Lean and Data-Driven: Remembering the Founder of a World-Class Renewable Energy Company

Remarks at the Memorial Service for my father

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I had the good fortune to work with my father on a weekly basis, and sometimes on a daily basis over the past 10 years, first in my role as Sunpower Chair of Board and later as a collaborator on engineering projects. Through many conversations over the years I learned that my father never worked alone, but that what he accomplished, he accomplished because he had the support of a lot of people, many of whom I see sitting here today. Thank you to those who worked with my father to achieve great things.

In thinking about my father and what he meant to me, I found two statements from those who knew him to be particularly illuminating. The first, from a Sunpower technician, is as follows:

“It is great, but common, for a person to believe that society should be energy efficient and environmentally conscious. But it is greater and more rare for a person to take a stand by actively working to make it happen.”

That's from a technician who worked with my father 20 years ago.

The second statement is from an investment banker who worked with my father only 4 years ago:

“Your Dad was a great guy. I enjoyed talking with him any time he was available. A very fertile mind, and one of the real classic Americans in invention and leadership. He had insights that no one else had, and he acted on those. The first is rare and the second very rare.”

Two very different observers of my father saying similar things: He had insights that no one else had, and he acted on those. The first is rare and the second very rare. This must be hitting on something important about my father, so I will focus on the sentiment of these two observers during my remarks today.

What I will not do today is talk about his personality or tell you any of his stories - a short video covering such topics is available on the internet[1].

What I want to focus on is an approach I saw my father use again and again, at really tough times in his life and in really triumphant times in his life as well.

And that approach has two parts. The first part is nothing more nor less than the scientific method, applied to human affairs as well as engineering. He had those insights, and he had them because he really, deeply understood the scientific method. He said to me many times, “be as uncertain as your data permits.” And that means two things. It means don't be too sure, don't be over-confident. But it also means – if your data is telling you something you don't want to believe – you must believe it, it's true. My father was ahead of his time in his broad application of the scientific method to human affairs. Others who apply this method broadly have recently revealed new truths in a great many fields,

for example in health care[2,3].

The second method is the lean method and by that I mean lean as in lean manufacturing and the Toyota Production System, the disciplined process of minimizing waste in everything we do. Now my father would never use those words because he invented all these things for himself when he was young before lean terminology became popular. Fortunately a lot of other people have caught on in the ensuing decades, and have developed and documented a variety of lean techniques[4,5,6,7,8]. My father employed the lean method throughout his life, and even dictated an essay on one aspect of this subject hours before he died[9].

Let me walk you through some events in my father's life to show you how he really turned lemons into lemonade using what appears to be two very simple ideas: the scientific method and the lean method.

When my father was 8 years old a bank foreclosed on his family's house. My grandfather had built the house himself, so it must have come as a shock. This foreclosure occurred during the depths of the depression, in 1936. My father and his four siblings and my grandparents packed themselves into a sedan. They moved from town to town in the Southern states, even living in a public work relief camp, a CCC camp, for a while. Despite everything my father was able to develop his skills and understanding, setting the stage for later achievements. During this period he really started to demonstrate a feel for machines. He was in charge of maintaining the engine of his father's motorboat. He learned how to troubleshoot mechanical problems with whatever tools and parts were available. I think it was at this time that he first learned how to apply the scientific method and the lean method.

Conditions in the country got even worse. When he was 14, my father, along with a lot of other Americans of that time, saw pillars of smoke rising on the horizon after an enemy attack on the United States. He saw with his own eyes that the oceans no longer protect us. I'm not talking about September 11, 2001 here, I'm talking about December 11, 1942. My father lived in Louisiana at the time. The columns of smoke he saw were from tankers burning out in the Gulf of Mexico after they had been torpedoed by German submarines.

When he was of age he volunteered for the Navy and here, once again, he was able to make good use of an adverse situation. He was very impressed with the new recruit placement process in the Navy, in how they would take in people from various different backgrounds and every conceivable level of ability and match each person to a job appropriate for that individual. Based on my father's high scores on a placement test, he was chosen to operate some of the most advanced technology of the time, such as radar. The Navy had efficiently determined where he belonged in a vast organization; this example of a lean method impressed my father.

Later he was chosen to relayed messages on an aircraft carrier flight deck. He saw several people get killed on that flight deck just because of landing miscues or traffic jams on the deck and he said – and this is the only time I'm going to use his words – he said “the bloody waste of war impressed me permanently.”

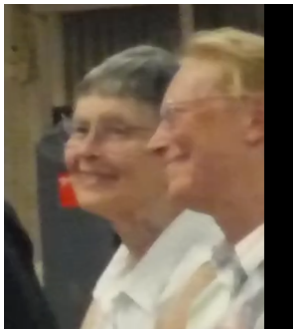
These two early experiences were, I think, the genesis of my fathers' scientific and lean approach.

My father used this approach masterfully a decade after the end of the Second World War. By this time he had obtained a BS degree from Washington State College, where he had been discovered and mentored by a Mechanical Engineering professor named Harry Sorensen. After that he had obtained an masters' degree from Caltech, also in Mechanical Engineering. In 1957 he was in a Ph.D. program at

MIT, the appeal of which was summarized in those days with the chant “MIT, Ph.D., M.O.N.E.Y.” But as we shall see, the siren song of money did not prevent him from pursuing his own priorities.

