bent upon destruction. The more highly developed a city, the easier it is for a dissident group to make life uncomfortable for others.

These are problems that will not go away automatically. Those concerned with the social implications of information processing and automation must face our contributions to this potential deterioration of the quality of our life.

Those who deal with records that can brand and divide must modify their actions toward the best long-range interests of society, even when such modification conflicts with the best interests of individual agencies or corporations. Is this too much to ask? Stealing can be viewed as in the best interest of the thief, but society has outlawed robbery simply because it is not in the best interest of *all* of society.

Engineers who have the most background in the *application* of quantitative methods are facing a new responsibility: to insure that the quantitative method, whose scope of application has been magnified by the computer, is not misunderstood and misused.

The better information processing techniques opened by the new computer art increase the temptation to profit the few and damage the many. Broader wisdom in selecting the qualities to be optimized is one of the major new challenges facing the engineer of tomorrow.