



## Stanford eCorner

### A Devotion to New Ideas [Entire Talk]

Bill Gross, *Idealab & eSolar*

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Bill Gross thrives on turning innovative ideas into pioneering companies. He serves as founder and CEO of Idealab, which started over 75 companies since 1996. In this stimulating lecture, he shares how Idealab continues to bring incredible ideas to market, and his personal insights on starting and running successful organizations. Gross also describes the work of eSolar, a spin-off company of Idealab that works to make solar energy cost-competitive in the global marketplace.



#### Transcript

We are really, really happy to have a Cal Tech grad and have a Los Angeles resident come all the way up here to Northern California to share his wisdom. So, give a big welcome to Bill Gross. Thank you very much for inviting me here. It's an honor to be here. I'd like to talk to you both about entrepreneurship and about my dreams for powering planet sustainably. I've been starting businesses all my life, ever since I was 12 years old. I'd like to share some of the painful lessons I have learned over those years with you, at the same time hopefully inspire more of you to take an entrepreneurial path because of how ridiculously rewarding that can be. First, let me go back to 1973. It was the energy crisis. I was 15 years old.

I grew up in San Fernando Valley. While this energy crisis was going on, I was taking physics and trigonometry in high school. So, I was learning about heat engines and parabolas. I got very excited about conic sections. Fortunately, my high school had a metal shop. I took metal shop and was trying to figure out how can we make devices that could possibly help the planet in this energy crisis at that time. So, I started making little engines and parabolic concentrators. My very first sketch, this was the very first sketch I found of a compact sterling engine that I wanted to make. And this was the actual engine running after I took a whole term of that metal shop class. I took that engine and I took a little parabolic concentrator that I made to be able to make it run off the sun.

I started making plans and kits for them. I actually started my first business then, a little company called Solar Devices. I took out ads in the back of popular science magazines and Scientific American magazine, little \$29 classified ads. But I sold these \$4 plans. I sold 5000 of them. I sold kits and it actually helped me pay my way through college. It was a really significant experience for me. I learned a lot about mail order. I learned a lot about testing. I went to the library then and read every single book I could on direct mail and direct marketing to try and learn how to figure out what was effective in convincing people to buy these products or not.

That turned out to be very useful for me later in my career. I'll talk more about that. One of the things I learned back then was to test the different ads I ran in the magazine. I would put a different return address in each ad. It would say "Sterling engine kits, A. Gross" and then "Try these new parabolas, B. Gross". That way, I could check for which magazine it came from and actually compare from the cost of the ad to how many early version of clickthroughs to try and figure out which ads were getting more response rate because I was really, really concerned about minimizing my costs and maximizing my sales. It was a very valuable experience for me. Then, I got into Cal Tech and I continued the business when I was there.

I was selling these kits and plans from the student houses there, from the labs that I was able to use at Cal Tech to improve

my designs. But by the time I graduated in 1981, the price of oil had completely collapsed. There had been all kinds of cartels formed to drive down the price and stop all interest in renewable energy. All the research stopped. All the interest stopped. Fortunately, when I graduated, there was no interest in energy. But it was the year the IBM PC came out. So, I ran down to my computer land in Pasadena and bought an IBM PC and thought myself to program. I had a 15-year detour in software products. I really, really love what was possible with that.

I'll try to abstract some lessons from some of the things I learned on that as well. So, I started making a whole bunch of different software products. The very first one was the CPA Plus product. It was a product that worked with Lotus 1-2-3, which had just come out at the time. And then, after that company, I started and acquired by Lotus. I made the product Lotus HAL, which was a natural language interface to 1-2-3. I really wanted to enhance the power of 1-2-3, reach more users. Then, I made a search product called Lotus Magellan. And then, in 1991 my son started kindergarten. He was five years old at that time.

I got really passionate about making sure he fell in love with learning. I was worried about that. I had a wonderful fourth grade teacher that made me become very passionate about learning. It really was a turning point for me. I was worried that he might not have that teacher. So, I wanted to try and make a software that can do that. I had seen this product, this amazing product, in 1991. We might even have been at a conference together. I think it was Stewart Alsav's Agenda conference. Someone demonstrated a product called Multimedia Beethoven.

It was a really, really amazing product at the time. It was a CD-ROM product with a HyperCard stack on a Mac. It was really, really incredible how beautifully it was able to express the power of Beethoven's Ninth Symphony. I said, "If this product could move me that much, relative to a jaded individual, if this multimedia product had that much impact, you can probably do that for children with educational software." I'd like to do that for my son and his generation and try to make an impact there. So, I quit Lotus in 1991. Originally, actually, after Lotus had acquired our company, they had signed me to a one-year contract. But I ended up staying there for six years. It was a really, really tremendous opportunity to learn at a big software company how to work as well as from the companies I started before that were small. So, I started this company called Knowledge Adventure. Our first product, we came out with Dinosaur Adventure, Knowledge Adventure, Space Adventure.

We worked with Buzz Aldrin to make a product called Space Adventure. These were all CD-ROM products, multimedia products in the early '90s. The company made an amazing pivot and there is an important story in the pivot that the company made. We were selling a lot of products, thousands, tens of thousands. We were making a little bit of money. We had got a Silicon Valley investor More Davidow really, really great person on our board. John Fiber joined our company. He really, really helped us, and then from Mayfield, Mike Leventhal. So, those were our two partners to help us grow the company. We were really challenged to try and explain to people who the product was for.

One Christmas, we really wanted to make our sales numbers. My brother, who was in the company with me as well, said, "We should do this thing, where we go into stores and really try and move the products ourselves." We had 65 people in the company at the time. Each one of us took a laptop and a stack of products. We'd go to a CompUSA or Egghead Software or Fry's or whatever in like 100-mile radius of Pasadena, where we were based. We would go in on a Saturday morning and set up, bring in a box of donuts to bribe the salespeople to let us set up at the end of the aisle. We called it Weekend Warriors, everybody the company had to volunteer to take two weekend days then get a day off after in the week to make up for it. So, this was really to try and make our numbers at Christmas time. We went in and we'd demo all day at the end of the aisle, showing parents the product with their kids in the software aisle. We sold a lot of products. The great thing about it was we would boost the sales in the stores we were at by so much that someone at headquarters, like at Texas or CompUSA, would say there's a big thing happening in California.

