Vital Speeches of the Day

REG. U.S. PAT. OFF.

VOL. LXVI SEPTEMBER 15, 2000 No. 23

The Dark Side Of Technology

MORALITY IN THE DOT COM ERA

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Delivered to the Commonwealth Club of California, San Francisco, California, June 6, 2000

Albert Einstein said that the unleashed power of the atom had changed everything except our way of thinking, and that we were drifting toward unparalleled catastrophe. He was, of course, speaking of the threat of nuclear weapons approximately 40 years ago. Today I want to talk to you about another threat that I see, but let me start by saying that I come here, fundamentally, because I'm an optimist about three new technologies: genetic engineering, nanotechnology and robotics (GNR). These technologies will bring us enormous benefits, creating almost unimaginable wealth. Genetic engineering will give us the ability to cure many diseases and extend our life spans. Nanotechnology promises to allow us to build material goods at much lower costs, certainly providing us the resources to end material poverty. And robotics may, within this century, allow us to end most manual labor. There may well be tens of thousands of dot geno, dot robo and dot nano startups that create this unimaginable wealth and create a lot of creative opportunity for bright people.

These benefits come about because of the confluence of the physical and biological sciences with the field that I practice in: information technology. It's the ability to take the information, say about genetics, and reduce it to a sequence of letters that can be manipulated in the computer that allows us to begin to think of doing some of these things. So, it's the continuation of a phenomenon in computing, called Moore's Law, that is a huge enabler. It says that computing has been getting cheaper and will continue to get cheaper and more powerful. Many people thought this trend would run out around 2010, but new technology that I just really learned about in detail last year, called nano or molecular electronics, now promises that we'll see this trend almost certainly continue to 2030. This would mean that, by 2030, we should have inexpensive personal computers that are about as a million times as powerful as they are today. These computers would allow people, with the information models in them, to begin to redesign the world in a very fundamental way. A factor of a million is an almost inconceivable number. A calculation, which would have taken a thousand years on a computer today, on a computer of 2030 is likely to finish in something like eight hours — a calculation that would take a year and twenty seconds. And we can also expect about another factor of a million in improvement from algorithms, from the ways in which we solve very difficult problems. For total improvement in 30 years, perhaps on large scale problems of 1012, a million million, which is about the ratio of the power of an atomic weapon to a match head. Clearly, these advances have enormous implications.

I believe that our culture is rooted in the Greeks. We've been running an experiment in freedom in civilization for 2500 years, with some interruptions, like the Dark Ages. But our experiment started in a relatively happy way with the Renaissance and, clearly, science and technology have been creating wonderful things for the last hundred or two hundred years and progress has been accelerating. Now, the Greeks were both spiritual and objective. Edith Hamilton, in her classic book The Greek Ways,

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Subscription Rates: Beginning September 1, 1999, the rates will be $45.00 a year. Foreign one year: $50.00 including Canada and Mexico. Single copies $3.00. Back issues, if available within two years, $4.00 a copy, plus postage. Microfilm and microfiche editions $32.00 per volume, subscribers only. On orders under $22.50, remittance must accompany order.

Claims for nondelivery of issues must be made within two months of the date of the issue.

Vital Speeches is Indexed in the Reader's Guide to Periodical Literature. An annual index is printed each November and distributed to all subscribers. Cumulative Index, Volumes 1-25, $75.00 per copy. Volumes 26-50, $50.00 per copy, plus postage. Volume Binder for Vital Speeches $15.00 plus postage. Vital Speeches will be found on file in thousands of public, college and high school libraries throughout the United States.

Periodical postage paid at Mount Pleasant, S.C., and additional mailing offices. Printed in the U.S.A.

POSTMASTER: Send address changes to: 389 Johnnie Dodd Blvd., Box 1247, Mount Pleasant, S.C. 29465.

said: "The Greeks weren't tempered to evade facts. It's we ourselves who are the sentimentalists. We to whom poetry all art is only a superficial decoration of life. The Greeks looked straight at life; they were completely unsentimental. It was a Roman who said it was sweet to die for one's country. The Greeks never said it was sweet to die for anything. They had no vital lies. I think, to be worthy of this tradition that we're the inheritors of, we have to be unsentimental when facing problems and dangers like we face. We have to be blunt if necessary, sometimes even unpleasant, and talk very honestly about our situation in the same way that they did that led to their great progress.

