Industry Notes

For each industry I study, I'd like to answer these basic questions (along with industry-specific questions) that determine whether I'd like to learn more about the industry, perhaps even work in it to try and solve some of those problems listed in the industry.

To be explicit, my goals are two-fold here when choosing a problem space I'd like to focus on during my undergraduate career.

The first is to make enough money to live a comfortable life, and the next is to satiate a niggling sense of intellectual curiosity and desire to engage in high leverage activities. These two goals are often misaligned, and so will have to be approached separately. This first section discusses "my number", or the amount of money I'd like to make before my 25th birthday so that I don't have to worry about supporting a family, living comfortably, for the rest of my days, and can afford the luxury of thinking about humanity-scale problems and efficient ways to leverage my education, network and intelligence to solve those.

The second section discusses more philosophical, overarching life goals, and dives into my most personal motivations, exploring what I really want from life, and how that has, and is likely to, change over time. It also grapples with questions of how I can make best use of the next 60 years I have on this planet, and what "best" even means in this context. Accordingly, I evaluate each industry by two metrics: how impactful my contribution to the industry is likely to be for the future of our species, and how profitable it is likely to be in the near future.

- **Is working in this industry and solving these problems this a high leverage activity?**
  - **What is the impact on humanity this will have?**
    - **Will advances in it be an important part of human history?**
    - **Will it alleviate lots of suffering, or induce lots of active happiness?**
    - **Or is it a problem of convenience? Efficiency?**
  - **Is technology the best way to solve this problem?**
    - **Are other methods, like legislation and changes in human behavior, likely to offer a better fix in the near future?**
- **Is working in this industry and solving these problems likely to be very profitable?**
  - **Is there a large market for solutions to these problems? Is this likely to change in the near future?**
  - **Are the markets conducive to rapid growth and monopolistic market share?**
  - **How saturated are these markets, and why are people trying, or not, to solve these problems?**
  - **Why haven't these problems been solved yet? What are the biggest obstacles in solving them?**
  - **What are current best solutions to these problems?**
  - **What are some of the hidden assumptions of the incumbent paradigms? Do they make sense?**
- **Does the idea of solving these problems using technology resonate with me on a personal and philosophical level?**
  - **Would I find this work interesting and intellectual stimulating?**
  - **Would I find this work meaningful given my values? Why?**
  - **Does my upbringing, background, network, or way of thinking, give me any unusual insight or advantage when working in this space?**

On Wealth, Happiness, and Finding My Number

The goal of this piece of examine the relationship between money and happiness, and think about how I want to approach making money in my life. It will be literature-backed, but also based on personal reflections. Indeed, there is literature on happiness, and whether "money can buy happiness". More concretely, this famous paper (by two Nobel laureate economists) divides

happiness into “evaluation of life” and “emotional well being”. The former refers to how people perceive their lives when asked about it, and the satisfaction they feel about the way they live. The latter refers to the intensity of joy, stress, anxiety, pride, and other emotions people report they feel on a day to day basis (how happy people are on a granular level). In addition to this one seminal paper, I’ll later examine a few other papers to try and weave a more holistic and rounded view of what the economics and psychology literature tells us about the relationship between wealth and happiness.

It should be noted that the way these studies are carried out are inherently inaccurate in the sense that 1) they only sample small amounts of American populations 2) more importantly, ask people how they feel about their own lives knowing that most people cannot accurately report and even understand the complexity of feelings they have 3) that “happiness” is certainly more nuanced than any two dimensions might suggest. It would be childish to take studies like this too seriously, as if they are as correct in their summations as papers on physics or medicine are. In light of this, I take this study, and any studies of its sort, with a grain of salt, and using it merely as a first-order approximation to understanding the complex relationship between wealth and happiness. With these caveats out of the way, let’s dive in.

On Adaptation

I’ve been fortunate to live a few different lives in one. Because of complex family dynamics and the nature of my parents’ jobs, I’ve lived in Kentucky, New York, Ohio, Delhi, Abu Dhabi, London and San Francisco. More importantly, my parents have had unusual career trajectories, meaning that I have lived at the intersection of myriad socio-economic brackets throughout my life. From living in a shoddy studio in a rough, inner city American neighborhood and having my father try to put two square meals on the table, to living in a beachside mansion overlooking a golf course and befriending the children of British royalty, my childhood has been anything but stable. I’ve been able to reflect on what I’ve seen and experienced to better understand how people across geographies, cultures and socio-economic backgrounds experience and perceive happiness and wealth.

Most visibly, I remember being momentarily excited and happy as my family ascended socio-economic brackets, and then very quickly adapting, and returning to the same level of happiness as before. For example, going from wearing thoroughly torn socks to being able to buy new ones when old ones get worn brought a wave of comfort and pleasure that meant I didn’t have to worry as much about the little things in life, like spending extra time at the thrifty grocery store trying to find the cheapest deals possible. Very quickly though, I got used to it. Going from inner city living to a middle-class living to a posh British boarding school brought new and welcome experiences and certainly little pleasures, but ultimately I have just as many fond memories and close friendships from a more difficult period in my family’s life as I do from more recent exposures to enormous wealth. With an increase in parental earnings and improvements in lifestyle, I experience temporary happiness that comes with increased material comfort, but ultimately regressed to a mean that had been dictated by the quality of relationships I had and ideas I spent time thinking about. More recently, when I visit some friends from Harvard living in the Bay Area and get tours of their $20M dollar houses, I can’t help but think that living in one of those really wouldn’t make me any happier than in the $200,000 dollar houses I’ve lived in the past. Sure, I can tell you firsthand that a $200,000 house/lifestyle is certainly significantly better than a $20,000 one, but, like most things, pleasure and comfort follow the law of diminishing returns, which is to say that making $20M is *significantly* harder than making $200K, while it only makes you *marginally* happier.

All of this is to say that people adapt quickly to increases in wealth. Moving across socioeconomic borders brings about temporary increases in day-to-day happiness, but these quickly fade as you habituate to your newfound lifestyle. One caveat (that the study also touches on) is that life satisfaction (general comfort and not having to worry about the small things like saving on comfortable clothes and nutritious groceries) *does* generally increase with wealth; certainly more so than day-to-day happiness. As Bill Gates says, the first few million bring about meaningful

freedom (high quality of your children's education, no worries about potential healthcare bills), but that's about as far money goes in insuring happiness, or even comfort. Not to mention the additional social complexities and anxieties that come with associating your identity with your numerical wealth, as many wealthy people inevitably do.

A final flourish to illustrate what I mean by the principle of adaptation: there is no significant difference in day-to-day happiness or overall life satisfaction between someone who makes $200K and someone who makes $300K a year, but if those people were to instantly switch lives (say, by getting a big promotion, or being fired), that would bring about considerable stress or aggressive happiness. This is an example of how "phase transitions" between socioeconomic classes cause changes in happiness, but generally sitting in a certain socioeconomic bracket is no guarantee of a certain amount of happiness.

With this in mind, you could approach making money in two ways. Try to get into a cushy corporate job which would gradually and surely give you a few "phase transitions" (ascensions in socioeconomic class) throughout your life—say, going from lower middle class to upper class, OR forgo the "rat race" altogether knowing that you won't have any phase transitions, and will live stably at one socio-economic bracket, and instead optimise for happiness from other sources aside from increases in socioeconomic class (sources like relationships, conversations, ideas, leisure activities). Having been fortunate to experience several ascensions in socioeconomic background throughout my life, and viscerally appreciating how little happiness it brings, I suspect I will settle on making a certain number as fast as possible, and living a stable life centered around high leverage activities, interesting conversations and ideas, close relationships and intense leisure—a life sustained by the interest that number brings, as opposed to the common goal of "make as much money as possible". This piece is a small part of me trying to get a sense of how big that number should be.

The Literature

We can start by discussing the famous "75K" study by Kahneman and Deaton, which posits that happiness does not meaningfully increase after a yearly income of $75,000/year. I know many people have heard of this, and often quote it blindly without having read or understood the paper and surrounding context. I have even heard friends at Harvard who think they have figured out the meaning of life after taking a course called "The Science of Happiness" that misunderstand this paper (many haven't actually read the full paper). After reading it, it quickly became clear how much people misunderstand and misquote its findings. With some caveats in place, though, its conclusions are still very useful when properly contextualised.

To summarise, the paper looks at around 400,000 Americans' reports on both their day-to-day emotional state, and long term satisfaction with their position in life, all reported through people writing about how they feel and sending it to the researchers. They find that increases in wealth continue to increase general feelings of satisfaction indefinitely, but that day-to-day experiences of joy and laughter cause to increase after $75,000.

The most important failings (which the authors recognise) of the paper include:

- It is cross-sectional and not longitudinal
- Small sample size and biased population sample (Americans only)
- Doesn't account for how living costs vary regionally
- Doesn't measure differences in net worth, but instead income alone
- Doesn't account for past experiences of individuals (whether they grew up rich or poor)

Other literature suggests that the amount millionaires make correlates moderately with their happiness, and that this happiness and sense of satisfaction is most viscerally felt when the millionaires have earned the money themselves, rather than inherited it. This study touts a $10M threshold that marks the most significant spike in millionaire's happiness. So, one study suggests marginal increases in happiness after a $75,000 income, and another (from HBR, I might add)

champions $10M net worth as the magic number? I emphasize this stark contrast to make it clear how ridiculously reductionist it is to think you can meaningfully distill the complexity and nuance of an idea like happiness into one simple number. Nevertheless, the order of magnitude of the numbers aren't useless.

Yet another study suggests that money is important only insofar as how we choose to spend it. And on that front, it's crucial that we choose to spend it on others rather than ourselves. Allegedly, spending money charitably or when thinking of others gives people a deeper and longer lasting sense of satisfaction than buying something for themselves. It need not be a large or substantial gift, merely a thoughtful token. And another similar study suggests that spending money on experiences and memories lasts longer and adds more value to your life than on material goods.

The main take-away from this literature is that since general feelings of life satisfaction increase indefinitely, it's optimal to pick the lowest number which represents the net worth associated with *your version of $75,000* (i.e. the net worth associated with the income after which your day-to-day happiness/emotional well being plateaus). Beyond thoughtfully picking a number and then relentlessly sticking to it, it's important to spend income on other people and on experiences.

Ballparking

Intuitively, we might be tempted to think that any estimate for desired net worth should err on the side of being too high. In my opinion, this is incorrect. You can always find ways to make some more money and add to the principle value generating the interest off which you are living, but you can never get back the time invested in reaching a number you never really needed to hit in the first place. I would rather spend my 20s shooting for a $2M net worth only to find that it was slightly too small a number, and I need $5M to finance things important to me I had not accounted for, than to work hard till 35 to hit a $10M net worth only to realize I'm living a little beyond my means. Those are 5 years of my life I can never get back.

So let's actually do some back-of-the-envelope calculations to determine what figure I need to hit before I'm 25.

Housing

A majority, or at least, significant, share of any human's assets can be found in the real estate and housing they own. Our Abu Dhabi beachfront house costs around $1M, and it's plenty comfortable for my needs. In fact, it likely exceeds them. Let's say we're looking for a 3-bedroom, though I don't expect we'll need a third bedroom for a very long time, and let's say we don't want to compromise on location. A reasonably pretty 3-bedroom in central London is around $2M. Let's assume we want two houses, one in London and another in the San Francisco Bay Area, with its exorbitant real estate prices. A 3-bedroom on Nob Hill is around $4M. Let's assume I'm paying off the mortgage for both of these at once (which would never happen), that's $350K a year in housing payments that needs to be covered by the principle value.

Lifestyle

Holidays

A good family holiday can run up to $25K from what I know. Let's say you go on holiday twice a year, that's another $50K.

Transport

Let's say you own two cars, both brand new, robust, Toyotas, totaling around $100K, that need to be replaced every 10 years. That's $10K a year.

Living Costs

Assume all the costs of maintaining the house, cars, going out for food, concerts, outings, add up to $50K a year, though they are realistically much lower than this.

Essentials

Healthcare

The principle is really the safety cushion when it comes to healthcare, but to avoid fees piling up we want to be in the green and have the principle increase, and compound over time. So we have to make sure the principle is large enough to give interest that will add to its value every year despite our many needs of living.

Education

Say you send two kids to a top private school for $100K a year.

A Tentative Conclusion

Assuming I never bring in another dime in my life, and that my spouse has never earned a dollar (both unreasonably conservative), I'd be living off the interest on some principle value, *X*. This is what I'm going to attempt to determine. My assumption is you can take 5% of the value of your stock assets out every year and that is what you have to live on. 5% because the S&P500 does on average around 7% a year and you lose 2% to inflation (because you need to protect the principal) so taking 5% is neutral in real terms on your assets. The S&P did 30% last year but often it does way less or even loses money so you need to be conservative.

The total costs add up to around $500K a year that needs to be derived from the principle value. Given that this represents the 5% interest you're making off the principle, after 20% capital gains tax from the principle, the principle would have to be about $12.5M. Given that we're shooting for a low-ball though (would rather have slightly too little than far too much), and many estimates involved were projecting a more lavish lifestyle than needed, I think a principle of $8-10M is more appropriate to shoot for by the age of 25.