They couldn't figure out what it was because we hadn't told them. Again, they would order more for all of their stores. That really, really boosted our sales. Eventually, we got Walmart to carry our product because our numbers were going up so much from CompUSA. But one thing that we learned after doing for about four weeks, every Monday morning after the Weekend Warriors, we'd sit down at the company. We have everybody tell stories about what happened in their stores and funny stories about parents with their children, what people liked. We really had great sessions, where we would learn more about the customer. That's what's so powerful about the companies that can be developed today with Internet. We had to go out and meet the customer firsthand on the pavement and then come back and tell stories about them. But now, you can be in contact with all of your customers.

It's obviously so incredible today. But let me tell you one of the things we learned. One of the people who went out to the stores saw that in the aisle, parents were confused about which product to buy for their particular child. They would look at their child. They would pick up boxes. We see them turn the boxes over. They read the back. They try and figure it out. They were so confused because the products had a wide age range. We were competing against EA and Broderbund and other companies who had products as well.

There was Dr. Seuss products and others. It was very hard to figure out, "Is this one going to be age-appropriate for my child?" And everybody, to try and make their products more broad, us included, would put the widest age range we could on the box. I think one of our products in Knowledge Adventure said "Fun for ages 8-108" to try and say it was good for everybody. Well, it turned out by saying that, it wasn't good for everybody. People could figure out if we would be good enough for their particular child. The idea we came up with was, "What about if we make a product that was just for one-year age range? What if we make something called JumpStart Kindergarten that was just for kindergarten. So, just parents who had preschoolers or people in kindergarten or just before kindergarten would know this was for kids who are starting kindergarten. We had a big argument at the company about this. We had argument with the sales team because they thought I can't convince a store to take a product that's for only one-year age range.

It's not going to move enough. I can't convince distributors to take it. But we talked about it more. We really felt this was going to be a worthwhile experiment. We should make JumpStart Preschool and JumpStart Kindergarten, put them in the stores. We'll take the risk. It would cost us 250 grand each to make them and let's just find out. It was a pretty big risk but we did it. The thing sold probably 20-50x our other products, just because parents would come in and pick up the box. There was an aspirational aspect to it where people would say, "Hey, I have a three-year-old.

I want him to do really well in kindergarten. I want her to do really well in preschool." They would buy up. When we eventually came out with JumpStart First Grade, parents with preschoolers were buying that because they wanted their kids. We eventually made all the way from toddler to sixth grade. We had JumpStart Toddler, Preschool, Kindergarten and then 1 through 6. We sold 20 million copies of that. It was a wild, wild success. We would have never, ever discover it had we not been in the stores, seen the confusion of parents in the aisle. It was an enormous risk for our company, maybe not that big a risk because the expense wasn't that great. But we would probably have gotten a pretty big thing had the product not worked out.

But if we hadn't heard from the parents so directly what they were looking for and what they were needing to make a decision, we would have never come up with that. I've tried to reuse that lesson as much as I can in other companies going forward. It was what got me so excited about the Internet a number of years later, about how you can have real-time interaction from Web browser and now with apps. You have unbelievable real-time interaction with customers to find out what they like, to iterate and really deliver what they want. So, I had this big detour in software. I had been starting all these companies. We sold this company in 1996. But every time we had a company, Knowledge Venture was one example of it, I always had these other ideas for things I wanted to do, even Knowledge Venture right around this time, in 1995. Netscape had its IPO. There were 30 million browsers out there.

I was getting really excited about doing things for online. I had this idea for a company called CitySearch. I really wanted to do it. I brought it to my board at Knowledge Venture and I said, "I had this other idea. We can do it in this company." And I said, "It's going to be a distraction to try and do this other idea. Let's just not focus on Knowledge Venture." "Bill, don't you see the more and more we focus the company, the better and better we're doing. The fewer and fewer things we've done, the better the company is done." I really sort of painfully learned the lesson that focus is always better unless you pick the wrong focus. You have to really think about that. Focus really is always better as long as you pick the right focus. But you really have to evaluate if you're really going down a path that is a focus that matches what customers want.

But if you do, I think focus always wins. But I was very unfocused personally. So, I couldn't resolve that problem. That's what led me to start Idealab. Idealab was this technology incubator, where I could be unfocused but I could tell all the companies to be very focused. What I would do is get a separate CEO for each company. I would have them do as I say, not as I do. I would be able to participate in many, many different ideas and brainstorm new ideas. But each company would have a laser-like focus on their one target market and not try to do too many things. It was kind of a weird experiment.

I didn't know if it would work but we tried it out. I got a few investors to go alongside some money I put up myself from having sold Knowledge Venture. We started developing a process. An important part of the process that I realized, one other thing I had realized back from Knowledge Venture as well, on motivation was that whenever we start a new division inside Knowledge Venture, it was very hard to come up with the incentive structure, to not have that incentive for that particular group conflict with the incentives of the overall company. I really felt that equity is such a great driver of performance and such a great motivator that I really wanted to have the most equity available for someone. But at Knowledge Venture, once we had grown to 250 people, almost by definition, the maximum number of equity someone could have was 0.4 percent, just taking the whole 100 percent and dividing it evenly. You can't do that. You have investors and so on. There's a magic that happens when you can get people above one percent in a company. People really feel like they have a significant stake when they have that.

So, one of the other ideas of Idealab was by starting these separate independent companies, it was sort of like manufacturing new 100-percent equity for each project. Each new project that would form as a company, I have a new 100 percent to play with. So, I can start bringing in people with higher equity stakes, albeit smaller companies. But the thing is they have more control and impact over it and that was very motivating to them. So, we started Idealab and we came up with this

process. We would start out and look for big problems and challenges that the world will face. We'll try and brainstorm technological solutions to them and then start prototyping the idea like crazy and then kill a lot of things that don't work. The particular idea that I had at Idealab was to be able to kill things with no negative impact to people because as much as you say that you want to encourage risks and take chances and all that, if people see people getting fired or laid off, when they take a risk, it doesn't pay off, they won't do it. I mean, it doesn't matter what you say, everybody sees what's going on. So, the structure of Idealab was I could hire a bunch of great people in Idealab who are always going to be working on new ideas.

