

An Interview with Bob Metcalfe

Bob Metcalfe is Going Meta on Innovation

Interviewed by Gil Press

Editor's Introduction

Bob Metcalfe thinks we are in a bubble, an innovation bubble, seeing that the word “innovation” is on everybody’s lips. To help ensure that this bubble does not burst, he has embarked on a new career path as Professor of Innovation and Murchison Fellow of Free Enterprise at the University of Texas at Austin. This is his fifth career, building on his work as an engineer-scientist leading the invention of Ethernet in the 1970s, entrepreneur-executive and founder of 3Com in the 1980s, publisher-pundit and CEO of InfoWorld in the 1990s, and venture capitalist in the 2000s. As General Partner with Polaris Venture Partners, he has invested primarily in cleantech and currently serves on the boards of five companies: Ember, Sun Catalyx, 1366 Technologies, Infinite Power, and SiOnyx.

I talked to Metcalfe, in between board meetings, at Polaris’s offices in Waltham, MA, just three days before he started on a 2000-mile road trip “from Baustein to Austin.” He made sure first to tell me that he “will be forever grateful for ACM for having given me my start” by providing the venue, CACM, for the “defining paper of my life”—the Ethernet paper published in July 1976. The following is an edited transcript of our conversation.

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Ubiquity: What have you learned about innovation in the past 10 years as a venture capitalist?

Bob Metcalfe: First, let's qualify what type of innovation we are talking about. I consider myself an expert on a very specific form of innovation which I call technological, entrepreneurial innovation at scale. There are many other kinds of innovation but that's the kind of innovation that I have been involved in.

Ubiquity: How is it different from other types of innovation?

BM: "Technological" means it's based on some new science and technology, usually coming from a research university. "Entrepreneurial" means it is innovation accomplished through the formation of a new company, a start-up. And "scale" means a hundred of millions if not billions of dollars in revenues. In Silicon Valley, from the very beginning they're thinking at scale, so they are designing their companies and growing their companies with scale in mind. The players in my world are research professors, their graduating students, scaling entrepreneurs, venture capitalists, corporate partners, and early adopting customers. These are the major players in this type of innovation—technological, entrepreneurial innovation at scale.

Ubiquity: Which is different, for example, from innovation that is based on customer ideas.

BM: Yes. I tend to be involved in solutions looking for a problem, or technologies for which market research does not bode well. Polaris would never have backed 3Com Corporation. I was proposing to sell Ethernet and if you called people and asked "Do you need Ethernet?" and tell them that's something that connects personal computers...

Ubiquity: And costs \$5000...

BM: ...And costs \$5000, they would say "What is a personal computer and why would you want to connect them together?" Part of Polaris's due diligence is to call potential customers, and in the case of 3Com, Polaris would have found a lot of people dumbfounded by the idea. That's a technology in search of a solution; a latent need that is revealed by the technology rather than customer-driven as you mentioned. On the other hand, the successful version of this type of innovation seeks customer engagement at an early stage in what I refer to as the heat seeking

process. Your corporate partners are surrogate for the market and the early adopters are the market. And the sooner you can get engaged with them, the more successful you're likely to be.

Ubiquity: As a venture capitalist, how do you evaluate technologies in search of problems?

BM: Well, the first filter that VCs are generally forced to use is "do I know these people?" Or "are they referred to me by people who I know?" I don't even read proposals from people I never heard of. That's ugly. It's also true. How the technical founder is regarded by the community would be the first cut. I hang around MIT because those MIT professors are way over the threshold of acceptable. But even there you find that some professors are more prolific than others in terms of commercializing technology. Bob Langer is the gold standard. If Bob Langer says "I have a technology and I think it's really great and you should invest in it," we say "yes" in the same meeting.

Ubiquity: Looking back at the last 10 years, what has changed in your view of innovation?

BM: That innovation is more than invention; that innovation is more than entrepreneurship and start-ups; it's a bigger topic and it goes backward into knowledge generation, all the way back into research universities, and it goes forward beyond the start-up into scale companies. Having been a founder it was natural for me to believe that innovation is all about founding companies. But it's more than just the founders.

My model of innovation is bigger than it was 10 years ago when I had the romanticized version of venture capital where you spend all your time with the founder and you do the seed round and the A round and the B round, etc. Of course, I should have known this since I lived through this experience; but since I have done only one company and not hundreds of companies, my experience was not statistically significant. I clung to the romantic notion of it being the VC and the entrepreneur over a one- or two-year period and innovation is much bigger than that.

And as a VC, I found out that getting to an exit, which is the only way for a VC to actually make money, is much harder than I'd imagined. It turned out that I have been a venture capitalist for the worst 10 years in the history of venture capital... Maybe it's easier getting exits in more normal years.