Why I'm Choosing to Work in Software

Axiom is that around half the planet owns a smartphone right now, and that number will asymptotically approach 100% in the coming decades, only widening the market for software. Most people will buy software on top of their limited electronics because it's cheap, simple, and fast, which buying hardware is not (people in the Valley may be able to, but the big Asian middle class who are most of the world's computer spending power, cannot afford to spend like that). And thus software is faster moving (less overhead), more scalable than hardware, and has a wider market (that will only grow). And this aligns with my philosophy that inventions are only meaningful additions to the world if they can, and do, grow to planet-scale usage.

A16z has three big bets on what technology is going to most impact—healthcare, education, government. They believe it's important that tech reduces costs through innovation in these verticals because if it doesn't, no amount of ingenious, well-implemented policy is going to be able to distribute healthcare or education at scale because the money to do that simply does not exist. You can increase government spending on education and healthcare blindly, and cause little change as it trickles down into existing and ineffective systems, or, you can revamp the systems using technology and then demand for increased spending and changed policy action, which actually improves outcomes. Only point of disagreement on this front is that actual implementation of this technology can only come about wrapped in some policy action, and since schools and parents are naturally risk averse, adoption and scale will take 50-100 years, and not 5-10.

It's worth contemplating how special it is for a company to have over a billion users on their service, like Facebook and Google do. Historically, that title has been granted to only the Catholic Church. And the fact that we're at a time where a kid who comes from nothing can, purely by having grit, vision and ambition, exert impact on the universe at roughly the same scale as the Pope, is unimaginable. Really, it's a special time to be alive.

It's important to note that while it's easier to start a company, it's harder to scale it and get meaningful adoption at scale because the markets are just larger as more people use electronics. Software, a16z claims, has already "eaten" film (Netflix), books (Amazon), games (Rovio of Angry Birds), marketing, telecom (Skype), retail (Walmart Labs), distribution (FedEx is a software monster), defense (Anduril). In industries with a heavy real-world component (cars, oil & gas, etc.) the opportunity is for incumbents to improve offerings and acquire startups to help them do so.

An interesting and slightly mind-boggling statistic is that Groupon generated $700M in revenue a mere *2 years* after being founded, showcasing how powerful a good product can be, and that it's not *all* down to MBA buzzwords.

On Research Spinoffs, the Valley, and Startups Based on Tech Innovation

- If you want people to adopt your research, you have to spin it off yourself, no-one else can be fucked to take it upon themselves to take that risk for you. Jobs did?
- Everyone expected another Valley to pop up soon, and the Bay Area only extended its lead. You need great universities, lots of VCs and a risk-embracing cultural attitude, including traits like generosity of mentorship and conversation, which I've certainly experienced.
- Because data is so integral to successful machine learning, and you can't really separate domain expertise and an understanding of the context of the data, CS+X is becoming a more incumbent paradigm.
- Much of the best research is coming out of big companies because they have more money, sure, but increasingly also because of data, computational resources, talent, and more.

Education

Sal Khan talks

sal khan's prediction for 2060

- classroom changes from passive information gulping to active project-based, discovery learning
- when you *do* need to take in information passively, it'll be in your own time, at your own pace
- societal structure of most (physical labor) many (mental labor) and few (innovation and creativity) will be flipping due to the advent of technology, and so R&D/creativity will be what most people are doing, and discovery-based learning prepares you for that
- instead of fixed length education variable achievement, we swap to fixed achievement (high standards) variables learning (people learn how and when they see fit)
- GPA/transcript is substituted for portfolio as most are in creative class
- teacher-student interaction fundamentally changes as you have students learning the material in their own time, teacher starts to act more as an advisor or coach, with multiple teachers collectively teaching lots of students, playing to each others' strengths, and becoming better paid as the current resources are now significantly allocated to them as the classroom changes structure (policy in navigating the current layers of bureaucracy)—*different people learn at different rates and take different times to learn different things* (why we did classroom approach historically, and why are we still doing it now(??)
- we will reach a global 99% literacy rate because of how technology has gotten cheaper, and we'll approach a global meritocracy, but only if policy evolves with technology, which is why only someone with an interdisciplinary background in government and technology can tackle the problem

- envision transitioning to a p-set in class, lecture at home model for customisability and ensuring project based learning. you can make fancy software and new technology that makes the lecture engaging, the projects fascinating and informative, but for these things to actually be implemented, you have to understand the economics and legislation that governments use to make decisions about their public education (the system in which most students are in), which is why it's interdisciplinary problem
- not suggesting replacing teachers—the teachers are best at mentoring, at explaining rich/nuanced concepts and pin-pointing holes in understanding, but instead, we focus their time on shallow, rote based learning to prepare to optimise certain metrics (like standardised test scores) that we prize as a society (another dimension to the problem)
- experiments in illinois done, showing significantly higher outcomes—but they said no because it was impractical logistically (each student gets different worksheets, teacher has to review different material with each student, etc.) but now it's no longer impractical because of technology!
- technologies useful for the future of edtech—VR, 3D printing,
- policy changes—when countries emphasise education, results show up (south korea case study, vietnam = germany etc.)
- addressing problems on a local/state level needs policy to be sustainable

EDUCATION NEWS

DACA is a bill that protects undocumented immigrants that have been educated in the US from deportation, and the Trump administration is doing away with it.

Death of a young schoolboy in Chicago prompted thousands of teachers in Chicago to march on the streets, and get legislation passed mandating a nurse and social worker in every school, every day.

SNAP is legislation that means families on food stamps are automatically eligible for free school lunches, and Trump administration is cutting that legislation, making it so that most of these families have to apply for free lunch, and millions are expected to fall through the cracks.

Amazon started Ignite, a peer to peer marketplace for teachers to sell and share resources and lesson plans, but it worries that could exacerbate IP infringement.

Notes from "This is Not a Test" and "Rethinking Education in the Age of Technology"

EDUCATION NOTES
What's actually wrong with American public secondary education?

[problems with educational outcomes/school design/curriculum]

important to show a healthy degree of skepticism so we don't try to fix something that isn't broken and don't just parrot truisms that everyone else is saying. at the same time, it's also important to recognise that the system has undergone revolution in the past and isn't as archaic as many people want to believe. if you stubbornly insist it's "broken", you're likely to implement half-baked solution, which just fucks everyone over.

people start education, but don't finish: 40% of people starting a college degree drop out, and 1 in 5 kids drop out before graduating high school.

even those who finished aren't set: HS education doesn't qualify you for college in 43 states, and the performance of US HS grads are shockingly poor on PISA rankings—it's with developing

countries in that regard, and it's not clear that the curriculum we're teaching kids is adequate preparation for our new technological world.

there's also a big mismatch between what research suggests are best practices and what's actually implemented at scale. holding kids back is fucking stupid! "it didn't work the first time, so let's do the exact same thing again!" >$12B is spent on this every year—why don't we do subject based improvement—that requires restructuring the whole system since it's a complex adaptive system.

teachers don't have enough voice. administrators have 3 years of teaching experience, and often despite teachers knowing the contexts of their students well, have to teach material they know won't be responded to well.

then, there's a question of standardised tests, so often vilified. implemented because you need a way to objectively compare performances across schools, but problem with human nature is that once you implement a metric, everyone games the metric instead of optimising for the spirit of the metric (learning). the problem with these is that schools spend 30% of the time preparing, and *students don't even learn from the results*. But these, I feel, are actually necessary—you can't simply copy and paste Finland's education strategy of using few tests because 1) their cultural values (trust) are completely different and 2) they don't operate at scale. And STD tests can be a great tool for social mobility, we just have to modify them by doing things like supplementing them with portfolios, re-examining MCQ paradigm (compare to UK mark schemes) and use better feedback to get kids to learn from them.

but teachers aren't perfect either. instead of designing objectively personalised lessons, they often go on what *they* found effective learning methods when they were children. in this way, I see a future where teachers facilitate, guide learning and technology augments their power and fixes their shortcomings, not where it replaces them.

[problems with equity, race, gender, class—tech can't help with this]

but you can't just focus on school design & curriculum, ignoring problems of equity, race, culture, and gender is wishful thinking. schools are shockingly segregated, even today, robbing youth of huge learning opportunities from peers, enforcing siloed thinking, and perpetuating negative feedback in underserved schools. a cultural shift in values is needed to get schools better funded, like in Korea/Singapore.

And teacher voice is even more important because of issues of race. despite teacher numbers rising, the number of black teachers has fallen. and this is important because studies show that minority students, the ones currently done the most injustice by our educational system, perform better when they have role models. lots of policy takes the wrong approach by replacing low-performing public schools with "innovate" and "experimental" charter schools that take experience teachers with roots in the community out of the picture. it makes sense, since a black teacher can more easily look past a black kids disheveled clothing and uncombed hair and urban mannerisms and slang to get at the quality of their ideas, so when students have teachers of matching minority races to act as role models, minority involvement in G&T doubles and dropout rates halve. isn't that crazy! epitome of how answer is half policy/values and half tech.

failed policy in the past, and why it was so

No Child Left Behind

all about 1) research based teaching and 2) equity and supporting poor performing students (minorities, disables, special-needs). however, since they didn't take input from teachers about how to implement this, the implementation was poor and it turned out to be ineffective in reaching its goals.

Common Core State Standards

This was a federally drafted set of expectations of what each child should know by each grade level. since, again, it had 0 teacher input, it strangled teachers who had a better sense of what *their* kids had to learn, and demanded the implementation of even more standardised tests to check if these expectations were being met.

Race To the Top

All about data-driven changes to teaching, which, again, sounds wonderful, by offering grants to states that suggest innovative ideas on how to change teaching practises by collecting large amounts of data on student performance. also failed because of inherently being an all-encompassing solution that blindly rewards tech innovation.

the lessons we've learned from these is that future legislation in the public education space, to be effective, must be 1) informed by teachers who have worked on the ground 2) operating at a grassroots level, districts optimally, but even state-based legislation would work better than federal legislation.

improvements necessary to the system and why I'm best positioned to implement them

is radical change possible? banks were all 10am-3pm until one crazy mf said we should make them all day so that people can come when they're actually free.

we have to keep international scaling in mind. resource-strained systems like in India need to be able to adopt a version of the new public school system we build, for example. the solution must come from a place that deeply understands the perspective of the student (me), teacher (via CF), programmer (via SWE), legislator (via policy at Harvard) and cultural nuances (living on almost every continent when growing up).

how can tech help with this

poorest kids fall behind over summer
    tech gives them access to the same resources the rich kids use
exam results aren't acted on
    computational teaching systems integrate what they learn about your mistakes into how they teach you—immediate, embedded feedback
people have to resit whole grade
    computers can enable people to work on only the areas that need work
personalisation has always been at odds w/ implementing things at scale
    tech can change this paradigm
most teachers spend most of their time teaching low-level google-able knowledge
    if you automate this part of learning, teachers can focus on motivating, inspiring students, helping them where they're stuck, and conveying and explaining deep, nuanced concepts in beautiful ways
a lot of the work kids are doing is busywork
    need to be wary of tech falling into the same trap, where they spend so much time learning how to handle the tech that they don't actually get anything out of it. and pretending that we're changing the world by implementing SMART board while racial and socioeconomic segregation is still rampant is wishful thinking.
teacher feedback is binary
    collecting data like recording lectures and submitting them for peer feedback can change the game

what are finland/Sinapore doing to do so well in education

private schools are illegal so rich parents are invested in public school quality. they have 5h days, almost no HW, long breaks. but we must understand it works in their cultural context only.

in singapore, they take a more tyrannical approach. there's one particular exam, in which students, if they don't perform, are sent to trade school—literally taught how to be baristas (mindblowing). their investment in education is much higher, so >40% of teachers have a degree in the related subject (in fact almost all, where US no. is 40%) because only top 30% of uni grads are even allowed to apply as a teacher. they've built a culture where it's as prestigious as being an investment banker or surgeon.

technology in education

how is society changing its demands on the education system

we use computers to read, writer, calculate, think, now. all the skills that operate underneath the hood are abstracted away, so we need more technology in education simply to mimic the real world, as well as a focus on more conceptual, abstract things that computers *can't* do. so education is providing a skillset different to that needed by an evolving society.

there is an uncoupling of schooling and learning. there's just too much to learn now that you can't simply add on more years to a school curriculum, and people are being forced to adopt a strategy of life-long learning to succeed.

and incorporation of technology is fundamentally incompatible with current classroom-based system, so you can't just add more technology like going 1 to n innovation. teachers aren't teaching kids to traverse fake news, tech would provide more distractions, more avenues for cheating and bullying is simply employed in a traditional classroom. as legislation seeks to standardise and narrows the curriculum to be able to do so, the scope of what needs to be learned is, commensurately, widening.

the technophilic argument

schools are 1) supposed to mimic the real world, which is now relying on computation everywhere, and therefore educations should too. in the real world, computation is changing the way we think (analogous to how industrial revolution amplified our physical capabilities) and communicate (affinity spaces over geographic communities, which presents its own set of challenges)

and computation itself can improve traditional educational outcomes:

context of applying knowledge: games/simulations are powerful tools—learn infectious disease and history by investigating the source of infection in a virtual village, learn to write by doing a fake political campaign and comparing how many people in the simulated country vote for you compared to your peers. instead of teaching arithmetic by doing "james has 42 watermelons" actually have kids set up a bank and compete to see who can make the most money, involving risk/loan calculations.