The ones that don't work out, we just shelve and work on new ideas. The ones that pass will form a company and that will get handed off to new people. Sometimes the people who work in the product might want to go with it. But new people would come to it. We have to recruit those new people to come to it. In that way, it made it very easy for people to see that they can take chances on things and try new risky things and they're not going to get fired. That's a really crucial thing if you want to really have some breakthrough new thing. You can't have someone worrying about their job being on the line about taking a risk to try something bold and new. So, that was one of the important structural things we realized when we set up for Idealab. In Idealab, we've done 100 companies over the last 15 years.

Tommy said earlier, those companies at the head of the screen right now are just the ones in the portfolio today. But over 15 years we've done so many different things. We've had some wild successes and some wild failures. We learned a lot more from the wild failures, I can tell you. One of the most impactful companies we had was a company called GoTo. I told you our first company was CitySearch. GoTo was a really great company that we started pay per click. We created pay per click in 1998. People thought that was a terrible idea. In fact, one particular quote, when we first came out with it, in the Wall Street Journal, I think, interviewed by Don Clark, someone from Yahoo! said, "That is the most awful company I've ever seen.

We would never do that in our search results." Five years later, they bought the company. But we really thought it was a good idea. And we stuck with it despite some people not liking the idea at the very beginning. It turned out to be a very big success. There's another company that we started way too early. A lot of companies started way too early but at the right time that the market grew. In 1999 digital cameras were just starting to really make an impact. They were really, really early. But we really felt there was going to be a day when people are going to have a challenge managing all their photos, managing their images. We started a company called Picasa.

It was way too early. We really struggled at the beginning. But we stuck with it and built it. Eventually, Google saw it and Google bought it in 2005. I'm so thrilled. One of the reasons we sold to Google is they said they would keep it up. They weren't going to buy it to kill it. They were going to buy it to grow it and really build on it. We're so happy they did. They've done a great job with it.

It's still the program that I used today. Some of the ideas we started were way too early and they were just way too early. We couldn't survive until the market came and the market was ready for it. We started some companies in 1999 that were really, really great companies in new media and entertainment. But they were so early because there was too small broadband penetration. And too many of our customers were using dial-up and it was too slow. The products and offerings were great. The companies decided to spend their money too fast to try and grow market share. When you're spending your money against the will of what the customer wants, you can't convince them to come if they don't have the right equipment or the right mentality. The companies went out of business.

That's a really big lesson I learned. It's to try and take your cash if you have something that's really great and survive until the market is ready for you, because almost by definition, if you're coming up with something that's novel or breakthrough or ahead of the competition, it's too early. Sometimes, you could be early enough that they're just not ready for you yet. Now you could give up, too, and decide to wait. You could shelve it and wait. Or you could stick it out. There are some companies that seem like overnight successes but they really stuck it out until the market was really ready for them. That was a very painful lesson we learned with a lot of companies. From some of the failures besides those, we learned things about management teams and what kind of skills you need on management teams. I'll talk a little bit about that as well.

So, the biggest pieces of advice I can give on companies starting from some of the lessons. First, follow your passion, one common trait of all the things that I started. It doesn't mean you're going to succeed. But I think it's almost a necessary condition for success, even if it's not sufficient. It's that you absolutely have to be so crazy in love with what you're doing. I say that because every startup is going to face hardship times, really deep, dark days. The only way you may get through it is if you and your team is passionate about it so that you have a reason to continue through those; otherwise, you give up. If I didn't love all the things I was working on, I wouldn't have done those things in the tough days at Knowledge Venture to make it through. If I didn't love the things I was doing on the energy stuff, I wouldn't have stuck it through. So, I believe it really matters that you're unbelievably passionate.

The second one, sharing your upside. I talked about that earlier. I think you unlock so much human potential when you give someone a significant equity stake and give everyone in the company. The teamwork that is engendered and the human

potential that is unlocked when people have a big equity stake is unbelievable. That's a really important thing. We do it in all of our companies. The receptionist, everybody in the company has equity to the company. The earliest receptionist of the company might make 50 times their salary when the company has a big success. That's a great thing to happen and everybody loves seeing that happen. It's just incredible how emotionally gratifying that is, to watch and be part of.

I really strongly recommend that. And then, on the complementary skills on management teams, let me talk to you about that a little bit. So, there are obviously a million ways of measuring the different personality types of people. This is one particular taxonomy. The entrepreneur, the producer, the administrator, the integrator. No person is just one of those four. Everybody is a blend of all of these talents. But everybody has dominance in one and has weaknesses in the other. I'm clearly an entrepreneur. I really love inventing new things, seeing things in a distance and trying to do things ahead of their time.

The producer is the person who actually makes things happen, who actually takes a product and executes on it, who sells it, all the execution stages to get into the customer's hand. I'm very high on the E. I'm actually moderate on the P. There are some entrepreneurial types who have no P. They're just not good at that or even negative. They get in the way of getting things done. That's actually OK as long as they find someone else to complement them who is good at getting things done and then has mutual trust and respect for them so that together as a team, they can get things done. But you have to get the P in the company as well. And then, the administrator, that's a little bit more the bureaucrat. You have to have that in the company, too, to succeed.

It sometimes gets in the way of things but it also helps organize things. The administrator puts systems in place and helps the trains run on time. It keeps the wheels in the bus when things are going crazy, when orders are going gang busters and helps. Any one of these skills taken to extreme is a negative. But any one of these skills in the right balance with others is exactly what you want. The final skill, the integrator, that is the person who is more of a people person, who understands the other three people there and helps those other three people, those three talents get along because very often those other three talents hate each other's guts. Sometimes the E hates the A. Almost always the P hates the A. The P wants to get things done and the A is trying to put a system in place. I'll just give you an example just so you can all sort of self-classify yourself and your strengths and weaknesses on these different things.

Imagine that there's these four personality types sitting together in a room. There's a window over there and they were looking out. The window is over there and there's some dirt on the window. The E looks at the window and says, "Look over there. There's a parking lot. We could build a building." He sees all of the stuff in the future. He doesn't even see the window. The P looks at the window and says, "There's a scratch in the window. That window is dirty. We better clean that, take care of that." The A looks at the window and says, "You know, we can make a form and people could fill out when they see something wrong.