My father carefully assessed the relevant factors: jobs were plentiful because of the booming economy and Cambridge Massachusetts was the biggest college town in the United States. He really thought about what had value, what was not a waste of his time, what he really cared about and yes, that led him to drop out of MIT. This freed up time to get involved in the Cambridge dating scene where he met my mother. What a brilliant decision to drop out of MIT. After that things started to really look up.

Dropping out of MIT wasn't his only unorthodox decision at the time. He realized that in order to direct a research program later he'd need to make sure before leaving the ivory tower that he knew Mechanical Engineering like nobody's business. He got a job at Boston University and taught every course in the Mechanical Engineering curriculum. After all, when you teach something you really learn it. Thus when he left Massachusetts he was very, very well-versed in Mechanical Engineering.



Fast forward to 1964. His research ability and his friendship with another no-nonsense Navy veteran, Dr. Taylor, Dean of the Ohio University College of Engineering, had served him well. My father had obtained tenure in the Ohio University Mechanical Engineering Department, lack of Ph.D. notwithstanding. By the time he was 36, my father had enough grant money to run a research group exploring renewable energy power plants. What happened next is described in the textbook “Free Piston Stirling Engines”[10], which I will paraphrase as follows:

“Half a dozen people in various parts of the world tried to make a free piston Stirling engine work. But the free piston Stirling engine is a paradox of seeming mechanical simplicity which is in fact difficult and complicated to execute. Most who tried failed completely.

William Beale was a notable exception. With unbelievable persistence Beale continued his efforts and was eventually rewarded with a stable engine. Since those pioneering days he has contributed as much as anyone to putting the technology on an established foundation.”

If I may interject - I have to add something to that last statement from “Free Piston Stirling Engines.” I think some of the key contributors are right here in this room today - I see David Berchowitz, David Gedeon, Robi Unger and many more - to all of you, and to Gary Wood and others not here today, this is your accomplishment as well as my fathers'.

Now returning to the passage in the textbook about putting the Stirling technology on an established foundation:

“In all this Carol Beale has supported him beyond all expectation. In recognition of this magnificent and sustained effort this book is dedicated to Carol and William Beale and all the employees of Sunpower of Athens, Ohio.”

The development of the free piston Stirling engine was an important achievement. During the 1970's and 1980's, the best work on Stirling engines was being done at Sunpower. Best in the entire world.

We can all take pride in that.

Note that the lean method played a part in this success. My fathers and the others at Sunpower could outlast all those competitors because they had low overhead, low burn rate, and the ability to really focus for as long as it took to get the technology right. All these competitors out there in California and Massachusetts didn't have the needed time and focus. There were other essential elements in Sunpower's success, of course, notably solid engineering and flashes of brilliance, but the lean method was certainly a contributing factor.

The lean method was again the guiding principle as my father and mother tackled the difficult task of taking the Stirling effort out of Ohio University and founding a new company. Resourcefulness and adaptability were key. By 1974 the United States had withdrawn from the Vietnam war, and those who were at Ohio University only to avoid the draft left school. Because of this, among other factors, enrollment at the university decreased. The Mechanical Engineering department considered closing its (then unused) machine shop and laying off the two mechanics who worked there. My parents arranged to rent the machine shop and hire the mechanics, solving a problem for the university while creating the nucleus around which Sunpower would grow. My mother taught herself accounting so she could manage the Sunpower books and supervise the non-technical staff.

Now at this point, forgive me but I can't imagine summarizing the life of William Beale without giving those of you who are not in the engineering field some idea of what a free piston Stirling engine is. After all, that is what my father invented[11]. (Danny Briggs, who served as my father's technician after the sale of Sunpower in 2012, holds up a manual water pump in the photo at right). What we have here – is not a free piston Stirling engine but just a regular pitcher pump of the type you'd use with a well or cistern.

Notice that when you push down on the handle, a plunger inside lifts a column of water which then pours out the spout, and also draws more water up from the reservoir below via suction. When you push the handle up, a check valve opens and the plunger goes down into the column of water. As you move the handle up and down, spurts of water come out the spout.

Now for a magic trick. In the spirit of one of my father's thought experiments, I will now turn this ordinary pitcher pump into a free piston Stirling water pump. Imagine this. You have a balloon with some air inside – when you heat the air, the balloon expands, when you cool the air, the balloon contracts. Now this is a magic balloon that is always perfectly spherical and doesn't pop. If I wedge this balloon between the handle and casing of the pitcher pump, and magically attach the balloon to each, then when I heat and cool the balloon it will move the handle up and down, pumping water. If we ignore details such as the regenerator, what we've created is a Stirling water pump. For you Stirling experts in the audience, I contend that it qualifies as a free piston Stirling water pump, as the amplitude of the pump handle can vary. The main point here is this mechanism turns heat energy into mechanical work by alternately heating and cooling a gas confined in an enclosed volume.

