

The Introspective Engineer

by **Samuel C. Florman**, *New York Alpha '44*, P.E.

Making the World Right:

Where was the use, originally, in rushing this whole globe through in six days? It is likely that if more time had been taken in the first place, the world would have been made right, and this ceaseless improving and repairing would not be necessary now.

— Mark Twain, *Life on the Mississippi*

I F, TO FOLLOW MARK TWAIN'S THINKING, the world had been “made right” in the first place, there would be little need for engineering. But because our planet is deficient in many ways — at least as a habitat for a rapidly growing population of more than five and a half billion humans — engineering is central to our lives.

One can deplore the current state of affairs and wish humanity could be what it was 20,000 years ago, just a handful of folk travelling in small tribes and living by hunting, and gathering berries. In fact, regrets about progress are to be found wherever progress has occurred. We find ample proof in the earliest myths, of which the one best known in the Western world tells of Adam and Eve, the Tree of Knowledge, and the expulsion from Eden. But we cannot go back. We have no choice but to move ahead, coping as best we can with the difficulties that confront us: overcrowded cities; famine-plagued countrysides; pollution, disease . . . the all too familiar litany of human affliction.

Some people see our reliance on technology as cause for despair. Others — including many engineers — find inspiration in the challenge. Most of us are both inspired and despairing in varying degrees at various times. But like it or not, here we are, engaged in a struggle, not only for lives — which is difficult enough — but for lives that are worth living. We can hold our own in this struggle only if we develop ever more effective technologies. Even the problem of overpopulation requires us to make more technical progress: experience shows that a modicum of prosperity is the necessary precondition for population control.

Indeed, experience shows that prosperity — not great wealth, but basic material comfort — is the necessary precondition for most of the things that human beings value. Somewhere along the Ganges, or high in the Himalayas, there may be sages who preach meek submission to the universe as we find it. But their followers appear to be growing fewer as the knowledge of ameliorative possibilities becomes widespread.

The United Nations Human Development Index rates nations on what they do to meet people's basic needs: keeping them healthy, raising educational standards, and helping them earn the income needed to make choices.

Needless to say, the most technologically advanced nations achieve the highest ratings. While there is no automatic link between a country's per capita gross national product and its level of human development (for example, Costa Rica ranks higher in “human development” than Brazil, although the average income in Brazil is greater), essentially national wealth is the key to felicity.

One would like to include among “basic needs” the concept of political emancipation, and in fact at one time the U.N. index did contain a “freedom” rating. This was dropped because of protests by some developing nations which feared that financial aid programs might be linked to political reforms. But even without a formal index, we know that the richest nations are also, by and large, the most democratic. Just about everything worth having begins with the development of material resources.

The term “technological fix” has become something of a pejorative in recent years, applied to thoughtless short-term solutions that result in long-term problems. Without pleading perfection for engineers — or for the people who often are in the position to tell engineers what to do — let me nevertheless suggest that at this moment in world history a few good technological fixes are just what we need. If, for example, we could provide ample supplies of pure water and wholesome food, conquer fear-some diseases, and develop new sources of energy — economical and environmentally benign — the elimination of mass misery could become a plausible objective.

“Happiness,” to be sure, is a word that nobody can define to the satisfaction of all. But freedom from want, plus ample opportunity to “pursue” happiness — these are goals that are universally shared.

Compared to most of the world, the United States is a wealthy nation. But Americans, also, have problems that cry out for technical remedies: decaying infrastructure, environmental degradation, and so forth. And though we are rich, we are not nearly as rich, relative to other nations, as we used to be. If we could somehow manage to make better products — imaginatively conceived, expertly manufactured, and attractively priced — we would be well on our way out of the economic quagmire into which we have strayed.

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Indeed, for all our compassion and good will toward others, Americans are engaged in a fierce battle to maintain leadership in world commerce. We are committed to enhancing national “security” by means of industrial strength and — although the Cold War has ended — by means of superior armaments. Clearly we are ambivalent about technology. We think of it as a source of sal-

vation for humankind; we see it as a means of keeping ahead of others in the pursuit of good things in a world of limited resources; we are apprehensive about its unanticipated side effects, social as well as physical.

It may be said that my emphasis on technology is simplistic. Others would argue the primacy of economics or politics. Do we need imaginative economic strategies? Absolutely. Politics is also important. And it would help if human nature could be improved! But given the world as we know it, I suggest that prospects for national prosperity — and global salvation — rest heavily on our ability to do good engineering work.