And then, they'll turn that in. That will go in a queue. And then, we'll get that taken care of." The I looks at that and says, "I wonder what those three people are thinking." It really is true. There are many people. I don't do it enough on the I. I have some I but not enough. I find I always hire an I at the company. The I actually is more worried about what other people are thinking or feeling than the actual product or execution or a customer. But that's hugely important. The I is the person who sits in a room when the P is screaming at the A and says, "Listen.

You both have a point here. The P wants to get this done and the A says let's do this," and bridges the gap. That's an important skill for a CEO to have as well, of course, to try and bridge that balance. But it's really important to try and find balance in a company at all those skills. Let me show you an example of what happens in a company that doesn't have all those because I've seen this many times. This is one of the things we learned after so many companies. When you think about this, we've had 100 companies in 15 years, probably 150 CEOs, probably say 300 rounds of financing each. Of all the problems and challenges and products and delays and all the things, the companies that made it had all these skills in balance than the companies that didn't. Let me give you a very specific example. So, a company always starts with E.

An I can't start a company. An A can't start a company. The company starts with a vision of the E person, the entrepreneurial person. The company starts out with that E. It's sort of making forward progress. It's going up into the right because there is a vision there. But then, very quickly, if the E just has vision and can't execute a thing, the thing just fizzles out and turns into nothing. It has to bring this P skill into the company at some point. It could be in a week. It could be in a month.

It could be in a year. But at some appropriate point, before the idea fizzles out, some P skill has to happen at the company. Now, it could be a solo entrepreneur who is an E, who also knows how to program or knows how to build or knows how to do whatever. So, that can be in the same person. But that skill has got to be there. It's usually better if it's in another person who really gets along with E. It really is great when there's a team who gets along. But then, eventually, even if the company starts producing things, starts selling things and starts going, it eventually, too, will fail if it doesn't get some system in place to be able to handle the order, get the money in the bank, pay the bills, pay the employees. Those are all A-like functions. But there's many other A-like functions that have to happen to make the company get past that stage.

But even then, a company will eventually fail because everybody could be at war with one another unless there's enough skill in the company to keep the company going up. One of the things that I wish I had learned when I was in college and life anywhere was what this skill even was and how to learn more about it myself. I never had a class on how to do the conflict resolution between people when they were having problems or even to see good ways of giving people feedback. That's a very, very valuable skill to make a successful company. If you look at some of the really, really incredible companies, they almost always had great teams of people, sometimes, a duo, sometimes more at the top, who really, really had opposite skills but really, really got along. They have such mutual trust and respect for one another that you really got the best out of both of them. You never have any war between them. That really is amazing when that happens. If I were to have any single thing that I would recommend for success in a company, it will be this after, of course, having a decent idea. I even think this is more important than having a decent idea because this team working together can take a not-so-decent idea and turn it into a decent idea because they'll have a method to get from not decent to incredible, whereas a great idea will usually fizzle if it doesn't have all these together.

So, that's one thing that I learned very painfully. I wish I had learned it earlier in my career. I could have made some things that weren't successful. A lot of this learning came to me from a consultant named Ishaq Adesisi, who first thought about this in the life cycles of companies and the different stages that companies go through. You can plot this either in time or a stage of revenues or things like that. But there's a great degree of flexibility. I'm just saying and repeating it a lot of times because I think it's so important. Get complementary skills in your startup. It's very, very valuable. So, now, fast forward.

After doing this for a while, year 2000 comes around, starting many software and Internet companies. I realized that we're really going to have a big resource problem in this century if we don't find a way to make our energy renewable. This was pretty early. This was before a lot of the clean tech interests had started. I started reading a lot about peak oil and things that were going on in the world and realized this would be a big problem. And it really brought me back to my passion that I had in high school. But now, this much later, I had a lot more resources available to me. I had Idealab available. I had team people. Now I have learned how to make companies.

I was doing solar devices, that little tiny thing, solo back then. Now I learned some of these lessons about putting teams together. So, I got excited about going back and trying to tackle some things in this energy challenge. My skill was in software and engineering. Mechanical engineering actually was my degree. But I had never built a real, large solar energy or energy company before. But we built a shop at Idealab. Actually, ironically, Idealab was in Pasadena. Next to it, there was a Korean restaurant. We were able to buy the Korean restaurant and turn the kitchen into a machine shop because it was already plumbed and everything and had all the concrete and the ventilation.

That machine shop was where we began working on the solar energy research. Let me tell you why I thought it was such a big problem that the world was facing in energy and why it has been great a move that has been made but how much has to happen in this next decade. Many of you have seen this before. This is symbolic of man's intense energy usage. Let me tell you some specific numbers. So, the whole planet uses 15 terrawatts. Continuous use, 24 hours a day, 15 terrawatts are being used to provide the energy to all of the humanity. If you divide that 15 terrawatts by about seven billion people, you get about 2200 watts per person. So, every single person alive on the planet is using 2200 watts all day long, 24 hours a day, to power our lifestyles. Now, those of us in this room are using a lot more than 2200 watts.

Many people in deep parts of India are using 50 watts. Those of us in this room are probably using more like 10,000 to 20,000 and if we fly a bunch, probably more like 30,000. If we use a lot of air conditioning and drive a lot, maybe more like 50,000. So, 50,000 watts all day long just making our lives comfortable. And we're mostly burning stuff to do that. Just to get a sense of the energy a typical family has 24 horses running for them at full out all day long, producing energy, if you just convert it to horsepower. We don't really think about the energy because it burns somewhere else to make our electricity. The fumes go somewhere else. The electrons come over copper so we don't see any of it. The big pipelines that bring stuff over is mostly hidden from us.

We go to the gas station. All the tanks are underground. We fill our tanks and drive around. So, we don't see it. If we were actually taking care of and feeding 24 horses constantly, we would sort of be more aware of the energy usage. But we don't. We've done a good job of making it invisible to us. Another interesting statistic on what's happened just in the last few years. In the United States, there is now 1.8 people per household and 1.9 cars per household. So, we have more cars per household than we do people.

