

Where Does Innovation Come From?

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Robert J. Marks:

Greetings and welcome to Mind Matters News. I'm your technically savvy host, Robert J. Marks. Where do today's technological advances come from, universities, private industry, the Department of Defense? And yes, innovation does come from the military. World War II gave us radar, analog computers used for example in the Norden bombsight, and like it or not, thermonuclear energy. This continues. DARPA today, which has been called the US Military's department of mad scientists because of their innovation, has initiated the idea of self-driving cars. They have initiated GPS that we all use and enjoyed today, and they also started the internet.

So we do get technological advances from universities, private industries, DOD, and we're going to talk about that today. Our guest to talk about this today, these innovations, is Jeffrey Funk. Dr. Funk has his PhD from Carnegie Mellon and he's a consultant on business models and economics of new technologies. He has served in professor positions at the National University of Singapore, Kobe University, and Pennsylvania State University, and he's a frequent contributor to Mind Matters News. Jeff keeps his fingers on the pulse of the impact of new technologies and it's good to talk to him. Welcome back, Jeff.

Jeffrey Funk:

Thank you. It's good to be here.

Robert J. Marks:

Okay, let's talk about where technology comes today, some of the things which have gone bad. Having read some of your works, boy, I agree with them. You mentioned that until, I believe the 1970s, most of the research was done in private companies like Bell Labs, RCA, and DuPont. This was research that led to Nobel Prizes and real products and services such as, for example, transistors, integrated circuits, plastics, radar. But since then, there's been a switch to university. The switch to universities, in my experience and according to your writing, has been spoiled a little bit because of Goodheart's Law. You point out some of the problems with this. I'm wondering if you could unpack some of the challenges which have gone on in switching the innovations largely to universities.

Jeffrey Funk:

Well, Goodheart's Law deals with the fact that once you institute a measure, it stops being useful because everybody games it. So we have decided that we're going to count the number of publications that professors have and more fancy techniques like the H-index, which measures ... So if you have an H-index of 20, you've published it at least 20 papers with 20 citations. So this has just caused people to become obsessed with publishing papers in order to make themselves look good. Two months ago, Nature came out with an article, a paper saying that it found 9,000 people, 9,000 scientists, who published a paper, one paper every five days. Now, think about that. Can you publish a paper every five days?

Robert J. Marks:

I can't even type that fast, Jeff.

Jeffrey Funk:

Well, obviously they're sending the same paper to a lot of journals, but this is what happens when you have this kind of measure. People are just hoping, well, you're not going to look at the papers at all. Of course, you don't. There are so many papers that no one looks on at them all. So many people have said that most papers are only read by the author, the reviewers, and nobody else.

Robert J. Marks:

I read somewhere, it was on the internet, so it has to be true, that the median number of citations to a paper that is published today, the median is zero. In other words, it follows up on your idea that nobody reads this except for the authors. I think that sometimes even the co-authors don't read some of the papers.

Jeffrey Funk:

You're right.

Robert J. Marks:

The impact, I think, on academia has been terrible because it's on a metric. Goodheart's Law has totally, totally destroyed it. I have a colleague in the physics department. His bio says that Dr. So-and-so, I won't mention his name, has published 115 papers. That is so, in my mind, so stupid. It's like a carpenter saying, "I have nailed 120 different nails into a piece of wood." It doesn't matter how many nails you've driven into a piece of wood, it's what you've built.

So the emphasis now is on the number of nails that you drive in, but you're right. As a professor, that's how I've made my living my whole life. You are judged by the number of papers you publish. There's an old joke in academia is that the dean can't read, but the dean can count. So he doesn't care about the quality of the papers you publish. He doesn't care about what you've built. They frankly don't have the time or the expertise to do that. So they end up reverting to a paper count. You mentioned this, and I look at Goodheart's Law, there's a sequence. People try to overcome Goodheart's Law, but in doing so, they impose a different version of Goodheart's Law. For example, with publications, you can't count the number of publications. Okay, so now we're going to go by the impact factor of a journal that measures the quality of the journal that you publish in.

