Freedom to Tinker: The Struggle to Access Devices You Own

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Information technologies are intertwining themselves into nearly all everyday products and processes. This trend raises many interesting public policy questions. I will focus here on one such question: how to ensure the public's access to important technologies.

By "access" to technologies I mean not who can afford to get them, or what is sometimes called the "digital divide" issue. I have in mind a different definition of access: the ability to understand, discuss, repair, and modify the devices that we own. Is the technology just a "black box" to us, or do we, having bought the devices, have the right and ability to understand and access their inner workings? This question turns out to have important ramifications for the public.

An Example: Voting Machines

Electronic voting is one good example of why the public should care about the ability to understand and discuss technologies.

The 2000 presidential election was a wake-up call to Americans about the poor state of our election technology. Punch-card ballots in Florida and elsewhere were cumbersome and error-prone, creating an error rate larger than the margin of victory. Policymakers vowed that future elections would use better technology.

The result was a move to electronic voting. Many states and counties bought touch-screen voting machines that could record votes at the touch of a finger and instantaneously send vote tallies to election headquarters when the polls closed. Our voting technology problems were solved – or so some people thought at the time.

Computer security experts were skeptical. Touch-screen voting machines are just computers, and computers are naturally prone to error and tampering. Were the new machines secure and reliable enough? The only way to tell was by detailed analysis of the machines' hardware and software.

But the voting machine vendors said the technology was proprietary and that neither the public nor election officials would be allowed to examine it or learn the details of how it worked. The contracts by which states and counties bought the voting machines required that the design be kept secret. Many of the contracts specifically prohibited testing and analysis of the technologies. So security experts and other concerned citizens were not allowed to examine the machines – they were not allowed to verify whether the most fundamental process of our democracy was functioning as it should.

This was a classic example of the public policy tradeoff around customers' access to technologies. The vendors' claim to limit access was based on conventional arguments about ownership of technology, which seemed to have some nonzero amount of legal support. But the citizens' argument for transparency in election processes was also strong. How should our laws and policies handle such tradeoffs?

Access and Public Policy Debate

Voting machines are just one example of where public policy debate is affected by limitations on access to technology. Whenever a policy issue involves technology and the relevant attributes of the technology are shrouded in secrecy, debate will be hampered. This happens surprisingly often. Here are a few examples:

Copyright enforcement: Copyright owners, concerned about widespread infringing redistribution of their works, are increasingly demanding that network intermediaries such as universities and Internet Service Providers be required to deploy content filtering and blocking technologies. Whether to require such technologies depends crucially on how effective they will be at eliminating infringement. Answering that question requires detailed examination and testing of the technologies.

Spectrum management: The electromagnetic spectrum is a valuable and limited resource. New technologies offer the possibility of sharing the spectrum by using smart devices that detect idle spectrum and use it until the owner resumes using it. Whether to allow these smart devices depends on the details of how efficiently they use the spectrum and how reliably they can stay clear of other users. Answering that question requires detailed understanding of the technologies.

Protecting children: Many people are concerned about the risk to children who use social-networking or other online services that also admit adults. One approach to this problem is to use age-verification technology to segregate users or content by age. Should such technologies be required? Should their use shield service providers from liability should something go wrong? Answering these questions requires knowledge about the nature and effectiveness of the technologies.

In all of these cases, public policy decisions – decisions not by individual consumers but by government on behalf of society as a whole – depend on knowledge of technology; but the necessary knowledge is not available.

Educational and Intellectual Benefits

To this audience of engineers, it must be self-evident that fostering understanding of technology, by experts and by the public, is a worthy goal. The same benefits that apply to big public decisions, such as what the law should be or which technologies our government should rely upon, also apply to everyday decisions. And the same benefits that apply to public discourse also apply to everyday education. In short, citizens and students benefit from understanding technology.

Generations of scientists and engineers grew up tinkering with technologies, from telegraphs to radios to chemistry sets to car engines to computers. For the most part, nobody tried to stop this. But nowadays more and more technologies come with license agreements that forbid the sorts of tinkering that many of us did as kids and some of us still do. Will future generations be able to learn as we did?