personalisation: literature says this is good—it's what we do for special needs kids, and now we can scale it!

interactivity gives feedback in real time, as opposed to tests where you almost never learn about your mistakes until it's too late.

teach kids how to traverse the world's information, by teaching them to work with and create websites, vlogs, web forums and more. instead of teaching them phases of the moon, adding fractions or date of the US civil war (all of which they forget after they leave school), teach them to learn.

the technophobic argument

schools are complex adaptive system that had to make changes at scale over time. for example, graded classrooms, tests, mandatory attendance, textbooks, and everything common in our current system is an adaptation to make classroom-based learning work better when it was first created in New England in the 19th century. as such, every time you make a new change, the system becomes more complex, and has more moving parts, and so it becomes harder to make an *additional* change, since there are now additional things that would affect. it has thus become rigid.

so introducing more tech to lessons in a 1 to n manner won't work. for example if you do, longer lessons are needed (set up time of tech), and thus there are fewer lessons, and thus we must rethink the curriculum. there are further deep incompatibilities between tech and the current system:

learning by reading vs learning by doing
memorising vs applying
teacher vs learner control
teachers as experts vs diverse knowledge sources

overall, just in case learning vs just in time learning cannot co-exist in a single school system.

it's also natural for teachers to be critical about technologies, even if the tech is going to empower them and not replace them. they have invested years in adapting and learning the rope of the existing infrastructure, so a major revamp will have them re-learn everything they've been taught. and sometimes skeptics are right—TV and film didn't revolutionise education like the technocrats predicted it might. and when computers make learning the nitty-gritty low level content unimportant, teachers double down on it:

quote from past—"students increasingly rely too much on pen/ink and it is a sad comment on education to see that most students can't use a knife to sharpen a pencil properly."

all of this hints that simply adding more technology to the current classroom-based system will not work.

establishment of universal schools & the first educational revolution

if we want to design a new system, we're going to have to build it from the ground up. has this ever been done before—a complete revamp of education? yes, so we have precedent.

apprenticeship era—> printing press made reading/writing crucial—> protestant reformation democratises religion—> religious states like MA shift the responsibility to religious education onto state now that everyone needs to study bible—> american revolution turns US into a republic, where not citizens need to be educated to guide policy decisions—> industrial revolution is main catalyst where we have mass migration into cities, more educated population needed to operate machines, and parents working in factories all day need somewhere to put their kids. since you already have a school system in MA working to solve all three of these issues, they simply scaled it, led by reformers like Horace Mann.

what are the analogous pressures forcing a new revolution today?

too much knowledge to simply add years to schooling
diversity of learner backgrounds (globalisation) means textbooks work less well
increased private spending on education
"adultification" of youth increases in-person bullying & children hating school

what can technology do to improve schooling

1) improve learning in the conventional sense. Khan Academy allows customisation, Pinterest allows teachers to get feedback on teaching plans, MOOCs allow access to content not usually taught in high schools.

2) transform education to centre it around production of content and affinity spaces, with Wikipedia, YouTube, etc., all playing an important role. EG if a kid likes dinosaurs, right now they have not outlet to explore that interest, even though doing so might teach them important lessons about history, geography, science, in the process. in the future, if a kid likes dinosaurs, they can choose to learn about that in class, read articles online about dinosaurs, make youtube videos and animations about their extinction, code a website teaching other kids about dinosaurs. this teaches him not only the science/history we'd teach him in a conventional class, but teaches him how to explain things to others, how to get feedback/criticism from a community, how to market his ideas and sell himself.

ultimately, the pros of using technology are the project based learning teaches kids how to learn, how to apply knowledge, and makes things fun since you have autonomy over what you're learning. also, creating a market for edu-products encourages competition and therefore increases the quality of products.

cons are that it might take away the intensity of social interaction found in schools, could increase inequity (but could also decrease it), and could cluster like-minded people together by being more focused on affinity spaces.

the three eras of education

these are going to be the fundamental changes made as we go from the 2nd to 3rd era:
ages: surrounded by adults (who teach you) to peers to mixed ages
responsibility: parents to state to individuals/parents
expectations: turn out same as parents to education as a great equaliser to individual choice of destiny
curriculum: practical skills to fixed body of knowledge to learning how to learn
pedagogy: apprenticeship to didacticism to interactivity
assessment: observation to testing to embedded and *coupled to learning*
location: home to school to anywhere
relationships: personal bonds to authority figures to computers guided by teachers

policy action and cultural value shifts needed
replace standardised tests with a certification program where 1) kids choose to take it when ready and 2) it tests skills like algebra, not math, and creative writing, not english and 3) it's on a computer where the questions asked are shifted in real time

project-based learning out of a list of possible projects for that grade: for youth, they might play a civilisation game specifically made to educate kids, where they learn about history, geography, strategy, economics while trying to expand their empire as the Romans. or similarly the dinosaur analogy teaching them science. for older kids, you might have them write a short novella to teach them english, or start a local business to teach them economics and entrepreneurship, or even act out Aristotle's life to discuss philosophy and learn drama.

there has to be a bunch of changes in how both parents and we as a society view technology for this to be effective, though. tech is inherently seen as bad and wasteful—any time I spend on my computer is seen as wasted time by my parents. we're told to read to expand our vocabulary, when research shows the same time spent watching videos is equally good. we've fallen into this rut believing that if it's fun, it's not productive.

we have to be okay understanding that school is not the only place people go to learn, and in giving students more autonomy over *what* they choose to learn. curriculum will have to be rethought, eg. math needs to be more abstract and conceptual and not as algorithmic since computers can do all the algorithms anyways.

and there needs to be a fundamental shift in how policy is devised. 1) needs to be context aware and so devised on the level of a district/state and not federal and 2) needs to be made by teachers who are intimately aware of technology, so ideally also programmers/engineers. on that note, the technocrats need to stop being missionaries thinking they're coming with their magical gifts, and instead need to think of how they can use their innovation to meet social needs in a scalable way.

I differ in my opinion that 1) technology is compatible with the current education system, we just need more of it 2) edtech companies are going to solve education 2) policy change, the way it's being done today, will solve education.

"Disrupting Class: How Disruptive Innovation Will Change the Way the World Learns"

"The Case Against Education"

"Liberating Learning: Technology, Politics, and the Future of American Education"

A16z education notes

Take aways from this section

—> life-long learning platforms educating adults is more interesting than disrupting heavily entrenched, regulated K-12/higher ed markets

—>

The future of edtech part 1

- good first principles thinking about why people actually choose to get educated and what different areas there are in which to innovate *within* education: preschools, K-12, higher education (universities), corporate learning, lifelong learning, bootcamps and intensive vocation development.
- Looking historically, countries seem to converge on 100% primary school attendance rate over time, it's unclear as to whether this holds for higher levels of education. The average age until which people are schooled around the world is 12. This is to say, over 3 billion people drop out of middle school, or never reach that far. Of course, in the west, almost all people have a high school education, which is why this is surprising to us, but this is not the case in Asia, South America, and Africa. 7% of people worldwide have a college education, but that's >25% in the US and high school graduation is >80% in the US. So if you're optimizing for impact or profit, be clear which market you're thinking about—local (American), or global, since the educational landscape is *very* different between the two. There's also the regulatory moat (accreditation for tech companies like colleges? Need it for federal aid to poorer students).
- People choose to get educated because institutions offer a number of services, all bundled into one, but increasingly private sector is teasing this "stack" apart in value offering:
  - Learning to learn and think
  - Learning vocational, employable skills
  - A pathway into an industry/country as an outsider
  - Meeting people, both socially and professional networking

- Brand signaling for “I’m smart and hardworking”

replacing higher Ed

- network and brand are the main reasons people go to these schools, each which carries a lot of momentum and is likely to continue into the foreseeable future. An interesting case study, though, is looking at why MBA enrollments (which are also for network and brand) have declined: increasing interest in tech (which is very anti-MBA), strong economy meaning people don’t have to upskill as much via further education, and less immigration meaning less international applications, none of which really apply to long-term conventional education since they’re all due to trends. We can therefore conclude that the network and brand moats for traditional undergrad educations will likely hold for the next 50+ years, especially since it’s entrenched in regulation and has been around for >1,000 years (people predicted half of all colleges would shut down by 2020, which has turned out to be utter fiction).

replacing preschool and K-12

- There are IaaS services set up in education, too. Wonderschool does all the legal, marketing, accounting for preschools and invites talented educators to set up their own preschools without having to worry about all the overhead, and just be great educators, causing Wonderschools to pop up all over the country to give consumers more choice in early education for their kids, and exposure to better teachers.
- Outschool is basically online group video chats for 3-18 year olds led by a teacher, teaching something a specific way, like math via rockets, tailored for the students’ learning style. For this kind of thing to *obviate* traditional schools requires 1) whole world shifting to ability-based employing as opposed to brand-signaling and 2) parents to recognize and be reassured that programs like these have better learning outcomes for their kids. Both of these are unlikely in the near future.

The future of edtech part 2

- it’s interesting that the largest edtech market in china isn’t K-12 or higher ed, but instead lifelong learning platforms for the 26-35 age range teaching things like leading a meeting, raising a child, and more. Big marketplaces are starting online “universities” to promote people teaching others how to use their platforms (taobao sellers)
- You have to understand cultural preferences. Chinese people rely more heavily on both mobile phones and mobile payments. They also approach problems fundamentally differently—learning mandarin solely to live in china and understand both the Chinese consumer, markets, and tech attitudes (by working at a Chinese tech startup) could be an interesting use of a year, say, after college, before starting a PhD in the US. LingoChamp, uses AI to grade its users’ English pronunciation, doing away with the flashcards of traditional edtech companies.
- Business models for creators also affect quality of deep education. YouTube incentives flashy, clickbait content for ad revenue, but some of the most impactful and meaningful content is made by people who don’t have the media skills to make beautiful thumbnails, do SEO and algorithm-gaming, as well as have great production quality. How do we pay creators for depth and quality of content as opposed to clicks?
- There are lots of people that want to talk about things like how to replace a doornob, how to be a good parent, how to give an excellent speech, but there isn’t any good platform optimized specifically for these niche, vocational creators that doesn’t have ad revenue, see the point above. It needs to be as easy as creating a Shopify website. (add to problem list)
- Keep in mind china can be so far ahead in edtech because there’s huge cultural support—it’s third biggest household expense after housing and medicine. People in the states just don’t care as much about it (as an outsider to that culture, am I really the best person to solve this problem or work in this industry?)
- Ad based business models also don’t work as well for startups because you have less data on users to be able to target those ads, and so less conversions, and so advertisers pay the platform less since they get less out of it compare to google or facebook.

The Case Against Education, From Signaling to Rainbow’s End

- The central thesis is that the only role education plays on a societal level is signalling traits of conformity and diligence because those who have degrees, earn more. For any individual it

makes sense to continue through education, but collectively, if it's just signaling (and it largely doesn't add real applicable skills or teach us 'how to think/learn') then reducing education on a wide scale uniformly will save the government trillions & millions of people years in their life—high school will be the new signaling equivalent of college.

-

- education isn't helpful in terms of real life productivity—it doesn't teach you material (you forget it all) and doesn't teach you "how to learn" (we're no better at applying things before/after, and evidence points otherwise), it's just a signaling mechanism that is the remnant of a failed attempt to produce a rational, informed electorate.
- Many people say reducing austerity would harm poor households that rely on robust public education pipelines as social mobility tools, but instead think not of one individual losing out, but on a generational shift where this large amount of austerity means employers expect high levels of education because everyone is so educated. If you make formal education less of a necessity by reducing austerity, the poor kid that dropped out is better off.
- Education funding is partisan—left thinks we need more funding (I agree with Caplan that so much funding is used in non-accordance with the literature that giving them more money is not smart) whereas the right advocate for more competition by loosening accreditation restrictions.
- College, he says, has just become a way for employers to select not just for intelligence, but conformity that comes with graduating.
- He advocates vocational school, like in Germany where government makes recommendations when you're 14 and many follow those on what jobs they should do, which is criticized for cutting off options early. He counters that most people empirically don't go to college, or finish college, and so for them the current system isn't working, and even for those that do, the current system is exposing them to paths that are inviable for them (academia in various subjects).
- It's interesting that currently, we have no idea what makes for a good teacher. None of the factors in the current pay formula (degree, experience) correlate meaningfully with teaching results, and so we can potentially revamp teaching hiring with no extra money added.
- He says that empirical results point to he fact that people don't apply things outside of their domain at all—even physicists are no better at games revolving around simple newtonian physics than normal people and pilots with high critical reasoning scores are no better than those with low reasoning scores. Perhaps this is the formal line people draw in their minds about work vs life. The best gamers and pilots are the people who spent the most time practicing gaming and piloting, respectively.
- It's funny that there can be huge improvements in the system with no additional investment, yet people are calling for tech innovation and additional investment.
- He claims that education only works because everyone agrees it does—it doesn't actually make you any smarter or better. He advocates cutting funding, doing more vocational education, and *lowering* the average age of education.
- There's a huge disparity between personal gain from investing in education and national gain, apparently, and this is explained by signaling not adding much actual productivity value. And in terms of government spending on university, investing in top schools pays good dividends, but not on average/overall, which is what most governmental funding is.