In the twentieth century, we've spent a lot of time dealing with nuclear, biological and chemical weapons. Clearly, if you follow the news, you see that these problems continue. These were technologies developed by the military; they had largely military uses with little commercial value, requiring large scale activities and often rare raw materials to make the weapons and create new trouble using these technologies. In particular, the knowledge about how to do this was not widely available, at least, not for a long time. The truly dangerous, the stuff with the ability to destroy civilization, was actually really held by a couple of nation-states: the U.S. and the former Soviet Union.

The technologies of concern in the twenty-first century — GNR — are quite different. They're being developed by the commercial sector, they have both military and, especially, enormous commercial uses and huge commercial value. As they become information sciences and are practicable on small computers, even personal computers, they are no longer requiring the large-scale facilities that the earlier twentieth century technologies did. If we're not careful, in the course we're on, the knowledge to do work in these fields will be widely, essentially universally, available.

The dangerous situation that we face is that if all practice in these sciences become information and all information is available, then clearly the weapon kind of information will be available as well. In an information age, if everything is information, obviously weapons are information also. We have a new situation that we haven't faced before, where the moral equivalent of the weapons of mass destruction may be available to people sitting at their personal computers, or even to small groups.

Why can an individual do damage on such a large scale? Well, if you make a bomb, you can blow it up once. If you make something that can replicate in the world and you release it, you can create harm far out of the scale to the act which released it into the world. The technologies that can be created by GNR can self-replicate. So, a single act, with these new kinds of knowledge-enabled massive destructive technologies, can cause extreme harm. By combining the enormous computing power that is released by these new technologies — these million times faster computers — with the manipulative advantage in the physical sciences, using these tools to manipulate what we understand about genetics and the physical world, we are releasing enormous transformative power. This power is certainly sufficient to redesign the world in a very fundamental way, for better or for worse, because the kind of replicating and evolving processes that have been confined to the natural world are becoming realms of human endeavor. The danger that we face is that we know there are evil people in the world and, if we democratize access to all this knowledge so that everyone has these tools and they can then release self-replicating things, we have a recipe for disaster. We're accustomed to living with almost routine scientific breakthroughs, but we haven't come to terms with the fact that these technologies pose a different threat than the technologies that have come before. Uncontrolled self-replication of these new technologies can create enormous damage in the physical world. I don't think it's an exaggeration to say that we're on the course to the perfection of extreme evil, basically allowing evil to spread well beyond that which the weapons of mass destruction bequeath to the nation-states to empowering this for extreme individuals.

To talk specifically about genetic engineering, the danger here is that the same technologies which can be used to cure many diseases and extend our life span, may allow people to go so far as designing their own disease. One would call it "designer pathogen." If you ask the experts in this field, they're not exactly sure when this would be possible, but 20 years, on our current course, would be a good guess. Diseases that are designed in the lab have no natural limits on their virulence. They needn't be weak because they're widespread, they can extinct the species that is their target, there's no Darwinian kind of principles that would prevent that even in the natural world. They certainly don't apply to things that we design in the lab. The virulence contagion and incubation period of such a disease could easily be engineered [and made capable of] avoiding the immune system. What barrier would there be to someone doing this given almost perfect knowledge of the world got from genetic engineering? If all the information is published, the equipment's getting cheaper, the computers are becoming almost infinitely powerful for design, and a good versus a bad design is simply a question of a sequence. This is a situation we have to avoid.

Nanotechnology is simply another technology practiced at the atomic scale. Instead of using only biological materials, nanotechnology opens to using any other elements in the periodic table and essentially mechanical kinds of designs and has a similar problem with an out of control replicator that the nanotech people call "regu." In response to the article that I wrote in Wired, one of the people involved in nanomedicine wrote an analysis of this — it's on the foresight.org website — and it's clear that it's not impossible for these replicators to, say, eat the biosphere, which is the particular analysis of this paper.

I think that these kinds of things, in general, have been called pestilences in the world of our ancestors. But, I think, the pestilences are roughly beyond our experience. I don't think, in our living memory, [that] we've seen things like this happen in the world. Clearly, in the fourteenth century in Europe, we had the plague. The Encyclopedia Britannica says that it was transmitted to Europeans when a Kipczech army, besieging a Genoese trading post in the Crimea, catapulted plague-infested corpses into the town and, subsequently, a third of Europe's population died. Other people might say that there were actually rats running off the ship and they didn't actually do it by catapulting the body, but that was clearly the intent — to use this as a weapon. In the sixteenth century in the Americas, a similar thing happened with smallpox. Robert Wright, in his book Stolen Continent, said: "The turning point, as so often with the conquest of America, came with the Plague. The scourge was no longer left in the hands of God. Lord Jeffery Amherst secured his place in history as the inventor of modern germ warfare with this notorious command: 'Infect the Indians with sheets upon which smallpox patients have been lying, or by any other means which may serve to exterminate this accursed race.' " The last fast moving pandemic that we had, I think, was the influenza epidemic of 1918, which is almost certainly out of our living collec-

tive memory.