That measure is really kind of stupid because it doesn't say anything directly about the quality of your paper. It just tells you about the company that you keep. An impact factor of a journal is high if those papers in that journal have been referenced a lot. So they figured out that wasn't good, so they went to the H-index. The H-index is something that you mentioned, which is if you've published 20 papers that have 20 or more citations, you have an H-index of 20. So the H-index is another measure that went against this impact factor. But one of the problems here, and I did some research on this in the web of science, it turns out that the number of publications in the last 10 years has doubled. So what has happened to the citations? They have doubled. So a citation today isn't worth what it was 10 years ago.

Jeffrey Funk:

Well, in fact, it's more than doubled.

Robert J. Marks:

Oh, it has more than doubled? Okay.

Jeffrey Funk:

Because papers today have more references than papers did 20 years ago. So they're going to get more citations, not only because there's more papers, but because every paper has more references. So it's citing more other work. So you're absolutely right.

Robert J. Marks:

And one of those things that makes the citations more available in Google Scholar, if you look up a paper and you go to that paper in Google Scholar, they have a little click there called cite. You click on that button and it gives you the citation that you need to put at the end of your paper to cite that paper. So you don't even have to type out references anymore. You just go to Google Scholar and click and paste. I think a lot of people click and paste things because, well, they need to click and paste because they need to get more references.

In fact, there's something that's happened too in my area called citation coercion wherein for example, I get back a review in the paper and they say, "Dr. Marks, I mentioned the journal is the IEEE Transactions on Systems, Man, and Cybernetic." He says, "Dr. Marks, this looks to be a good paper, but we really don't know if this is a good paper for our journal because you haven't cited any papers from our journal. So how do we know that our readership is going to be interested in your paper?" What they were doing very transparently is they were trying to get me to cite more papers in their journal to increase their journal's impact factor. That's a big problem too and is mitigated by this, or not mitigated, but it's accelerated by Goodheart's Law.

Jeffrey Funk:

Well, that's a particularly sad story because, IEEE is one of the most respected engineering institutions in the world. So if they are stooping this low, then what are all these other journals doing? They're stooping even lower.

Robert J. Marks:

Well, I have been a member of IEEE since I've been a student, and this was, I hope, an outlier. It hasn't happened a bunch of times, but I just hope it's an outlier. In one case, this was from the Journal of the Optical Society of America, I submitted a paper. They said, "Well, you should reference this." This is another thing they do. If you get a reviewed paper and somebody says, "This is a good paper, but you haven't referenced such-and-such," and what they try to sneak in is they tried to get you to reference their paper. That happened and I wrote back the editor, and because I'm at the point, I need another publication like I need another toe, but I wrote back the editor. And I says, "Look, this is totally inappropriate. I hope you bring this to the attention of whoever needs to know about such things, that this was a totally inappropriate review, trying to use their leverage over me of the acceptance of my paper in order to reference their paper." This is all due to what you mentioned, which was Goodheart's Law.

Jeffrey Funk:

My impression is that's very common.

Robert J. Marks:

So the question is, what is the solution? We are now publishing more and enjoying it less. I'm listening to these old radio plays. There's one for Chesterfield Cigarettes. It says, "Are you smoking now and

enjoying it less?" That was was their little sales line. So are you publishing more or enjoying it less? The question is, what do we do? It turns out in a chapter by, I believe, Frank Tipler, he pointed out that during Einstein's time, if you submitted a paper to one of their journals, it was probably refereed by ... There was a chance of one in three that it was refereed by a current or future Nobel Laureate winner.

So you really had peer review back then, and boy, we certainly don't have it now. So the question is, I guess to you, Jeff, is we recognize this problem. It seems to be ubiquitous. How do we solve it? How do we get around this? How do we start getting more substance in the publications that come from universities? These universities, by the way, are funded by US tax dollars in the United States. So yeah, how do we get better service out of it?