Edtech case studies

Clever

What exactly do they do

How did they come up with the idea or see the problem

What will they do in the future and will it change the world

Why did no-one do this before

SolverIQ

What exactly do they do

How did they come up with the idea or see the problem

What will they do in the future and will it change the world

Why did no-one do this before

Cognii

What exactly do they do

How did they come up with the idea or see the problem

What will they do in the future and will it change the world

Why did no-one do this before

Squirrel AI Learning

What exactly do they do

How did they come up with the idea or see the problem

What will they do in the future and will it change the world

Why did no-one do this before

Talking to education professors and edtech entreprenuers

Harvard edtech guy
IIT cognii
Phil hedaytania dropout edtech failed
Clever founders via Ann Miura Ko

—> look at edtech successes, so you CAN succeed (what do I want out of my first company, high valuation, early exit, transform the industry, or what? Would I be happy founding Clever, for example? Is that pushing human progress? Is that okay for my first idea? Do some serious reading and thinking about companies in the space, what they're doing, whether I'd want to start them, how they identified problems, and then do similar things to identify problems as well as reflect on the space in terms of human progress)
—> think in terms of incentive alignment (quizlet might be improving outcomes and reducing costs of the current system, but if what we need is a revamped system, is it really a value-add?)

The Environment

Questions to have concrete answers to by the end of December:

- What exactly is the climate/energy crisis? What's the science? What are common misconceptions?

- To what extent is change/energy crisis a pressing problem for humanity?

- What are the biggest obstacles in solving this problem?

- To what extent can it be solved by deep technology (as opposed to policy)?

- What exactly are the routes we would use to solve this through tech innovation?

For example, if the Earth's energy imbalance comes from solar radiation in VS out, you'd have to start a tech company that directly or indirectly reduces energy in or reduces greenhouse gas output. This could be directly, via sequestration tech, solar shielding via aerosols or research based via fourth-generation nuclear fission, or a software company helping one of these other companies achieve their aims, or helping consumers improve energy efficiency on a personal level, or a hardware company looking at new types of renewables or, indeed, a think tank doing policy research. The solution can take many forms, but ones you've narrowed it down to the general *structure* of the form it can take, you're positioned to see if it's something *you're* equipped to tackle.

- To what extent does the mission resonate with me? Why?

- To what extent has my background/upbringing/experience equipped me with a competitive advantage in tackling this problem?

Climate & Energy

"the best thing humanity has done in the last century for the climate is to undergo two global financial crises"

"the top 25 oil & gas companies on earth alone account for 50% of humanity's CO2 output"

"people will listen to religious figures before they listen to scientists" (on Pope Francis appeal on climate change)

Videos

Democratic candidates debate: Climate change (ABC News)

You see the candidates presented with questions on climate change; and each, unequivocally and passionately argues that this is the pressing challenge of our time, that quick, decisive action will be taken under their administration. But that's what *every administration said*. And none have taken action; as soon as they get sworn in, they're victim to re-election pressures, compromising to special interests, blocking by Congress and Senate, so there is indeed a stark disparate between words and action.

It's also hilarious to watch these candidates talk about climate change using the very same buzzwords—it's clear they understand very little about the science or reality of the crisis. They reference "scientists" as if those people are some rare, foreign breed that you have to accept at face value. Shows how little politicians understand science. That said, you can viscerally feel how their rhetoric is less powerful when sprinkled with facts and figures as opposed to anecdotes or emotive imagery, and so I, in that sense, appreciate why they aren't incentivised to look into or understand the science of any of this.

The democrats also collectively vilify their Republican counterparts (and vice versa), making it almost a finger-pointing game as opposed to understanding they're all part of the problem. Even politicians seem to acknowledge (or atlas pretend to, for votes) that Washington is overrun with corporate interests.

Why humans are so bad at thinking about climate change. (Vox)

A lot of scientists are employing alarmist rhetoric; perhaps because it's appropriate, perhaps not. Either way, I personally don't think individual humans care very much. Even if you outline, with vivid imagery, the changes that will happen on an individual level, people just don't really *believe* you. It's a complex, esoteric issue that they haven't begun to experience the impacts of themselves greatly enough to care. But they pretend to, since everyone else is. People feel like the impact is distant in both time and space (in the US).

Another view is that the alarmist perspectives are creating an atmosphere of doom & gloom, encouraging people to withdraw from the issue, and not think about it, for fear of being paranoid and worried (like the girl who approached me on the BART). It's easy to respond by leaving it to someone else.

Climate change is a "policy problem from hell". It's hard to design a more challenging problem for human psychology and political structure.

Examine how we responded to the "hole in the ozone". First, scientists identified the problem exists and explained why it's a problem to the individuals in a convincing way (you're going to get cancer, yes, you). Then, they explain a simple solution (stop using hair spray, which contains CFCs), to give people easy, actionable ways to fix it. Problem solves. Except with climate change, we it's difficult to explain a clear impact on individuals, as well as one clear way they can take action, since much of it has to do with corporate emissions (see stat at top).

An interesting take on this is the behavioural science approach to look at what and how humans respond to stimuli asking them to change. There has been research done to look at how we might encourage individuals, households, communities to take action to save energy where they can. They found that sending emails about money savings possible was ineffective, but emails about health concerns were effective, and social pressures—public displays of how people are doing were also very effective. There was even a startup that just worked with power companies to get

social competition to be embedded in the bills those companies provide, which helped energy consumption drop by a good margin.

Why Bill Gates Is Funding Solar Geoengineering Research

This is an approach where many planes release reflective particles to mimic a volcanic eruption, sans the devastation. This essentially buys time for us to stop greenhouse emissions as it prevents additional energy input into the Earth, but is not a solution to the problem, since if we stop doing this but continue releasing CO2, we now have lots and lots of CO2 but no reflective layer, and it warms up extremely fast. Some believe it's too early to be thinking of brute force tech solutions when we can so easily change this by altering our behaviour.

There are also more nuances wrt int'l cooperation—it affects different geographic climates in different ways, so if one country deployed it, it would affect other countries, triggering disputes, even conflict, if not everyone is on board. Mr Tomasi would abhor this solution—the Earth is a complex adaptive system, and this is putting a band-aid on the problem by fixing the first order problem (temperature from incoming solar radiation) without thinking of all the second, third order effects (which we don't understand well enough yet). Instead, we should seek to minimise human impact to this already stable complex system (the Earth), by simply reducing emissions—which we're going to have to do, one way or another.

The Biggest Lie About Climate Change (AsapScience)

Exxon (a member of the Big Oil companies that make money by drilling for oil/gas) hired scientists to study the effects of oil on the Earth for future projections of how they might provide energy. As early as 1970-1980, scientists got convincing evidence that burning fuels was worryingly causing climate change (the greenhouse effect is straightforward). At that point, Exxon could've played the long-game, publishing those papers and divesting into alternative sources, making tons of money in the future with a monopoly in the industry as a result, but continuing to rake in money by providing industries with the energy they need. In the 1980s, people were starting to become climate aware, and it was not a political issue. In response, Exxon, and other similar orgnisations, took stark, decisive actions to actively convince the public and lobby governments that climate science was very much still under debate and not settled, and that their fossil fuels will drive technological growth into the future. Exxon is particularly bad because they made climate change a political issue by lobbying George Bush Jr (which is a big reason he took CO2 off the four big pollutants list, as Hansen notes in his book).

The Greenhouse Effect Explained (Sixty Symbols)

Stefan's law says that power output is proportional to the temperature of a body raised to the fourth power. But why do things emit energy at all when raised in temperature? After all, being raised in temperature means gaining kinetic energy. Well, that's because the bodies gaining energy are made of electrically charged particles—particles that interact with the EM field. And so jiggling them causes them to cause the field to move—emitted waves of EM light, which is also the case with gravitational waves being emitted. Thus, when you heat the Earth, it radiates energy outwards.

When you start with an Earth exposed to no radiation, it heats up until the power output radiated away matches the power input. This is what people talk about when thinking about "energy balance" and is what's disrupted by climate forcings. If you calculate, based on power input from energy the sun radiates, where the EQM should be for a blackbody Earth, you get -18 celsius. This is about the temperature of the moon. Deviations from this are because of the atmosphere—which is why the Earth is warmer than might be theoretically expected. If the atmosphere stops some radiation leaving (but doesn't change incoming radiation), EQM temperature at which energy balance will occur, rises.

[rest on iPad]

Can We Block the Sun to Stop Climate Change (Real Engineering)

Standard "block the sun" method to mimic eruptions. Tall towers to disperse SO2 and balloons were considered, but planes are cheapest right now. Sulfuric acid particles absorb (then radiate outwards) shorter wavelengths, which are what we get from the sun. Upon absorption by Earth, Earth re-radiates longer wavelengths, which correspond to the absorption spectra of greenhouse gases. We'd disperse SO2 in the stratosphere, above the bottom layer we're in of the atmosphere, the troposphere. That layer is characterised by no vertical motion of layers, and no precipitation, so once it goes up, it'll stay there. But again, this is a band-aid fix in an otherwise complex system—we have no idea how it will affect photosynthesis, transpiration, atmospheric dynamics with other chemicals, and more.

One climate scientist takes on a room of sceptics (Insight SBS)

Scepticisms included:

"Haven't seen convincing evidence it's man-made. It's alarmist rhetoric by scientists to get more funding."

"There are natural variations much larger than the changes we're seeing today!"

"The Earth has its own methods of cooling itself if the temperature gets too high."

There is decade to decade "noise". Saying X decade wasn't warm and so climate change isn't occurring is as ridiculous as saying 2000-2010 was the warmest decade on record so we're all going to fry in a few decades. There are large variations in short term temperature due to local, chaotic, factors, and these are at least as large as the overall trend. So, to get an idea for warming, you take a look at centuries, not decades. And from 1850 to now, the temperature trend over those centuries has unequivocally been warming.

It's interesting to see these "lay-people" listen to a scientist. I'm at the right level to understand what he's saying, and the nuances and context of his statements—but for most of them, it's going over their heads, and so if, to them, he's just dropping jargon, how can they be convinced? The most convincing part for many of them was when he used an analogy to a bathtub. That speaks volumes.

One of the reasons people are so reliant on models is because the alternative, paleoclimate, wasn't measured using a thermometer, so isn't "direct". Instead, it was measured using various proxies, some of which we know aren't very accurate—like snowflake structure, tree rings, bubbles in tundra, etc. And so, understandably, many people think our paleoclimate understanding—what Hansen's whole argument is predicated on—is potentially inaccurate and unfair to rely on. The alternative, our models, are demonstrably not great because we struggle to computationally model complex adaptive systems properly.

An effective tactic when challenging sceptics is to tell them they're asking a good question—and that you can see why they would think or ask that, and that you asked yourself that in the past, and came to this different conclusion. When a sceptic asked about the sensors measuring global climate being positioned near cities (urban heat island effect) where it's hotter due to decrease in transpiration cooling & increase in machine use, Schneider explains how scientists correct for that by plotting population of a city against average temperature higher than suburbs, then subtracting that amount from the measurements, to find that things are *still* heating up, hence the conclusion of warming.

Many sceptics worry about the actions that will be taken in response to climate change. They worry that it will require us "throwing ourselves back into the stone age" by slashing what they perceive to be power output, instead of simply replacing our current power with renewables.

The ice age cycles due to changes in the Earth's axis of rotation as well as it's orbital eccentricity are called the "Milankovitch Cycles".

"if the effect of CO2 is logarithmic, how can 30% increase in the coming decades possible make a difference?"

Interesting to note that the effect of CO2 on warming is logarithmic. That is, the more CO2 we add, the smaller the effect of each additional amount in terms of pure greenhouse warming. The problem, of course, is feedbacks. This logarithmic effect has been known for decades, and is a part of any climate model we have. Despite this, we are on a track to being fucked.

Land use is an important contributor to CO2 emissions—on the order of fossil fuels. This is because methods to clear land include burning trees (releasing CO2) as well as the very fact those trees are not absorbing CO2 anymore means that more CO2 is released than would otherwise have been.

"I'm worried about the extent of alarmist rhetoric being employed"

I would agree. I actually think many scientists who, themselves, have gaps in their understanding, are somewhat hiding behind the veil of knowledge and seeming expertise, and misusing their positions of power to say the world is ending. This doesn't diminish the magnitude of the problem we face, but I think the fact that scientists are human beings means they can fall victim to irrational biases that make them more likely to emphasise certain facts that would scare over others. So it isn't a clear cut issue.

In large ice sheets in Greenland, Alaska, Antarctica, and more, there is a race between increasing ice on the tops as temperature increases, and melting ice near the water. Which is winning? NASA sent satellites to do remote analysis looking at gravitational changes at different points (high res) to get at an answer—the loss of ice is 4x faster than the buildup.

It's also admittedly true that there does exist "scientific reticence" to go against the pseudo-populist stance that the world is ending and we have to do something about it. There are very few scientists who will go against the media and politicians who are saying the world will end and saying "well, hold on, this is in fact a problem, but it's not that bad"—because they want action to be taken and they think the propaganda will be an important part of that!