Prior to 1964 Stirling engines were not practical. My father and the other Sunpower experts'

contribution was to invent and perfect the free piston variant of the Stirling engine, a practical and potentially very cheap Stirling. Prior to 1964, Stirling engines were toys that couldn't compete with gasoline, diesel or gas turbine engines, steam turbines, fuel cells or electric motors. Now free piston Stirling engines and coolers are commercial products used all over the world. Unlike the other power plants mentioned, free piston Stirling engines are nearly maintenance-free and are well suited for a wide variety of renewable energy sources such as biomass, waste heat and solar energy.

Let me say just one more thing before I wrap up. An important example of both the scientific method and the lean method is the creation of the corporate culture that made Sunpower such a stimulating place to work in the early days.

Long before Google commissioned studies on how best to run a startup, Sunpower got a lot of things right. My father wrote very convincing papers about his invention; his Stirling engine papers attracted recruits from all over the world. We can see that by looking around the room today. For example I see David Berchowitz, Izzi Urieli and Robi Unger who are from South Africa and Israel.

My father also hired people from all different kinds of backgrounds, even backgrounds that didn't seem to fit. And he gave people a chance because in the lean method – my term not his – in the lean method you don't waste anything. You don't waste time, you don't waste energy and most importantly you don't waste human potential. He could go and look at someone and say “I think this person is capable of more than they themselves think they can do.” He would say “here are your objectives, see if you can do it.” More often than not, the new hire would rise to the occasion. A job candidate whose long rap sheet included running through Athens in his underpants after a wild college party became a world-renowned Stirling engine expert. Another candidate who claimed to have a high IQ despite having little formal education became the company's foremost master technician and hardware troubleshooting wizard, and has provided three decades of service to Sunpower so far.

My father took great care to foster the free flow of ideas at Sunpower. When an engineer suggested an idea that was clearly wrong, he told me recently, he would gently introduce a better idea and let the engineer claim it as their own if they wished. He guided group meetings such that they became a respectful, humorous banter about all the technical issues they were facing at any given time. For innovation to flourish, my father believed, the atmosphere had to be respectful. And it was. Anybody could speak their mind in the safe environment of a Sunpower brainstorming session. Google did an extensive study on the best way to make a team creative and ended up reinventing the Sunpower brainstorming session, 40 years after my father first developed it[12].

Now, what can we learn from this summary of a company founder's life? My father had insights no one else had, and he acted on them. The scientific method yielded those insights, and the lean method gave him the ability to act. Individuals and organizations don't naturally use scientific or lean methods, therefore my father needed to keep things on track with discipline and persistence.

Forgive me, I was instructed to speak today only about my feelings for my father. But in thinking about my father and what he might have wanted, it occurred to me that he didn't just want people to feel things, he wanted people to do things. I will close with my guess about what my father might say to all of you if he were here today. I may be completely wrong – you can be the judge of that.

In conclusion:

For you young people, wouldn't you like to get accurate answers to all your questions – about people,

about choices you face? Don't you want to know the unvarnished truth about the issues that matter to you? The scientific method can answer those questions and uncover those truths. The scientific method guided my father to good decisions and it can work of you too. Caveat - for this to work you should employ the lean method also and here's why. If you waste time and money, as so many people do, you'll have no time and money left to pursue the next great idea that comes your way.

For you older people, I implore you to register and vote. We all wish climate change weren't so horribly real, but facts are stubborn things[13]. Engineering solutions are available[14]; the problem is the lack of political will. Our best hope is to do everything we can to elect politicians who will fight climate change.

[1]Two links to the video are:
http://www.communitysolution.org/mediaandeducation/energyandclimateyoutubechannel/home
https://vimeo.com/182715288
[2]Atul Gawande, "The Mistrust of Science", New Yorker Magazine, 10 June, 2016.
[3]Julie Schwartz Gottman, "Level 1 Clinical Training," The Gottman Institute, 2016.
[4]Ben Hartman, "The Lean Farm," Chelsea Green Publishing, 2015.
[5]Jeff Sutherland, "Scrum", Crown Business, 2014.
[6]Jeffrey Liker, "The Toyota Way", McGraw Hill, 2004.
[7]David Anderson, "Kanban", Blue Hole Press, 2010.
[8]Kanboard, https://kanboard.net
[9]William Beale, "Level of Requirement", Community Solutions Blog, 25 July, 2016.
http://www.communitysolution.org/blog/2016/7/25/poppys-dream?rq=level%20of%20requirement
[10]Graham Walker & Jim Senft, "Free Piston Stirling Engines", Springer-Verlag, 1985.
http://link.springer.com/book/10.1007%2F978-3-642-82526-2
[11]https://www.ohio.edu/mechanical/stirling/engines/WilliamBeale.html
[12]Charles Duhigg, "What Google Learned From Its Quest to Build the Perfect Team", New York Times Magazine, Feb. 25, 2016.
[13]George Marshall, "Don't Even Think About It: Why Our Brains Are Wired to Ignore Climate Change", Bloomsbury, 2015.
[14]William Beale, "Bottom-Line Thinking Won't Save Our Climate; Solar Thermal Machines", New York Times, November 30, 1989.