Ubiquity: What else has changed in your understanding of innovation?

BM: I guess I learned that it's hard to cookie cutter it. I'm on five Polaris-backed boards now and each one is as different as night and day. As a venture capitalist, you would like to think that the problems are the same and they're not. The challenges of each of these companies vary over time and are also different among them so I guess that the diversity of innovation is another kind of lesson learned.

I also learned that the limiting factor in venture capital is CEOs. We are limited in how much we can invest by the CEO capacity of our system. Silicon Valley's principal advantage, I think, is the CEO pool they have there, people who have started a company before, who you can pair up with technical founders to get going.

Ubiquity: The technical founder cannot be the CEO?

BM: There are counter-examples, but this is the general rule. The technical founder can't have developed the skills, and learned the practices of being a company's CEO, of a company that you plan to scale.

Ubiquity: And the pool is also limited by the fact that not any CEO can be a CEO of a start-up?

BM: There's another concept which I've learned in the previous 20 years, and that's the notion of gear-shifting. In a big company, people grow faster than the company so they get promoted in time. But in a small start-up, the company is growing faster than the people, so you have to shift gears. A CEO who is appropriate for the founding of the company would be like first gear, but then if the company grows, at some point you have to shift into second gear, and then maybe into third and fourth gear. In my own company, I noticed the gear shifting most prominently in sales and marketing. I was personally first gear in sales and marketing and at about a million dollars a month we brought in a sales executive from HP and he took us from one million dollars a month to roughly 5 million a month, and then a guy that came from Wang took us to 25 million a month, and then, yet another person, from Rohm Corporation, shifted us into fourth gear. That's what I mean by gear shifting. As your start-up is growing, you need people with different experience to help you shift gears, which is the opposite of what's happening in a large company.

Ubiquity: How are you going to apply these lessons to your new career as a professor of innovation?

BM: My view of a professor is that he does three things: Research, teaching, and practice. The practice part is the day a week that professors get to do whatever they want and my day a week will be at Polaris where I will continue as a venture partner.

The research part is trying to improve on this particular form of innovation that I described. Just to be particularly annoying, in the research professor world I have three issues: tenure, curiosity-driven research, and the peer review method. Now, those are good things but they are malfunctioning. Even the professors complain about them: "Peer review is too conservative, and tenure, we have all of this deadwood around here that we don't know what to do with and they are getting old and how do we get rid of them?" And then there is this curiosity-driven

research, which I think is self-indulgent. We have big problems to solve in the world and we need to put our resources behind solving those problems as opposed to supporting people's curiosity.

Ubiquity: The other side of the coin is that curiosity has always driven the progress of science. And it may well be that a significant part of the research going on today is not driven by curiosity but rather by where the funding, mostly government funding, is available.

BM: I heard that complaint and I call that problem the peer-review process. The NSF is peer-review research and the professors I talk to complain that it is too conservative and directive. But I'm setting this problem aside for now. There's curiosity-driven versus mission-oriented research. Curiosity-driven research is vital and exciting and interesting and occasionally uncovers something but mission-oriented solves real problems. The answer to reconciling the two is very simple. Hire people who are curious about solving these problems.

Ubiquity: Back to the three pillars of your professorship. We talked about practice and research. What about teaching?

BM: There's a lot of entrepreneurship and innovation being taught at the university already, so one alternative is for me to find the right colleagues to co-teach and merge with existing curriculum. That's attractive to me because it's easier. The other alternative, which the Dean is pressing me to do, is to come up with my own course on innovation, likely for grad students.

I asked the dean of engineering who is my boss and he said "Bob, you are a professor, you don't have a boss," and I said, "Dean, I'm used to having a boss, I want to have a boss. Even if you don't want to be, you are my boss." He really liked the following pitch: It is relatively easy to get famous, successful alumni to return to campus to be mentors for students in innovation and it's relatively easy because it's such a fun thing to do. It is relatively easy to get students all excited about running companies and entering business plan competitions and all that. What is the hard part? The hard part is developing entrepreneurial culture among the faculty. What percentage of the MIT faculty has started a company? My guess is that it's about 25 percent. I bet you that the number is a lot lower at the University of Texas. So I want to work on the hypothesis that the hard thing to do and the thing worth doing is to develop entrepreneurial culture among the faculty. Getting the faculty to believe that their mission isn't just two-fold, but three-fold: It isn't just to do research and it isn't just to do teaching, but it is also to do innovation, get their ideas and their students out into the world where they can do some good. My course is likely to be related to that topic.

Ubiquity: This sounds like a fourth leg of your activities rather than what you're teaching will be about. It's changing the culture of the university.

BM: Well, it's going meta on innovation. Anyway, I think I'm on to something. I think that focusing on the faculty is important.