Carbon Capture - Humanity's Last Hope? (Real Engineering)

It's interesting that, as an organism, we have the behaviour of a single celled fungus, Yeast, which poisons its environment until it dies due it its own doing. There are several existing methods for pre and post-combustion carbon capture in power plants and factories—all involving chemical reactions a chemist or chemical engineer would dream up. The CO2 is then isolated, and storage methods include pumping it into the large reservoirs from which we extracted natural gas, or to store it at the bottom of the sea, under whose pressure it would become a liquid. The store of this CO2 is called sequestration. Problem is, though, if it comes back up, both we and the climate are screwed. This technique could remove up to 80-90% of the CO2 that would otherwise be emitted by power plants producing electricity. Sadly, these power plants only make up around 25% of total CO2 emissions—with transport and land use comprising most of the rest. How might we reduce emissions there?

There is another approach, though, called direct air capture, which literally pulls CO2 out of the air, by using a giant fan to pump air into a chemical chamber, form carbonates and then pull out the CO2—again, Carbon Engineering, the startup pioneering this, is headed by chemical engineers. There is not much room for algorithmic or software innovation in the main product. This has been prototyped, and for around $150 a ton they can convert CO2 back into fuel that can be re-used. Still too expensive, but the first company to really make a step towards it making financial sense.

This way, no more oil has to be dug up and we can be carbon-neutral moving forwards—this is an important technology that could be useful, alongside policy changes to reduce CO2 output.

Can We Terraform the Sahara to Stop Climate Change? (Real Engineering)

So, we need lots of land in which to reforest. The best candidates are desert areas, since you can't take countries' agricultural land. Deserts have low populations and producitivites. We would choose a certain few species of trees, and be able to plant billions in the Sahara and Australian outback. With advances in desalination tech, we can cheaply use seawater to irrigate these forests, which, if implemented, would increase the total number of trees in the world by 50%. This would halve the world's CO2 output as the trees grew for a century or so, before balancing out. Remember corollary benefits include us harvesting the trees for fuel, setting up new industries for economic health, and more.

But all is not as it seems. Irrigation costs work out to only $2B, not so bad, but the upfront infrastructure will cost trillions to plant them and clean up the land to be able to do this. No-one will be willing to pay this enormous cost. More importantly, forests reduce albedo, and when replacing deserts, would actually make temperatures go up due to the enormous decrease in worldwide albedo these massive forests create. Thus, sure, CO2 would decrease drastically, but the thing we're actually concerned about—temperature, wouldn't change in any meaningful way.

Climate change is already irreversible (Simon Clark)

Carbon in the atmosphere stays there longer than nuclear waste. By the year 3000, only 40% of the peak CO2 concentration would've disappeared. So, if we stop at 500ppm (optimistic—we're at 410ppm right now), then we'd be at 370 ppm in the year 3000, which is manageable; slightly cooler than today—but still markedly higher than pre-industrial values.

The name of a common climate model is called the Earth System Model of Intermediate Complexity, or EMIC. There are many different types of EMIC, made by different people, by they rely on the same algorithmic approach to modelling weather. And concretely, by 'model', it is meant that we write code to simulate real world objects and process—like thermal expansion, cooling, and chemical cycles, and then run out models into the future to see what happens to those objects if we tweak the values of certain variables. You can see how these models would be useful, but fallible, since they account for only a small portion of the variables that manifest in real life.

Using Carbon Engineering's CO2 extraction tech, it'd cost $3T p.a. to become a carbon-neutral society. This is somewhat promising through, because the fact that CO2 will be around for thousands of years to come makes carbon sequestration technologies important to create, and it's exciting that in the future, it might go from $90 per ton of CO2 extracted to, say, 90 cents. Such is the power of innovation. That would make the annual cost go down from $3T to a more reasonable 30 billion, which world governments would be able to collectively contribute to, especially as the situation becomes more dire. Action item—look more into the potential of carbon capture technologies.

Climate change will also cause permanent changes like species extinction, and changes to the 'thermohaline cycle'.

Articles

What are the sources of greenhouse gases?

29% comes from transportation.
28% comes from power plants generating electricity.
22% comes from industry (making clothes, computers, tables, etc.)

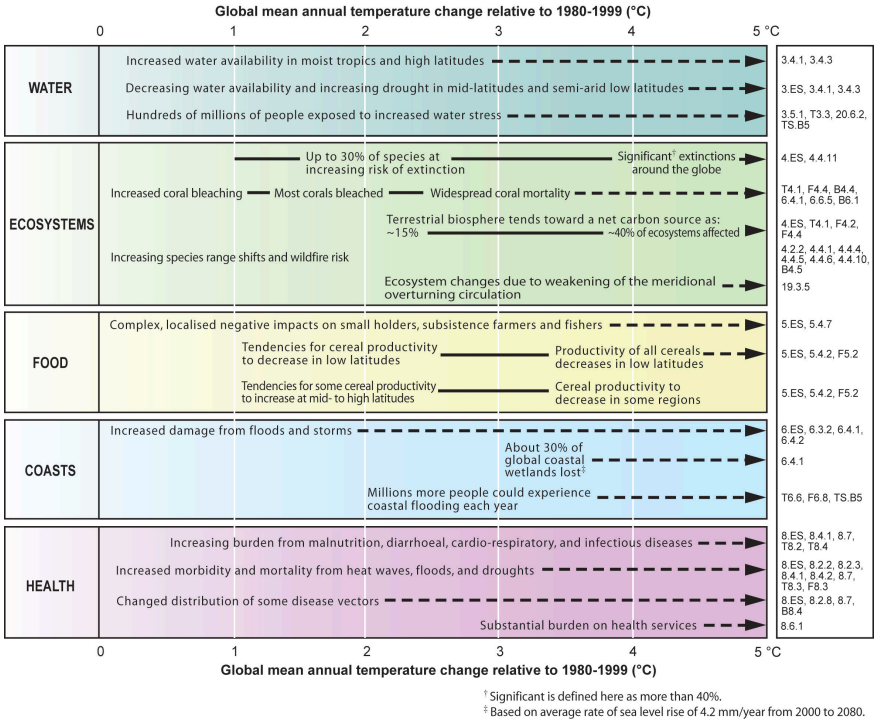
12% is commercial and residential (civilian living)
9% is agriculture (growing food)

Note that while only 9% of the US's contribution if agricultural, about 25-33% of the world's is (big countries like India and China produce a *lot* of food). And of that agricultural contribution, a significant chunk of it, around two thirds, would be removed if everyone on Earth were to become vegan. That means world CO2 output would go down by 20% if we all went vegan. That's a big difference—not nearly the 50% reduction we need in a mere one to two decades, but a big step in the right direction. That, of course, means that poorest 1-2 billion, who feed themselves by consuming cheap, calorie-dense foods, would be expected to switch diets to a more "eco-friendly" alternative.

What happens if temperatures rise?

We compare the average temperature to pre-industrial times. Right now, we're 1.1 degrees above pre-industrial, aiming to cap emissions off at a 2 degree rise, though really we should be capping it off at 1.5 degrees. At current rate of following through with legislation/promises, we're heading towards a 3-3.5 degree rise in worldwide average temperature compared with pre-industrial times.

A two degree rise, an optimistic take for our world's trajectory, *seas rise 5 meters*, causing a few hundred million to be displaced, and thousands to die. Prices of raw materials will rise, as *agriculture* becomes more expensive to conduct in a harsher atmosphere, killing off many due to starvation since they won't then be able to afford food. Ocean acidification increases, starkly reducing *ecosystem biodiversity*, causing compounding effects since it's a complex adaptive system.



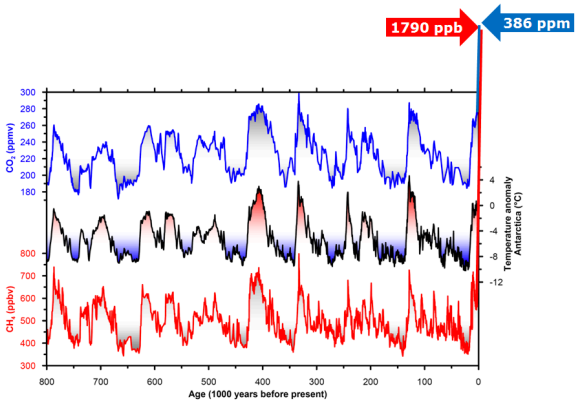
A three degree rise, as is expected, would mean we reach Hansen's "great tipping point". Sea levels rise by 25 meters, which displaces over a billion humans, causing them to have to relocate, like a few million did out of Syria during the civil war. Thousands that can't relocate die to starvation, disease. Others live a nomadic existence. Drought and forest fires wipe about about half of the Amazon and similar rainforests, releasing unprecedented amounts of carbon into the atmosphere, accelerating warming. We see more *freak hurricanes and floods* than ever before, alongside these *droughts and heatwaves*. Collectively, these disasters kill hundreds of thousands every year. Many areas of the planet near the equator that are now "hot" will become uninhabitable, further causing mass migration.

A world of four or five degrees looks dystopic. Millions die, billions are displaced. London and Vancouver look like Baghdad and Dubai. The equator is uninhabitable. There are natural disasters of unprecedented scope. Humanity struggles to thrive.

What difference does half a degree make? Why are people trying to limit warming to 1.5 degrees instead of 2 degrees?

This is close to the thermal limit for growth of many crops. Yes, effects would be about a third worse in general, but this is where feedbacks come in. You reach a soft tipping point, where agriculture becomes much harder, and many species will barely be able to survive (coral reefs will certainly die at 2, but probably not at 1.5). So agriculture and biodiversity are the main reasons for wanting to limit that, beyond even more sever effects otherwise.

Addressing climate myths



"Climate naturally changes throughout history"

The world "should be" heading towards an ice age now. But we aren't. And sure, temp and CO2 have been higher millions of years ago, but humans weren't around then, and don't think we'll survive those conditions now, either. Past examples of the rise we see on the right have had disastrous effects.

"Climate change and global warming are synonymous"

Climate change includes global warming, as well as ocean acidification, increased freak storms and droughts.

"We only emit a small portion of CO2 compared to the Earth"

It's about net emissions, not gross. Also, humans emit mostly Carbon-12, and we're seeing how, over time, cumulatively, the proportion of Carbon-13 in the atmosphere is decreasing as a result.

Book Notes

Storms of my Grandchildren (climate science & policy inaction)

Energy for Future Presidents (energy technology & policy reflection)

10 Technologies to Fix Energy and Climate (promising energy/climate innovation)

Energy and Civilization

Energy Myths and Realities

Growth: From Microorganisms to Megacities

Talking to academics and entrepreneurs

Agriculture, Resources & Waste Management (population, world hunger, recycling, etc.)

The Alchemy of Air (Haber-Bosch & Nitrogen fixation)

- Key insight is knowing that crop growth is limited by fixed nitrogen bottleneck, and there is not enough natural fertilizer (compost, manure) in the world to support large land masses of crops sustainably. But there *is* enormous amounts in the atmosphere.
- Malthus predicted civilizational collapse (and advocated eugenics/social darwinism as a method to reduce population), and was wrong because we invented synthetic feriliser, which was supported by ancillary innovations like the steel plow, tractor, pesticides, refrigerator, and more, and also because geometric growth, for reasons to be explored later, is never sustained by a population for extended periods of time. Both legs of his argument are specious.
- The 19th century was one of colonialism. As science and technology advanced in Europe, the birthplace of the Industrial Revolution, things like fertilizer were suddenly imbued with value once scientists knew what they could do, and so sent ships to South American lands like Peru and Bolivia (and India) to secure large amounts of fertilizer, for both agriculture and war, as they were ahead in military terms, too. This was the century of the Guano War, Nitrate War, Boer War, and more
- Natural fertilizer was treated like oil is today, with the whole geopolitical drama surrounding it, where it's most abundantly located, easily mined, easily exported, and more. If the Haber-Bosch process weren't invented at the time, with truly dwindling natural fertilizer, I'm not sure if people would have starved, but population growth surely would've capped. Macroeconomics, being a CAS, also meant that countries like the US wouldn't have the explosives necessary for rapid infrastructure & economy expansion (blasts used in road, railway, artificial waterway, monument construction).
- The reason fertilizers can easily be made into explosives is because nitrogen gas is very stable, and fertilizers hold nitrogen in a non diatomic form, so lots of energy is released when they combust to form things like water and nitrogen gas. Moreover, lots of nitrogen containing compounds are unstable (like TNT with steric hindrance of nitro groups) and therefore react easily.
- *Why was early 20th century Germany a scientific powerhouse?* Same question as that of 17th century England (Newton, Halley, Hooke), 18th century France (Laplace, Fourier, Langrange, Ampere, Coulomb, Carnot), as of Germany in 1900s (Einstein, Plank, Born, Bohr, Schrodinger, Nernst, Haber, Bosch, Ostwald), and of late 20th century Hungary (von Neumann, Erdos, Wigner, Polya, Teller).
  - Not clear relationship b/w science, education, economy: US has poor mass education, strong science/economy, China has strong education/economy, poor science. Maybe power on institutional level b/w mass education and individual prodigies (KWI, RSC, etc)?
- There are several obstacles to overcome in the discovery of synthetic ammonia. First, there were multiple paths that might yield the answer: electric arc fixation, cynanimide, and high pressure atmospheric fixation. Prompted by a company seeing Chilean saltpeter declining, Ostwald thought about the elemental approach and started the path. Haber took it forward and found you could create small amounts of Ammonia from its elements, but Nernst did much of the work discovering the high pressure route, abandoning it because he didn't believe it could scale. Haber's main contribution was the discovery of an osmium (then uranium) catalyst that gave industrial level efficiency (6%) as well as heat and gas exchangers to make the demo economical. Beyond this, the system had to be scale industrially. Even the development of Haber's apparatus was a significant engineering challenge (containing huge pressure continuously) which Le Rossignol achieved.
- It's important to realize that scaling it industrially was probably harder than coming up with the original catalyst. Bosch did an incredible amount of work, conjuring a phenomenal team as BASF that developed hundreds of patents and invented whole new fields of chemistry (like high pressure and advanced catalytic)—an R&D work on the scale of the Manhattan project. Everything in Haber's original formulation was replaced (iron w/ promotor catalyst, industrial reactors, and more) so it was only a sketch to guide industrial scale production, which Bosch, along with Mittasch (catalysts), von Brunck (funding), Nernst (advising), and Krauch (chemistry).
- Heavy chemistry in the 20th century is a good model for modern high-tech, as it was heavily innovation/product based, with high levels of R&D and technical talent being put first. BASF bought lead by investing in aspirin then synthetic indigo dye, then synthetic ammonia, inventing thousands of technologies in the process. Innovation-derived product leads are easily copied but there is still incentive to create them (eg bitmapping/GUI at Apple then everywhere else), and heavy profits from huge demand subsidizes R&D at scale. Will, then, today's big-tech's products (search engines, social networks) that have scaled and permeated all of our lives, be remembered as similar step functions? Maybe.