This century, we've had advances in antibiotics and sanitation that have prevented most of these kinds of things from occurring, at least for a while. To try to bring back some memory of these things, I'd like to read you from the Roman Lucretius, the book "The Way Things Are," the last chapter, describing a plague on Athens. He says: "A plague once visited Athens. At first, they felt their heads burning with fever, throats blackened, sweating blood. The tongue filled up, engorged with blood, became to hard to move. Men's inner parts were burning to their very bones; their guts were furnaces. The only thing they had to drink was thirst, which made a deluge seem less than a raindrop. Doctors shook their heads while patients stared blankly. The signs of death were obvious; the mind was crazed with grief and fear. Eight days or nine would find the limbs grow stiff and death. There seemed to be no certain remedy; what gave life to one killed others. This plague was most infectious; it could spread as pestilences do with animals, cattle and sheep. So death was piled on death. None were left, sometimes, as mourners when the dead were hurried to their grave. Battles broke out as the survivors fought for funeral piers of corpses heaped on corpses. Funeral rites, which these pious people held in all-traditional reverence, became quite out of fashion. Everyone in grief buried his own whatever way he could amidst the general panic. Sudden need and poverty persuaded men to use horrible makeshifts. Howling, they would place their dead on piers prepared for other men, apply the torches, maim and bleed and brawl to keep the corpses from abandonment." Okay, let's change the subject.

Robotics is the third technology, and it's really different in the sense that the threat here is to create a wild successor species. Nanoelectronics seems to give us sufficient CPU power that we could create something on the scale of a brain. These dangers have been broadly outlined by Hans Moravec in his book Robot: "Robots would be very different from us. They'd probably be asexual, Lamarckian — meaning that they could pass experience directly and they wouldn't necessarily have a strong notion of an individual. So, any romantic notion that robots would be like people, I think, is a folly. The most important thing to note about implementing robots is that it's a real change to the evolutionary paradigm." We had biological evolution until humans came along and, since then, evolution has been largely dominated by cultural evolution, which might go, say, a thousand times faster than biological evolution. The technological evolution is moving much, much faster than cultural evolution and perhaps a million times faster than biological evolution. It's no surprise that it's difficult for cultural institutions to maintain any sort of notion of control over the technology.

The danger with these technologies — GNR — is extremist and delusional people writing in the Seattle Times in response to my article in Wired. William Calvin, a neurobiologist at the University of Washington, wrote: "There's a class of people with delusional disorder who can remain employed and pretty functional for decades. Even if they're only one percent of the population, that's 25,000 mostly untreated, delusional people in the Puget Sound area. Even if only one percent of these has the intelligence or education to intentionally create sustained or widespread harm, it's still a pool of 200 high-performing, sociopathic or delusional techies in the Puget Sound area alone." Now, the question really is: are we going to give the people in our society who are clearly crazy — and we can't deny that they're out there — illimitable power? Imagine that we're all on an airplane together, the airplane being the planet, but on Egypt Airline Ninety where everyone's a pilot and everyone has a button to crash the plane by doing one of these crazy things. That's clearly not acceptable — it brings back fate, like we saw in the ancient world. It's clearly insane to create widespread enabling of genocide or extinction or worse.

People have proposed technical fixes to this problem: Carl Sagan saw the problem and said, "Well, we could head to the stars." But I don't think there's enough time, and who would take ethical responsibility for the people who were left behind? Ray Kurzweil imagined we'd all become one with technology since we'd all upload ourselves into being robots, but the robots would certainly have their own psychological problems. If anything, given that they're smarter and more powerful than we are, that seems like an even more dangerous situation. The people who didn't choose to be robots would be in a particular peril even if it [were] possible, which is arguable. Other people have argued for shields. Luis Alvarez, a great physicist, said of the people who proposed the great SDI shield: "They were bright guys with no common sense." I think the reality is that the ability to create havoc with these technologies will probably out-race our ability to defend against them. That doesn't mean we shouldn't try to create some defenses, but a defense against a bioengineered pathogen would be the rough analogue of a perfect human immune system, which seems a little bit unlikely given that, for example, today we have no cures for any viral diseases.

