The Engineer's Burden[1]

Edward F. Tuck

Whether they're engineers or computer science people or graduates of some other technical discipline, people with a technical education acquire a culture and a set of values along with their formal learning. They share that culture and those values with other technical university graduates around the world. Theose values not only shape the way they approach their life's work, but the way they address their lives. They define us in the eyes of the people we work with and live with.

Technical people have things that set them apart, and they are special things: they are the things that bring us success and the respect of others.

First, we think critically: we understand that the things that others tell us or show us are always partly untrue. Sometimes they're deliberate lies, attempts to influence our beliefs and thinking for our or their own good, or sell us something, or advance some big plan that benefits someone else; but more often they are errors that come from laziness or lack of understanding.

You and I learned critical thinking by looking at physical things: "How pure is the sample?" or, "How noisy are the data?" or, "Is the program doing something we really need?" But we soon learned to extend those questions to the very fabric of our lives: "Do I really need to take pills every day?" "What's our real agenda in Iraq?" "Why is she telling me this?"

At the same time, we learned how to solve problems: how to use truth to create a greater truth, or to create something that's of use to everyone. When we go out to earn a living, this is what we've been hired to do.

And the last thing we learn, very slowly, after we've been employed for a while, is that we are the truth-tellers in our organizations. We are the people whom others believe, whom others seek out when they need to know the truth. This is a huge responsibility, and one that's given us without our asking or even wanting it. *It's the burden of our profession.*

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1. Adapted from a Commencement address delivered at the University of Missouri at Rolla, December 20, 1997. Copyright 2005, 2008 Edward F. Tuck.

Until very recently, engineers and scientists were looked down upon by graduates of the big Ivy League schools. Their Liberal Arts education was the leaders' education, the education of the elite; to them, Engineering colleges were glorified trade schools. The value of an Ivy League education was the contacts one made: children of "important" people went to the big, expensive private universities. Except for a few token minorities, they all had the same background, and they all looked alike.

A few years ago, that changed: We entered The Age of the Nerd. Now, the people who do important things, the people who command the wealth, are technical people. Many are software and hardware engineers. They think like you and I think. Today, it's the engineering schools that produce the leaders, and it's the Ivy League universities that run the trade schools: they offer MBA programs, hard for a liberal-arts major, easy for an engineer.

So you're stuck. Whether you like it or not, you and your colleagues will run our businesses and our nations. You don't have any choice. You, and the other technical people of the world, are the movers and shakers of your generation. It doesn't matter if you're from a minority or whether you're a man or a woman; because these distinctions have disappeared in technical companies. They're irrelevant. But even if you, the world's new leaders, don't look alike, or talk alike, you behave and think alike: you have a high ethical standard, you're smart, you understand technology, and you know how to spot a lie and how to solve a problem.

You *must* lead because it's ethically necessary. Look at the US space program: A bunch of young, bright, dedicated engineers, for an incredibly small amount of money, about $10 billion in today's dollars, went to the Moon, did good science, and came back. It made us proud of our country and our profession at a time when we and the world were questioning both. It was the engineering triumph of all time. Like good employees, because that's what engineers were then trained to be, they did their work and they let others run the organization. Then they watched their beautiful, competent NASA turn into a mess: a notorious example of bureaucratic bloat that for a while could accomplish nothing, that spoiled our hopes and dreams, and cheapened their success. Even the extraordinary Dan Goldin wasn't able to repair it. *It was 1972, over 30 years ago, that a person last walked on the Moon.* Maybe the newly-appointed Michael Griffin, an engineer and scientist, can fix NASA, but it won't be easy[2].

This will happen again and again in your companies, your nations and your lives if you don't question your superiors, your employers and your government. It will happen again and again if you don't question the belief systems you've grown up with. It will happen again and again until you take charge and do the things you know are right. You cannot say, "I work here," and allow lesser people to lead your world. *To do so is morally wrong.*

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2. Kennedy, Donald, "NASA Redux," Science, Vol 308 (22 April 2005) p. 467.

I'm a guy who creates companies. Most of them are failures. In fact, most of the companies *anyone* starts are failures. To the extent that my venture funds have been successful, it's because we've had a lower failure rate than unsuccessful funds. This may be luck, but it's also because I've learned why companies fail, and why their managers carry the seeds of their own destruction. Looking at companies with the help of Tim Earle, who chairs the Anthropology Department at Northwestern[3], we've found that the hierarchical social structure we humans created fifteen thousand years ago, when we organized ourselves into tribes and nations, has been so successful at dealing with war and crime that we've come to rely on it too much. It's a bad way to organize a company. It's actually smaller working groups, groups that generate their own leadership from within, that get things done. When we apply this principle that worked so well for humans over three million years of their evolution, we create companies that are more successful than traditional companies. The way to assemble these teams is now scientifically understood[4,5].