But here's a completely different tack. There's my new book project, which is both research and teaching. You heard of Metcalfe's Law? It's very simple, but people make too much of it or they hate it. So I want to do something with Metcalfe's Law. The title of the book is *Metcalfe's Law*. The sub-title is where it begins to get interesting: "The network effect in innovation." This is my working sub-title. Take Metcalfe's Law and apply it to innovation, that's what the book should be about.

Ubiquity: Would you share with me the outline of the book?

BM: I don't have an outline of the book.

Ubiquity: What's the main idea? How does the network effect encourage innovation?

BM: I haven't started the book yet. I'm early in that process.

Ubiquity: But I want a scoop. And I'm sure *Ubiquity* readers would like to know.

BM: All right, here's your scoop. This book project has two halves. One is the content of the book, which is what you were just asking me about: How does one talk about the network effect in innovation. The other half of the project is that the book, being about the network effect, must itself provoke the network effect. What does that mean? It means it isn't just the author talking to the readers and it isn't just the readers talking to the author, it's the readers talking to each other. It has to be an online book, what I'm calling an n-book. An e-book is electronic; an n-book is networked. So the second half of that project is figuring out what that means. That's the outline of my book project, that's all I have.

Ubiquity: Tell me about the idea itself. What have you seen in terms of the network effect being applied to the practice of innovation?

BM: Are you familiar with the word "schmoozing"? I have observed that one of the aspects of the Silicon Valley model that we are all envious of is schmoozing. You can make a long list of all the structures—events, conferences, luncheons, associations—that stimulate schmoozing. All of us who have put on conferences have learned that the value of the conference is mostly in the coffee area and not on the stage. Now, you must have content, that's important, it has to be good. But you notice yourself, if you organize these conferences, you start making the breaks longer and longer, and as you make the breaks longer, the conferences get better. So there's a network effect in the social structures of innovation, certainly in the Silicon Valley model. I used to hang around the Western Association of Venture Capitalists—that's where I

did my early research when I started my company. I got their directory and went through it and that was the network that I used.

Ubiquity: That's networking, not the network effect.

BM: I'm developing, with you, right now, the outline of my new book. Schmoozing is going to be a chapter in the book despite the fact that you dismiss it immediately. It's a place where you create connectivity and the connectivity has value to the people who are connected, that is, it helps them to form companies.

Then there's the whole structure of publishing. A big issue today is peer-reviewed academic journals. Poor Elsevier, all these years they have been providing this valuable service to the academic community and now they are evil incarnate because they charge so much money for their publications. There are now professors and institutions trying new publishing models. Publishing is a networking function so it's going to be another chapter in my book.

I want to improve peer-review, not do away with it. It took me two years to get my Ethernet paper published in *CACM*. Part of this was Xerox's reluctance to publish it until the patents were filed and part of it was the endless peer-review process that I had to go through. But as a result of that delay, the paper got better and better. So the two years were well spent, honing the paper. Today, we don't wait two years, we publish on the Internet. Thanks to blogs and things like that you have peer-review on steroids. I'll have to make in the book some insightful observations and discoveries and suggestions to improving the peer-review process relating to the network effect. I don't have the chapter, I haven't written it yet; we are outlining it.

Ubiquity: What else would you like to write about?

BM: Other chapters of the book will deal with Metcalfe's Law. Metcalfe's Law has been widely criticized and it's adored in many places, but it has never been evaluated numerically. Briscoe, Odlyzko, and Tilly published a few years ago an [IEEE Spectrum article](#) in which they argued that Metcalfe's Law is wrong and that the value of a network does not grow as the square of its number of users, $V \sim N^2$, but at a slower growth rate, $V \sim N \cdot \log(N)$. Whichever formulation you choose—and both assume the existence of a critical mass crossover—no one has ever tried to fit any resulting curve to actual network sizes and values.

I would like to develop a mathematical model of value and connectivity and see if the law comes out as originally stated or as a revised Metcalfe's Law. And then I need to find data sets relating to value and growth—say about all the start-ups in the world, or the growth of Facebook—to see whether there's an identifiable curve, just like Moore's Law, going predictably through the dots. I've got to do that, that's another chapter.

I want to have a chapter on virality. I met a guy who is a part of the social networking movement and he has a formula for evaluating social networking software, which he calls virality. It's like a response rate: When you send out a copy of the app, how many people adopt it? And his theory is that if the number is below one, you don't have an explosive situation. He has a very successful dating service but he hasn't raised any money because, he told me, "my virality is only .98. So as soon as I get it above one, I'll be back." Virality has to do with the dynamics of network growth rather than the value of network growth.

Ubiquity: Talk a bit more about the dynamics of network growth.

