**Stanford eCorner**

**Sergey Brin (Google & Alphabet) – Google Origins and AI Futures [Entire Talk]**

**Sergey Brin, *Alphabet***

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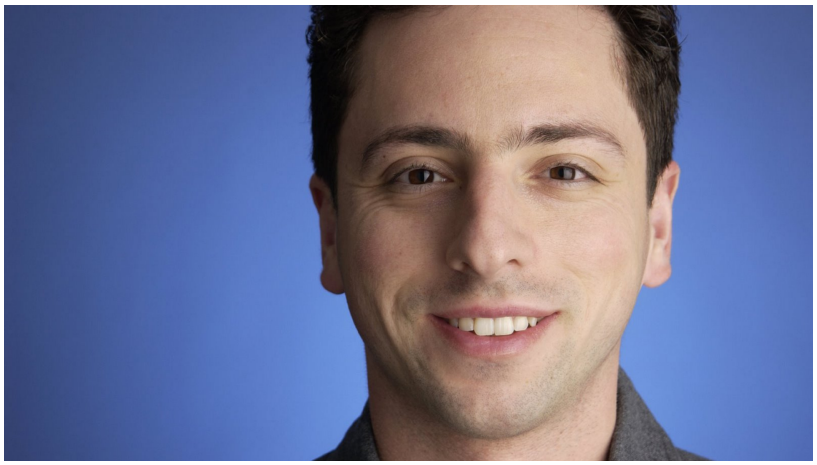
Recorded live at the capstone celebration of the Stanford School of Engineering Centennial, this ETL episode features Sergey Brin, the American computer scientist and entrepreneur who co-founded Google with Larry Page and revolutionized global information access. Brin remains an active co-founder and board member of Google's parent company, Alphabet, and he has been involved in Google's Gemini artificial intelligence efforts. In this conversation with Stanford President Jonathan Levin and School of Engineering Dean Jennifer Widom, Brin tells stories from his Stanford years, shares insights from throughout Google's history, and gives advice for students and aspiring entrepreneurs – including his perspective on the AI landscape.



## Transcript

(upbeat music) (upbeat music continues) (people clapping) - Welcome everybody. This is the closing event of our centennial year. It's pretty exciting. I'm Jennifer Widom. I'm the 10th Dean of Engineering, and you can do a little math there and figure out we deans like to stay around for a while here. It's been a great year. It's been a year of celebration, reflection. Looking to the future. For those of you who haven't heard about the history, we've had engineering at Stanford since the beginning of the university, 1891. We started with chemical engineering, electrical engineering, mechanical engineering, and mining and metallurgy.

And it was in 1925, 100 years ago, when those four departments were brought together to form a school. And those four departments are still with us today. One of them has been renamed, it's now Material Science and Engineering, rather than metallurgy. And we have five more departments and many, many interdisciplinary programs. We've had events throughout the year to celebrate the centennial. They've been fantastic. We started with a panel with the five deans of the 10 who are still with us. That panel was moderated by Jerry Yang, who I think is here today, a great friend of the school. Our second event was on May 15th. We had a big party out on the quad.

We expected 2000 people. We got 3000. And we didn't run out of food. We had a great showcase of projects and research. The next event was a fireside chat with Jensen Huang and John Hennessy. That was actually on this very stage, around the end of May. We partnered with Stanford football and had a school of engineering themed football game. Nobody told me when I took the job as Dean that one of my jobs would be to drive a motorized couch on national TV with Andrew Luck as my passenger, but I nailed it and that that was great. We had on Reunion weekend, a trivia contest on the history of the school. The alums enjoyed it.

And now this is our closing event. If we look back on the hundred years of the School of Engineering, obviously the formation of Google was a shining moment. Sergey Brin, who you'll soon meet, met Larry Page when he visited to think about coming to our PhD program. That was in 1995. They worked together on a project called Digital Libraries that was funded by the National Science Foundation. So if you ever have any doubt about the impact of federal funding, Google came directly from an NSF project. We all know what happened next. They developed an algorithm called BackRub, which became PageRank. And by the way, that server right there is the first server that ran the PageRank algorithm. So a bit of history right in front of you.

We're gonna hear more about that time shortly. But I do wanna say that's only one example of the entrepreneurship that has happened across the decades and the the year, the century of Sanford Engineering. Thousands of other companies have been founded by students, by faculty, by alumni. They've generated literally trillions of dollars in economic growth. And that foundation was laid by the third Dean of the School of Engineering, someone by the name of Fred Terman. Fred mentored William Hewlett and David Packard. He also mentored the Varian Brothers, and he also helped establish the Stanford Industrial Park, which is now known as the Stanford Research Park. Still going strong today. So many breakthroughs over the

years in Stanford engineering in aeronautics, electricity transmission, microwave radar, semiconductor work that really sparked Silicon Valley, cybersecurity, that all of us rely on, internet transmission protocols that all of us rely on, the foundations of AI, bio electronics, lithium ion batteries. The list goes on and on, and there's surely more to come.

Now, I do wanna acknowledge that when we look at the work that we do, a lot of the details are really done by students. And today's event is also a class. More than half of the room here are students in the Entrepreneurial Thought Leaders Program at Stanford. And I just wanna say to the students, you're the sequel to our histories. So thank you students for coming. (people clapping) And today's conversation is also really about students. John Levin, the president, who you'll meet shortly, and Sergey Brin, we're Stanford students just like all of you. Today, they're helping define the future of technology and the future of education. So this is really an ideal way to close our centennial. Now I wanna set the stage of the early 1990s when Sergey Brin arrived as a CS PhD student, computer science.

