

Steve Blank

The Secret History of Silicon Valley Part VI: Every World War II Movie was Wrong

Posted on April 27, 2009 by steveblank

This is Part VI of how I came to write "[The Secret History of Silicon Valley \(http://www.youtube.com/watch?v=ZTC_RxWN_xo\)](http://www.youtube.com/watch?v=ZTC_RxWN_xo)". This post makes a lot more sense if you look at the [earlier posts \(https://steveblank.com/category/secret-history-of-silicon-valley/\)](https://steveblank.com/category/secret-history-of-silicon-valley/) as well as the [video \(http://www.youtube.com/watch?v=ZTC_RxWN_xo\)](http://www.youtube.com/watch?v=ZTC_RxWN_xo) and [slides \(http://www.slideshare.net/sblank/computer-history-museum-112008-presentation\)](http://www.slideshare.net/sblank/computer-history-museum-112008-presentation).

The next piece of the Secret History of Silicon Valley puzzle came together when [Tom Byers \(http://www.stanford.edu/dept/MSandE/people/faculty/byers/index.html\)](http://www.stanford.edu/dept/MSandE/people/faculty/byers/index.html), [Tina Selig \(http://www.stanford.edu/dept/MSandE/people/teaching/tseelig/index.html\)](http://www.stanford.edu/dept/MSandE/people/teaching/tseelig/index.html) and [Mark Leslie \(http://gsbapps.stanford.edu/facultybios/biomain.asp?id=87463849\)](http://gsbapps.stanford.edu/facultybios/biomain.asp?id=87463849) invited me to teach entrepreneurship in the Stanford Technology Ventures Program (STVP (<http://stvp.stanford.edu/>)) in Stanford's School of Engineering. My office is in the Terman Engineering Building.

Fred Terman - the Cover Story

I'd heard of Terman but I didn't really know what he did - his [biography \(http://www.amazon.com/Fred-Terman-Stanford-Discipline-University/dp/0804749140\)](http://www.amazon.com/Fred-Terman-Stanford-Discipline-University/dp/0804749140) said that he was one of the preeminent radio engineers in the 1930's literally writing the [textbooks \(http://www.amazon.com/s/ref=nb_ss_b?url=search-alias%3Dstripbooks&field-keywords=frederick+emmons+terman&x=0&y=0\)](http://www.amazon.com/s/ref=nb_ss_b?url=search-alias%3Dstripbooks&field-keywords=frederick+emmons+terman&x=0&y=0). He was the professor who helped his students Bill Hewlett and David Packard start a company in 1939. In World War II he headed up something called the Harvard Radio Research Lab. There was plenty in his biography about his post WWII activities: chair of electrical engineering in 1937, dean of engineering in 1946, provost in 1955. He started the Stanford Honors Co-op in 1954 which allowed companies in the valley to send their engineers to Stanford graduate engineering programs. 74HGZA3MZ6SV

Since I was interested in the [history of Silicon Valley \(https://steveblank.com/2009/04/20/the-secret-history-of-silicon-valley-part-v-happy-100th-birthday-silicon-valley/\)](https://steveblank.com/2009/04/20/the-secret-history-of-silicon-valley-part-v-happy-100th-birthday-silicon-valley/), Entrepreneurship, and now Terman, I began to understand that Terman had a lot to do with the [proliferation of microwave companies \(https://steveblank.com/2009/04/20/the-secret-history-of-silicon-valley-part-v-happy-100th-birthday-silicon-valley/\)](https://steveblank.com/2009/04/20/the-secret-history-of-silicon-valley-part-v-happy-100th-birthday-silicon-valley/) in Silicon Valley in the 1950's and '60's. But how? And why? So I started to read all I could find on the development of microwaves. That led me back to the [history of radar in World War II \(http://www.amazon.com/Radar-History-Technical-Military-Imperatives/dp/0750306599\)](http://www.amazon.com/Radar-History-Technical-Military-Imperatives/dp/0750306599) - and a story you may not know.

What Does WWII Have to Do with Silicon Valley?

Just a quick history refresher. In December 1941, the Japanese attack Pearl Harbor, and Germany declares war on the United States. And while the Soviets are fighting the Germans in massive land battles in eastern Europe, until the allies invade Western Europe in June 1944, the only way the U.S. and Britian can affect German war-fighting capability is by mounting a [Strategic Bombing campaign \(http://www.amazon.com/Air-War-1939-1945-Cornerstones-Military/dp/1574887165\)](http://www.amazon.com/Air-War-1939-1945-Cornerstones-Military/dp/1574887165), from England. Their goal was to destroy the German capability to wage war by aerial bombing the critical infrastructure of the German war machine.