BM: Metcalfe's Law points to a critical mass of connectivity after which the benefits of a network grow larger than its costs. The number of users at which this critical mass is achieved can be calculated by solving $C \cdot N = A \cdot N^2$, where C is the cost per connection and A is the value per connection. The N at which critical mass is achieved is $N = C/A$. The lower the cost per connection, C , the lower the critical mass number of users, N . And the higher the value per connection, A , the lower the critical mass number of users, N . In the dynamic model, where virality comes in, cost is coming down and value is going up because the early Internet offered just email but today we have the World Wide Web. The value being delivered by an Internet connection has been going up and the cost has come down, so the critical mass point has been coming down. With Facebook, we are all the way down where it's economic and very valuable to network with your five friends. The critical mass point has been approaching zero.

Ubiquity: There's an interesting dynamic between the bigger network, a platform such as Facebook, and the sub-networks within it.

BM: Social networks form around what might be called affinities. For each affinity, there is a critical mass size given by $N = C/A$. If the number of people sharing an affinity is above this critical mass, then their social network may form. As Internet access gets cheaper and the tools for exploiting affinities get better, many more social networks become viable, which brings us to how Metcalfe's Law recurses. If you go down a level from the value of just being on the Internet, N is now the number of people in a particular social network, which has its own C , A , V , and critical mass N . Here's another chapter of the book, to flesh out that recursion and how you can integrate the value of the sub-networks and the sub-sub-networks to get back to the square law, $V \sim N^2$. Assuming that I want to defend my square law as opposed to revise it.

Ubiquity: How all of this relates to improving the practice of innovation?

BM: The first word that comes to mind is collaboration. Let me just focus on research professors. Previously, they were working in isolation through their two-year-long peer-review process. Now they are blogging and Facebooking, so there must be something we can uncover

about the impact on the pace of innovation. Can we find an accelerated innovation rate associated with the accelerated collaboration rate enabled by the Internet? If I can find evidence to support this hypothesis, that would be worth a chapter in the book.

Ubiquity: Collaboration also means collaborating beyond the boundaries of a specific discipline.

BM: I'm chairing the visiting committee for chemistry at MIT. We discovered recently that they have four silos: physical chemistry, biological chemistry, inorganic chemistry, and organic chemistry. Each professor is associated with one of the four silos and they do their research and it's peer-reviewed by other people in the silo, so it gets even more siloed. One of the things we suggested in our report was to do away with these silos.

Ubiquity: And not just within an established discipline. Breakthroughs and innovations often come from looking beyond disciplinary boundaries.

BM: Is there any evidence for that? I believe it, and I heard it a million times. Innovation happens at the interfaces among the disciplines. If there was evidence for that, another way to accelerate innovation is to network among the disciplines. It is interesting to me that there are these truisms for which there are many anecdotes but I do wonder whether they are actually true. One of them is that innovation occurs at the boundaries; another one is that innovation is serendipitous. Another narrative that has attracted my attention is the Bell Labs narrative: "Oh, it's so sad. We broke up the AT&T monopoly and then Bell Labs, this wonderful Camelot, fell apart and what a wonderful productive research environment that was. If only we could go back to Bell Labs, wouldn't it be great?" I started to wonder if it's actually true when I learned how many people worked at Bell Labs: 25,000. We've been talking about the numerator, but 25,000 is the denominator. My theory is that research should be done at research universities, not at corporate monopolies. For the tax payers to put their research dollars to work, it is better to put them into universities than to overpay monopolies to have research centers. The key is that research universities graduate students, but it wasn't Bell Labs' business to graduate students. This is my hypothesis about the practice of innovation, which I hope to pursue in my research and teaching: It's more effective to do research in a university environment where you are sending people into the world with new knowledge.

Ubiquity: And you are going to try and change the environment within at least one research university to encourage people to practice innovation.

BM: Austin is already an innovation center. It's seething with start-ups and technology and so on. And the University of Texas at Austin has 50,000 students and 2,700 faculty members. But I'm told that the connection between the innovation community and the university is very

weak. So in the practice section of my agenda, another item is to build the relationships between the Austin innovation engine and the university with the goal of improving both.

Here's something really amazing. Four days ago I got this letter from South by Southwest (SXSW) and the letter begins: "Congratulations! You have been accepted as a speaker at South by Southwest." It's not often that I'm congratulated for being accepted as a speaker. I briefly thought of sending them an email back congratulating them that I have accepted their invitation. But I'm going to be humble. The remarkable coincidence is that I'm moving to Austin and I'm getting accepted into South by Southwest in the same year!

About the Author

Gil Press is an Associate Editor for *Ubiquity*. He has worked as a research and marketing executive at NORC, Digital Equipment Corporation, and EMC Corporation. He is also Managing Partner of gPress, a social sciences and market research consultancy.

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