We love taking our bodies, wrapping them in two tons of steel and moving it somewhere else. If you think about how much energy we're doing to carry that two tons of steel along with our bodies, it's just unbelievable. And yet, we just do it because it's relatively inexpensive. You know we've come up with a good way to make it not cost that much. Now, the problem is, if we run out of stuff that's going to cost a lot. It's going to cost a lot of resource battles, a lot of fighting. Here's why I think we're going to have some of those challenges. Jump forward to 2050, it's estimated that we're going to need 50 terrawatts. The 50 terrawatts is not so much because of the population growth, because people believe the population growth is going to slow down and

we'll only be about nine billion people by 2050. So, even with conservative population growth, we're going to need 50 terrawatts because we're lifting so many people out of poverty.

And the first thing people want when they get lifted out of poverty is they want their car. They want their plasma screen. They want their iPhone. iPhone doesn't use that much energy. They want all the electronics that we have and all the electricity production that we have. If you take the number of people in the planet times somewhat closer, not quite our standard of living but even a little bit, you'll get to 50 terrawatts. So, there's a 35-terrawatt gap between the 15 terrawatts we're burning right now and where we need to get. There's only a limited number of places that can come from. Of course, we can burn things to get there. But we're going to run out of things we can burn.

So, there's only a limited number of places. There's nuclear, geothermal, wind, tidal, biomass and solar. Each of these only can contribute about two or three terrawatts. The reason why it can only contribute that much is because you build a nuclear power plant, a gigawatt nuclear power plant. If you build one nuclear power plant every other day for the next 35 years, you'll only get to a number sort of in this order. It takes about seven years to permanent nuclear power plant because you're not going to build one every other day. So, you just can't get 35-terrawatt gap from nuclear, from any of these. For geothermal, you can put a geothermal power plant at every single site on earth where there's heat underground and you get about two terrawatts. I'm not saying we should do it, we have to do it. But you don't get 35 from there.

The same thing with wind. You go to every single high-wind location on the planet, put a wind turbine, every single one, and you get relatively low, three terrawatts. Tidal power, biomass. If you go make a biomass plant, almost everywhere where we grow food, you can get to these three terrawatts, still only a tenth of what we need. The sun, however, strikes the earth with 15,000 terrawatts, a thousand times we're using right now, 500 times the 35 terrawatts we need. It's the only one that can really make up that kind of gap with a very tiny fraction. And yet, why don't we do it? It's because it's too expensive. If you go back and look, solar is the most uniform natural resource. Maybe except for air and dirt, solar is evenly distributed across the whole planet. The very, very top of the planet, the very, very bottom of the planet, there's not much sun.

But almost everywhere else, there's enough sun to do this with. And everybody gets it. It's not like scarcity like other of our natural resources. The sun goes to everybody. So, it's a really fair resource as well. But it's very, very hard to convert cost-effectively. It also takes a relatively small amount of land. People talk about how much land it takes. But you can power the whole United States with a square of 83 miles by 83 miles. You wouldn't put it all in one spot.

You spread it around. It's a relatively doable amount of space. Of course, you can power all of Europe with a square about the same size, actually a little smaller, in the northern Sahara Desert. So, you can really practically make it happen if we can get the cost right. The problem has been that it has been too much. Earlier this decade, solar was costing about four times other ways of making electricity, for example. Now, it's down to about two times. We've made a lot of progress in the last eight years since this chart came out or the last nine years. But it's still two times too expensive. So, the way solar has been going so far, it has only been with subsidies.

I really believe that solar energy is just a novelty until it can beat the price of fossil fuels without subsidies. There is a lot of interest around the world. But the governments don't have the money. And the amount of money is too great to be able to subsidize the gap between the cost of fossil fuels and solar. But once you cross the prize of fossil fuels with solar, then it will take off wildly because then it will be an enormous profit opportunity. Even if you beat the price of fossil fuel-generated electricity by 100th of a cent, that will be unbelievable. You don't even have to buy a lot because it's a commodity. You buy the commodity by a little bit and then just have people flock to that because they can make a profit there. So, there's an unbelievable opportunity if you could just get that last factor of two out. People are working on it.

There's a lot of different ways we're going to get there. I'll talk to you about some of them. And I'll talk to you about one that I'm working on. The breakthrough to get that last factor of two, it could be some kind of chemical breakthrough. It could be some kind of solar paint or some kind of solar plant. It could be the biological breakthrough, some kind of organism. It could be a physics engineering breakthrough. It could be all of these. And I think it's going to be all of these. I think the opportunity is so big that we have to invest heavily in all these areas.

I know a lot of that investment is going on here. I'm going to talk to you about one particular new weapon that I think we have in the solar arsenal to try and get there. This new weapon in the solar arsenal, I feel, is Moore's Law. Let me talk to you about some other resources and their trend lines. If you look at coal, it's going up. Oil is going up. Natural gas is going up. Steel, gold, metals, everything, food, corn, rice, everything is going up. The one thing that's going down consistently over the years, the price of computing power is going down so much while everything else in the world is going up because everything else is a scarce resource. Computing power, the way we've been able to use our brain power to fit more in less space means that cost is going down so dramatically.

How can we use this? How can we use Moore's Law to drive down the price of solar energy? I started thinking about that a

lot. I started thinking about how could I take the one thing that's going down in price and apply that to solar? You can't apply Moore's Law to PV panels, to photovoltaic cells, because PV panels don't have microprocessors on them or in them. They're not taking advantage of the density that Moore's Law brings. They're taking advantage of maybe a slight reduction in the cost of silicon. But that's again a natural resource that's not going down. PV cells are based on area of usage. You just need a lot of area. Well, that means you have to use all of the heavy, intensive energy process and chemical process to make the cells on a large area basis. Well, we need to come up with some way to apply Moore's Law that doesn't need the area, some way we can use a small microprocessor to leverage against something that's big. So, that's what I started working on.

I took a look at the taxonomy of all the different types of solar things. Over here on the left, you have photovoltaic techniques, silicon panels, thin film panels, concentrated PV panels. Over here on the right, solar thermal. You have dishes and troughs, parabolic troughs and linear fresnels, concentrators and power tower. I looked at all these things. Way over here, this has the highest efficiency, the solar power tower. The solar thermal power tower has the highest efficiency of solar conversion in the high 30 percent you can get. So, I figured if there's any place to try and apply Moore's Law, it would be way over here on the right. That's what I want to try and do. How do you apply Moore's Law to this high-efficiency solar conversion system? So, this is the company we're creating to do that.

