
Refreshing the Innovation Ecology

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The National Academies' report *Rising Above the Gathering Storm* (and many others) made recommendations to improve the climate for innovation in the United States. There are, however, many components of an “ecology” of interacting laws, regulations, policies and institutions that are not mentioned in the report—the intellectual property system, broad tax policy that encourages investment, a culture that encourages risk taking, etc. I will argue that there are two deep problems with many of the components of this ecology. First, many of them were designed for technology that *was*, not *is* or *will be*, and so are sub-optimal for achieving their avowed intent. Second, we almost never do a zero-based rethinking of them, but rather we try to tweak them in relatively small ways to reflect current reality. The result, I believe, is an ecology that is far less than ideal for spurring innovation, and in some cases many even be counter-productive.

I'm not going to go into the details of it, but the essential message of *Rising Above the Gathering Storm* is that the United States is, by any measure, doing well today. However, some of the leading indicators are less than ideal, and we may not enjoy the same kind of prosperity in the future. Traditionally, innovation has been a forte of the United States and if we want to continue to prosper, that's something that we had better nurture. The report then goes on to make some recommendations about how to do that.

First, we have to have a strong technical work force, so education is key. Second, we need to generate good ideas, so we had better be serious about supporting basic research.

Third, we need to make sure that we attract the best and brightest minds, from both inside and outside the United States.

In addition to these crucial components, there is a larger “ecology” of things that support innovation. There has to be a culture that permits and even encourages risk taking. There must be “patient capital” available to the entrepreneur. The tax laws need to support and reward investment. There must be adequate and appropriate protection for intellectual property. There must be laws and regulations that protect the public while simultaneously encouraging experimentation. The list of essential components in the innovation ecology, or the collection of interacting and interdependent things that support innovation, goes on and on.

The [innovation] ecology we have today was invented for technology that *was*, as opposed to the technology that *will be*.

Before proceeding, let me emphasize that I am neither a lawyer nor an economist; what follows are the observations of a layperson for whom some things just violate common sense. I will use those observations to illustrate two points: (1) that the ecology we have today was invented for technology that *was*, as opposed to the technology that *will be*, and (2) that changes to the elements of the innovation ecology have generally been incremental. We don’t fly up to 30,000 feet and ask whether this element of the ecology is working in the best possible way to achieve its intent. That is, there isn’t a process for using “zero-based analysis” to rethink the best way for these elements of the innovation ecology to achieve their intended purpose.

Let’s start with the current patent system. The system was originally designed to protect physical macroscopic machines, things for which you could build physical models. In fact, until relatively recently you were required to submit such a model with your application. Maybe the system is still okay, but, at the very least, it would be surprising if a system designed for macroscopic machines was ideally suited for protecting software, or snippets of DNA, or business processes. What bothers me is not that the patent system is necessarily broken, but that we’re not even asking the question.

On the other hand, I was speaking to a group of about thirty Silicon Valley Chief Technology Officers (CTOs) about a year ago, and every single one of them said that the patent system was broken. Every single one of them said that the only reason they continue to patent things is defensive—so that they can trade patents with other firms. They all said that from the point of view of the constitutional intent to promote

innovation, the current patent system was at best irrelevant, and in some cases even counterproductive.

Now, admittedly, these were mostly people from the IT industry and a few from the biotechnology industry. In both cases the speed of product cycles is so great that the notion of decadal protection is just irrelevant. But that's exactly my point. The patent system, as it exists, is rooted in macroscopic machines, not software or biotech; it's not tuned to their technology as it exists today. For them, the patent system simply isn't working.

Clearly, intellectual property protection is important as a component of the innovation system, but let's pick on copyright for a minute. The very idea of the prohibition of "copying" as the mechanism for protecting some intellectual property is absolutely anachronistic. It does not make sense in a 21st century context.

Every once in a while I encounter a web page containing one of those c's with a circle around it—the copyright symbol. Of course this page was copied at least a half dozen times on its way to being displayed on my screen. It was copied from the hard drive of the server to the primary memory of the server. It was copied from the server's main memory onto the Internet. The page may have been copied anywhere from one to several hundred times in the process of being transmitted over the network (that's the way the Internet works—it's called "store and forward"). Finally, it was copied from the Internet to my computer's primary memory in order to be displayed on my screen.