The [allies bombed \(http://www.amazon.com/Battle-Over-Reich-Strategic-Offensive/dp/1903223482\)](http://www.amazon.com/Battle-Over-Reich-Strategic-Offensive/dp/1903223482) the German petroleum infrastructure, aircraft manufacturing infrastructure, chemical infrastructure, and transportation infrastructure. The Americans and British split up the air campaign: the British bombed at night, the Americans during the day.

<https://steveblank.files.wordpress.com/2009/04/lancaster.jpg>

<https://steveblank.files.wordpress.com/2009/04/b-17.jpg>**The Odds Weren't Good**

These bombers flew for 7+ hours from England and over occupied Europe, through a gauntlet of intense anti-aircraft fire and continuous attack by German fighter planes. And they got it coming and going to the target.

But what the bomber crews didn't know was that the anti-aircraft fire and German fighters they encountered were controlled via a sophisticated *radar-guided electronic air defense system* (<http://www.gyges.dk/>) covering all of occupied Europe and Germany.

The *German electronic air defense system* (<http://www.vectorsite.net/ttwiz.html>) was designed to detect the allied bomber raids, target and aim the German radar-guided weapons, and destroy the American and British bombers. The German air defense system had 100's of early warning radars, *and thousands* of radar controlled anti-aircraft guns, and Ground Controlled Intercept radars to guide the fighters into the bombers.

And the German night fighters had their own on-board radar. In all the Germans had over *7,500 radars* dedicated to tracking and killing the allied bombers.

<https://steveblank.files.wordpress.com/2009/04/german-nightfighter.jpg>

Each allied bombing mission lost 2-20% of their planes. Bomber crews had to fly 25 missions to go home. The German objective was to make strategic bombing too costly for the Allies to continue.

By 1942 the Allied Air Command recognized they needed to reduce allied losses to fighters and flak. We needed a way to shut down the German Air Defense system. (Bear with me as this history takes you from the skies of Europe to Fred Terman.)

The Electronic Shield

To shut it down we first needed to understand the German "Radar Order of Battle." What radars did the Germans have and what were their technical characteristics? How effective they were? What weapons were they associated with? We needed to find out all this stuff and then we needed to figure out how to confuse it and make it ineffective.

So the U.S. set up a top secret, 800-person lab to do just that, first, to gather signals intelligence to understand the "Radar Order of Battle" and then, to wage "electronic warfare" by building mechanical and electronic devices to severely hamper the Germans' ability to target and aim their weapons.

Ferrets and Crows - Signals Intelligence

The first job of the secret lab was to find and understand the German air defense system. So we invented the U.S. *Signals Intelligence* (<http://jya.com/usic08.htm>) industry in about 12 months (*with help* (<http://www.amazon.com/Instruments-Darkness-History-Electronic-1939-1945/dp/1853676160>) from their British counterparts at the Telecommunications Research Establishment.) These mission of the planes called Ferrets, manned by crews called Crows, was to find and understand the German electronic air defense system. We stripped out B-24 bombers, took out all the bomb racks, took out all the bombs and even took out all the guns. And we filled it with racks of *receivers and displays* (<http://aafradio.org/>), wire and strip recorders and communications intercept equipment that could search the electromagnetic spectrum from 50 megahertz to 3 gigahertz, and this is 1943.

We flew these unarmed planes in and out of Germany alongside our bombers and basically built up the “radar order of battle.” We now understood where the German radars were, their technical details and what weapons they controlled.

Tin Foil Rain - Chaff

We first decided to shut down the German radars that were directing the anti-aircraft guns and the fighter planes. And to do that *we dropped tin foil on the Germans*. No kidding. Radar engineers had observed if you cut a strip of aluminum foil to 1/2 the wavelength of a radar transmitter and throw it in front of the radars antenna, the radar signal would reflect perfectly. All the radar operator would see was noise, rather than airplanes.

Well, you couldn't stand in front of the German radars and throw out tin foil, but you could if you had a fleet of airplanes. Each plane threw out packets of aluminum foil (called “chaff”.) The raid on Hamburg in July, 1943 was the first use of chaff in World War II. It completely shut down the German air defense system in and around Hamburg. The British and then the Americans firebombed the city with minimal air losses.

Chaff used 3/4's of all the aluminum foil in the U.S. in World War II, because by the end of the war, every bomber stream was dumping chaff on every mission.