It's called eSolar. There's a picture of an eSolar plant in southern California. I'll talk to you how we apply Moore's Law to this. The typical solar power plant at the solar thermal concentration takes a large mirror, a big parabolic mirror, that is about the size of a tennis court and tries to track in two axes to concentrate sunlight to a single tower. But that requires huge construction in the field. We thought, "What if you take that mirror and break it up into lots of tiny mirrors?" Now, all of those would have to be controlled separately because they all have to move differently over the day to redirect their light to a single point. They're not all moving together. They're moving differently. But that's exactly what microprocessors would be good at. What if we put a microprocessor in every single mirror? So, compared to doing this big assembly in cranes, an assembly in the field because this is larger than can be shipped.

This is larger than a shipping container. Each of these things could be smaller, we could deliver it. And this is what we came up with. A system that comes out. These things get pulled out of a shipping container. They get unfolded like an accordion onto the field and get bolted down to a bunch of ballasts that are sitting on the ground and just use a regular wrench to tighten down, so just regular hand tools. We get rid of all the heavy equipment. Then, you walk down the aisles and put the mirrors on. They're all crooked and in different angles and everything like that. But we're going to use software to try and straighten that all out.

This is what it looks like at the ground level. You can see these racks that have all the wiring in it in advance, double-access actuators and some plain old one-square-meter flat mirrors. So, we don't have to curve the mirrors anymore. We don't have to make a parabola in metal and in glass. We're now going to make a parabola in software. We're going to concentrate the sunlight dynamically with software. And the way we do that is this. We, again, take advantage of Moore's Law, too. Today you can buy high-resolution sensors. You can put on some towers in the corner.

Those sensors can look at all the mirrors and really detect every single mirror with an image recognition pick out each mirror, with a GPS time clock figure out the time of day and where the sun is and look at the reflected beam coming out of each mirror and in real time compute the angle of every mirror. We can do it way, way higher precision than you ever could by observing where the mirror is the way it has been done in the past. Now it requires a \$2 microprocessor in every mirror. But a \$2 microprocessor is now negligible, an off-the-shelf product. Even 10 years ago, it cost \$5000 per mirror and you couldn't have done it. But today it costs \$2, which is unbelievable it has happened that Moore's Law allows this to take place. We can point the mirrors much more precisely, which means higher temperatures and higher efficiency, less spillage of light at the receiver. We can just get much, much more cost-effectiveness because we can have lighter structures, less steel and less labor, all made up for by microprocessors. So, what it looks like as an example, when you first put down this row of mirrors, this may be hard to see back there, but on the left because the ground is a little bit not flat, because the metal has thermal expansions, a little bit crooked, because the mirrors have end stops that aren't exactly aligned, the best you can do with lining this up, the mirrors are accurate plus or minus about three degrees. But then, after you run the software and command the mirrors to go flat, you can see here this row is accurate to a 20th of a degree.

About the most accurate anybody ever achieved with this method was half a degree and now we're at 20th of a degree. So, we're 10 times more accurate just with a \$2 microprocessor in every single mirror. So, it really, really has cost a big difference in cost, a big difference in performance. This is what the whole plant looks like. Here's rows of mirrors. You can see the parabola is made and all of the mirrors are all slightly curved. All the light from the sun is reflected up to the tower. Up at the tower, it's immensely hot. And then, we make a steam then run a steam turbine at high efficiency and take the electricity and go into the grid. This is a five-megawatt plant, this one in Palmdale, California.

We now have an order for a 1000-megawatt in India and 2000-megawatt in China. The one in India is already under construction. China will begin next year. You can imagine how proud I am of this. I started with my little tiny stuff back in high



school to be able to walk in a field like this. It's an eerie feeling actually because it's very quiet. You don't really hear much because there's these little tiny motor actuators moving the mirrors. The steam, of course, you don't hear any of that in the tower. There's an immense amount of thermal energy up at the top of the tower. It's very, very bright.

But it's a really, really amazing sight to see, to be able to take Moore's Law, apply it to an old idea but really drive down the cost and hopefully get us there. We're within striking distance of the price of fossil fuels right now. With some additional storage techniques and additional production, we should be able to get to the price of fossil fuels in just three to five years. Now this is just one way of doing it. There's many, many ways. We encourage all of them. But I was just really excited to share with you this one particular angle of how you can take entrepreneurship, Moore's Law and technology, apply it to relatively static field and solar energy and try and make a new way to try arbitrage technologies to try and make a breakthrough. In quick summary, I really do feel we have to get to the majority renewable energy this century. The only question is whether it's going to be painful or respectful to get there because we're going to get there by force one way or another. It's just going to be how problematic.

If we apply foresight and start working on it all out this decade, we can make it be with less pain. And it's not just about climate change. It's about resource wars. I mean, even if you're not worried at all about climate change, we need to get there anyway because we're going to have big fights over the stuff we burn if we don't get there because everybody is going to want to live like us. We have everybody in the planet wanting to live like us. There's just not going to be enough to go around. It's very, very hard to compete with fossil fuels with no subsidies but it's possible. I really feel that should be the goal of this decade. And I personally believe, as I have told you here, innovation, engineering and science, that's the way to solve this problem. I think not laws.

I don't think laws forcing people to do it are the way to get there. I think innovating is the way to get there. I actually personally believe that entrepreneurship is the best way to mobilize great minds to do this problem, but actually I think to mobilize to solve almost any problem. So, I really encourage that. Thank you very much. You've been a great audience. Well, it's really an honor to be here. I'd love to answer any questions that I can for you on any front, on energy, on entrepreneurship, starting companies, challenges we had, anything. Yes? What do we do about the problem of currently the concentration of wealth? Will this industry be able to work against that or is it going to be more of the same? Question on the concentration of wealth. I think this industry actually can combat that.

My belief is that it would because the resource is so distributed. The system has to be put where the people are. So, unlike other wealth, which is concentrated in a country, and then someone hoards it and then throttles it out to people by selling it around the world, rare earth metals or oil or anything, this has to be placed where the resource is, where the people are. So, I hope that this would lead to a more even distribution. I'm not sure that it will but I hope that it does. First, I just want to say that it was really cool just to get your presentation. I actually used the JumpStart stuff when I was a kid. Oh, great. So, when I saw it up there, I read about it. That obviously feels really great.

