



Stanford eCorner

Entrepreneurship Strengthens a Nation [Entire Talk]

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November 09, 2016

Video URL: <http://ecorner.stanford.edu/videos/4684/Entrepreneurship-Strengthens-a-Nation-Entire-Talk>

Retired serial entrepreneur Steve Blank, creator of the “Lean LaunchPad” methodology for startups, discusses Silicon Valley’s roots as the epicenter of electronic warfare in the mid-20th century and how the region’s innovation ecosystem formed. An adjunct professor in Stanford University’s Department of Management Science & Engineering, Blank also walks through the lean-startup movement and how its principles are now helping the U.S. government innovate faster in the areas of basic science, health, national defense and international diplomacy.



Transcript

(audience clapping) - Thank you, so I thought I'd start with maybe a question, which is why on earth and how does Stanford have currently, currently, this quarter, 163 entrepreneurship and innovation courses? And the most interesting question, for at least the next hour, is then why the heck am I teaching three of them? And so to answer that question, believe it or not, we'd need to go back 75 years to World War II. And we're gonna take a look in this talk at four areas that kind of drove Stanford's innovation and entrepreneurship. In the '50s and '60s Stanford was a Cold War University. Startups and venture capital emerging not only outside the university, but driven by a single professor inside the university. The Lean Methodology, which I and others helped to invent and then promote, and then things going on outside the university's control, and actually outside the control of the country, disruptive adversaries. So, let me start with the idea of the Cold War University, Stanford in the '40s, '50s and '60s. 75 years ago when World War II started, a scientist named Vannevar Bush, had a really interesting idea he took to the President of the United States. He said "Look, up until now "the only people who built military weapon systems "were military laboratories." That's how it worked in the United States. His insight was that World War II was gonna be a technology war, and that civilians could make better weapons in service of their country, than the military could. And of course, anybody wanna guess what the military said? (laughs) They laughed.

But the guy was so persuasive, they cut a deal with the president. They were gonna allow civilian scientists to build weapon systems that had the most advanced technology, and the Army, and the Navy, and Army Air Forces were gonna build traditional weapons. That's how we set up technology in World War II. And so, civilians were gonna focus on these new technologies called electronics, some physics problems, and advanced medical problems. And to do this, the United States set up an organization called the Office of Scientific Research and Development, OSR and D, existed for six years. OSR and D had about 1,000 direct employees. Academics, professors, grad students, and about 10,000 of their contractors. And it built a series of organizations that were scattered throughout the best research universities at the time in the United States, East Coast, West Coast, et cetera. And they set up 19 divisions, five committees, two panels, et cetera all focused on different problems of radar, anti-submarine warfare, electronic warfare, chemical engineering, ballistic research, all advanced technologies. And they also actually had a small physics problem from Berkeley, that had 125,000 employees when it was done, and spent \$26,000,000.00 on this problem, which was so big they spun it out of this organization, and resulted in some applied physics by the end of the war.

So, OSR and D was responsible for spending a ton of money in a bunch of interesting areas. One of the groups was

something called Electronic Warfare, which just for short, was a way to confuse radar that was trying to locate US airplanes. And this was a secret lab called the Harvard Radio Research Lab. What's interesting is, it had nothing to do with Harvard, other than it was there. It had nothing to do with radio, and definitely had nothing to do with research. They were building jammers, electronic warfare equipment that would go into every US bomber that flew over Europe and Japan, to make the planes essentially invisible to German and Japanese radar. So, Harvard Radio Research Lab ran all the electronic warfare in World War II, had 800 people, the question was, who ran this lab? The director was an Engineering Professor from Stanford, named Fred Terman. Fred Terman built the lab of the best microwave and electronics people people could find at Harvard, because the guy who ran OSR and D, his PhD thesis advisor, Vannevar Bush, believed that besides Terman, Stanford had no other engineering talent worth speaking of. That was the state of Stanford's Engineering School, circa 1941. Terman, you could come, we think highly of you, but just set this thing up at Harvard 'cause there's nothing at Stanford.

Keep that in mind. Also keep in mind, that before World War II US universities, research universities, regular universities, got a total of essentially \$0.00 from the federal government for research. Essentially zero. There was no federal funding of science research in the United States. Starting in World War II, OSR and D, these are in 2016 dollars, gave out \$6,000,000.00 in a span of 3-1/2 years. This was the first time US universities tasted federal money. What do you think they thought? And by the way just for scale, who got most of it? Well, MIT got about 1.5 billion, Caltech got 1.1 billion for rockets. MIT's money went mostly for radar, Caltech for rockets, Harvard 400 million, Columbia another 400 million for mostly anti-submarine warfare. And again, just to put it in scale, MIT a billion, Stanford, here's how much they thought of Stanford, six million bucks for teacher training. For teacher training! There was nothing actually funded for Stanford in engineering at all.