Email was just becoming the way all of us were communicating. Entrepreneurship was just beginning to accelerate. The sixth Dean of the School of Engineering, Jim Gibbons, hatched the idea for the Stanford Technology Ventures program, which hosts the class that's here today. The Science and Engineering Quad was on drafting paper at best, maybe just in people's minds. And by the way, I arrived the same year that Sergey did. I joined as an assistant professor in 1993. There was also an undergraduate at Stanford beginning his senior year that same time. And that was John Levin. And one wonders was he thinking he'd eventually become the president? Who knows. John was an undergraduate in math and English here.

He went to get his PhD at MIT and returned as a faculty member in 2000. He was chair of the Economics Department, the Dean of the Business School, and became Stanford's 13th president in August of 2024. I wanna say that John is really a wonderful champion of the School of Engineering. He's been so helpful throughout our centennial year. He deeply understands our culture and our spirit of entrepreneurship. So it is my pleasure now to bring John Levin, president of Stanford, and Sergey Brin, to join our conversation. (people clapping) - I'm John Levin. It's great to see all of you here and to have this chance to celebrate the final event of the engineering school's centennial year. We have an extraordinary guest and fitting guests for the final event of the centennial with Sergey Brin, who really needs very little introduction. But I thought I might just start before we get into questions with Sergey, to roll the clock back to, as Jennifer just did.

She gave such a wonderful sweeping history of the school, but to roll the clock back to that particular moment in the 1990s when Sergey came to Stanford in 1993 as a PhD student. Jennifer was a new faculty member. I was a Stanford undergraduate at that time. I was a senior in the fall of 1993. And some years ago a reporter for the New York Times wrote an article about my Stanford graduating class, which was the class of 94. And the gist of the article was, it was, I hope that's better. The gist of the article was that it was the most fortunate grad college graduating class of all time, because we graduated at a moment that was on the cusp of the internet and technology taking off. And we were right in the middle of it in Silicon Valley. And the reporter called me when they were writing that article, it was about 10 years ago, and said, "I wanted to talk to you about this." At the time, I was a faculty member at Stanford. And she said, "You're the first person that I'm calling about this article." And I said, "Look, I'm, I'm really sorry to disappoint you.

It's true, I was at Stanford in the early nineties. I was in the class of 1994, but I was clueless at the time. And in fact, I left Stanford in 1994, and I went to be a graduate student at Oxford in England, a country where they had forgotten the technology for the ice cube. And by the time I made it back to Stanford, which was a few years later in 2000, you know, things had already taken off. So I really can't help you." And she said, "Well, don't worry about that. I like to start these articles by talking to people on the periphery, and then I work my way in." (people laughing) So if I was on the periphery, there were a few people who were at the absolute core of the internet revolution. And and there's no one who was more at the center than Sergey Brin, who did see the potential and the future of where technology could go and did something extraordinary and world changing, of the kind that we, you know, we hope many people, has been done many times from the engineering school, and we hope will happen many times in the school's next century. So, Sergey, thank you for being here to be part of this celebration of the school. - Okay, you guys are flattering me way too much. I think there was a huge amount of luck there, but anyway, thank you for hosting me.

It's a pleasure to be here. - So let's go back to that time and take us back to, you're a graduate student at Stanford. Tell us a little bit what it was like to be at the engineering school and how it helped to shape you and open up the opportunity to create Google. - In hindsight, maybe I didn't appreciate it at the time, but it was a very creative and free time, I would say. We started in, or I started my PhD program in Margaret Jacks Hal. So on the main quad actually. And this old kind of building with, you know, creaky little rooms and doors. I learned how to pick locks there thanks to the MIT guy to lock picking. And yeah, I'm kind of surprised honestly how much freedom I was given in hindsight, because I, you know, I could spend my time. Initially I was trying to reverse shredders, like, you know, you shred your documents and then scan it and put it back together.

I never fully got that working, actually, but I don't know, nobody ever told me not to do that. I had a couple advisors over the years, Hector, I'm sorry, he's passed away, but what a sweet heart he is. Yeah, what a nice guy. And then Jeff Ullman. And they, I don't know, I guess they would periodically ask me what I was doing. Yeah, they didn't really put many limits. When we moved to the new building, the gates building of computer science at SAIL, it was a little bit naughty back then. So I knew my lock picking days were over because you had these electronic keys with the little, you know, infrared things. Do you still have

those? Or did they change 'em out? Still? - They're there. - Okay, so they were, the locks are not actually networked, so it actually trusts the key to tell it if it can open the lock, or at least back then they weren't networked.

And I doubt they've changed since. But nevertheless, they were electronic and complicated. So just when we were moving into the building, there was a scaffolding outside. They were still finishing some stuff, but all the the doors, all the offices, they were locked with these electronic locks that I couldn't pick, except the balcony lock to the room that had the computer that would stamp out the keys. (people laughing) So I climbed out, I know the statute of limitations has passed. I hope so. I could tell the story. I climbed out, you know, from my office on the scaffolding. Like we, you know, I had to do this. I knew they were gonna take the scaffolding down like in the next week, - [Jennifer] Weren't we on the fourth floor? - Yeah.

- [Jennifer] Okay. - But it was like a real, you know, scaffolding with like all the, I don't know, seems say I don't, I was a kid. That was the judgment I had. So anyway, I climbed over to the balcony, picked, that one was a physical lock, probably still is. Got into the computer there. I think I made a copy of all the software on the computer, like made myself a master key and then erased the copy. And then for a while the master key worked for kind of everything, but. - And I thought all you were doing was rollerblading up and down the hallways, which you were also doing. But yeah, okay. - But the scaffolding I didn't try with skates on, that would've been, that would've been too much.