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Yet, engineering is not a word one is likely to hear in our communal discussions — for example, on Sunday morning television interview programs. Everybody agrees that we live in an era of “high tech,” and that technology has changed our lives. Multimedia, virtual reality, information highway, genetic engineering — these are buzzwords of the day. But real engineers, the people who conceive of computers and oversee their manufacture, the people who design and build information systems, cars, bridges, airplanes, and so many other things that are central to our lives, are nameless and obscure. Thirty-five percent of American adults have “no idea” how professional engineers spend their time, or think they run trains or manage boiler rooms.¹ Eighty percent of electrical engineers feel that the public has “no understanding” of what they do.² It is a very long time since Eiffel built his tower, since the Roebings built the Brooklyn Bridge, and since Thomas Edison was said by the *New York Times* to be the most admired American.³

Does it really matter? So what if our popular heroes are athletes, rock stars, and business tycoons? So what if our television role models are lawyers and doctors, detectives and reporters, publishers and fashion models? Why should we pay more attention to engineers than we do to other essential but unsung people, like optometrists and bus drivers, or if you prefer a professional comparison, accountants and dentists?

One pragmatic answer is that because the quality of our lives depends in large measure upon the quality of our engineering, we must attract good people to the profession and keep them happy in it. At the moment we are not doing an adequate job of this. Enrollment in engineering schools grew steadily into the late 1980s, but has declined in the 90s, just when our need for technical ingenuity is greater than ever. Women and under-represented minorities show profound indifference to the profession. This is particularly disturbing because, according to demographic studies, they will soon constitute a substantial majority of the workforce. We need a large and steady supply of engineers who are smart and well trained and a goodly number who are ambitious and entrepreneurial as well. We need engineers who are idealistic and committed to public service. We need engineers who will become leaders, and we need potential leaders to decide that they ought to study engineering. If the profession is to grow, flourish, and be equal to the requirements of our society, engineering must be widely understood, appreciated, and esteemed. This can hap-

pen only if engineering is examined, discussed, and debated, if it becomes part of our everyday discourse, our art, and our popular culture. Our best young people need opportunities to be “turned on” to engineering. This is the first response to anyone who questions the importance of the issue.

Second, consider our politicians and decision-makers. Most of them seem unclear about where engineering fits into the scheme of things — as well they might be with only one percent of the members of Congress, for example, having engineering backgrounds. We talk of economic growth, but our society is mainly in the hands of people who are, in the words of Labor Secretary Robert Reich, “pie-slicers” rather than “pie-enlargers.” During the Cold War, much support for engineering came serendipitously out of budgets for national defense. Will support be there in the absence of direct military threat? Will the government invest in long-term technology development when short-term problems demand attention? And what of federal policies that indirectly affect technological advance? I refer to taxes, trade and investment strategies, antitrust restrictions, intellectual property rights, and product liability laws? Will politicians do what needs to be done if they — and their constituents — are uninformed about engineering and confused about technology?

This brings to mind those people who worry about the adverse effects of technology. Isn't it important that they speak with some understanding rather than out of unthinking dread? Engineers have increasingly come to recognize the importance of politics in making technical decisions. They do not expect blind patronage; but they do hope for the rule of reason that is crucial to communal well-being. In a climate of confusion and anxiety, one fears that our representatives in government will fail to act constructively. Society needs informed politicians and enlightened citizens to support — and help guide — our technical enterprise. This is a second reason for us to be talking about engineering and technology.

There is a third reason that goes beyond pragmatism, beyond questions of global need and national strength.

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Mr. Florman earned his B.S. in 1944 and his C.E. in 1946 from the Thayer School of Engineering at Dartmouth and the master's degree in English literature from Columbia University in 1947. His more than 200 articles dealing with the relationship of technology to the general culture have appeared in many professional journals and scholarly magazines. He is the author of five books, including: *The Civilized Engineer*, *Blaming Technology*, and *The Existential Pleasures of Engineering*. A registered professional engineer, he is a member of the National Academy of Engineering and a fellow of the American Society of Civil Engineers.

I suggest that our culture, to the extent that it ignores engineering — an essential element of its organic life — becomes impoverished.