So, just put that in context, by the way, what happened to OSR and D? Well some of you might be familiar with what happened, after World War II it got broken up. It got broken up but universities thought hey, this idea of federal funding of science and research, this is a pretty good idea. And even Congress said "We actually did get "a lot of interesting stuff out of having civilians "kinda work on these problems." And so, the country decided that we did need federal research organizations, and split up OSR and D into the National Science Foundation, the Atomic Energy Commission, the Department of Defense took a chunk, and the NIH, National Institute of Health, took back all the medical panels. In 1958, we added two more federal research agencies, the National Aeronautics and Space Administration, NASA, and DARPA, the Defense Advanced Research Project Agency. And the Atomic Energy Commission in 1957 went over to the Department of Energy. And so, that's what happened with federal research dollars. Now what's interesting is, what happened to Terman? Here was a Stanford professor, well thought of by the East Coast science establishment, but his school wasn't thought of at all for engineering prowess. Now, what they didn't realize when they did this to Terman, said we love you, we hate your school, not in so many words, is they forget he was a second generation Stanford professor. His father invented, or co-invented, the IQ Test, Terman-Binet IQ Test. So, Terman had grown up in Palo Alto, grown up in the Stanford culture, and when he returned from World War II, he became Dean of Engineering at Stanford, 1946.

And the number one thing he said is "We're never gonna be left out "of government dollars again, ever. "Stanford's gonna become an engineering powerhouse." Now, it's just like any startup goin' I'm gonna take on, name of the largest company. That was the silliest statement one could make at the end of 1945, 1946. MIT just got \$1,000,000.00 from the US Government, and Stanford got money for teacher training. But Terman says "Look, I just collected "the best engineers the world had ever seen "in microwaves and electronics. "I built the most advanced systems." In fact, there were factories going 24/7 that produced 24,000 jammers of his design that went on every bomber that went over Europe. So, he wasn't just talking theory, he had actually built large-scale production systems. So he looked around at his engineering staff at the Radio Research Lab at Harvard, and said "Congratulations, I'm Dean of Engineering, "Stanford's a nice back-order school, "congratulations, all of you now have tenure." Took his most senior members of the Radio Research Lab, and made them tenured academic faculty at Stanford. And by 1950, Stanford becomes the MIT of the West. Now for the first time, Stanford's actually a player focused in microwaves and electronics, builds an electronics research lab, and works on unclassified projects.

Now, in the United States the Korean War was a real shock to the country, the Cold War is starting to kinda cast a pall over the United States. And so Terman, at the request of the US Military, sets up something called the Systems Engineering Lab, and now does applied and classified research, doubles the size of the military program, and makes the university, for the first time, a real partner in the military industrial complex. This was not only going on at Stanford, it was going on in any and every major research university in the United States. In the '50s and '60s all research universities in the United States participated with the US Military in helping advance science and military weapon systems. And inside of Stanford's Engineering Department Terman built a pretty impressive organization, here's what he did. He sat on every possible Military Advisory board. Terman was the ultimate rainmaker. He built a network in relationships between Stanford and every branch of the military that needed electronics. Number two, he reached out to military customers to understand their needs, and then he used Stanford's Engineering School to build prototypes. We didn't get into manufacturing military systems, but he built proof of concept prototypes, what we would call today minimum viable products.

And it generated revenue for the university and strengthened, again, their military relationship. Third is, if the customer liked

their prototype, he did something that no other university Dean ever did to that point. Instead of encouraging his best students to become academics, he did something heretical. He said "Take our research, take our prototype, "and leave Stanford, and start a company." Unheard of in the '50s, unheard of. And he put a Stanford faculty member, or himself, on the boards of these new companies. And this trained Stanford faculty in business, and turned them into much better teachers, and mentors for these students. And finally, he helped develop something called the Stanford Industrial Park. Now the lore at Stanford was oh that was for commercial concerns, et cetera, actually it was for his military partners, who wanted to take the fruits of the Stanford Systems Engineering Lab and actually build military weapon systems, and insured that the startups actually stayed close to Stanford itself. The consequences? Stanford became the preferred contractor for Electronic Warfare and Electronic Intelligence. It attracted talented students, but it also attracted military customers, and started a private investor ecosystem.