- Your career could have gone in so many different directions given the. (people laughing) - [Sergey] Yeah. - Education you were getting at the engineering school. But it didn't go in any, just any, the lock picking and career as a CIA agent or something, it didn't fully materialize. Tell us about how it did materialize. The, I mean. - I think what, you know, we worked on the ideas behind Google for a number of years, starting probably like in 95, and kudos to Larry to like really focusing on the link structure of the web. But at the time, the web was the new thing and everybody would do, you know, it was so easy to create some new idea. Like I think my first moneymaking idea was this pizza ordering, you know, it seemed crazy at the time that you could order food online. Nowadays we take it for granted.

And as a joke, I like put a coke ad at the top. I thought it was ha, ha so funny. There'd be internet ads. But obviously, yeah. Turned out to be not that funny. (people laughing) Anyway, it failed quite profoundly because like the way it worked is you'd put in your order to the website and then, you know, pizza places were not online generally speaking, but I had this idea they had fax machines, so it would automatically send them a fax with the order. But then I realized they don't actually check their faxes very often and it flopped from there, so. That didn't particularly pan out, but it was, you know, at the time, like I guess all of us probably in the computer science department, like understood how the internet worked pretty well. How, you know, web servers worked. Like you could whip one of these out really quickly.

So everybody was just drawing stuff on the web. It was just a very creative period. Anyway, so Larry was focused on the link structure. I was working on data mining at the time and we joined forces. And you know, soon enough we found we had something that was pretty useful for search, but we spent a while just experimenting with it at Stanford and like thinking to make an academic project or not. We tried to, you know, license it to various internet companies. One time we had pitched it to Excite and Vinod Khosla to his credit thought, hey, this is great, you guys should buy this. But Excite wasn't very interested. But we had an email back and forth with Vinod and we sent a note and said, okay, we'll you know, We'll license you the technology for $1.6 million. And we got a reply like 15 minutes later saying that, "Oh, that's a lot of moolah," but okay.

And we're like excited. To graduate students, that was a lot of money. And then our friend Scott at the time, there were four us working on it. Scott and Alan were the other two. They went off to start their own companies. Anyway, Scott comes in laughing hysterically and it turns out he had faked the reply. 'Cause back then you could, (people laughing) you couldn't send an email from anybody. So yeah, that deal didn't come to pass, obviously. But eventually Larry and I just decided that, hey, to scale this up, it would be really good to, you know, get actual money. And eventually we found some angels, which was very easy.

And you know, my advisor Jeff, because for me, I was leaving a PhD program. My parents were disappointed, but he was like, well, why don't you just give it a try and if it doesn't work out, you come back. So I'm still on leave of absence technically, might still come back. We'll see how it goes. - I'm gonna come back to that later to see. - [Sergey] Yeah. - See if you might wanna think about coming back to get your degree. I love that part of the story. and it actually, it's interesting to think about in the context of today that entrepreneurship was sort of the last option to explore after you went out and tried to license and so forth. I mean you actually probably contributed a lot to changing that in some ways.

- Yeah, I don't know. I mean, our journey was its own particular one. I mean, both Scott and Alan went off to run their own companies. That was part of the reason they left. Maybe they were impatient with us trying to take it out, but it wasn't like, you know, at the time a lot of people were starting companies, quite honestly. And like I said, they, Alan was kind of involved already with this weather company. I guess now known as Weather Underground, I think it got bought by, I can't remember, weather.com or one of the other ones recent, well, like in recent years. And Scott had this company that was archiving mailing lists and it was e-Groups and eventually got bought by Yahoo and so forth. But it was pretty common. But yeah, I don't know.

We kind of, we probably took longer to make that kind of decision than a lot of other people would've. - So you, from that

start, I mean, you look back now, of course, and Google's a $4 trillion company and you process 10 million searches every minute and are in a huge number of, I mean, just the enormous number of different product and so forth. At the time that you and Larry went to start the company. I mean, that none of that was obvious, at least to most people. And that's why I wasn't licensed and so forth. An you must have, you must have, you obviously made a lot of good decisions over the years to get from where you started to where the company ended up. Are there things that you did right at the beginning when you were creating Google that you look back and you think that was really important that we did that right from the start of the company? - I mean, I think early on, well, Larry was always very ambitious. He still is. In fact, there's almost no plan you can suggest to him that he won't say like, "Oh, that's not ambitious enough." You need, you know, not just the solar system, the galaxy, you know? So I think that's a little bit of sort of his passion. And, so yeah, we did have fairly early on the, you know, very ambitious mission statement.

You know, to organize all the world's information and so forth. And, you know, I think that was a good kind of philosophy to start a company on. And also, we did start a fairly academic, I guess, minded company. I mean, we both came out of the PhD program, like a lot of the startups at the time were kind of out of college. I just do think that sort of shifts how you think about things a little bit. And you know, there are many phenomenal companies, just to be clear, that have come out of college. But you know, the investment in sort of foundational R&D and so forth, I do think was a part of the culture quite early on. - You hired a lot of PhDs as well, so it wasn't just the two of you. - Yeah, very much. I mean, I remember Urs Hölzle, who was one of our earliest guys.

I knew him because I was on the Stanford, you know, the professor search committee. Like, like I'd already interviewed him. He got turned down for the Stanford job for, I don't know, whatever. It's complicated. You got a lot of good candidates. But like the moment he sent me a note, I was like, can you start tomorrow? I mean, because I already knew him and all of his qualifications. - I mean, you built, probably, I think there's a good argument that Google's been the most innovative company of the last 25 years in the whole world. And I mean, you can, and that by both in terms of product innovation, if you look, and a lot of great decisions went in there like building out video with YouTube and advertising with DoubleClick and Waymo and technical innovation going back to the beginning. But even now with chips, and and so forth. I'm curious about how you've, it's really hard for large companies to stay hugely innovative.