Of course, the person who put the copyright symbol on that web page didn't mean to prohibit *that* kind of copying; that kind is essential to displaying their page on my screen. It's perhaps ironic that the web page with the copyright symbol would have *absolutely zero value* if it hadn't been copied. If it was just stuck on the hard drive of the server it would be of no value whatsoever.

The problem is, that kind of copying is absolutely indistinguishable from the kind of copying that they didn't want to happen. The difference has to do with the intent of making the copy—to display the page or to steal it's content—and, at the level of the machine, there is no way to distinguish between the two.

My point is that the concept of prohibiting copying as a means of protecting intellectual property made a lot of sense when artistic or literary expressions were on physical pieces of paper. It doesn't make sense when it comes to digital information. "Copying" is just the wrong concept to use in the digital world as the tool to enforce what the copyright laws were intended to accomplish.

Let me pick on somebody else—the Food and Drug Administration. One of the members of the Academy of Engineering is a very successful serial entrepreneur. He has

mostly been involved with medical device companies, although recently he has branched out to deal with some treatment techniques as well. Caveat: I'm only repeating here what he told me. I'm not saying I know this for the absolute truth, but he claims to have an extremely effective vaccine against cancer.

As an aside, I always thought that a vaccine is something that you give to prevent someone from getting sick. I have since learned that a vaccine is simply something that simulates the immune system. My friend's vaccine is given to a person who already has cancer and it destroys the cancer by creating an immune response to it. He says it's extremely effective against tumors that are otherwise very difficult to treat.

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So what, then, is the problem? Well, it is unlikely that this vaccine will ever be sold in the U.S. Here the gold standard for FDA tests of safety and efficacy is the randomized, double-blind clinical trial. The problem is that this vaccine is manufactured for *a* patient and *a* tumor. It's the ultimate personalized medicine—there is only one person and one tumor against which it is effective. Hence, it is impossible to do a randomized, double-blind test, so under current FDA policy this therapy cannot be approved in the U.S.

Again, isn't it ironic. A procedure created to ensure safety and efficacy is, in fact, preventing access to what my friend claims is effective therapy. Once again, a procedure created for a technology that *was* isn't working for a technology that *is*.

Let me switch again and move on to the antitrust laws, which are a component of the innovation ecology in that they help make room for new players. These laws were passed in the late 19th century, in the era of railroads and steel monopolies. They were developed in the context of the economic theories of the time—theories that equated value with scarcity. Diamonds are more valuable than gold because they're scarcer. Gold is more valuable than copper because gold is scarcer than copper. If we have to compete in the marketplace to buy diamonds, because they are rare we will bid each other up to a relatively high price.

Well, in software and some other things, the premise of scarcity as a determinant of value is absolutely turned on its head. Value is not related to scarcity; instead, it's related to ubiquity. You all know Moore's law (the number of transistors per unit area doubles every 18 months), but you might not know Metcalfe's law. Bob Metcalfe is the man who invented the Ethernet, and his law says that the value of a network is proportional to the square of the number of nodes connected to it. If you're the only

person in the world who owns a telephone, it's not very valuable. Its value goes up as more and more people have telephones, and it is at maximum value to me when everyone has one.

The same principle holds true when it comes to certain software. For example, I use Microsoft Word. I do not use it because it's the best word processor. I do not use it because it is the most bug-free, nor do I use it because it is the cheapest. I use it because I am reasonably confident that if I create a ".doc" file and attach it to an email and send it to you, you'll be able to open it, edit it, and send it back to me. It is the ubiquity of Word that makes it valuable to me, not its scarcity.

My point is that a law based on the economics of scarcity is not likely to be effective in an economy of ubiquity. Moreover, the remedies in the anti-trust system do not reflect the economics of ubiquity, either. Take Microsoft as an example. I think that it is fairly difficult to argue that Microsoft doesn't have a monopoly. Yet, a few years ago the courts ruled in their favor when the government tried to enforce the antitrust laws.