And academic research and Electronic Intelligence and Electronic Warfare was driven by customer needs, this is a big idea. Terman for the first time was doing customer discovery before I, or anybody else, ever coined the term. But the downside for Stanford is by 1966 over a third of the research funding for electronics and engineering was for classified projects inside of Stanford. And for those of you who know Stanford history, in 1968 the student riots forced out all classified programs from inside Stanford University, and that was the beginning of Terman, and Terman's influence. In summary, Terman encouraged graduate students to start companies. He encouraged professors to consult for these companies. And Terman and other professors, as I said earlier, sat on board seats, Terman personally was on the board of the first three IPOs, Public Offerings, in Silicon Valley, HP, Varian, and Watkins Johnson. And he made, back then, technology and IP licensing easy. There wasn't an IP licensing office, there was a handshake with Fred Terman. Take the IP, build something great for the country, let us know, that was it.

And this was just an amazing thing, again in the '50s and '60s, getting out of academia was actually good for your academic career, and that was just a bizarre concept to have in the '50s and '60s. Stanford for the first time ever, became an outward-facing university led by the Engineering School. And what I mean by outward-facing is we started to take into account the needs of commerce, military customers, and the outside world. Now by the way, Berkeley also had a great engineering school, also had great activity with the military in World War II. And I'll leave it as an exercise about why didn't Berkeley's technology, that they developed in World War II, become outward facing? You should think about that. So, Stanford and the Cold War, this was Silicon Valley's first wave of innovation. We had great infrastructure, which meant we had great research universities, we had a predictable economic system, stable legal system, 24/7 utilities, you don't know how important it is to have power on 24/7 until you're a country that doesn't have it. We had a great culture. Our academic and innovation culture kind of rewarded, or at least at the time, didn't punish risk-taking. We were entrepreneurial.

As I said, we had outward-facing universities and a free-flow of people and information. What we didn't have at the time were any innovation management tools, and we'll get back to that. And the motivation at the time in the '50s and '60s for doing these startups was not particularly how to become a unicorn. It was not about money, it was about a Cold War crisis. And the entrepreneurial ecosystem was from people who were building weapon systems funding these spin-outs out of Stanford, there was no venture capital as we know it. There was no Sand Hill Road. You got funded by your customer, with either prepaid products, or give you a contract, or give you what was called nonrecurring engineering, but there was no traditional venture cap. And so, that was the state of Stanford in the Cold War. What's interesting is, obviously in the '60s and '70s what started to emerge were startups and a venture capital ecosystem. But surprisingly, it all started in one year, in 1956.

In 1956 an airplane manufacturer from Burbank, California, called the Lockheed, bid on and won a contract to build something called submarine launched ballistic missiles, think of these as rockets that went inside of submarines. Couldn't find a place in LA, but they found a great airbase in the middle of this valley, called the Valley of Heart's Delight, which just had mostly orchards, way before it was called Silicon Valley. And they built their facility in Sunnyvale, California, and that company was Lockheed. They built the Polaris, then the Poseidon, then the Trident missiles on an assembly line in Sunnyvale. Now, Lockheed set up a special Missiles Division in Sunnyvale, and just to give you some scale about the impact that Lockheed had way before most of you were born, is from the day they started that division in 1956, in four years they hired 20,000 employees. Just for scale, Hewlett Packard in 1960 had 3,000 people. Silicon Valley had turned into an arms merchant for the US Military, this was Defense Valley. And around the Lockheed, other subcontractors emerged. Westinghouse was building the launch tubes out in Hunters Point, and lots of other manufacturers sprung up. And what's interesting is while the Polaris was understood and at least known, what was not known until 40 years later is that Stanford and Lockheed were building spy satellites at the same time.

So, the lab that Terman had started, Electronic Intelligence, to find radars and missile telemetry, was now building sub-satellites that were being launched by Lockheed into space. And the Lockheed was creating a whole generation of electronic intelligence satellites, photo satellites, communications intelligence satellites, infrared detection satellites to see if somebody else is launching missiles, and nuclear detection satellites to see if anybody was testing nuclear weapons in space. Now just for scale, the largest satellite that was built in the Lockheed was called Hexagon, the last film-recovery satellite. That tube, that's longer than a school bus, it's 60 feet long. We built a ton of these, and lots of other stuff that went into space, and the

interesting part is those sub-satellites were being designed and built here at Stanford. Now for the third piece of entrepreneurship, and that's startups and venture capital. On the other side of town in 1956, someone named William Shockley starts a company. I don't know if any of you know Shockley's name today, it's not on a lotta things, but in World War II he was Director of Naval Anti-Submarine Warfare at Columbia, and then he moved over to the Air Force and did radar bombing training. But he's mostly known, if you're in technology, as the co-inventor of the transistor, and won the Nobel Prize in 1956. But what he had to do with Silicon Valley is he founded the first transistor company, the first semi-conductor company in Silicon Valley.