Everyone has struggled with that and you've managed to do it. And many people, you know, attribute you personally with having a big impact there. How do you think about fostering a culture of innovation and your role in it? - Well, okay, thank you. You keep flattering me. I think that, well, first of all, we've definitely flopped on a bunch of things. We don't need to get into all of them right now, but we've had a long list of failures at the same time. So, you know, part of it is just trying. I think that because of the kind of academic roots, maybe we were more inclined to try hard things. And I think kind of coming into this last decade or so, especially the hard things have become more and more valuable. I guess I'm gonna, you know, if you look at AI, which obviously a huge trend, but like just, you know, the amount of computing that has to go into that, the amount of kind of deep math that has to go into that, those are all, you know, technically deep and challenging problems.

And I guess it's just kind of a twist of fate that that turns out to be important at this stage in the world. I mean, there was a while where, you know, you could do, there was like pets.com, you remember? You can put anything on.com. It wasn't really that technically deep, marginal understanding of the web and you can do whatever.com. And you know, fortunately we were doing search, which did require some deeper technical skills, but the technical sophistication level has only gone up. And in fact, well now the people we hire are just, well, they're much more qualified than I am, or I was at the time. I was kind of a mathy computer science major because I had, like, during college, I did both math and computer science, which was somewhat unusual in my class. But nowadays, as we like hire people out of Stanford, and, you know, all the other top programs. Like these people are pretty sharp mathematically and computer science wise, and a bunch of 'em are physicists, because physicists kind of have to do the hard math and a lot of the stuff they do is like very computationally limited. So they need to kind of have some degree of the computation skills. So I just think somehow it has happened to be the case that some of the deep part tech has become increasingly important.

And I think we just kind of lucked out on having set the bit early on in that direction. - That's an interesting observation that the technical problems have come to the fore again, as a competitive advantage for companies. So let's talk about AI for a minute. I mean, everyone's thinking about it. You're back at Google working on it. You guys are at the forefront in a whole bunch of ways, and it's incredibly competitive. I mean, the amount of capital that's going into AI infrastructure is hundreds of billions of dollars, even at the level of individual companies. It's really extraordinary. How are you seeing the landscape right now for what's going on in AI? - Okay, let me think how to answer that without just pounding my own chest. I mean, yes, it's a huge amount of investment for sure.

I guess I would say in some ways we for sure messed up in that we underinvested and sort of didn't take it as seriously as we should have, say eight years ago when we published the transformer paper. We actually didn't take it all that seriously and didn't necessarily invest in scaling the compute. And also we were too scared to bring it to people because chatbots say dumb things. And you know, OpenAI ran with it, which good for them. It was a super smart insight and it was also our people like Ilya who went there to do that. But I do think we still have benefited from that long history. So we had a lot of the research and development of neural networks kind of going back to Google Brain. That was also kind of lucky. It wasn't, you know, it wasn't luck that we hired Jeff Dean. I mean, we were lucky to get him, but we were in this sort of mindset that deep technical

things mattered.

And so we hired him. We hired a lot of people from Deck, honestly, because they had the top research labs at the time. But he was passionate about neural networks and it stemmed, I think from actually his college experiment. I don't know, he's like, he was like, whatever, curing third world disease and figuring out neural networks when he was like 16. And he's done crazy things, but he was passionate about it. He built up a whole effort. And actually in my division at the time in Google X, we had him, but I didn't, I was like, okay, Jeff, you do whatever you want. He's like, "Oh, we can tell cats from dogs." I'm like, oh, okay, cool. (people laughing) But you know, you also trust your technical people. And soon enough they were developing all these algorithms, these neural nets that were, you know, doing some of our search.

And then, you know, Nome came up with a transformer and we were able to do more and more. But yeah, I mean we, so we had the underpinnings. We had the RD. We did underinvest for a number of years and didn't take it as seriously as we should have. But we also, at the time, we had developed the chips for it, like the TPUs go back, I don't know, 12 years or something like that. Initially we were using GPUs or probably also among the earliest use GPUs. And then we used FPGAs, and then we tried to develop our own chips, which have now evolved through a bazillion generations. So I guess it was that the trust into going after the deep tech, getting the more computation out, developing the algorithms. And in parallel we were big investors in compute for a long time. So we've had the data centers for a long, long time, kind of on a scale that I don't think, well Amazon AWS also, it does have very sizable data centers, but very few have, you know, that scale of data center.

You know, have their own semiconductors. Have, you know, the deep learning algorithms and so forth to kind of all the components of the stack to be able to perform at the forefront of modern AI. - How are you thinking about, I mean, the technology keeps getting better every year. There's a set of people who, and there's a lot of different visions for what artificial intelligence is gonna look like. Like are AI's really gonna be able to do everything humans can do, at least in front of a computer and maybe more broadly. What will that world look like? Do you have a view on that, on where the technology is going? - I mean, it is absolutely amazing just the rate of innovation and it's hugely competitive, now, obviously, as all of you see between the top US companies, the top Chinese companies, and it's, yeah, I mean, like, you know, if you skip the news in AI for a month, you're like way behind. Like, you know. So where is it going to go? I mean, I don't, you know, I think we just don't know. Is there a ceiling to intelligence? I guess in addition to the question that you raised, like, can it do anything a person can do? There's the question like what things can it do that a person cannot do? - [Jonathan] Yeah. - That's sort of a super intelligence question.