- Interesting that Brunck, great businessman who fostered innovative culture and made important bets that paid off for the company—much like Jobs—was not remembered whereas Jobs was. Why is this? Will Jobs be similarly forgotten or maybe this was an enterprise product and so less well known to the public?
- Seems like revolutions happen when there is wired-up, proven widespread demand for step-function innovation, proof of concept provided, scale technology is not clearly impossible, and the few individuals with the right combinations of background and personalities are given sufficient funding and pressure to make things happen that haven't ever been tried before.
- Many things that sound fictional when the science doesn't exist end up being clearly impossible (lead to gold, gold from seawater), but other equally ambitious things (flying, air to bread, mass to energy via fission) end up being possible and memorable step functions that change mankind. Without big bets, you lose by default—you're not even playing the game.
- Oppau was losing to cynanimide because it wasn't proven at scale and didn't have funds for larger trials, and cyanamide had a heavy lobby. It just so happened that the war upped the demand for nitric acid and Bosch took advantage to make the Saltpeter promise to the government, which, along with the happenstance that Oppau was the victim of the first-ever air-raids, funded Leuna and catapulted BASF to a monopoly. Circumstance and someone to take correct advantage of it.
- IG Farben = 330k employees, 98% uneducated, $7B modern at peak, Amazon has 750k employees, $1T market cap for context. We really are living in unprecedented times.
- It's an open question as to whether ambition and love can ever be compatible. Most times, great men throw themselves into their work with such ferocity that those close to them feel ignored, leading to failed relationships, both with their spouses and kids. For those that succeed (Churchill, Jobs), they must know that their children will be attention starved and live a harder childhood, and their spouses must be independent enough and of a temperament that doesn't mind effectively living and managing things alone—they must be truly, on a deep level, okay and supportive about the sacrifice you're making.
- Leuna was an example of something built *fast*, with the incentive of war and authoritarian swiftness behind it, going from raw land to a functioning production plant in less than a year. That's outrageous and shows the capacity for human efficiency at its peak.
- Once you succeed once, you're free to innovate for life. You have funding, talent pool, distribution on tap to be able to start major R&D projects on a dime, making it demising difficulty in starting major research efforts (companies).
- BASF is such an inspiring company. It essentially invented synthetic dyes, fixed nitrogen and synthetic fuel/gasoline, as well as thousands of ancillary patents to make these processes work at industrial scale. That is such, such, high leverage—yet it's not known by the general public despite quite literally being ubiquitous! All done by leaders who saw incoming macroeconomic trends correctly, and mobilized lots of resources before others.
- History quickly forgets your biggest personal and professional failures, and remembers your big successes. Even those that hear about Haber don't hear about his wife committing suicide or his panning of seawater for gold, but instead the Haber process.
- Haber turned back to his religious roots on leaving Germany and growing old—there must be some truly deep realization we have about life and its meaning when we grow old for most people to have this frameshift—make an effort to talk to people and find out what this realization is.
- For some companies, who were needed for the war or Hitler liked, the Nazi regime was fantastic, buying endless supplies of their products above market rate. But even for executives there, they became political pawns at Hitler's mercy as well as many Jewish execs voluntarily leaving around 1933. IG Farben is controversial because it got into bed with the Hitler regime to great effect, with the Leuna bombings being a crucial factor in the Axis defeat.
- The problem with large scale fixed nitrogen is that we're injecting, unwittingly, large amounts into ground ecosystems, causing changes in chemical cycles and biodiversity loss at scale, which is starting to damage our very farming efforts, and other effects are not fully known.

Gaming

Interesting to note that recently the gaming industry has been blowing up—it has increased in terms of revenue by an OOM in the last 2 years, and is expected to double in the coming 5 years. It has now surpassed the revenue of the entire world film industry!

Types:

FPS (Halo, CoD)
RPG (fictional setting with a narrative)
MMO (online interaction with others)
RTS (manage resources like Harvest Moon, Age of Empires)
Sandbox/open-world (minecraft, GTA)
MMORPG (fictional world with narrative where others are involved—RS, WoW)
MOBA (LoL, Dota 2, StarCraft)

Designers & engineers often have to think in terms of platforms (console, PC, mobile, etc because you have to heavily adapt game design and technology decisions (even narrative/story decisions) depending on platforms, which are constantly changing (will my PS4 game get funded if tablet sales are expected to be high, the PS4 has more RAM but for my game to be legacy compatible it needs to run on a memory-constrained system as you can't build it too differently for PS3 vs PS4 etc)

Interesting stats:

>2.5B people play video games on a regular basis, everything from Candy Crush and 2048 to LoL and Fifa

Gaming is now the biggest sector within entertainment tech, and has a total market cap of >$150B, about a quarter of which comes from China, which has 600M people that play games regularly, and the Chinese government had to legally regulate 'QQ coins', a video game currency, from devaluing the Yuan because they were used for RWT by so many people

Mobile games are 1/2 of all revenue, PC 1/4 and console 1/4
The average gamer age is a surprisingly old 35
Once you've become a gamer, you remain one for the rest of your life
>60% of CXOs take game breaks *at work*

Huge companies (Valve, Blizzard) account for 1/4 of the industry, the same amount as all indie developers combined

What improbable does: distributed computing innovation to allow for multiple game engines to contribute to a single simulation allowing for more complex virtual worlds to be built.

Reality is Broken (why games make us better and how they can change the world)

SQUELCH = forcefully silence, repress
VERTIGO = dizziness, loss of balance
MALIGN = evil, malevolent / defame, slander
MODUS OPERANDI = method of working, way of something being done, technique

- It's not that reality is broken, but that games, by the very nature of being engineered realities, are optimal ways to have positive stress and be deeply engaged in the way that forms memories. There are genuine human emotional and intellectual needs being satisfied by games that are not easily met in the real world.
- She believes the four defining features of any game are: a goal, rules, feedback, voluntary participation.
- Video games are so engaging and adrenaline-inducing compared to other games because they are engineered to give you constant feedback, keeping you playing at the edge of your abilities, in a so called 'flow' state. You use hardware (joystick), algorithms

(potentially ML), and graphics/narrative to give instant feedback, and what's more, software allows you to distribute these experiences in a personalized, scaled, cheap way.

- An axiom of game design is that nothing makes the mind happier than good, hard work. This comes in many forms: busywork (mining in Runescape), mental work (calculating and planning GP), creative work (solving a clue), high-stakes work (killing Corp), and more.
- What people associate as 'fun': browsing YouTube or Netflix, when experience sampled, are actually showing symptoms of depression, and so the opposite of stress and anxiety and sorrow is not 'chilling', but being engaged, feeling alive.
- She posits that we want four things from work that we do: satisfying work (edge of our abilities & see direct impact), the hope of being successful in the task, social connection, and meaning—feeling like we're part of a bigger community.
  - Work: we need clear, actionable steps with guaranteed payoff (fishing or woodcutting in RS, practicing CS in LoL), so we get a strong sense of productivity and progress, being able to see a strong sense of cause and effect is *immensely* empowering.
  - Success: failure is spectacular and entertaining, so you can't help but marvel that *I did that* when reflecting on the failure. Moreover, you get feedback on why you failed, and know exactly how to fix it, so you know that in a way, success is inevitable.
  - Social: gaming is *not* an individual endeavor, and promotes social behavior when done right. When combined with ideas from social networking, it can help people have a reason to catch up and keep in touch; but, more importantly, it can actually convert introverts to extroverts by getting them more comfortable with interacting with strangers. Also teasing that comes with losing/winning a game forges close bonds (social vaccine), as well as the vicarious pride of mentoring/advising someone as they play—which is an important component of gameplay, which brings people together. Ultimately, beyond all this, community is the lifeblood of any successful game, and an important part of the joy that people derive from it.
  - Feeling like a part of something bigger than ourselves: perhaps the most positive emotion you can feel is awe. And game trailers and worlds, when done right, inspire this again and again by playing on themes of human achievement at scale. Just because these games don't create value doesn't mean that they lack *meaning*. That comes from knowing we're a part of something bigger, that our actions matter in other peoples' lives—even if fighting the Covenant in Halo doesn't create anything real, any individuals' contribution sure as hell matter to everyone else, who is also trying to defeat the enemy.
- The challenges in games are fun because they are ultimately in our control, unlike challenges in the real world. If you know you fail a level, you can go back and change one thing and then go further than you did before, which isn't the case in the real world.
- Gamers have collectively spend >6M years playing WoW. That's >6M years of active, engaged happiness that Blizzard has added to the world—isn't that insane, as a founder, to think about?
- The technology behind diffing, making virtual worlds unique to a player, must be very interesting—could we manipulate these in subtle ways to change user behavior and psychology at scale? Rock Star made more people pick up real instruments, young gamers who were incentivized to help people in game are now being more altruistic in real life, and more.
- Building the technology for game engines and things like Improbable's SpatialOS must be so interesting—it's work at the bleeding edge of physics, computer science, needing insights from psychology, history, philosophy, neuroscience, art, design, UX research, and more.

- ARGs are ways to ‘gamify’ reality to a certain end. Examples include gamifying chores (Chore Wars), public education (Q2L), recovering from an illness (SuperBetter). I’m not convinced these work because if you know you’re making a chore into a game to do it, it doesn’t make it any easier—you just feel like you’re being manipulated—does research agree? How are Q2L outcomes? How could that be implemented at scale in the current education system? Could technology help with that?
- Foursquare started off as an app that would promote real-world interaction by notifying friends when you’re in a certain location. They had to build out lots of location-managing infra for this, and then pivoted to make that their central product, more accurate location tracking for sales (B2B SaaS). Understand why or why not the first product worked might be interesting to explore for Almanac by Phil Pfeffer. Other things to study on this front are Comfort of Strangers, Come Out & Play NYC, Urban Play Seoul, and more.
- Game-thinking isn’t high-tech; it’s all about restructuring our daily activities and planetary goals so that they fit the constraints of a game, so that we can hack our psychology to make them more enjoyable and easier to do.
- There are games that invite the public to get involved in real world events, making them more active in participating—in everything from public health to politics to natural disasters. For example, after an MP spent taxpayer dollars on vices and the government released MP expense data to the public in thousands of forms, a game dev crowdsourced the parsing of this, inviting public members to hunt down guilty MPs by parsing through these pages—it would be cool to be the person that develops the web app and leases with a journalism site to get the public access to this stuff—you’re doing real good and making meaningful change on a non-trivially large scale, only 1 to 2 tiers below a historic-change. Think about how you can help in this way anytime there’s a major event in world politics, even if as a side project. Look into the Serious Games Summit if you’re interested in this stuff (SF).

Biotech Notes

Fintech

A high level view and gaining intuition for what companies do

Examples of big winners:

Stripe

What exactly do they do

They are a payments gateway that connect merchants/startups with an online presence to existing legacy payments infrastructure like banks and card networks. They are an end-to-end solution which just involves creating an account with them (for non-devs) or hitting their API (for devs). They are cheap, simple to use which is a big selling point as a lot of other developers can cut payments-related code out of their codebase now (including things like building a dashboard to visualize revenue, compliance requirements for routing payments internationally)—essentially IaaS.

How did they come up with the idea or see the problem

Patrick was working on side projects, like the one that evolved into Auctomatic, and ran into the problem of accepting payments over the web first-hand, and questioned why it was so difficult to do so. They had some background with fintech via Auctomatic and so knew they had the background and connections to be able to go about solving it. They then prototyped and iterated for 6 months before finding a customer.