Now, what's interesting about Shockley was not that company. What was interesting about Shockley was he was a great researcher, probably the world's best talent-spotter, and equally pretty well-known as the world's worst manager in the history of Silicon Valley. And the reason why is, he made life so miserable for his eight best employees, that they all got up 15 months after he founded the company and left, and they started a little company called Fairchild Semiconductor. And two of those eight, was someone named Gordon Moore, and another guy named Robert Noyce, would also go off and found Intel. Now what's interesting about Shockley though in 1956, is every other, let me say it again, every other semiconductor company that was started in Silicon Valley, came from Shockley. So here's Shockley, let me zoom out. Every other silicon company came from this one startup in 1956. What started to happen, about 20 years later was that private investors noticed that there was some activity going on south of San Francisco in technology. Silicon, semiconductors, this whole chip business, this whole diagram now by the mid-'60s, early '70s, is getting kind of interesting. And while there was some private money funding them, some customers funding them, there was no organized venture capital as we know it today.

At best, it could of been described as angel capital. And so what happened is, a couple of smart investors decided to raise money from pension funds, private universities and wealthy individuals, called The Limited Partners. And in 1978 and 1979, the US Government changed two tax rules that made this actually pretty lucrative for all parties. One is the capital gains rate was cut in half essentially, from 48 to 25%, but more importantly, what was called the Prudent Man Rule for pension funds, that said you couldn't invest in risky ventures was loosened, so pension funds who were sitting on billions of dollars to invest, were allowed to put up to 10% of those dollars, and for the first time ever, into venture capital funds. And VC funds until then which had been kind of, you know, a couple hundred grand, maybe a million, could now tap into tens of millions of dollars that were never available before. And so what you start seeing in the mid-'70s is people inventing this form of venture capital called 2 and 20. The general partners would take 2% as a management fee, and keep 20% of the profits, and a whole set of firms started to emerge. A couple of the first of them were kind of experiments, but some of them you might still recognize, Patricof, Kleiner Perkins, Sequoia, all started building the idea of a culture that would fund risky ventures. Be patient through the failures, and make their money on the obscene returns of the ones that succeeded. No unicorns yet, not even for the next 25 years.

But this was the first time that there was a financial asset class that matched the passion and the vision of the technology entrepreneurs. And so venture capital is actually now driving this second wave of innovation in Silicon Valley. Again, we had great infrastructure. We had great culture, we still had no management tools, but now for the first time, the motivation instead of crisis, was profit. And instead of getting military financing, we were now getting venture financing tied into this profit cycle. Things are getting interesting because now money is starting to scale Silicon Valley. So, let me take you through the third part, which is lean entrepreneurship. Now, this is where I come in. I did eight startups in 21 years, all of them in the 20th century. And the only tool I had as a founder was this thing, anybody recognize this? It says Business Plan.

Business plan was the book when venture capitalists said "Go write a plan." You kind of looked at what everybody else was doing and basically a business plan was what you thought you were gonna do. And it had a great appendix, Appendix A, which had a five-year forecast. And surprisingly, all of them said "\$100,000,000.00 by year five." And in fact, if you really think about it, a business plan still to today makes all the sense in the world for your second, third or fifth product in a large corporation, because you have a series of knowns. But a business plan for a startup is really kinda different. Because in a startup, you don't have a series of knowns, you have mostly a series of unknowns, and this is a big idea. Because the only people in the 20th century to require a five-year plan for a series of unknowns were venture capitalists and the Soviet Union. That's a joke, write that down. One of the other things we recognized as entrepreneurs was that no business plan survived first contact with customers. Yet, this was the only tool we had. And it kinda made sense because most venture capitalists at the last quarter of the 20th century, were either MBAs or financial-types, and that's what they grew up with.

And what's interesting was, there was clearly no distinction between the tools of what a startup would need, versus what a large company would need. We didn't even have a language to distinguish the two. So when I retired, after doing eight of these I started to contemplate, what worked and what didn't. And what I realized was, we never even were able to articulate something as simple as this. Startups are not smaller versions of large companies. This, believe it or not, which seems like duh, was a heretical idea 16 years ago. And even more so, this was heretical, large companies execute known business models. A large company knows its customers, knows its competitors, knows its channel, knows pricing, it knows that 'cause that's how it got large. Yeah, stuff'll change but yes, we're large 'cause we know all that and we do a great job of executing it. But here was the distinction.

Startups don't execute known business models, startups search for business models. This distinction between search and execution, in the history of entrepreneurship, had never been written down. If you would have asked practitioners, they would of said yeah, we know something's different, we keep getting fired, or our company keeps not working but we don't know why. And the mistake we were making as entrepreneurs we're assuming that everything we wrote in that plan, somehow magically translated into facts, when all we had were a series of untested hypotheses. And we were failing because we were confusing what we should of been doing, which was searching for business models, but instead we were executing them. And so, I realized that startups needed their own tools, different from those used in existing companies, and so we came up with this idea called the Lean Startup. Which is simply, a risk reduction methodology for early stage ventures. Nowadays not only for startups, but inside of large companies as well, and as you'll see later, inside the government. And the Lean Startup has three simple components. One is let's take all our hypotheses, who are our customers? Who are the stakeholders? Who are the regulators? What are we building for them? What are their needs? What jobs do they want to get done? What pains or gains? Who are the customer, and what are you building, are the two most important things in any market you need to figure out, and it has a special name, called Product/market Fit.