- [Jonathan] Yeah. - And I think that's just not known, like how smart can a thing be? You know, we've had however many hundreds of thousands of years of human evolution and I don't know, whatever, millions of primate, but that's a pretty slow process compared to what's going on with AI. - Do you think we're ready for the speed at which the technology is advancing? - Are we ready for the speed the technology is advancing? I mean, look, so far I think people are getting, you know, definitely great use out of technology. I think even though there are doom and gloom forecasts here and there, like everybody's pretty well empowered. And the AI's, truth be told, are periodically dumb enough that you're always like supervising them anyway. But occasionally they're brilliant and give you a great idea. And occasionally, especially as a non-expert, well like, whatever, if I want to figure out how to create a new AI chip, I guess I could talk to our expert designers and stuff. But as a base case, I can at least, I can whip on my phone, I can talk to an AI about it. It'll probably give me a 90%, 80%, 90% decent sort of overview and understand it, or whatever, my health questions or whatnot. I mean, I do think it makes individuals very empowered, because generally speaking, you don't have like experts in X, Y, Z all around you all the time.

And I think that empowerment can create a lot of potential, whether it's, you know, career or enterprise or health or living well. So look, I mean I don't think I have all the answers. I just do think it has a huge potential to improve individual capability. - Yeah, that's certainly the positive vision. That it could be an incredible augmenter of human capability. It's great that you're thinking about it that way. Let me ask a question, I think, which is always asked in the entrepreneurial thought leaders class, but is maybe particularly salient with the discussion of AI. Because one of the things I think every student at Stanford, and probably every college age student in the country is thinking about, is how will this technology affect their careers and their job opportunities and what they might go on to do. I'm curious if you have any advice for the students about what they ought to be studying or what they ought to be thinking about as they look at it, the job market and the future. - I mean, I think it's super hard to predict exactly what'll happen.

I think, you know, if we look at from the advent of the web to cell phones and so forth, those have transformed our society profoundly, have transformed the kinds of jobs and careers and studies people do for sure. And AI will a hundred percent change that. But I think it's very hard right now in a rapidly shifting landscape to say exactly what. And also the AI we have today is very different from the AI that we well had five years ago, or the AI we are going to have in five years. So, yeah, I don't know. I think it's tough to really forecast. I mean, I would for sure use AI to your benefit. There are just so many things that you can do. Yeah, I mean, just myself as an individual, like I just, whether it's, you know, choosing a gift for my friends or family or brainstorming new ideas for products or what have you, or for art or something like that. Like I just turn to AI all the time now and it doesn't do it for me, because I always, you know, I typically will ask, give me five ideas, blah, blah, blah.

And you know, probably three of them are gonna be junk in some way that I'll just be able to tell. But two will have some grain of brilliance, and you know, or possibly put it in perspective for me or something like that, that I'll be able to refine,

think through my ideas. - Let me jump in with a really concrete question. So we have about 250 students out there. A lot of them are undergraduates. A great number of them have not selected their major yet because we give them a lot of flexibility here at Stanford for the undergraduates as well. A few years ago we could predict that a large number would choose computer science as their major. Are you recommending they pick, continue to pick computer science as their major and they're listening closely? - I mean, I chose computer science because I had a passion for it. So it was kind of a no-brainer for me. I guess you could say I was also lucky, because I was also in such a transformative field.

I wouldn't like not choose computer science just because, you know, AI can be decent at coding nowadays. AI is pretty decent at a lot of things. Coding just happens to have like a lot of market value, which is why a lot of people pursue it. And furthermore, you know, better coding makes for better AI. So a lot of the companies like our own, that work on it care a lot about it. Like we use it a lot for our own coding and even for our algorithmic ideas and so forth. But that's because it's such an important thing. So I guess I wouldn't, I wouldn't go off and like switch to comparative literature because you think the AI is good at coding. The AI is probably even better comparative literature, just to be perfectly honest anyway. - [Jonathan] Yeah.

- Like, I don't mean to disrespect comparative literature majors, but just like, you know, when you, when the AI writes the code, and just be honest, sometimes doesn't work, like it'll make a mistake that's pretty significant. Like, you know, getting sentence wrong in your essay about comparative literature isn't gonna like really have that consequence. So it's honestly easier for AI to do some of the, you know, creative things. - I think it's a very interesting observation about the technology. 'Cause I think, you know, one inclination to say about AI is it's gonna be really good at solving these technical problems, but it won't necessarily do the things we associate with humans. Like being empathetic in a conversation. And if you ask one of these AI engines to say, simulate a conversation, it's actually pretty good at doing a lot of sort of giving you the structure for a complicated conversation. So I think that actually, I like that you're pointing to that uncertainty. One more question and then I wanna open up to the audience so that we give people a chance to ask questions. So this is the hundredth anniversary of the School of Engineering.

If you were, if you were Jennifer and had to launch the school's second century, what would you be thinking about for the second century of the school of engineering? - Wow, okay. That's a big responsibility to like kind of plan. - [Jennifer] The dean job will come open. - It's a big responsibility. (people laughing) I mean, I guess I just would rethink what it means to have a university. I mean I know that sounds kind of annoying. (people laughing) That's the kind of thing Larry would say and I would be really annoyed with him. But you know, I mean we have this geographically concentrated thing and there's like the buildings and the fancy lecture halls. That really annoying blinking light, sorry, can't help it. You guys need to fix your, but realistically now, you know, information spreads very quickly.

And many of the universities have, you know, obviously, whatever gone online, including Stanford. But, you know, MIT with the open courseware early on and all these startups that have gone this way, whatever, Coursera, Udacity, you name it. So the teaching is sort of getting spread and anybody can go online now and learn about it. You know, you can talk to an AI or take one of these classes and watch the YouTube videos. So I guess, yeah, what does it mean to have a university? Are you trying to maximize the impact in that case? You know, probably just limiting the geographically is not gonna be so effective. To be fair, I guess, you know, in the Bay area is kind of a special place. But yeah, I mean, I know I'm kind of rambling here and thinking through, but yeah, I just, I don't know that for the coming century that, you know, the idea of school of engineering and the university is gonna mean the same thing as it used to. I mean, people move around, work remotely, collaborate across. It's a little bit at odds, 'cause we're trying to get people actually into the office and I think they do work better in person together, but that's at a certain particular scale. Like at some level if you have a hundred people together over there, it's like kind of fine.