Frankly, I think the judge made the right decision, given the context he was working in. That is to say, it would not have made any difference whatsoever if Microsoft had been broken up into a Windows company, a Word company, and an Excel company. The motivation for me to use Word would have remained exactly the same.¹

Now let's address the idiocy of the R&D tax credit, which Congress keeps reauthorizing one year at a time. I got onto this subject with the same set of thirty CTOs I mentioned earlier, and again there was near unanimity amongst them about the fact that the R&D tax credit had no influence whatsoever on their R&D investments.

The reason is quite obvious: R&D takes many years. If they invested this year to take advantage of the R&D credit and then next year it went away, they probably would have to stop that research and they would have just wasted money. It is only under the assurance that the credit will last for a reasonable period of time that it could have a meaningful effect. That doesn't necessarily mean it should be made permanent. It just means that there needs to be an assurance that it will be there over some reasonable number of years.

Each of these things I have addressed serves as an example of how our current innovation ecology was designed for things that *were*, not things that *are* or things that *will be*. I will share one final example, although there are many others. I happen to be

¹ On the other hand, perhaps if we had made the internal format of the ".doc" files a public standard, then perhaps we could have created that competition and had better word processors as a result.

on the Deemed Export Advisory Committee to the Department of Commerce. We have not finished our hearings, and the committee has not reached any conclusions, but let me share with you my personal reaction up to this point.

First, the intent of export controls is completely logical. We really don't want somebody, on their own, deciding to sell F-16s to Bin Laden. On the other hand, I believe that in many cases the implementation of export controls is broken and counterproductive. We control things, for example, that are widely available from non-U.S. suppliers. So, as in all the previous cases, new circumstances have made an old implementation inappropriate. Again, it's ironic that in many cases the controls only have the effect of damaging U.S. business.

You can quibble with any of these examples, but my point is not in the examples themselves, but rather that new technology sometimes requires the *implementation* (and not the *intent*) of parts of the innovation ecology to be re-thought. For example, the *intent* of encouraging innovation by protecting the expression of intellectual or artistic work is right on target. However, while the mechanism of enforcing that intent by prohibiting copying once made good sense, it no longer does.

I think we all feel that the pace of technological change is accelerating. Thus, even if we managed to fix every one of the components of this innovation ecology to be just right for today and tomorrow, they probably wouldn't be right for the day after tomorrow. Accordingly, our solution has got to involve a process by which we are able to periodically stand back and evaluate the intent and methods of implementation for things like intellectual property protection, import/export control, and antitrust laws. In other words, what we need is not just a set of changes to patents, copyrights, and so on, but an institutionalized process for renewal that is also relevant to the formation of laws and regulations.

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Let me finish with a personal experience. Eleven months ago on June 5th, 2006 I was in Beijing for the annual meeting of the Chinese Academy of Engineering. It so happens that the Chinese Academy of Sciences and the Academy of Engineering hold their annual meetings at the same time, and so they have a joint opening session. This session is held in their parliament building, the Great Hall of the People. The floor of the Great Hall seats an audience of 3,000; of those 3,000 there were about twelve of us foreigners in the midst of 2,988 of the best scientists and engineers in China. On the

dais were the president of China, the prime minister of China, and every single member of the Politburo—the dozen most powerful people in all of China.

The keynote address was given by the president of China, Hu Jintao. His theme was “what needs to be done to make China into an innovation-driven country.” Hu could have been reading from *Rising Above the Gathering Storm* or any one of the other dozen reports that say more or less the same thing. He addressed education, support of basic research, the rule of law, intellectual property protection, and the issue of how to make China into an environment that attracts both Chinese and foreigners to do science and engineering. As I listened to Hu, I thought about how ironic it will be if China implements *Rising Above the Gathering Storm* before the United States does.

With that in mind, I’d like to send you all away with a homework assignment: think about how we can begin to reinvigorate the innovation ecology of the United States. I don’t know the answer, but I’d like to engage all of you in thinking about it. It’s incredibly important that we get this right as soon as possible.