The mistake very bright founders make is believing that because you implicitly think you understand the problem on day one, you take some money ,and you go build the solution, and you ship the product. And the smarter you are, the deeper the hole you tend to dig. One of the things I learned painfully is that as smart as you are, there is no way you're smarter than the collective intelligence of your potential customers. And they don't exist inside your building, so therefore, there are no facts inside your building, so get the heck outside. We used this thing called a Business Model Canvas by Alexander Osterwalter, to kind of frame the core commercialization hypotheses early-stage ventures need to worry about. It's not all of 'em, but it's the core. Customers, value proposition. How are you gonna make money? What are your costs? What do partners, activities, resources, et cetera. But then, we say you need to get out of the building and test those hypotheses, and by test them I don't just mean, here's a product, do you wanna buy it? That's selling. I mean getting out and understanding deeply what are the customer problems, what are their needs, and what kinda solution might actually solve them? And so, not only do you talk to those customers, you build something called minimum viable products, because the third piece of Lean is using agile engineering.

Instead of specing an entire solution, and then building it, and shipping it, and finding out people don't want it, you build a product incrementally and iteratively, and you continually interact with those customers trying to understand whether you're on the right track. These three components, business model design, customer development, and agile engineering, is the Lean Startup. Now, it's nice we put together a great theory. But, what happened? So, let me tell you about the theory. It started when I wrote a book called The Four Steps to the Epiphany, it was kind of articulated because we're in development process and kind of the problem, and we were trying to solve this gap between search and execution. Alexander Osterwalter wrote a book called Business Model Generation, described the Business Model Canvas. And then my best student, Eric Ries, wrote a book called The Lean Startup. In fact, when Eric became a Lean Startup practitioner, the total available market for Lean Startup practitioners doubled from me to him. In fact, this week is now a Lean Startup Week, there are 5,000 people attending his Lean Startup Conference in San Francisco. So, the Lean Startup movement has truly caught on.

And then when Harvard Business Review put the article, The Lean Startup Changes Everything, on its cover in May 2013, it kind of blessed this notion of lean is not only for startups, but is now for corporations trying to keep up with disruptive innovation. And so, the theory was in place but still there really wasn't the class that taught all these components. Let me just remind you, up to 2011, at Stanford University, let alone any other university, if you wanted to take the capstone Innovation and Entrepreneurship course in Engineering, or the Business School, or anywhere else, you'd be taking a How To Write a Business Plan class, that was the state of entrepreneurial education. Not 'cause anybody dumb, or we were wrong, we just didn't know what goes next, so we created something different. In 2011 we said, let's teach students entrepreneurship and Lean Methods by simulating a startup. Let's have students work on their own ideas, but create startup pressures, and uncertainties, challenges and chaos. And so we started a class here called The Lean LaunchPad, Engineering 245, in STVP. Number one, keep differences of the classes experiential. Every week our students have to get out and talk to 10 to 15 customers, partners, regulators, et cetera, a week. And, they have to build the minimum viable product that is an incremental prototype, weekly, based on what they learned.

And, they used the Lean Methodology, and what's normally lectures, are now actually homework. We built the first MOOC in 2011 for an entrepreneurship class. It's team-based, it's not students sitting reading cases, students apply, there's teams of four, and these are student-originated problems. So from the components, they validate the problem first, as I said, they use minimum viable products. To understand the value, they get outta the building, and they draw lots of pictures. How does stuff work, how do the customers connect, what's the market look like, et cetera. What happened was, I think, kind of gratifying for all of us. So this first class, 2011, is now taught in over 75 other universities, over 1200 teams of students have been through it. But more interesting for all of us, is that same year I blogged every week of the class, I got a call from the Head of Commercialization at the National Science Foundation that said "We think you invented "the scientific method for entrepreneurship. "We've been trying to teach our scientists "who wanna commercialize their science, "who are about to get an

SBRR grant.