What will they do in the future and will it change the world

Outside of expanding the reach of their payments API, they want to do other things that allow for a lower barrier to entry to starting a company, like Atlas, which registers/incorporates a company for you, and start to lend to companies, potentially as a bank. They have over a billion in revenue, but whether they are profitable is unknown. From a leverage perspective, they really are changing the world—they are an important piece in increasing the “GDP of the internet” by removing an important barrier to entry, making way for thousands of tech startups that may never have existed otherwise.

Why did no-one do this before

No developer had a background in payments? IaaS was not really a business model back then?

Brex

What exactly do they do

A corporate credit card that is easy to get and use for startups. They give it less stringently to startups based on metrics of the business as opposed to personal credit history and using it 1)_ provides more insight into how employees expense money. You pay the charges off (it's a charge card, not quite a credit card) every 30 days and CANNOT move debt from one month to the next—you must pay every 30 days. It 2) has no personal guarantee 3) has above average rewards, importantly on things startups needs, like Google Ads and AWS as opposed to hotel points and shit like other cards. Allegedly, they make more money off interest from big successful startups that spend a lot of money than they lose on startups that default on a loan one month and can't pay back what they spent.

How did they come up with the idea or see the problem

The founders sold "the Stripe of Brazil" when they were still in high school, having raised $30M and processed >$1.5B in transactions as young teens. They then started a couple more companies, which failed, before starting Brex. As with all fintech companies, they take one service (startup spending) and do it better than what big incumbents can afford to do. They have a business model innovation in that they can afford to not have a personal guarantee from founders and because of it being a charge card and big startups spending lots of money and being reliable bets they make more money than they lose in 1 month of spending if a startup spends that month then dies.

What will they do in the future and will it change the world

They are innovating new products, like trying to make bank accounts obsolete via Brex cash. They have given capital to lots of companies that genuinely would not get a card from a bank in the past, allowing them to grow and succeed and provide value to consumers where they otherwise can't. Trend in IaaS or enabling platforms that lower activation energy using some clever business model innovation implemented through technology.

Why did no-one do this before

Niche corporate credit cards, weird thing for a fintech to go after? I guess some ideas really hadn't been tapped beforehand, being seen as batshit crazy or childish.

Robinhood

What exactly do they do

An app that allows you to trade securities for no commission, thereby "democratizing" it. Many people who would never have traded before trade now because of this. That said, other competitors have sprung up with a similar model, making it lose its moat, and is just distinguished by the fact that it was the first and is currently the most robust. It offers the same services that brokerages (people who are licensed to enact trades) do, like Fidelity Investments and Charles Schwab.

They make most of their money from payments for order flow direction—they send the orders from their clients to particular "market makers" (Two Sigma, Citadel, etc.) that benefit from each transaction made through them as opposed to directly via an exchange, and give Robinhood a commission for doing so—but since each exchange takes different fees from the customer's trade order cash flow, this is potentially a conflict of interest, and the SEC mandates that the brokerage disclose this.

How did they come up with the idea or see the problem

After occupy wall street, they wanted to come up with a way that the 99% could trade just as easily and painlessly as the 1% who had insider access to the bureaucracy that was strangling the majority. It's interesting that they had 75 failed investor pitches, much like other unicorn founders who had 50+ failed pitches under their belt.

What will they do in the future and will it change the world

They are continuing to try and offer new ways to give customers free access to things and innovate the back end to make it financially viable. In aggregate, they've allowed a few hundreds thousands people in the middle class to make a few hundred, if not a couple thousand bucks (though I'm sure many have also lost money) that they would not otherwise had—it's not clear that this is net positive for society in itself, though I'm sure that the business model innovation will be useful in other, subtle, ways in the future.

Why did no-one do this before

Genuine business model innovation? I'm sure other people had the idea, but none could make it work—these guys wrote the tech that enabled it, had the right networks to get sufficient talent, know enough VCs, be just tenacious enough, and I'm sure a combination of other factors.

SoFi

What exactly do they do

They give student loans, undercutting existing lenders by taking into account the likelihood of customers to pay back their loans based on their education and background, and by converting operations into technology as opposed to in-person. They finance these loans by selling them to asset managers like pension and hedge funds that know they are likely to be paid back. If they cover a student loan for $100, the incumbents charge 7% APR and SoFi charges simple 5% over, say, 5 years, when the principle is due. At the end of the 5 years, they have been paid $125 by the borrower. They sell the loan to investors for $105, and the investors make $20 profit, leaving $5 for SoFi. They've used similar business model innovation to branch out into other types of loans—this is fundamentally creating a new financial instrument and implementing it using some technology, not really a technology startup. They are valued at over $4B. To be able to extend credit before loans having been paid back, they receive enormous amounts of funding from banks and investors —quite literally a form of VC2C.

How did they come up with the idea or see the problem

Four MBA students met at GSB, and since this was inherently a problem of coming up with a better financial instrument rather than any meaningful technology innovation, people with backgrounds in finance were well enough equipped to start the company, and knew the right people to ask for capital at the intersection of startups and finance. They had obviously experienced the problems themselves, and were in a position to solve it.

What will they do in the future and will it change the world

Branch out into other loans and generic financial products. I don't think this is productive—the good customers are subsidizing the bad ones, who need insurance most, and separately only treating them basically stops anyone who really needs a loan from getting one. This is just an efficiency optimization to make money.

Why did no-one do this before

Perhaps genuine business model innovation. I'm sure people have tried to use peoples' career prospects in underwriting before, so likely partnerships/networks they had to make it possible.

Plaid

What exactly do they do

Financial IaaS for bank integrations. If you have a startup idea, you don't need to partner/integrate with hundreds of banks to get information about the cash flow of your customers, you can just tap into Plaid who has done all of that for you, and move on with building your product.

How did they come up with the idea or see the problem

The co-founders were trying to build other braindead fintech apps and in the process of doing so repeatedly had to rebuild integrations and partner with banks to get off the ground, which came with a lot of overhead, and so they pivoted to build a unified payments API instead.

What will they do in the future and will it change the world

The key play here is getting user consent to use their data. Plaid powers all fintech companies under the hood, and so they need to explicitly ask permission for plaid to use and collect their data —all data about everyone's banks and transactions. This data is an immense treasure trove. An interesting take is that Visa bought Plaid to quietly kill it because it enables the kind of banking innovation that would put Visa's customers—issuing banks and credit unions—out of business.

Why did no-one do this before

Affirm

What exactly do they do

Its foundation is predicated on the fact that the credit card is very nuanced and powerful, much too so for the layperson, who will not understand the complexity of compounding interest, etc., and just wants to see things in plain dollar amounts, with no additional hidden fees. supposedly, taking individual loans on items brings clarity and simplicity—a blunter tool than the credit card, if you will —to the process of buying things. Essentially, they allow you to take a POS loan on an item and pay it back month-by-month—a fundamentally new way to pay for shopping.

How did they come up with the idea or see the problem

Levchin was the first mover in this space, with a deep background in consumer finance and payments. The problem he saw was that credit cards were too nuanced for a layperson to navigate successfully, and they needed a clearer way to borrow to buy stuff.

What will they do in the future and will it change the world

They are constrained by the number of partnerships they have—by the number of vendors that offer the opportunity for consumers to finance their products this way. If they scale to billions, they can save consumers billions if not trillions of dollars that those consumers can spend elsewhere (but it's not clear that the act of saving these people this money is adding value to society).

Why did no-one do this before

Point-of-sale loans are hardly new — banks have been offering them indirectly at the likes of furniture stores and orthodontists' offices for decades. The biggest players historically have been Wells Fargo, Citigroup and Synchrony Financial. But this type of lending has become increasingly popular in recent years as technology has improved to the point where merchants and contractors that previously may have only accepted cash, check or credit cards are now offering the option of a loan at the moment of purchase, whether online, in stores, or in person. They have also been a boon for online lenders — San Francisco-based Affirm originated more than $1 billion in point-of-

sale loans last year — and, increasingly, for regional banks that are funding the loans, either directly or behind the scenes.

At a high level, the purpose of the financial industry is to allow for efficient access to capital by both consumers and businesses. That is to say, make borrowing and lending easier. When done correctly, people can deploy capital that is not theres, strengthening the economy (more goods and services, in absolute terms, produced) as well as promoting social mobility. Fintech refers to use of software and algorithms to improve the efficiency of this process, previously thought of only in bank-end of large financial institutions but now also in the hands of individual consumers.

Thematically, Fintech startups try to offer the same services that large institutions do, but using technology to reduce operational costs, and offering a simpler interface. In other words, making personal and business finance cheaper and easier. This could be everything from personal money transfers to personal investing. In the industry, partnerships are king. How many banks/lenders does your API interface with? If you can't partner with the big players, you have no value prop for your consumers and the network effect won't kick in.

Important avenues for Fintech work include banking (mobile banking), personal finance (robo-advisors and investment tracks), insurance (rethinking incentive structures and automation), and crypto/blockchain. Part of the reason that big tech companies are getting into finance is because big tech itself is starting to become more regulated, and so they aren't moving as fast as they used to and hence lose less by setting roots in the finance space (where all the biggest non-tech companies are).

Interesting to note the hype around new technologies affecting stock price—an iced tea company (Long Island Iced Tea) changed their name to Long Blockchain corporation, and share prices went up 430%. This name-hype phenomenon has been observed in the past with .com and .ai too.

Geographically speaking, London and New York are financial hubs, and so people tout these cities, as well as others like Singapore and Hong Kong, as Fintech capitals. This is not the case. The San Francisco Bay Area is, and will continue to be, the world capital for anything to do with technology, Fintech included. All the biggest Fintech companies come out of the valley, because they are fundamentally technology companies, and the valley is ripe with both talent and funding. It should be noted, however, that rising commercial rent prices and increasing taxes (to pay for homelessness shelters, etc.) are stacking the odds slowly against the city in the long-term.

Fintech IaaS future

One opinion/bet is that every company will become a fintech company. Just as AWS took away all the overhead from starting a software company, new startups will soon enter the space and provide IaaS products reducing the complexity and overhead that comes with starting a fintech company. Currently, there are several barriers/hurdles when one wants to start a fintech business, since it's heavily regulated. Before you even start building out your actual product, you have to get certain licenses, find ways to ensure lots of compliance with regulation (and, indeed, know what that regulations even is)

The premise here is that current banking experiences are shitty (from surveys) and large investments into technology are just being used for maintenance of shitty, legacy systems rather than genuine innovation on behalf of the big banks. But there is a big moat a la complex regulations and infrastructure—if only someone could abstract those away people would love to compete with the big banks.

The current way to offer any banking services involves 1) applying for a license (which takes years, so many startups looking to offer banking services borrow a license from an existing player) 2) core

systems that actually store/move money from place to place 3) payment systems that allow customers to get money out of their accounts 4) giving loans means you need to know customers' backgrounds which come through credit bureaus (private, for-profit companies that collect information on you, like Equifax or TransUnion) 5) comply with regulation from government agencies 6) prevent fraud. And to do all of these, you need partnerships and integrations with loads of companies, from payment systems to credit bureaus and more, which takes lots of time and money. This is analogous to how 15 years ago if you wanted to start a software company, you'd have to buy servers, set up racks, and build out all the *very same* infrastructure again and again until AWS came in and abstracted it away at scale, which is exactly what can happen with each one of these obstacles—it can be abstracted away.

Examples of how you'd start some fintech companies

Financial planning/budgeting help application—this doesn't need to reinvent the stack, it just needs some information on your spending habits to get information *out* of the stack. To serve people, you need to know everything about all their bank accounts; i.e., exactly what they are doing with their money. You need to be able to hit the APIs of hundreds of different banks (these are integrations), and structure code to be able to stomach different core systems you're interacting with (UBS loans vs M&A may have non-uniform data formats, etc.) and compliance methods for each bank. You also need to integrate with brokerage firms like Fidelity that have information about your customer's investments/trades. Similar with information about their payroll—when they're getting paid, how much, by whom, means you have to integrate with firms like Gusto and Zenefits, and then other miscellaneous things like student loans, which begets an entirely different set of integrations. *Here's the kicker—Plaid builds and maintains all of these hundreds of integrations, and translates data into the format that you need, meaning that you don't spend months setting up the infrastructure for your financial planning web application, you can just hit the Plaid API and get up and running in a day. Isn't that crazy?!*

Another example is Synapse, which actually implements these integrations, and integrations with ATM providers and more, so you can actually start a banking service on top of it, like Mercury—the ads for which you've seen all the time when walking around the city.

Another example is ComplyAdvantage, which makes it easier for banks to find fraudulent accounts. Normally, banks have to integrate with hundreds of government lists of suspects, and then iterate to make sure none of them have access to accounts. Not only does this lead to frustrating UX in a false positive case, but also means banks have thousands of employees just so they can manually comply with these regulatory mandates, and still are pretty terrible at this. CA reduces integrations to one, and automates much of the searches for fraud, saving banks tons of money.

This is important because a platform like AWS essentially launched us into the tech-centric world we know today, where startups are ubiquitous and omnipresent in their influence. Many of them wouldn't have come to exist wit it wasn't easy to start a software company. The same will happen in finance, where tons of new fintech products will enter the market, adding to consumer choice, lowering prices and making finance generally less bureaucratic and much easier to navigate just by virtue of competition.