So, in order to deal with this problem as we had to deal with the nuclear problem, we have to look beyond technical fixed to non-technical fixes. We could hope for a second coming, some sort of faith-based thing. But if you talk to people of faith, you find out that God isn't going to come back to save us from ourselves in any of the major cases that I can find. In fact, we have the freedom to destroy ourselves — that's part of the covenant after the Noah and the Ark story in my faith. We are responsible for ourselves and what we have to do, I think, is decide how we're going to manage these technologies to reduce the danger. We have done some things along these lines. Historically, starting in the Nixon administration, for example, the U.S. renounced the use and research of offensive, biological weapons. [The weapons of] this category are so bad that you don't even want to make them, even if the enemy makes them, because the ones you are making might get stolen by somebody else. Since there's no defense, the only real answer is to not have them in the first place.

How much danger is there? John Leslie, the Canadian philosopher, estimated the danger at roughly 30 percent, but much more if you accept something called the Doomsday argument, which I'll explain if someone asks a question [about it]. Ray Kurzweil said, in his book about the age of spiritual machines, meaning robots: "Well, if we have a better than even chance of making it through, but I've always been accused of being an optimist."

You can come up with your own estimate. I think that either case is so far beyond completely unacceptable, and they don't include a horrible outcome short of extinction, some sort of living, degraded death, that we clearly have to do something.

We have an ethical issue: if these technologies can clearly cause genocide or extinction, and genocide is a crime of the highest possible order, we as science and technologists must not be complicit in genocide. We have to put in limits or safeguards on development. And it has to account for the reality of

extremists. We've got to move beyond fatalism; we don't want to risk our future on the fact that we'll be able somehow to come up with defenses for things that are almost impossible to defend against through some magical intervention of cleverness. Now, the scientific attitude has always revered knowledge above all things. Robert Oppenheimer, two months after the bomb was dropped on Hiroshima, said: "It's not possible to be a scientist unless you believe that the knowledge of the world and the power which it gives is a thing which is of intrinsic value to humanity. And [scientists should be] using it to help in the spread of knowledge and are willing to take the consequences." Essentially, disclaiming any responsibility as a scientist for the further use of the things you're creating — and I agree that knowledge is good, and so is the search for truths. We clearly have a bedrock value in our society long agreed on the value of open access to information and recognize the problems that arise with attempts to restrict access to and development of knowledge.

Certainly, in recent times, we've [come] to particularly revere scientific knowledge. Despite the strong historical precedence of open access to an unlimited development of knowledge puts us all in clear danger of extinction, then common sense demands that we reexamine even the basic long held truths. Nietzsche warned us, at the end of the nineteenth century, not only that God was dead, but that "faith in science, which, after all, exists undeniably, cannot owe its origin to a calculus of utility. It must have originated, in spite of the fact that the disutility and dangerousness of the will to truth or truth at any price is proved to it constantly." It's this further danger that we now fully face: the consequences of our truth seeking. The truth that science seeks can certainly be considered a dangerous substitute for God if it's likely to lead to our extinction. Edith Hamilton, in The Greek Way, points out that "the wisest of Roman law-givers said that "the enforcement of an absolutely just law, without any exceptions, irrespective of particular differences, worked absolute injustice." And so we see here that, even if the pursuit of truth and openness is an absolutely just thing, that even it must admit exceptions, such as in this case.

Aristotle, one of the founders of science, perhaps the founder of science, in his book on ethics pointed out that "the final end of human life is happiness, not truth." He said, "We call final that without qualification that which is always desirable in itself and never for the sake of something else. Such a thing happiness, above all else, is because we never choose it for the sake of something else." The Dalai Lama has made a similar point in arguing for secular ethics in his book Ethics for the New Millennium. Both, in this way, clearly recognize the limits of science.

There's been a lot of reaction to the article I wrote. I've been very encouraged by people's willingness to engage on this subject. The twentieth century was clearly a bloody century, a century of war, a century of creation of enormously horrible weapons. We fortunately avoided nuclear disaster. We unfortunately created the ability for the nation states to destroy civilization. The twenty-first century may be a century of pestilences if we don't take some action, more like the fourteenth or, perhaps, the sixteenth century. I think we have to change our ways to avoid such disasters. We can't afford to democratize extreme evil. I think we have to find a new way of thinking about the world, perhaps thinking of earth as a sanctuary for people. If our home is a sanctuary for our children, we don't leave loaded guns lying around the house. If the zoo is a sanctuary for animals, we don't take toxic chemicals and PCBs into the zoo. So, there are certainly things that we're clever enough to make that we shouldn't have on the earth, and that's the challenge that's in front of us. Thank you.