"It has funding from the US Government, "we still don't know what to teach 'em after 30 years. "We wanna try a prototype of your class." Fast forward six years, that's now called the National Science Foundation Innovation Core, it's our Stanford class. We've put over 1,000 teams of the best scientists and engineers in the country through this. It's taught in 53 other universities. And we took those lectures, put them online, we have over 300,000 students who have taken those classes. Then in 2014, I prototyped a version of the class at UCSF for Therapeutics, Devices, Diagnostics, and Digital Health, and by week four the NIH came out and said "We'll take it." And so, I-Corps went from NSF into NIH. Then the National Security Agency picked it up in 2015, and then we're gonna be talking about Hacking for Defense, and Hacking for Diplomacy. So, that's what happened with Lean, and Lean Innovation classes. What's really interesting is Lean Entrepreneurship now provided us with the key part of the missing piece of what was necessary to build an entrepreneurial ecosystem. And that is, management tools, not designed for large companies, but management tools for startups.

So, customer development, agile engineering, business model design, my work, Osterwalter's work, David Kelley's work, the D School's work for design thinking, all kind of fit into now we have a set of tools that actually work for a different environment, instead of execution when you're trying to understand customers, customer needs, and how to efficiently build new products. The last piece I wanna talk about is the threats outside the university and outside the country, and why that led to Hacking for Defense, and Hacking for Diplomacy. Just as an aside, in the Iraq and Afghanistan war, the US Army stood up, or started a group, called the Army's Rapid Equipping Force. And their job was to search for problems that our soldiers and war-fighters had on the ground, and rapidly deliver commercial off-the-shelf solutions to those problems. And let me give you an example, and then I'll point out the Colonel in the audience who actually built this. In 2010, what the Army were buying were these heavily-armed MRAP vehicles that solved the problem that soldiers in Iraq had, which were improvised explosive devices exploding outside their unarmored Humvees. So, we now delivered up-armored vehicles to Iraq. Solved that problem, or mostly. Except, now our troops were in Afghanistan, where they didn't have roads, and instead of driving around like this, this is how they got around in the mountains. Oops, no armor.

What happened? Well what happened is, IED attacks against dismounted squads were pretty terrific. The Taliban had a pretty interesting innovation cycle. They'd start, we'd stop 'em, they'd innovate, learn and change. They'd start, we'd stop 'em, they innovate and change. Unto such that we were losing a lot of soldiers, because we didn't have a way to counter IEDs for dismounted troops. Our innovation cycle looked like this, we'd learn, and then we'd change. The problem is, guess whose cycle was faster? Ours or theirs? So, the Army decided we needed to do something better, because in-between their cycle and ours, we took 4900 casualties before we could respond. So the Rapid Equipping Force was a mission focused group, that was focused on problem sourcing and definition, and basically used networking and crowd curation, and basically something called the OODA Loop to rapidly get solutions out on the field. It was run by Pete Newell, Pete why don't you raise you hand? Colonel Pete Newell, and you'll see his picture again, next time dressed up in something different than what he's wearing here. Pete found that the real impediments to innovation in the Army was we didn't understand.

We didn't understand the problem, we didn't understand the threat or the environment. War-fighters didn't know what they wanted, they wanted to like stop gettin' blown up, but they didn't know what the solutions was. We were delivering static solutions with no plans for a threat that was evolving. Yeah here, we have a solution, that's great, but the enemy is constantly iterating. And we lacked collaborative information about what kind of development environment we should be using, and a good chunk of our organization didn't get promoted if they took any risk. So in fact, people back home were gettin' pretty risk averse, while people were getting killed on the battlefield. And finally, we were hindered by outdated policies, no you can't spend this money, Congress didn't budget it. Well no, people are dying. No, but it's not in my spec for the money you could spend. And so Pete and the REF put together a different philosophy that said "Be Present, Be Predictive, Be Intuitive, "Be Inclusive, Be Aggressive." And started delivering solutions now.

Pete went out across the country and found commercial off-the-shelf solutions that could either be used right now, like a bulldozer with a new front end, or a mini-portable line charge, or a small robotics device, and actually started deploying them as rapidly as they can, and the casualties started to go down equally fast. What Pete Newell and the Rapid Equipping Force did was essentially build a Lean Startup Methodology, if you don't recognize it, this is a Lean Startup. When instead of building apps for the iPhone, was actually building real world solutions at speed. At speed, and delivering them out on the battle field. And that's where interesting things happened for our next two classes, where the "Hacking for" classes came from. So the Hacking for Defense, and Hacking for Diplomacy classes are essentially when DoD and State Department problems meet the Lean Methodology. I'll use Hacking for Defense as an example. You take the US Army's Rapid Equipping Force, Pete decided he didn't wanna be a general, he actually wanted to be a civilian in Silicon Valley, good choice, Pete, thank you. After 30 years, and he set up a company to help the government find advanced technology, called BMNT Partners, and then we took my Lean LaunchPad class and said "Let's set up something called Hacking for Defense, "and actually go out to the Department of Defense "and Intelligence communities in the US, "and have them give us their toughest problems." Their toughest problems. "And let's see if we could get teams of Stanford students "interested in working, not on their own problems, "but on real live US

Government problems." And by the way, we'll scrub these problems down to an unclassified level, so any student, from any country, could take the class here, and in other schools, let's see if we could pull that off.