Jeffrey Funk:

Well, we have to change the metrics. Metrics is what drives people's behavior. By the way, this problem is ubiquitous. It isn't just researchers. There was a great book about 20 years ago called *The Tyranny of Metrics* and doesn't talk about research at all. It just talks about organization in general and how organizations have come up with all these metrics, most of them just ridiculous, very narrow metrics to measure the performance of people. People come up with them to measure organizations. They come up with them to measure organizational units within an organization. They come up with them to measure individuals. There are so many, right? You can think of all the recent ones such as ESG and things like this. We're just coming up with more and more and more metrics.

Robert J. Marks:

What is ESG?

Jeffrey Funk:

This environmental and social governance. So we're going to measure a company not by its profits, but by whether it is being environmentally and socially beneficial.

Robert J. Marks:

I don't know if I'd invest in a company which had that as their metric, but people do that, don't they?

Jeffrey Funk:

Yeah, they do. It's just constant, these metrics. The idea there is that humans are so stupid. We can't think, unless we've got a number there. We're too stupid. Well, there are people, humans like this. But most of us, we grew up in an age when common sense and being able to put together an argument was valued. That's kind of fallen out of value. We have a whole educational system that's very superficial, that doesn't require students to do in depth thinking, and that's the way our organizations are run. So that's the way our universities is run.

So this tyranny of metrics, it's everywhere, when we need to step back and say, "Wait a minute. Okay, you're doing research. You know what? We're only going to really know whether you're doing good research in 10 years or 20 years. So the first thing we're going to do is going to stop paying people a lot to get lots of publications. Because you know what? We don't really know if they're that good. We don't know. We need to keep a we don't know attitude towards things and think that, okay, there's these ideas out there. Some are going to win, but we're not sure which ones."

The second thing is that we have to be able to talk about an idea. We have to talk about the idea of the paper. We have to talk about the ideas that professors are producing, whether they're useful. And we

need people who can do that. So now we're talking about a completely different person than the kind of person who likes the tyranny of metrics, or I should say who likes metrics. This is going back to a different world. You think back to Bell Labs, RCA, or the old IBM. You think back to them, there was no bureaucracy. There was much smaller bureaucracy than we see now. So today, researchers, professors, they're producing papers, many with 100 authors for these hyper-specialized journals. They're producing grants. They're writing letters of recommendation. They have a big lab they run with lots and lots of PhD students, lots and lots of postdocs. They're administrators. They're not scientists.

Now think back to Bell Labs in the 1950s. Where were the administrators, right? It was much different. What they were doing was they were talking. They were talking about the ideas. They weren't just producing all this paper and saying, "Oh, we've got so much paper. It's so great." They were talking about ideas. That's what we need to go back to. We need to get back to the idea states to talk about an idea. Okay, you've got this idea. You say that science is wrong. Here's your evidence why you say it's wrong, and your idea is going to help us develop these kinds of products or these kinds of processes or change the way we do medical practice. That's the state we want to have. We want to have all these smart people talking about ideas again, not about how to publish a paper and how to game the system, how to get the right reviewer, and how to cite the right paper so that we'll look right and we'll look good to reviewers.

Robert J. Marks:

And unfortunately, it's been that way for a long time. Frank Tipler, for example, was up for tenure. He was a physics professor. It looked like he wasn't going to get tenure. Now, why wasn't he going to get tenure? Well, it wasn't because his ideas were bad. He was well-published. He really thought of some good ideas, but he wasn't going to get tenure because he hadn't attracted any money. Then all of a sudden, a grant came in and everybody got excited and Tipler got tenure. I tell you, that's the way it is with academia today. In the STEM field, if you come in and you get a National Science Foundation, a young investigator award from the National Science Foundation, you are guaranteed tenure. It has nothing to do with your productivity, has nothing to do with your ideas. It's just that you've attracted money.

And you're right, it has changed. I love the story about Dwight Eisenhower when he was president of Columbia University. It was after World War II and before his presidency, and he went to the faculty and he says, "It's great to be here among all the employees of Columbia University. One of the professors interrupted and he says, "I'm sorry, General Eisenhower or President Eisenhower," whatever they called them. He says, "We are not the employees of the university. We are the university." That certainly is not the case anymore. Professors are employees of their university and they are pressured to publish and they are pressured to do things which in the end have currency in academia, but don't have currency outside. So it's a very sad situation.