I hope you enjoyed it. I mean I'm at Stanford now. We didn't put that on the box. Use JumpStart, get into Stanford. But I just also wanted to say, so I was reading about Idealab. I'm in the MS&E178 class. We have a discussion before each of the speakers come in. One of the questions I kept coming up was the fact that Idealab is like something between a venture capital firm and a startup incubator and the one big difference is that you guys don't take outside ideas and come up with your own ideas. Obviously, it has been successful so far, especially since a lot of the companies that had been shown on the slides have been acquired or have done well themselves. But I was just wondering, do you ever think that it's a competitive advantage that you don't take outside business proposals, that you don't spend the time with VCs meeting entrepreneurs? Or do you ever feel that idea generation becomes stagnant with all of the staff at Idealab? Question about the idea generation and taking ideas from outside.

I actually think it's a competitive disadvantage that we wouldn't take ideas from the outside and meet outside entrepreneurs. So, we're actually starting to do that more. The reason we did it was not because it's smart or not. It's just we had more ideas we wanted to do than we could find people to do. It has been my problem all my life. Just every week, we're coming up with a new idea. We would do 52 companies a year, if we could. It's just finding talent to execute on those ideas that is the bottleneck. So, we are having people come to us from the outside with ideas. Sometimes, that idea merges with one of ours.

Sometimes, we'll found that company separately. But I really think of what we do as we're really trying to be more of a lab, where we have the chance just because we like it. I'm not saying this is a good business model. We just love doing it. We love being in the part of experiencing new idea generation, trying them out and seeing what works and doesn't work. That's just fun to us. The other aspect that we're trying to do is we're trying to make a big impact. So, we actually are looking probably in our criteria for going forward with an idea, will this idea be something that someone else would never have done, because then we can make more impact on the world. As soon as we call an idea is a great idea, test out on a business model. But it's sort of close to what other people are doing.

So, even if we can make an OK business, it's just not interesting enough for us. Again, that's just our choice. So, we're trying to judge on impact, not ROI, sort of impact on ROI. We try and find ways to meet great people who can help us do the things that we think will have a big impact. Can you expand a little more on the idea generation in the idea sense? I mean, do these just come to you or do you have a methodology with this? Well, a lot of them are things that I personally want. I mean, I really have to say even pay per click was something that I personally wanted because we had other companies and we were trying to find ways to market more effectively online. I needed that as a way. So, many of the things are things that we find a need for, that we see there's a big need, at least for us, because we feel it's very hard to predict what someone else might want. But to talk a little bit more about that idea generation part, we have regular brainstorming sessions. We have 50 people in Idealab.

There's about 15 people, the core, who really are involved in the brainstorming. We have these sessions. A lot of the ideas we come up with, we can't carry out but we patent things still. Maybe they'll get useful later. We bring in outside people to brainstorm with us. I've had a brainstorming session with Nathan Merville, Vanilla TruVentures, to try and brainstorm new ideas. But what I mostly do is I just read everything. So, I'm just always reading everything and looking at what's going on and seeing what else people are doing and trying to find new ways to combine different things that I see happening. With this new technology and this problem and this, there's something new there. That's the way I try and come up with them.

Can you talk a little bit more about the methodology you use to compare various ideas that you generate? To air? Compare. Compare? Oh, yeah. How do you objectify their ideas? That's a good question. How do we objectively compare ideas? It's very hard and it's very emotional, for sure, because I said, one of our metrics is impact. Sometimes we look at two ideas. One has a better business opportunity. But we look at it and say, "I think this is going to change the world more. It'll be better for people, better for humanity. Let's do that." We have a company we started called Duron Power. It's a company that is making very small-scale solar solutions for villagers in India and Africa.

It's a \$99 product with a solar panel and battery and lighting and cell phone charger and fan. We're not going to make very much money on that. We're selling it for maybe a few dollars more than we make it for. But we can have a million families have that, it will have a great impact. So, we chose to go with that when even though it wasn't maybe the best economic one. So, measuring that is one way. The other way we try and compare is we do business models and projections and forecasts. We, of course, do that. We do focus groups. We test on people.

The thing we really like to do, I don't know if we're known for this but is the thing that I'm most proud of what we do, is we try and find ways to come up with the absolute minimum viable product and test. I think you guys have heard that variation thing before. But I'll give you one specific story. One thing that I want, going back to things I want, it's like 1997 or 1998, I think. People were starting to use credit cards online and that was taking off. But still, a lot of people were scared about turning credit cards online. I wanted to get a new car. I didn't want to go to a dealer. I just hated the hassle of going to a car dealer. I've been so messed up by all the lies and everything that I got from going to a car dealer.

I wanted to go to a website. I wanted to do the whole transaction website. I wanted the car show up at my house and flat via a truck. I thought that's the way the whole transaction should occur. I told people that idea. They said, "That's crazy. I don't think people do it. People aren't going to buy a car online. No one is going to use a credit card. No one is going to put a deposit of \$1000 down without seeing the car." And I said, "Yeah, I think they will because I'll do the research and I'll figure out what car I want.

I know what I want, I'll configure it and I just want to buy it." That was the concept that was called CarsDirect. We had a lot of disbelievers. I gave a particular CEO that we found a budget of \$100,000 and 90 days to see if someone wants to buy a car online. The idea was to make a website where you could configure some cars and we'd see if people had put in \$1,000 deposit. Then, if they did, we would sell them the car. He kept on coming back to me 30 days and, "OK, we're talking to car dealers about this and getting supplies." "What are you talking to car dealers for? I just want you to make a website." He was just talking to find out how to find out how to become a dealer for Ford and dealer for Honda." "We're not going to do that. We're just seeing if someone wants to do it." Then, he came back in 60 days, "Well, I'm working on this." On the 80th day, I said, "Just put the site up. If someone buys a car, put it up at the end of the day. If someone buys a car by the morning, we'll the site off and we'll go buy them at the Honda auto mall down in Monrovia and we'll deliver the car to them. We are not trying to actually sell a car." So, he finally put the site up one Thursday evening.