They don't have to be at the same place as these other a hundred people. And increasingly I do see sort of individuals kind of who create new things sort of regardless of degree. I mean, in as much as we've hired a lot of academic stars, we've hired tons of people who don't have bachelor's degrees or anything like that and they just figure things out, you know, on their own in some weird corner. I don't know. I, I think it's really a hard question. Yeah, I guess I don't feel like I'm gonna magically deliver you like the new recipe, but I just think this format is likely to be the one for the next a hundred years. - You took that in a deeper direction than I was. - [Sergey] Oh, sorry. - No, it was great actually. It was a bit deeper.

- It sounded more presidential than Dean like. I think he's talking to you. - I agree. - It applies to the whole university. - You actually surface the most fundamental questions about the university. Which is that that the, you know, part of the university is about the creation and transmission of knowledge. That's the fundamental mission. Those can be done in different ways as technology advances. And then there's a question about the model of having kind of a density of talent all in one place, bumping into each other, sort of, you know, which, of course, was what led to you creating Google and has led to a lot of great things. And will there be substitutes for that kind of ecosystem that gets created on a university campus and, or, you know, how fundamental is that? And will it continue to be? So I actually thought that was, I appreciate that you surface such a deep question in this session.

All right, I wanna make sure we give some questions for other folks out in the audience. So Jennifer, I'm gonna turn to you to take some questions from the folks out here. - Yes, so the students in the Entrepreneurial Thought Leaders class submitted questions in advance and a number of those were selected. And so with the time we have left, we're going to have a few

questions from our students. I think the first one is over here. - Dean Widom, President Levin and Sergey Brin, thank you for your time. My name is Rasha Barve from Kansas City studying MSENIR. And my first question goes out to Sergey. It actually just touches on what we were discussing. Google largely grew out of the academic work you authored on PageRank, and with industry now driving so much of today's innovation, do you still feel that the academia to industry pipeline is crucial? And if so, how might you strengthen it? - Wow, that's a great question.

Is the academia to industry pipeline crucial? Yeah, I'm gonna give you an I don't know on that, because I guess, you know, when I was a grad student, the sort of time from some new idea to it being maybe commercially valuable was many decades. If that compresses, then it no longer makes as much sense to do. I mean, in academia you have freedom to think about it for a while. Whatever, you apply for grants, you do this and that and you can kind of spend couple decades thinking about it and then it percolates. And then, you know, eventually maybe there's some big company or your startup kind of pursues it. The question is, does that make sense if that timeline shrinks a lot? I think there are, I think there are certain things that for sure make sense and I definitely, you know, even within AI, you know, periodically keep up with the Stanford research and other universities. Occasionally we, whatever, hire those folks and collaborate with 'em and whatnot. But I guess I don't know that they needed to have that sort of period of time that they were trying, whatever, some new attention thing let's say. And they spent a couple years experiment and then, you know, they took it to industry in one form or another. I mean obviously industry is also doing all those things.

So probably not a huge argument for that. Radical sort of new architectures and things, maybe. But it's sort of, you know, the time that industry will scale, it will be much faster. I guess, you know, quantum computing comes to mind. There was sort of first brainstormed, I dunno, when did Definement, like in the eighties or something kind of postulate this idea of quantum computing and now there are a bunch of companies that are included. They're sort of doing it. There are also university labs that try like new ways to do it. That's kind of like on the fence maybe. I guess I would say if you have some completely new idea, like you're not doing superconducting qubits like we are, or whatever, the trapped ions like a bunch of startups are, but you have some new way. Maybe you need to let it marinate in university for some number of years.

Those things are kind of hard. It could make sense, but then at some point if you decide it's really compelling, you're probably gonna go ahead and take it commercial in one way or another. Yeah, I don't know. I want to give you a clear cut answer, because you know, the top companies now do invest in much more fundamental research and I think it's sort of with AI starting to pay off that, you know, those investments are paying off. So I guess it would shift the proportion of endeavors that you would do. But I do think there are still some things that do, that do take, you know, like the decade of kind of more pure research that maybe companies are gonna be more reluctant to pursue because that's just too long in a time to market. - All right, next question I think is over here. - Hi everyone, my name is Arnov and I'm a freshman studying computer science and math. My question is for Sergey Brin. As AI accelerates at this unprecedented rate, what mindset should young aspiring entrepreneurs like myself adopt to avoid repeating earlier mistakes? - Oh, what mindset should you adopt to avoid repeating earlier mistakes? Yeah, when you have it like your cool new wearable device idea, really fully bake it before you have a cool stunt involving skydiving and airships.

That's one tip. No, I actually, I like the sort of what we were doing back in the day for Google Glass that's like, you know, an example of prior mistakes. But I think I tried to commercialize it too quickly before, you know, we could make it more, you know, as cost-effectively as we needed to and as polished as we needed to from consumer standpoint and so forth. I sort of, you know, jumped the gun and I thought, oh, I'm the next Steve Jobs, I can make this thing, ta, da. That's probably one. I guess, yeah, if I encapsulate it, yeah, everybody thinks they're the next Steve Jobs. I've definitely made that mistake. But you know, he was a pretty unique kind of guy. So, yeah, I guess I would say, you know, make sure you've baked your idea long and developed it sort of long enough to far enough point before, there's sort of a treadmill you get onto where you're sort of, outside expectations increase, the expenses increase, and you're sort of then, you kind of have to deliver by a certain time. And you might not have that, you know, you might not be able to do everything you to do in that amount of time.