Let me offer this. This is one of the suggestions that Tipler gave in the United States. Right now, we have funding in the United States. Now, you're in Singapore. This is the modern technology, ladies and gentlemen. I am talking to Jeffrey Funk and he's in Singapore right now. I'm in Waco, Texas. But in the United States, if you get funding from the government, from the National Science Foundation, National Institutes of Health, the Department of Energy, et cetera, you get tenure.

One of Tipler's suggestions was to disseminate this to individual states. In other words, make the funding a little bit more local in order to get a better handle on the way that the funds were expended. I don't know if this would work, but it seemed like one solution that could possibly work. Because right now, and you mentioned this in your article, that all of this Goodheart's Law effect has really stifled creativity. In order to get money from the National Science Foundation, you have to go in and you have

to tap into one of the areas that they have identified. So there is very little room for creativity there. You mentioned this in your work in your paper and I thought that was just spot on.

Jeffrey Funk:

Well, this local-ness of universities is a very important point because 200 years ago, universities supported their local economy. So if you had agricultural professors in Minnesota, they were expected to work with farmers and help farmers introduce new types of wheat. So they were measured by working with those farmers. They may never publish a paper, but who cares? They were helping farmers understand something complicated such as new strains of wheat, how to implement them. That's all gone away. No one works with local people, whether it's a local city or a local rural area. It's all global now. Almost every university hires now by the same criteria. Have you published in these papers? They don't care whether you can work with local industry. They don't care whether you have expertise in the local technology so that you can help students find jobs with local companies. They don't care about that. It's all this incredibly, this H-index or something like that that's being used to measure everyone.

Robert J. Marks:

So you have taught in Japan, and I have had some colleagues in Japan, some professor colleagues. I've also visited Germany and some of the colleagues they have there. In both Germany and Japan, there is a greater connection to industry, is my experience. Was that your experience in Japan?

Jeffrey Funk:

No, I agree. They've fought against this. So it's a bit American led, this global way to do things. So there's a lot of countries that have said, "Okay, we've got to be like America and we're going to measure our universities not by whether they contribute to societies, but how well they stack up against American universities." Oh my gosh, in Singapore, we have these universities that are as good as those American and UK universities. Wow, they must be doing great, no mention of whether or not anything is coming out of those universities that helps local industry. But you're right, Germany and Japan have fought, are fighting against this. And I hope they continue to fight, because this is the way that ... I haven't mentioned the free market, but this is the way the free market works. Different countries try different things and some things work better than others. I think that Germany and Japan are right to emphasize professors working with local industry, trying to produce something that's useful for the people of the country.

Robert J. Marks:

And do you know why the United States, in my opinion, does not, why the universities don't appeal to local companies? They don't get big bucks. Smaller industry or companies, private enterprises do not have the money to give to universities to the degree that the National Science Foundation, the National Institutes of Health give to the universities. They would be in the tens of thousands of dollars, where NSF and NIH can go up into the hundreds of thousands possibly. So that's unfortunately one of the reasons that that is not pursued very much. Yeah, very sad situation.

So yeah, hopefully something can happen here. It's kind of like the universities live in their own little world where they have their own currency. That currency is how much money do you bring in? How many papers do you publish? Nobody outside of their world carries very much. We were visited at Baylor by General Murray. He's a four-star general that was head of the Army Futures Command. God bless him, he came in and I love DOD. I love working with the Department of Defense of the United States. He came in and the first thing he said, "I don't want to see your stupid papers. I want to see what

you have in the lab that I can take to the war fighter. I want to see what I can reduce to practice. I don't want to see all these vacuous papers that don't really say very much."

So I think that the military understands what they need to avoid in universities. There was likewise with the journal, not the journal, but the Joint Artificial Intelligence Command, which was a multi-discipline command over all of the armed forces where they did something similar. They said, "We want things which can be reduced to practice." I'm an engineer, and so that needs to be done, but that does not address the question, what do you do to these pure mathematicians and these theoretical physicists who are studying string theory that they can't be reduced to practice? Do we throw them under the bus? Or how do we support them?