When ice-age peoples lived by hunting, they painted pictures of animals on their cave walls, a symbolic affirmation of the occupation that was central to their existence. In agricultural communities fertility rites evolved along with holidays to celebrate the harvest. When tribes went to war, they beat drums, danced, and made ferocious masks. Throughout history, societies have embodied their life-sustaining activities into art and ritual. In the United States we have a culture rich in art and music, literature and drama, both serious and popular. We have a wealth of newspapers, magazines, and cinema. Television is ubiquitous, bringing us serious documentaries and frivolous entertainment. In all of this, engineering is practically invisible. Yet engineering is a significant part of what we are and an indispensable part of what we seek to be. Engineering can also be great fun — to learn about as well as to do. But, in spite of its great importance and inherent appeal, engineering is taken for granted.

Engineers themselves have not helped the cause, being as a group that they are somewhat taciturn; although there are indications that this may be changing. Nevertheless, one hopes that engineers would not have to become orators or creative writers in order for their profession's importance to be recognized. (Cowboys were traditionally uncommunicative, yet they became central figures in American mythology!)

I do not look for romantic novels with engineer heroes — or heroines — nor a TV program called, "L.A. Engineer," as a few engineering colleagues have proposed. (Although, come to think of it, why not?) What I do hope for is a heightened awareness of engineering and its role in society, a modest objective, all things considered.

There are some hopeful signs. In the press, science writers are a relatively new presence, greatly enriching our cultural discourse. Some of them have drifted into technology and taken to discussing the work of engineers. (Science, by the way, has had its own image problems, and engineering's difficulties stem in part from a public that confuses engineering with science, or worse, sees it as subservient to its esteemed relative.) Financial writers, too, are increasingly interested in the work of engineers, recognizing the centrality of technology to the world of commerce. In academe, the history of technology has become a flourishing discipline, and related fields have arisen, such as STS (science, technology, and society), the philosophy of technology, and engineering ethics. On television, there have been a handful of "specials" with engineering content, and hopeful producers are planning others. As for creative literature, we've had Tracy Kidder's *The Soul of New Machine*, David McCullough's books about the Panama Canal and the Brooklyn Bridge, and a few other encouraging contributions.

A culturally enriching awareness of engineering and technology should also yield synergistic benefits for the first two goals argued above: the need for good young people to enter the engineering profession; and the practical need for leaders, as well as the public in general, to become knowledgeable about technological issues.

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There is yet one more argument to support thinking about — looking into — engineering. I believe that the engineering cast of mind, a particular way of approaching problems — in short, the engineering view — has much to contribute to our society. Our public debates are too often characterized by passion, ill will, and distortion of the facts, sometimes intentional and sometimes unwitting. Engineers are trained to solve problems, adhering to facts and the truths of experience, shunning personal sentiment, or at least recognizing it for what it is. Engineers do not expect to find perfect solutions, because in their work there usually are none; they seek optimal solutions, given constraints of time, materials, and money. Their objective is to get a product "out the door," on schedule and within budget. They have to take human nature into account, considering what happens at a machine's "user interface." They are better than they used to be at predicting the environmental effects of what they do. In addition to being problem-solvers they are also — the best of them — imaginative creators, inventors, discoverers of new paths. They are realistic but not defeatist. If we are to prevail over the difficulties that beset us, this approach to problems, this engineering view, must percolate into the perspective of every citizen, and particularly into the outlook of our leaders.

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A generation ago the engineering view could be summed up in the famed Seabee motto: "Can Do! The difficult we do immediately. The impossible takes a little longer." Engineers, like everybody else nowadays, have been sobered by the daunting realities of exploding populations, limited resources, and an environment that is more fragile than many had supposed. But the Can Do spirit is still very much alive. Within the parameters of the possible, engineers are willing to take on all problems and to join in the struggle to improve the world, which as Mark Twain points out, doesn't seem to have been "made right."

A philosopher might speculate that the world was made in just such a way as to present us with challenges, to make us become engineers. If this is the case — if it is human destiny to become technological — then engineers have all the more reason to feel fortunate. ¶

References

1. Gallup Poll, commissioned by the American Consulting Engineers Council (ACEC). Press release from ACEC (20 February 1990).
2. Howard Wolff, "How Engineers View Themselves," *IEEE Spectrum* (April 1993), p. 25.
3. Cited in T.R. Reid, *The Chip* (New York: Simon & Schuster, 1984), p. 196.

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