And so, the Hacking for Defense charter was learn about the nation's threats and security challenges while working with innovators inside the Department of Defense and Intelligence Community while we, 'cause it's a class, teach our students entrepreneurship while they engage in something dear to my heart, national public service. And so for the first time we ran something called Hacking 4 Defense. To apply the Lean Startup Methodology to real problems, offer students an opportunity for National Service. Just as a sidebar for me, we've run a 40-year experiment in the United States disconnecting national service with Foreign Policy. And I think all of you could make a judgment to see how well, or not, that's worked out. And today, if students want to engage in national service, you could do Teach for America, or AmeriCorps, but there really is no formal way to get involved with the DoD Intelligence Community other than intern for a summer or a year. My intent was to give all of you another vehicle to do that, and solve some really interesting problems, and learn Lean entrepreneurship. And so, the teaching team looked like this. Pete Newell, how he used to dress up, and Joe Felter who's an MS in E, and CISAC, and those were the two instructors, and me. They looked a lot meaner than I did, you didn't wanna get an answer wrong with these guys, right? And so, Pete and Joe who had actually been in the DoD for decades, helped sourced these problems from the Department of Defense, and we modified the Business Model Canvas into something called the Mission Model Canvas.

The biggest thing to note is in the Department of Defense, and also in social ventures, you don't have revenue to measure, you have mission achievement, or some kind of metric that isn't monetary. So, how do you know that you've been successful? And you don't have a distribution channel, but you do have to worry about deployment, one of the biggest problems that DoD has today, my opinion is, they have more demos from technologists that you'll ever see on the planet. The problem isn't demos, it's deployment. And deployment means figuring out to get the money, how to get the right people to sign off, how to take risks, et cetera. So, our students not worry about just demos, sometimes you need demo to get a general to deploy, but the goal is deployment, not demos. We teach them how to get money. I don't mean personally, but how would get this thing funded and deployed? And given Pete managed to spend \$1,000,000,000.00 on a \$100,000,000.00 budget and not get court martialled, I think he is one of the world's experts on figuring how to spend other people's money. And so the Mission Model Canvas allowed us to put together problem understanding, with a curated problem ecosystem from the Department of Defense, and start offering the DoD and Intelligence Community rapid solutions. Here were some of the problems that our students were working on. Wearable sensors for divers.

Synthetic Aperture Radar Cubesats. Detecting CatPhishing for the National Security Agency. Explosive Ordnance Disposal, et cetera. These were serious, real problems, for students who had no idea what even some of the terms meant. And I have to tell you, by the end of the class, they all deeply understood the problem. They were either getting under water and building diving equipment, or wearing explosive ordnance disposal suits, or something else. In fact, let me show you an example of one of the teams, AquaLink. - [Narrator] We're Team AquaLink. Our sponsor for Hacking for Defense is Seal Delivery Vehicle Team 1. The Seal Delivery Vehicle, or SDV, is an unpressurized, water-filled submersible that carries Navy SEALs from a submarine to a secondary location.

We were tasked with providing real-time feedback, and capturing data, to solve long-term health problems for their divers. After getting out of the building and talking to our users, as well as, getting as close as we could to walking in their shoes, we realized that a vitals monitoring system was not their most pressing issue. We did not have a product/market fit. So, we pivoted to improving their location and communication capabilities. Currently for the SDV to get a GPS fix, they must rise to the surface to stand up an antenna on top of the SDV. This means, they must stop and wait at various depth intervals to go through a full dive profile for the SEALs in the vehicle. If they rise too quickly, they risk giving the SEALs within decompression sickness. Our solution is a deployable GPS buoy that will allow the SDV to stay at depth while acquiring an updated position in 20% of the time. We continued to test if the product would fit within their current operating procedures through customer discovery. To test the feasibility of the product, we created a minimum viable product which could be tested in the pool, and in a high-pressure chamber.

In its current state, the buoy can be submerged to over 100 feet, and draw, display and send an accurate GPS signal to within a meter. We learned about our key partners, as well as dug deep into how the product would be deployed. Because of this, we understand the deployment process, and the key partners we need for the GPS buoy to actually make it into the hands of SDV Team 1 Divers. - So, this is just one example of one team. None of this they knew before, I think they did know how to swim, but that was about it. This would be great if it was just a Stanford class, but that really doesn't create national service. So what Pete, and I, and Tom Byers, who was also part of the teaching team did, was we decided to scale this class to other universities, with the help of the National Defense University. And so, we started with just one university, us, by the end of 2017 there'll be 17 other universities teaching this with 22 government agencies involved in the class. My goal is after five years, much like the National Science Foundation Program, to have 50-plus universities teaching Hacking for Defense. Now that would be kinda fun just for one year, but we decided let's do something else.