Jeffrey Funk:

Well, I think you need multiple measures that are different for each person, for each discipline. I don't think you should have one measure. I realize what's driving it. We've got to be fair. We've got to decide which department is doing better than the others and things like this. But even in physics, you're asking, "Well, have you really changed the models of physics?" It's not just whether or not products and service come up, but have you really changed our model of physics? Does your work change it? Because that's ultimately related in most disciplines to products and process. If you're able to come up with a different model of science, a different model of whatever specialty you're looking at, you can think of, you can envision products and services being based on that new model. So I don't think it's too hard. It takes work.

It takes more work than just counting. And we live in a world where everything has to be simplified down to some counting, right? Again, it's the tyranny of metrics, tyranny of superficiality, of simplicity, of bureaucrats who can't think of new ... who can't talk about ideas, who can only talk about numbers. It's the old bean counters. It's just that now the bean counters aren't just in accounting. We've let the bean counters into every aspect of our life, including all this research. They reduced this science, this wonderful science, all the wonders of science. I'm sure you're like me. You grew up on being so excited about science. I was 13, we went to the moon. This was so exciting and bean counters have reduced this to how many papers did you publish?

Robert J. Marks:

Yeah, it's very frustrating. One of the things you mentioned in your article concerning the consequences of Goodheart's Law is the proliferation of journals. The number of journals published by the Association of Computing Machinery, you said, has reached 59. They publish 59 journals. The American Chemical Society has 39, the Society of Mechanical Engineers, 35 different journals. For the IEEE which we've mentioned, IEEE stands for Institute of Electrical and Electronics Engineers, it's the largest professional society in the world. I think it has 400,000 members or so. The number is over 200 journals and magazines that they publish in technology.

What this has led to, you pointed out ... Oh, and Nature, by the way, Nature has reached 157 journals. 50 years ago, they had one journal according to your paper, which I found just terribly jaw dropping. One of the things that this has led to is hyper-specialization. There is no cross-fertilization. And I can't tell you the number of times I have submitted a paper to a journal and had it returned to me without review because it says, "The paper you submitted is a square peg and we only have round holes. Your paper does not fit within the little silo of our specialization." So this hyper-specialization is turning against cross-fertilization and innovation. And it's really a sad thing. So that needs to be addressed also.

So I don't know. Well, we've ripped apart the Goodheart's Law and the American university and the way they've done business. I would like to put in a good pitch for the Department of Defense. We're funded

with the Department of Defense. Most of these funding agencies, they're just interested in giving you money. They give you money and they say, "File a report at the end of year, proforma. Maybe somebody will look at it. Maybe somebody won't." And the Department of Defense doesn't do that. With the Department of Defense, you get a contract and they meet with you weekly to make sure you stay on track for your deliverables. They also have their bureaucratic problems, of course. But I'm really impressed with the Department of Defense, at least in their funding operations for development of military weapons at least, that they keep you on track and they care. So that's one of the good points. Okay, any final thoughts here, Jeff?

Jeffrey Funk:

Well, I think we need to get back to products part. We need to measure people differently. And we need to encourage corporations to get back into the business of basic and applied research. They've been getting out of the business and that's unfortunate. We need to get them back into business. We need to give them incentives to do this. We need to get them to create alliances among firms in the same industry to do basic and applied research in some specific area. So we need to do that. We need to have the research, a lot of research moved from universities to companies. We have to do it in a way that enables this basic and applied research to be done and for something to come out based on it.

Robert J. Marks:

There's an old saying that only rich countries can afford poets. In a way, that's probably true of some of these large corporations. I do know that places like Amazon and Google make some of their AI software available for free to anybody that wants to use it, TensorFlow for example. I think that's good. So they're doing a lot of interesting work there. Just making available ChatGPT to the public is a big deal. And it has to be a rich country that does this. So yeah, hopefully these things will happen. Well, thank you, Jeff. We've been talking to Jeffrey Funk. He is a consultant on business models and economics of new technologies. It's just been a wonderful chat with him. We're going to have him back one more time. Thanks for joining us on Mind Matters News. Until next time, be a good chair.

Announcer:

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