This change works because today's work is work of the mind. Because mind work doesn't require big factories and enormous amounts of capital like the old industries, small companies do it better. What this means to you is that you're much more likely than your parents to work for a small company, and it means that you're much more likely, eventually, to be a senior executive or the chief of the company you work for. It means that you'll lose your job often, and that your work will thread its way through all of the parts of your life, rather than being a job you go to and come home from. It means that unlike many of your parents, you will truly enjoy your work, and that you'll feel when you grow old that you've done something useful and important with your life. You'll be proud of yourself and the things you've done. You'll be like a member of a hunting-gathering camp. A hunter is carrying a spear. Is she working? Is she playing? She's living her life.

It seems very risky. It *is* risky. You'll lose your job because your company fails, or because you've exercised your ethical and moral obligations, or because you'll have done your part of the work and you aren't needed any more. You can't avoid it. In fact, to survive and prosper, you'll have to take even more risk.

Those of you who will be the happiest are those of you who will lead, and leadership implies risk. It means risking your career, and risking your reputation, for a new idea that people think is nutty. You'll be ridiculed. This is your job.

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3. Tuck, E. and Earle, T., "Why CEOs Succeed (And Why They Fail): Hunters and Gatherers in the Corporate Life," *Strategy and Business*, Issue 5 (Fourth Quarter 1996)
4. See Roger Guimerà et al, "Team Assembly Mechanisms Determine Collaboration Network Structure and Team Performance," *Science*, Vol. 308 (29 April 2005), pp 697-702.
5. Barabási, Albert-László, "Network Theory – the Emergence of the Creative Enterprise," *Science*, Vol. 308 (29 April 2005), pp. 639-641.

You'll fail. Maybe you'll get fired. Maybe you'll start a business, and it will fail. That's OK. The strength of our culture, the difference between our culture and Europe's, is that here one can fail, and start again, and fail, and start again, and finally succeed. To fail is not to die, and to fail is not to become a social outcast[6].

Thelonius Monk, the great jazz pianist, said, "The only cats worth anything are the cats who take chances." The only people who succeed are the people who manage risk.

Your work is to create the things people buy and use. The people you create for will be members of every culture on Earth. They'll choose or reject your creations based on their needs, which in turn arise from their own social context. Your company will have a Marketing function, whose job is to decide what people will buy. Marketing will ask you to design variations of the things that already exist, but they won't ask for something completely new and different. That's because they can't do a market survey on a new and different thing. If a product doesn't exist, there's no market to survey. Because you are one of us, you are creative, and you are a truth-teller. It is therefore your responsibility to tell your company what is possible. Your new ideas will always be resisted, and they will usually be ridiculed. As a responsible technical person, you must take the risk of being pushy and annoying until your ideas are fully considered. Eventually, you'll have an idea you know is good, and your employer will think it's stupid. That's the time to quit and start your own company.

To know how to create things people will buy and use, you must pay attention to changes in your own and others' lives. You have to read. You have to travel. You have to learn another language. You have to stay hip. If your children's music sounds like noise to you, you're not paying attention. If you think the younger generation is going to pot, you're not paying attention, and what's worse, you're a politician's patsy[7]. You're saying something that's been said by every generation, back to ancient Greece and beyond. In fact, the younger generation is *not* going to pot. Teen births are lower than in the fifties[8]. Crime is down[9]. Teen suicide is 'way down[10]. Drug-overdose deaths are *ninety-two percent lower* than in 1970[11]! Today's popular music is unbelievably good. If you won't accept changes in the world as they happen, if you whine that it was better in the old days, if you blame your discomfort on "today's kids," your life will be a failure. You will lose the respect of your peers, and you will be irrelevant to your children. You will lose their respect because you deserve to. You'll be a spent bullet.

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6. "The surest way for attaining immortality is to commit an act of spectacular failure." Attributed to John Kenneth Galbraith.

7. Males, Mike A., *The Scapegoat Generation: America's War on Adolescents*, Common Courage Press, 1996.

8. Ludtke, Melissa, *Unmarried Motherhood in America*, 1997, Random House, New York

9. Ostrow, Ronald J. et al, "L.A. Crime Rate Falls 15% in FBI Midyear Figures," *The Los Angeles Times*, November 24, 1997.

10. Males, Mike A., "State's Teenage Suicide Rate Declines, So How Come No One Knows Why?" *The Los Angeles Times*, December 14, 1997.

11. Ibid.

For example: Soon, most retail sales will be done over the Internet. Will this start a new round of urban decay, as centralized retailing did in the fifties, or will the savings let us build a few parks? You have to decide, and you must lead.

For example: Satellites will bring the Internet to developing nations. This will cause disintermediation in their economies. Rich middlemen won't be influential any more. There will be social and economic upheaval. How can you make this a good thing? You have to decide, and you must lead.

For example: Cheap communications allows young people all over the world to share ideas and dreams with people from profoundly different cultures and belief systems. Telecommunications will become the very fabric of our society, and the world's societies will begin to merge. You can't stop it. Can you make it a good thing? You have to decide, and you must lead.

For example: You will see Mars colonized. You or your children or someone you know will be among the colonists. This will change your life. What will you do? You have to decide, and you must lead.

You've picked a really good time to graduate, and you didn't pick an easy school. It's been hard. You've earned a chance to have a good life. Go enjoy it.