You kind of get this snowball, I guess, of expectations that happens and you don't give yourself all the time you need to process them. That's the mistake I would've tried to avoid. - All right. I think we're gonna go over to this side. - I thank you for the talk. This question is, so my name is Esha Bargetag. I'm an undergraduate freshman at Stanford University. This question is for Sergey Brin and Jennifer. So we see a lot of AI companies improving large language models via scaling data and scaling compute. My question is, once we do run out of data and once we do run out of compute, what do you think will be the next direction? Would it be in newer architecture, something an alternative to transformers? Or would it be a better learning method, something better than like supervised learning or RL that we use to train these large language models? Or is it a completely different direction that you have thought of before? Thank you.

- Yeah, I take it from my point of view. I mean all of the things that you listed, I would say have already been bigger factors than scaling computer, scaling data. I think that's sort of what people notice the scaling, because you're like building data centers and buying chips and like, well there were all the publications from OpenAI and Anthropic about like different kinds of scaling laws. So I think that attracts a lot of attention. But I think if you carefully line things up, you'll see that actually the algorithmic progress as outpaced, even the scaling, over the last decade or something. At some point, actually a while ago, many, while I was in grad school, I think I saw this kind of plot for like the N-body problem. You know, like if you have gravitation, they're all flying around and it actually, you know, there's been huge, you know, Moore's law increase in compute

over since people started worrying about that in the fifties to, I don't know, by the time I read about in the nineties, but actually the algorithms to do the N-body problem far outpaced that compute scale up. So I think you're gonna find that, you know, companies like ours are never gonna turn down being at the frontier of compute. But that's, yeah, that's just sort of an, that's the dessert after, you know, your main course and the veggies of actually having done your algorithmic work. - I guess I'll jump in and say that in terms of running out of compute or running out of data, or specifically running out of compute, we're very familiar with that here already.

It's actually a issue that it's difficult for a university to have the type of compute that the companies have. We don't even come close. But that does lead us to do quite a bit of innovative work in what happens when you have less compute and how to make, you know, more of less. So we do do a lot of that work here already. Next question I think also on this side, - Hi everyone, my name is Andy Zivortsy. I'm a second year graduate student in chemical engineering. My question is to all the speakers, which emergent technology do you think is seriously being underestimated in terms of its long term impact? Thank you. - Whew, okay. What emergent technology is being seriously underestimated? Wow. Okay, I probably, obviously can't say AI because it's hard to argue.

But it could be underestimated. - [Jonathan] It could be underestimated. - It could be underestimated, but probably not emergent at this point. We couldn't use that one. I mean a lot of people do wonder about quantum computing. What it will bring. It's probably not what I would hang my hat on to answer that question. Although I definitely support sort of our efforts in quantum computing and so forth. But there are many unknowns. I mean, technically speaking we don't even know if p is not equal to np.

Like on the computation front, there's just so many unanswered questions And the quantum algorithms are, you know, specific for particular, very particular structured problems. That side I'm a big proponent, but it's hard to put my finger on that. I mean, perhaps the applications of both AI, and for that at quantum computing, to materials science, because what could we do with different kinds of materials that are better in a whole host of ways? I mean, kind of the sky's the limit. - I was thinking of materials as well actually, but partly 'cause a lot of, the underestimated is sort of interesting. There's so much attention right now on, you know, like what are the opportunities for technological innovation? So many technologies that aren't there yet, like fusion energy or quantum, they probably, it'd be hard to say that people are missing them and not paying any attention to them right now and AI, but I think materials would be, in my mind, would be one of them. And probably some of the opportunities in biology and health of which there are many in molecular science that that's a. It's probably getting less attention than AI right now. But there's also a huge revolution in molecular science. - Yeah, I was gonna say exactly the same thing. I kind of watched the spotlight move around and the spotlight is very large on AI right now, but it was shining on biology and it shouldn't stop shining on it.

There's all kinds of things going on in synthetic biology, very exciting things. So I think we need to broaden that spotlight a little bit. Okay, over here. - Hi, my name is Drew Mi and I'm a student coming from Singapore. My question today is for Sergey and it's a bit more personal. So we all grew up having limiting beliefs and I was curious of what limiting beliefs or deeply held beliefs you had while building Google that you had to change and how did that affect your decision-making? Thank you. - Huh, limiting beliefs. Yeah, I guess like, I, I had a very, like my life expanded pretty dramatically at a much of stages. Like I was born in Moscow in the Soviet Union and it was very different. You know, very poor, where everybody was very poor.

And I lived in a little 400 square foot apartment with my parents and my grandmother and had to walk up five flights of stairs. I dunno, didn't really think about the world outside. I guess I was lucky that my father kind of got a hint of the world outside. He, I guess went to some conference in Poland where they told him what the western world was like and he decided to move us, which was very controversial at the time in the family. But eventually we got to the US and we're still, you know, very poor and had to make our way out of having nothing. And, you know, at time I had to learn a new language, give up, you know, I had to meet, make all new friends. So it was sort of challenging transition, but awakening. And I think when I came to grad school at Stanford, it was sort of a similar, like now I had sort of this, all this freedom in the way the professors entrusted me and just something about California that was very freeing and liberating in thought, given the tradition of the state. One that we're a little bit getting away from in California, if I'm being honest. But I'm not gonna complain about that.