I remember coming in on Friday. He came up to me silently, "We sold four cars." I said, "Hurry up and turn the site off." Well, we saw that people wanted to buy a car. They didn't know that we were driving down to pick up the car. That didn't matter. Then, we turned the site off. Then, we built out a system because the test worked. We found out that someone actually would do that. I really, really try and do that all the time with the companies, like how can you find out in some fake, kludge way do people really like what you have. And then, go build the whole thing if they do. But don't build the whole thing first and then find that out afterwards.

Clearly, all sorts of brilliant thinkers are working with you. How do you put the ideas out that you can't pursue yourselves for other people to pursue? Yeah. That's a really good question. We don't do enough of that. I'd like to invent a company to do that. I would like to invent a company that could allow people to come together around ideas and sort of self-organized around ideas that we come up with or that other people come up with. I'm thinking about that right now. It's in the early stages but stay tuned. There might be some way to be able to do that. In modern breakthroughs, so I was curious you mentioned you decided to eventually sell it.

Can you describe what was like, when you, your first company you started to feel like you fashioned... it was your baby. So was it hard to make that decision? It is always hard to make that decision. It's hard now that we have Idealab where sometimes a company grows up and moves out of our building. It's sad. It's our baby. But I have experienced that with my kids now. So, I have experienced that with our companies. It's a lot like that. With Knowledge Venture, my brother took over for me.

So, I felt like it was in good hands. I really, really wanted to try this Idealab experiment. I really wanted to try this thing where you could do multiple companies under one roof at one time. I had always been starting companies in my life in series and I wanted to try doing it in parallel. Because my brother was there to take over for me, it was a great way to make it happen. You were talking about failure and having ideas that are just a little bit too early for the market. I'm just curious about one of those failure stories. Speaking to entrepreneurs who maybe don't have another company around them like Idealab to keep them going for a couple extra years, what is your advice for how do you know when to stop? Well, let me do the last one first. It is really, really hard to know when to stop. I mean, the hallmark of success is perseverance and sticking through the tough times.

But it would also be a hallmark of stupidity to stay with something too long when all the indicators and all the signals are saying there's no market for this. I have experienced that many times. We have had a bunch of companies. We had a company Omnilux, which was doing optical mesh communications. We had a bunch of different companies that we just tried and tried and tried. We were always close. It always seemed like the order was around the corner. It is so hard to tell, so hard. We had another company, RayTracker, that we started. It was making solar energy tracker.

We were just always about to get a customer. It just wasn't happening. It was just starting to crash just now the economic crash in the last few years. The product was good. It seemed like sales were coming. We had a pipeline but just no one could get their financing. We just stuck with it and stuck with it. We had so many tough decisions, tough board meetings where we really thought we should kill it. We kept on putting money in. And then, the quarter turned a little bit in 2009.

It got a little better. Then, the company sold the first solar a few months ago and a great exit for us. That was a success story where we stayed. There was an equal other story where we stayed and we felt the same emotion and it failed. So, there is no simple thing I can look at and say, "You know, if you see this sign, it's going to make. If this sign, it isn't." It takes a lot of luck and timing to make everything work out. It just takes really digging down and looking at all the circumstances. I would say probably the best thing is getting outside advisers that you trust to look at the situation with you so that at least your own bias because, of course, you're in love with the idea. Your bias isn't the only thing looking at the idea and you can listen to other people. It doesn't mean you should listen to them blindly.

But it means you should hear the other voices. We brought in some outside advisers in this particular case, who thought, "You know, this really does seem right. The team seems good. The price seems good. It's worth sticking with it a little more." I remember putting in like extra \$1 million. We made it and then it turned the corner. And then, it was a great success. On the first part of your question on some lessons from a failure, it's almost always a team or running out of money. Team issues, when the team doesn't get along or doesn't have all the skills or team spending too fast and doesn't conserve cash. The first one is probably the harder one because finding great people that have all the skills is always hard.

The second one should be easy. But sometimes people are often so worried, and this was one of the excesses of the dotcom crash, about, "If I don't spend the money now, I'm going to lose the market share. It's about to go away. It's going to get way more expensive." That's always the excuse for spending faster. I haven't seen too many cases where that works. It does work sometimes. I mean, there are cases where there truly is a race to a winner-take-all-like market. But usually, the better executor with the greater persistence wins. So, I would say those would be the two biggest lessons from a failure. With tens of companies under your roof at one time, how do you scale your own talent to be able to touch each one in a real way? Well, that's really hard.

But it's what I love to do. So, I try and give 25 percent each to 10 companies. I work a lot. I'm always in contact with all the CEOs. I meet with them periodically. What I found for me the way it works is I try and only be involved in the very important strategic and product things and not involved with more of the minutiae of the company. I'm really not involved in the finances or HR or the things. I have other people in Idealab who take care of that. So, I really try and focus on that where I have the most value at and the stuff I love the most. And then, I really try to be available more impromptu like sort of just in time.

So, I try and stay aware of what's happening in the company and give a piece of wisdom or experience right when they're having that problem as opposed to trying to, "What I'm doing here is I'm trying to give you examples." These might not apply to you at that particular moment. But if I give you a really laser-like focus-targeted thing when you're having that problem, it can be very helpful. So, I try and do that for the company as well. Having them in the building is pretty great, though, because then I can just walk around. A lot of VCs like to have companies within 30 minutes. I like to have them in 30 seconds, just as I am walking around at lunch. We have a bar at the company where people hang out. They're just all around. I just hear things and see things going on. So, I can be connected to them very, very casually.

That's one of the things I really like to do. One more question, Bill. Yes, right here. So, you observe companies going from birth to finished product. And you get this with a bunch of different companies all the time. Is there a particular state of the development process for each company that's really enjoyable for you or pretty much at least is unenjoyable? Well, for me, being the E off the charts there at the very early stage, I love it. I love seeing an idea go from nothing to something. All the hard work after that, that is not as fulfilling to me because I get so much leverage in that first stage. So, I love that part. But there are people who love each part.

You have to get the people together who love each part. And that's where the complementary skills comes in. But whenever there is a tough challenge, that's when I get excited. When I could be juggling in my head all the different ways you could solve a particular problem, that really gets my juices flowing. That's where I love to be called into the room. Thank you very much. You've been a great audience.