Jam It and Shut it Down - Electronic Warfare

But this secret lab was focused on *electronic* (<http://www.amazon.com/History-U-S-Electronic-Warfare-Vol/dp/999643088X>) warfare (<http://www.amazon.com/History-U-S-Electronic-Warfare-Vol/dp/999643088X>). So they systematically designed electronic devices called “jammers” to shut down each part of the German air defense system. Think of a “jammer” as a radio transmitter broadcasting noise on the same frequency of the enemy radar set. The goal is to overwhelm the enemy radar with noise so they couldn't see the bombers. We built electronic jammers to target each part of the German air defense system: their early warning radars, the short range radars, the anti-aircraft gun radars, the Ground Control Intercept Radars, the air to ground radio links and even the radars onboard the German night fighters. By the end of the war we had put multiple jammers on every one of our bombers, and while their power output was ridiculously low, these jammers were flying in formation with 1,000 other planes with their jammers on, and the combined power was enough to confuse the radar operators.

Just to give you a sense of scale of how big this electronic warfare effort was, *we built over 30,000 jammers*, with entire factories running 24/7 in the U.S. making nothing but jammers to put on our bombers.

By the end of World War II, over Europe, a bomber stream no longer consisted of just planes with bombs. Now the bombers were accompanied by electronics intelligence planes looking for new radar signals, escort bombers just full of jammers and others full of chaff, as well as P-51 fighter planes patrolling alongside our bomber stream.

(<https://steveblank.files.wordpress.com/2009/04/radarj1.jpg>)

Every WWII Movie and Book with a Bomber was Wrong

While there were lots of stories about how the British early warning radar system, called “[Chain Home](http://www.amazon.com/Most-Secret-Wordsworth-Military-Library/dp/185326699X)” saved England during the Battle of Britain by giving the Spitfire pilots time to scramble to intercept German bombers, there wasn't a coherent story about American and British bombers encountering the German radar-guided air defense system.

This lack of information meant that every World War II movie or book that had airplanes on bombing missions in it was wrong. Every one of them. (To someone who had grown up with reruns of WWII war movies on TV, this was a shock.) Every movie I had seen - 12 O'clock High, Memphis Belle, etc. - assumed that there were no electronics other than radios on these bombers. Wrong. Not only didn't the movie makers know, but *the pilots and crews didn't know* about the German radar guided system trying to kill them. Nor did they know about the electronic shield being assembled to try to protect them.

But while this may be a great story what does this have to do with the history of Silicon Valley?

The answer lies with who ran this lab and became the father of electronic warfare and Signals Intelligence in the Cold War for the next 20 years.

Who Ran the Most Secret Lab You Never Heard of?

It was *Fred Terman of Stanford*. The Harvard Radio Research Lab was his creation. A Stanford professor was at Harvard in World War II because the head of the [Office of Scientific Research and Development](#)

(<http://books.google.com/books?id=IZUJwsDDzucC&pg=PA7>) thought Terman was the best radio engineer in the country. (Why couldn't he have set up a lab at Stanford? Apparently, the Office of Scientific Research thought that Stanford's engineering department was second rate.)

Finally, I had an answer to the question I had asked 35 years earlier (<https://steveblank.com/2009/03/23/if-i-told-you-i-d-have-to-kill-you-the-story-behind-the-secret-history-of-silicon-valley/>) when I was in Thailand: "How did electronic warfare get started?" Now I knew that it began in the early days of World War II as a crash program to reduce the losses of bombers to the German air defense network. *Electronic warfare and signals intelligence in the U.S. started with Fred Terman and the Harvard Radio Research Lab.*

Spooky Music

Reading about Terman was like finding the missing link in my career. Here was the guy who invented the field I had spent the first five years of my adult life working on. And 30 years later I was teaching in a building named after him and never knew a thing about him. Play spooky music here.

I began to realize a few things: First, everything we had done in electronic warfare in the Vietnam War was just a slightly more modern version of what we had done over occupied Europe in World War II. (And in hindsight, we seemed a bit more agile and innovative in WWII.)

Unbelievably, in less than two years, Terman's Radio Research lab invented an industry and had turned out a flurry of new electronic devices the likes of which had never been seen. Yet decades later the military lacked the agility to write a spec in two years, let alone get 10's of thousands of new systems deployed on aircraft as Terman had done.

How was this possible? *In 21st century terminology we'd say that Terman built the Radio Research lab into a customer-centric organization (<http://www.slideshare.net/startuplessonslearned/lean-startup-presentation-to-maples-investments-by-steve-blank-and-eric-ries-presentation>) doing agile development.*

Just the Beginning

The public history of Terman's involvement with the military ends when he returns back to Stanford at the end of the war. Nothing in his biography or any Stanford history mentions anything as exciting as his work in World War II. The public story of his last 20 years at Stanford, in the 1950's and '60's, seems to have him settle into the role of the kindly dean and innovative provost.