But I guess it's this experience, I guess. I guess I'm answering question backwards, not like really a limiting belief. I guess I had had the experience of expanding my world in ways that seemed very painful at the times, but later paid off just because of my personal history. And I guess, you know, those challenging transitions can pay off. - Right, next question. - Hello, thank you to all of you for being here. My name is Lu Baba, I'm a second year master student in management, science and engineering. Originally from Casablanca, Morocco. My question is also for you Sergey, it's also more on the personal side. So you've achieved success at a scale most people never experience.

Looking at your life now, what is your definition of a good life? What does it mean to you beyond all these accomplishments? Thank you. - Okay, thanks, what is the definition of a good life? Well I guess that's, you know, being able to enjoy your life, you know, whatever you build. I like to have family. Have one of my kiddos here. My girlfriend is here. You know, I feel grateful to be able to spend quality time with them. I do feel quite grateful to be able to be intellectually challenged sort of at this stage. I actually retired like a month before COVID hit and it was like the worst decision. I had this

vision that I was gonna sit in cafes and study physics, which was my passion at the time. And yeah, that didn't work 'cause there were no more cafes.

(people laughing) And yeah, I don't know, I was just kind of stewing and kind of felt myself spiraling, kind of not being sharp. And then I was like, oh I gotta get back to the office, which at the time was closed. But you know, after a number of months we started to have some folks going to the office and I started to do that occasionally and then started spending more and more time on what later became called Gemini, which is super exciting. And to be able to have that technical creative outlet, I think that's very rewarding, as opposed to if I'd like stayed retired. I think that would've been a big mistake. - All right, I think we have time for one or two more. I believe over on this side. - Hello. thank you guys all so much for being here. My name's Stanley Leo.

I'm a freshman planning on studying management, science and engineering. And I had a question for all three of you. So for some context, like before arriving here, I was absolutely terrified. 'Cause everyone here is like super talented. I'm like, what is going on? Like I have no clue like why I'm here. And everyone just seems way too smart for me. But after getting to know people, I realized they're all just really relatable and normal people. So for all three of you, you guys are viewed as like some of the best leaders, innovators in the world. But if there's one thing you'd like to share that is reassuringly relatable and human about yourself, what would that be? Yeah. - You wanna start Sergey? (people laughing) Okay, I'm gonna share it and then I'm going to try to undo it, but okay.

I realize that sometimes I'm embarrassed to ask things. I don't know, but I will go ahead. Wait, what is management, science and engineering like? (audience laughing) Is it like a Dilbert kind of like, I'm gonna manage, how does that work? - [Stanley] It's the class. - It's a class. - [Jennifer] It's a major - [Sergey] Wait, this class? - [Jennifer] It's a department. - It's a class of management, science. - Is that this class? I guess I should have read the details more. - [Stanley] It's a major. - It's called management science and. It's the department? - It's a department, yes.

- But what do you study? (people laughing) Like what are the classes? - So management, science and operate, and engineering. I'm going to just. - Okay. - Say they just had their 25th anniversary, but they were the merger of three departments, industrial engineering, operations research, and engineering economic systems. So I think that describes. - [Sergey] Okay, okay. - That sort gives you a little triangle there of what they do. So some universities will have an industrial engineering or operations research. We have this all bundled together here in Management Science and Engineering, which is the department that sponsors the Entrepreneurial Thought Leaders seminar, which is what we are. - [Sergey] Okay.

- Conducting right now. - All right, well I guess I didn't really know that, so that's my embarrassing truth, but I'm glad I asked. - What makes me relatable is that I can explain things to Sergey Brin, pay attention to them. (people clapping) I'll let you off the hook, John, and we'll go to our last question. Do we have one more question? I think we do, yeah. - We can ask one more. Hi, my name's Zena. I'm actually the course assistant for the class. So thank you for being here and it's a great thing that we can have this last class. I'm gonna ask you something that we ask a lot of our speakers usually is to give a recommendation to the students as to what do you do with your time to stay on top of things.

And you just said you really like staying sharp and being on top of what's happening in AI and whatnot. So what books do you read? What podcasts do you listen to in your car? - Okay, I'm gonna try to do this without advertising or so. Well, okay, so the thing I like to do, but you shouldn't do it now because we have like way better version coming, but I do talk to Gemini live in the car often and I ask, but the publicly available version right now is not our good version. So like, you shouldn't do it today, but give me a few weeks to actually ship what I have access to, because we have like an ancient model behind it in the publicly research version right now. It's a little embarrassing, but I do like ask it like, you know, whatever, I want to develop a data center, you know, whatever, I need how many hundreds of megawatts of this kind of power, that kind of power, how much it's gonna cost. And I just talk to it about stuff on my drive. Okay, that does seem kind of self advertising with Gemini. I mean, I do periodically listen to a whole bunch of podcasts. The "All In Guys," are actually one of my favorites and they're great hosts. We just visited Ben Shapiro, another podcaster down in, we were in Florida, got to see his studio.

I mean a bunch of these podcasters are actually pretty fun to meet in person. But yeah, I guess, okay, that's not how you're gonna learn about it. You're gonna, but I do just listen to them, see what's up. But I do prefer to have an interactive discussion on my drive, so that's why I talk to the AI, as embarrassing as that sounds. - [Jennifer] Okay. - [Jonathan] Sort of a glimpse of the future, I think actually. That's a good way to end. We'll probably all be doing it. - [Jennifer] So - Soon. - Might, yes.

So thank you John. Thank you, Sergey. I also wanted to thank Emily Ma. Emily is a Stanford adjunct lecturer. (people clapping) Emily is a co-instructor of the course. She's also a Google employee, and she saw the potential for this event and partnered with us. So thank you very much. Thank you all for being here, for celebrating the School of Engineering's 100th year. This was a perfect way to close out our first century and let's see what happens next. Thank you.

- [Sergey] Thank you. - [Jonathan] Thank you. (people clapping) - [Jonathan] Congratulations...