I believe that we as engineers should worry about this trend, that we should speak up for the public benefits of kids and others tinkering with technology. We should support what I call the "freedom to tinker," not only to improve public policy decisions but also to foster public education and build a population of tinkerers.

Tinkering and Intellectual Property

I have argued that barriers to understanding technology cause harm. But of course barriers may still be justified if they provide countervailing benefits to society.

The barriers I have described are based in intellectual property law, which gives the creator of a technology certain exclusive rights relating to it. To figure out whether intellectual property should outweigh the public interest in understanding and tinkering with technology, we have to look at the scope and purpose of intellectual property. Can the purposes of intellectual property be met without frustrating public understanding of technology?

Intellectual property differs from physical property because ideas differ from objects. In the language of economics, ideas are nonrivalrous, which means that I can possess an idea without depriving you of it. This is unlike physical objects, which by their nature can only be in one place at a time, a distinction that has profound implications for the design and justification of intellectual property rules.

In a sense, we have to set up property rules for physical objects, because any given object will by its nature be unavailable to almost everybody. If we tried to do without property rules for physical objects, bullies would take your stuff. But ideas are different: an idea is capable of being known by everybody at the same time, and once you have an idea no bully can deprive you of it.

Intellectual property exists not by necessity but in order to create incentives. If we give the creator of any idea some limited exclusive rights over its use, the creator can sell and license those rights in exchange for money; and the promise of this revenue creates an incentive to devise the idea in the first place.

It has long been recognized that the exclusive rights of the creator should not be absolute but should instead be balanced against the cost of restricting ideas. If every idea were owned forever, we couldn't think or debate without entangling ourselves in a thicket of legal restrictions. Intellectual property rules are engineered to avoid this entanglement, while at the same time providing enough incentive that people will invest in creating valuable ideas, so that ideas are both usable and plentiful.

Reconciling Tinkering with Intellectual Property

The public policy question before us, then, is how to reconcile freedom to tinker with intellectual property. Can we allow tinkering while preserving the incentive to create technologies with which others can tinker?

The key to doing this is to draw a line between commercial copying of a product on the one hand, and analysis and discussion on the other. To copy a product for commercial purposes, for example to sell copies in competition with the original, is to challenge the fundamental incentive behind intellectual property. To understand, discuss, repair or modify a product that you own leaves the creator's core business intact, and therefore is much less challenging to intellectual property goals.

This distinction is only the beginning of the analysis; many more challenges remain. Even commercial copying is sometimes beneficial, for example when it fosters competition between vendors without undercutting the creator's incentive too much. And modifying products will sometimes undermine the producer's business model, for example when a company creates a cheaper, reduced-functionality "home" or "student" version of its product and modification can easily convert this into the full version. The

policy, economics, and engineering issues surrounding these questions are complex, and time does not permit me to delve deeply into them.

Tinkering and Computer Science Research

To connect this all back to engineering research, let me tell you briefly what first inspired me to think about this issue. My students and I study security and privacy challenges in information systems, especially the systems used in everyday tasks like driving, shopping, web surfing, and listening to music. To do this, we have to do deep examinations of the computerized innards of consumer products. If we do this well, we can help users make better choices about which technologies to trust, and we can help product engineers design stronger and safer technologies.

The products we study come from specific companies. Sometimes those companies are happy with our work and sometimes – especially when we find serious problems in the product – they are unhappy. When a large company is unhappy with you, their lawyers look for ways to cause you legal trouble. If the law is ambivalent about tinkering, and your research looks like tinkering, you need to tread carefully.

Legal factors like these have driven some good researchers out of our subfield. We have stayed because we're convinced that what we're doing is legal and benefits society. Our work in this area is supported by an informal network of lawyers who help us steer clear of legal landmines. We're deeply grateful to them, but we recognize that researchers who don't have that level of legal help, or who are allergic to lawyers as many engineers are, will find another kind of work to do.

Engineers have a lot to contribute to public policy debates. Good engineers know how to solve problems, how to make tradeoffs, and how to think about the big picture. We can all do more to educate ourselves and join the debate.