Nothing could be further from the truth.

The Secret Life of Fred Terman in a War you never heard of in [Part VII of the Secret History of Silicon Valley](https://steveblank.com/2009/08/03/the-secret-history-of-silicon-valley-part-vii-we-fought-a-war-you-never-heard-of/) (<https://steveblank.com/2009/08/03/the-secret-history-of-silicon-valley-part-vii-we-fought-a-war-you-never-heard-of/>).

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19 Responses

[dispatches from TJICistan » Blog Archive » a secret history](#), on [April 27, 2009 at 7:25 am](#) said:
[...] invention of electronic warfare, part I and [...]

[Reply](#)

[Augusta Prince](#), on [April 16, 2010 at 3:08 pm](#) said:

My late friend Gordon P. McCouch wrote in his Harvard '41 25th anniversary report: "I spent the war as a civilian associated with the radar countermeasures effort at Harvard's Radio Research Laboratory. From mid-1943 until the summer of '45, I was in England doing liaison work with the RAF, installing the first radar jammers in a wing of the 8th Bomber Command under Colonel LeMay, and in France, Belgium, and Germany analyzing captured electronic equipment, and working on captured electronic equipment, and working in communications for the 9th Air Force. These exciting days of contact with stimulating, dedicated people provided a breadth of experience which I still treasure."

Is there anything more to be added to his memoir? Thanks.

[Reply](#)

[Wall 85: Squint « 365 Wallpapers](#), on [April 27, 2009 at 8:29 am](#) said:

[...] <https://steveblank.com/2009/04/27/the-secret-history-of-silicon-valley-part-vi-the-secret-life-of-fre...> [...]

[Reply](#)

[rohit sharma](#), on [April 27, 2009 at 9:47 am](#) said:

in addition to his WWII contributions, Terman also helped educate a generation of engineers or two with his excellent text. my father who had been at Harvard in '60s remembered the excellent lab manuals that Terman had authored (including some at MIT Lincoln Lab) and brought an old edition for me that was a revelation in radio, modulation, and radar...

[Reply](#)

Ben Tanen, on [April 27, 2009 at 10:18 am](#) said:

Awesome post, Steve. I propose that most of these things are secret due to disinterest in history, not because they have been particularly concealed.

In your spare time you should use the library to dig out Henry Guerlac's great two-volume set called "Radar in World War II" — it is cited heavily by Buderer and others, and rightly so. On microelectronics, with a nice section on the post-war Valley and the Shockley descendants, I would add Michael Eckert and Helmut Schubert's "Crystals, Electrons, Transistors." On Cold War/computing/etc., I would add "The Closed World" by Paul N. Edwards.

On RRL, you probably would love to visit the Harvard Archives and have them pull out some material for you. I had the privilege of doing my undergrad thesis on the information design and radar display work that was done at the Radiation Lab (MIT) and at the Psycho-Acoustic / Electro-Acoustic Labs (Harvard — which were often lumped together with RRL). The archives are amazing when you get a box full of correspondence on (real!) carbon copy paper.

The number of other important figures who passed through or led these labs is quite extraordinary. Lee DuBridge led the Radiation Laboratory, was of the same generation as Terman, and went on to a hugely successful presidency of CalTech. Leo Beranek led the EAL and went on to co-found BBN. And so on.

Feel free to write me directly; would love to talk to you more about this.

Regards,
Ben Tanen

[Reply](#)

steveblank, on [April 27, 2009 at 12:52 pm](#) said:

Ben,

Thanks for the reading suggestions. I just put Guerlac's and Eckert/Schubert's books in my "to read" pile. I've had "The Closed World" on my shelf for 10 years, but it didn't make an impression. I'll go back and give it another read.

My two cents is that it's less of a "disinterest in history" than an inability to make the history of technology accessible to a non-technical audience. It's the tension between being "technically accurate" and writing something your mother could understand. Few writers do it well.

Add to that, in this particular area the subject was/is classified during the cold war.

steve

[Reply](#)

Brian Dunbar, on [April 27, 2009 at 11:54 am](#) said:

Not only didn't the movie makers know, but the pilots and crews didn't know about the German radar guided system trying to kill them. Nor did they know about the electronic shield being assembled to try to protect them.

I have trouble with the last sentence.