Turns out the State Department has a technical representative in Silicon Valley, Zvika Kreiger. And Zvika sat through the Hacking for Defense class and said "Well wait a minute, if you could solve problems "for the Department of Defense, can you solve real problems "for the State Department?" And we said "Sure, why don't we put together that class." And so we just started this September, in fact going on now, Hacking 4 Diplomacy, where we got a series of problems from State, and the charter for here is learn about foreign policy challenges while working with innovators inside the State Department. And again, by teaching our students entrepreneurship while they engage in a national public service. And again, this time the problems are different. Hacking violent extremism online. Designing an informal leadership dataset. Avoiding space collisions. So all of a sudden, using the same methodology, same protocol, but working with different government agencies. So in summary, there are three classes Lean LaunchPad, Hacking for Defense, Hacking for Diplomacy. You all can make a difference and work on some of the toughest problems that the country has.

Sign up, and for further reading here's the links to the class. So, thank you very much. (audience clapping) I'd be happy to take any questions. - [Presentation MC] We have five minutes, Steve, for questions. - Questions? - [Presentation MC] And repeat the questions, Steve, when they're asked. - Going once, yeah, sir. - [Questioner] Yes hello, I had a question about the intellectual property of those classes and-- - Open-Source. - Oh, open-source. So, I can take the solutions back to France? - Open-source. So, one of the nice things about-- - [Presentation MC] And Steve, repeat the question. - Thank you, so the question is, what about the intellectual property of the class. IP is open-source, unless there's some proprietary code owned by Stanford, or some if its researchers with all the caveats about Stanford Intellectual Property Licensing Office, but all the slides historically, for all the classes have been on slideshare.net/sblank.

Feel free to go take a look, there's over 650 from the National Science Foundation, and from our classes, and multiple universities. Other questions? Yes, in the back. - [Questioner] You mentioned that you have (mumbles), but I was wondering, how do you see like the Lean Startup (mumbles) in the context of medicine where you have to get like two (mumbles) before-- - That's a great question. It was the one we had and the venture capitalists I talked to, so the question was, how does the Lean Methodology work in medical devices when gee, it's all about regulation, and I'll even raise the ante, how does it work in therapeutics where it's 15 years in the lab? What's the NDP look like there? You'll kill somebody with half of a drug or, you can implant half of a device, and you know, what happens if their knee goes out? And the answer is, not intuitively obvious, because you would think oh it's all about the device, or the product. It turns out in the life sciences, a good reason why most of those companies fail, are not just the science or the product, but that you didn't understand the regulatory environment, the financing environment, you didn't understand clinical trials, or clinical end points. That's a lotta stuff, particularly if you're a scientist or an engineer, and if you've never built one of these companies before, you could spend an enormous amount of time and energy, and find out that your business model was just untenable, let alone that your technology didn't work. Maybe the technology worked, but there was no way to make it profitable. So, our folks in medical devices spend their time understanding, for example, is it a PMA or 510(k)? That is, what type of regulatory regime are you gonna have? What kind of clinical trials do you need? Who is your clinical partner, et cetera. Does that answer your question? Other questions? Yes, sir? - [Questioner] Professor Blank, greetings from Lima, Peru. My name Paul Morales, and I come from (mumbles).

- Welcome. - [Questioner] Now, (mumbles) question about that, do you think that the (mumbles) system, or ecosystem, for the Latin America region could be useful like the Silicon Valley systems? Because-- - Useful for who? - [Paul] Yeah, that's one of the questions. - So the question is, is the Latin American-- I'm sorry? - [Paul] For the people anyway. For the product development. - So, if the question is can an innovation ecosystem in Latin America be useful for the people? Of course, is the answer. The question is, is it can you emulate the Silicon Valley ecosystem, is that a question? - [Paul] Yes, that's right, I tried to say that. - So, Silicon Valley has a unique set of advantages which right now have to do with density. And density not only of innovation talent, but density of capital. We have more risk capital here than many other places, in fact, most places in the world. It isn't that entrepreneurship talent isn't everywhere, it's that entrepreneurship talent and risk capital are the things that make entrepreneurship happen at scale here.

Does that make sense? So, it isn't that you couldn't start another ecosystem, it's that the density has some self-perpetuating value right now. - [Paul] The lack of (mumbles). - Hard, hard but not impossible, happy to talk with you after the talk. Do we have time for one more, no? - [Presentation MC] You should probably cut it off, sir. - Cut it off, okay, I can't talk that fast. So, thank you very much, I'm happy to take more questions. (audience clapping)