You wrote that the crews were dumping tinfoil. That every bomber had multiple jammers. That every bomb run was accompanied by electronic warfare planes.

I can easily believe this did not make it's way into the movies: it's pretty dull stuff for a movie. Need to know would keep the details and the full sweep of the shield a secret from the crews.

But you couldn't keep something that big a complete secret from the crews. If nothing else you'd expect them to notice the planes flying around with the weird antennas and no bombs ...

Or could you?

[Reply](#)

steveblank, on [April 27, 2009 at 1:04 pm](#) said:

Brian,

You're right. It should have said something like, "Not only didn't the movie makers know, but the pilots and crews didn't know *the size and scale of the* the German radar guided system trying to kill them. Nor did they

know *the full extent of resources put in place to provide* the electronic shield being assembled to try to protect them.

steve

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Top Posts « WordPress.com, on [April 27, 2009 at 5:25 pm](#) said:

[...] The Secret History of Silicon Valley Part VI: Every World War II Movie was Wrong This is Part VI of how I came to write "The Secret History of Silicon Valley". This post makes a lot more sense if [...] [...]

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Μπράβο στον Δημήτρη Ιατρίδη, που όλα τα προλαβαίνει! « Τσουκνίδα, on [April 27, 2009 at 9:45 pm](#) said:

[...] The Secret History of Silicon Valley Part VI: Every World War II Movie was Wrong This is Part VI of how I came to write "The Secret History of Silicon Valley". This post makes a lot more sense if [...] [...]

[Reply](#)



Tim, on [April 28, 2009 at 1:13 pm](#) said:

The description of chaff is a little misleading. The effect was discussed before WWII even started, and in 1942 the British and Germans independently developed their own version of it ("window" and "dueppel").

Its use was *deliberately* suppressed until 1943, to avoid the Germans relaunching a second Blitz.

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Benjamin A. Shelton | Blog » Blog Archive » Links: April 29th, on [April 29, 2009 at 12:02 am](#) said:

[...] is an interesting write up on World War II and how it influenced Silicon Valley. I had no idea that electronic countermeasures like this were [...]

[Reply](#)

History buff, on [April 29, 2009 at 3:49 am](#) said:

Excellent stuff Steve - thanks for the heads up on Fred Terman. Will check out this aspect of WW2 history from your post - amazing really, "kindly dean and innovative provost" doesn't even begin to tell the half of it.

David

[Reply](#)

John Dunham, on [May 3, 2009 at 4:25 pm](#) said:

Steve: thanks for identifying a previously hidden synchronistic loop in my life. My first job out of RPI was as an engineer on the EF-111, an electronic counter measures laden derivative of the original F-111 swing-wing fighter / bomber. Had not yet heard of Silicon Valley at the time, but the siren call was already sounding. My first business trip to the valley was to visit California Microwave. I ultimately answered that call, joining Sun Microsystems with a 3-digit employee number. And now am leading a startup of my own (<http://sauce labs.com>) where we're students of you and Eric Ries' lean startup principles. Thanks for connecting the historical dots!

[Reply](#)

Alexander Mikhalev, on [May 11, 2009 at 9:21 am](#) said:

Thank you Steve, it is really useful for me and hopefully few EW students.

[Reply](#)

Elephants Can Dance - Reinventing HP « Steve Blank, on [June 22, 2009 at 7:31 am](#) said:

[...] March of 1956, Fred Terman, the Stanford professor who encouraged Bill Hewlett and David Packard to start HP, wrote Bill [...]

[Reply](#)

The Secret History of Silicon Valley 12: The Rise of "Risk Capital" Part 2 « Steve Blank, on [October 29, 2009 at 12:30 pm](#) said:

[...] to get acquired to raise money or get their founders and investors liquid. Interestingly enough, Fred Terman, Dean of Stanford Engineering was tied to all three [...]

[Reply](#)

The Endless Frontier: U.S. Science and National Industrial Policy (part 1) « The Berkeley Blog, on [January 14, 2013 at 11:04 am](#) said:

[...] Establish a role for government funding for military weapons research inside of U.S. universities (See the blog posts on the Secret History of Silicon Valley here, and for a story about one of the University weapons labs here.) [...]

[Reply](#)

[The Endless Frontier: U.S. Science and National Industrial Policy \(part 1\) | Home | AlwaysOn](#), on [March 29, 2013 at 4:36 am](#) said:

[...] Establish a role for government funding for military weapons research inside of U.S. universities (See the blog posts on the Secret History of Silicon Valley here, and for a story about one of the University weapons labs here.) [...]

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