There are lots of opportunities for companies building IaaS, but even more for companies that *use those products* to get financial services as one of their offerings, just like Rappi is offering financial services to the unbanked that are using their food delivery platform (and Uber is introducing Uber Money). Moreover, bigger institutions can move faster as a result of this, and have more startups to partner with.

The future of Fintech (and general entrepreneurship advice)

A general advantage of the Silicon Valley paradigm is that smart people have access to lots of problems they would otherwise never be exposed to, because all those problems have a common thread—they can be solved using technology. In this way, an atomic physicist turned software engineer could improve the efficiency of the taxi industry, then how people get loans, then how people order clothes, all in one career. That would never have happened 50, or even 20, years ago. There's a fundamental paradigm shift that the valley has brought about in how problems are solved, and it's more than "just another industrial fad" in that sense.

Another key insight is that most tech companies don't use advanced tech. They use tech as a medium to make one unified end-to-end experience that is clean, simple, fast, and easy. And there is no industry more wrought with customer dissatisfaction and unnecessary bureaucracy and complexity than finance.

An aside—when a16z finance branch head met 19 year old Patrick Collison in a Palo Alto cafe, when asked about how he'd take over from incumbents, Patrick responded with "my customers don't exist yet". How incredibly *chilling* in its visionary accuracy and self-awareness. He saw a wave of tech companies coming into the world, and Stripe would capitalize on that market.

An important thing to recognise when founding a company is that your idea is not novel. The difference is successful founders recognize that, and think about how they can best position the idea to succeed by planting it at the right place and time.

Battles between startups and big incumbents often come down to whether the startup can get to market sooner, or whether the incumbent can innovate sooner, and very often it's the latter.

A huge operational point to be mindful of is the importance of distribution channels—who controls access to the consumer. After Square and Stripe build out their customer base and have many people using their platform, their CaC becomes near 0 going forwards since so many people are using their products. This is specific to platforms, since they can build products on top of their own platforms, unlike others' products, who are dependent on Square and Stripe's infrastructure. This is why it can be beneficial to think of a first product as a boring product that establishes a platform/distribution channel upon which you can build other products. It's enormously powerful to have both distribution AND engineering talent.

On the Chinese fintech market—many believe china to be ahead of the US in fintech due to 1) quick user adoption due to cultural reasons 2) leapfrogging over existing infrastructure. It's interesting how different cultures can evolve in separate directions due to small variations in initial conditions—Chinese weChat has the ability to buy movie tickets, serve as your asset manager and a chat application all in the same app—that would never be culturally normal in the US!

It's also important to recognize that you can embed and couple fintech innovations in any other industry—Zola Electric and M-Kopa are energy innovators in developing countries that finance their products by giving them to customers and getting customers to pay back their loans with the savings from using their product (via mobile banking), thereby making something that was previously uneconomical, economical and giving clean, 24/7 power to millions who wouldn't otherwise have it. In the future, insurtech for cars will be part of buying the car, and similarly other verticals will integrate technology into them in the same way.

Interview of Max Levchin of Affirm

He sees a future where you can walk out of a store having bought something with a mobile wallet, and at POS the wallet had AI embedded that chose a particular method of financing that particular thing (groceries vs car, etc.) based on both your background and the market more broadly (taking a POS loan vs up-front payment vs using other financial products, etc.) to optimise your money saved.

He believes that the credit card loan system, as a product, is very nuanced and complicated, and far too subtle for the average layperson for whom it was intended to be useful. And then when the average person doesn't fully understand its complexities, they seek refinancing and birth the current trillion dollar debt.

Understanding Visa as a Case Study

Understanding Visa is a good way to understand the payments landscape and the complexity behind much of the world's financial infrastructure that happens behind the scenes. Almost no member of the public actually understands how this company works, despite it being the very backbone of modern payment technology. Visa doesn't give loans (that's a bank) or issue credit cards (also a bank), merely connects the banks that need to transfer money.

A customer goes to a shoe shop to buy a shoe. They flash/insert their card, and when this is done a message goes from the card reader at the merchant (shoe shop) to the acquirer bank (the merchant's bank) which then routes the card request through Visa's network, which then hits the issuer bank (the customer's bank) that does identity verification, credit checks and fraud prevention before sending a request back to the acquirer bank (through VisaNet) saying the transaction is good-to-go, in which case, the POS terminal shows the card has been approved, and the customer leaves. Later, overnight, the acquirer bank deposits the money from the days sales into the merchant's account, and the issuer's bank pays them back (through VisaNet) and is paid by the customer when they pay off their credit at the end of the month. There are transaction small fees littered throughout the process, which mean that for every $100 a customer pays, the merchant gets about $98, with the rest being split by Visa and the banks in processing fees. The real value prop in this complex system isn't just the authentication and fraud checks, but the systems in place in case something goes wrong. In this case, there's complete and instant transparency into where money went and how it got there, so that funds can be traced and secured in case of any fraud. In payments, security is at the heart of everything that is done (take class on cryptography and cybersecurity if interested in solving fintech problems). There are also additional layers of complexity like other parties intervening and exchanging small sums of money to send to airlines and hotels to fuel rewards/loyalty programs, etc. Visa also has other Fintech products, like the entire ATM network.

But because all of this communication infrastructure is so complicated, it's all based on legacy infrastructure (AmEx hires devs who write in a 1970s language, so that's what their backend must be based on—billions is spent on maintaining this infrastructure). This means it's almost impossible to move fast and keep up with current best practices. So when we started using electronic payments, instead of the acquirer bank implementing the infrastructure for this, payments gateway companies like Stripe came in, and basically said we'll be the intermediate between online card details and the whole credit-card-5-parties loop we just discussed since the acquirer back didn't have the bandwidth to accommodate loads of different browsers and data formats. This is important because then by working with the gateway, the merchant is agnostic to the backend infrastructure—they can swap banks/from Visa to MasterCard based on what's pricing optimal, and the merchant potentially will not be able to tell as they're just using Stripe.

Biography of Levchin
Grew up in Ukraine to a family of physicists, escaped after the Chernobyl accident. Introduced to programming in assembly when 11, became deeply passionate about computing and studied CS at Urbana-Champagne. Moved to Palo Alto at peak of dot-com explosion and met Thiel at a Stanford lecture, and talked lots with him then co-founded PayPal. His deep experience was not a huge advantage when building it though as it's not as if it was cutting-edge software, just a new way of thinking about payments and a bet that people will want to send money over palm pilots in the future. Similarly, the Collison brothers, when asked who their customer was in a Palo Alto cafe, replied that "my customers don't exist yet" when thinking about how millions of merchants were about to come online. *Both of these were big bets on a particular future coming to life in the next 5*

years based on extensive research, firsthand experience in the industry, and general independent/ intelligent thinking.

The physical cost and overhead of infrastructure like branches, tellers, ATMs means that small transactions are money-losing, which isn't the case with digital banking, where you can afford to take small margins off small transactions at scale. There are challenger banks popping up everywhere in the developing world, like mPesa in Kenya, bKash in Bangladesh, easyPesa in Pakistan, and virtually an analogous one in every major developing country. There are still difficulties in getting these types of companies off the ground—you have to apply for a banking license, partner/be supported by a bigger bank, all of which takes a lot of time and capital, and a lot of failures on the way. There's also strict and often nebulous regulation around the industry which only big banks can stomach.

mPesa works by allowing people without access to a bank account to use it through a SIM card and their phone number as their unique ID. You take cash to an mPesa desk and they credit your phone number with money, which you can then transfer easily however you wish.

Despite all this, a little under 2 billion people remain unbanked, without access to basic financial services. Only a third of Africans are banked, and around half of south Asians. How might we align incentives to solve this, using mobile or otherwise?

3 Ways Startups Are Coming for Established Fintech Companies -- And What To Do About It

When competing with an incumbent, it's less about taking *all* their customers than taking *their most profitable* ones. For a startup vying with an insurance company or bank that has to underwrite insurance or loans, you can do so by offering the very best customers better rates, because they are less likely to default, and still be profitable. The big players need these customers to subsidize paying for bad customers, but you don't *have* bad customers and thus can thus undercut them (only accepting healthy people or safe drivers, as measured by a variety of metrics used in underwriting). This is what SoFi is doing with student loans, offering lower rates by 1) having less overhead via being a tech company and 2) predicting future career prospects and offering better rates by only loaning to high-potential people. So the first way a startup can take on an incumbent is by using psychology in marketing and their business model to select for a particular type of customer that is especially profitable.

The second approach is to collect and leverage new sources of data that incumbents would never think to collect—literally anything—and check for correlation with credit worthiness (signal building like at RenTec). There is lots of regulation surrounding who you discriminate against—if any signal you match (like number of cats you own) corresponds to a gender, race, religion, or something of the sort—you can't use it as a basis to not give someone a loan. Instead, by collecting new and unusual data sources like phone metadata you can map signals to determine how creditworthy someone is without any discrimination.

The final way that startups can take on incumbents is by changing the behavior of customers to benefit them. This could be by employing a business model that taps their peers and gets co-commitments as a social pressure for the borrower to pay back their loan, or using their phone to re-underwrite their insurance prices every day, forcing them, say—if it's car insurance we're talking about—to make sure they aren't trying to game the system by changing their behavior in the short term to simply get a good deal.

Would I like to look further into this industry in college? Why?

There seems to be a big difference in terms of philosophy, mission and impact between finance (banking, hedge funds) and fintech. There is little bureaucracy, nepotism and corruption in fintech because fintech companies are ultimately technology companies employing engineers, but they are offering many of the same services as banks, at scale (other financial institutions, like hedge funds, really don't offer any services/value to society). I hadn't realized this until now because I had little to nor exposure toor understanding of finial products/services, but offering people access to financial products genuinely means they get access to capital (and hence opportunities) they would otherwise, in less efficient and innovative markets, have access to. This can be life-changing—the difference between owning a house and a car and sending your kids to good schools and being able to afford healthcare for your family, all done even though you don't quite have the money to do so straight up. Banks offer many of these products, but are culturally prone to corruption and misaligned incentives and bureaucracy. Tech companies offer these services, and more, and suffer none of those problems, and can also automate software to solve and deploy these solutions at scale. A company like Plaid without which potentially hundreds of *other* innovative fintech companies could not have entered the market, is literally adding billions of dollars of value and hundreds of new, creative, potentially world changing ideas to humanity, giving people access to trillions in capital they wouldn't otherwise have had access to. Financial services can be confusing at times, sure, but when done right, they add tons of value, and I couldn't see that before because the canonical intuitions of finance (banks, hedge funds, etc.) are not optimizing for impact.

Urban Tech & Mobility

Smart cities, buildings

Embedded systems/'cyber physical spaces' are all around us, from flow control algorithms on a bridge to HVAC within a building taking sensor input on people inside a building and choosing to change temperature accordingly. This is important because we spend our whole lives in buildings, and more importantly, buildings and vehicles take up a significant proportion of the energy we use, meaning urban tech has important consequences for sustainability as well as for time-efficiency.

Problematically, the IoT systems of today don't communicate—the HVAC doesn't talk to security systems, and more. Thinking in terms of computer science, software for a building requires an understanding of energy environment (what does electricity cost right now, what mix of green/brown do we want, what machines are we okay to turn off if the cost is too high), personal environment (how many people inside the building, where), and outside environment (is it raining—I might have to lower the AC, or is it a hot day?).

Interesting to see that we take in lots of electronic devices to buildings and buildings don't make any use of it, either for learning about us or for letting us control the environment. You also have to think about productivity and comfort gained by building smart buildings vs the cost of doing so—if you don't monitor temperature then SWE at google aren't productive, but if you have a super niche optimizing feature costing millions but only adding marginal comfort, maybe not. So we need to understand how these optimizations leads to productivity and efficiency gains to make a trade-off decision.

Interesting to consider 'clouds' of buildings, where there is shared information—an office building in Beijing could share data to improve the machine learning of a control system in an office building in Guangzhou.

With all of this we start collecting more data as wells actually using the vast amounts o data we collect, and that raises a new dimension of privacy concerns.

Singapore is moving fast to deploy urban tech but the reason they can move so fast is that they have a culture where citizens are okay with governments knowing absolutely everything about their lives and every inch of the urban landscape. An example is their public CCTV seeing someone

smoking too close to a building, then following them home on their series of public CCTV cameras to get their address and issue a citation.

Computer Science in Energy Landscape: Grids and Datacenters

Current solution for electricity grid is power plant (Arizona/Nevada) through wires to loops inside cities (the 'grid'). We need go re-architect the grid to remove long-distance transmission, as well as allow electricity to flow both ways to minimize wastage, neither of which the current grid is suitable for.

IT contributes to 2% of the world's emissions, comparable to the world aviation industry, and the fastest growing segment within that (currently at around a third of it) comes from data centers, and so it's important to optimize them for sustainability and cost purposes. For example, only about 30% of the compute power of a data centre is being used at any time, but that requires near 100% of the power you'd need if the data centre was running at maximum capacity (non-linear relationship) and so there's lots of power wastage.

Part of Professor Katz's research is thinking about the structure of VMs on a single hardware port and doing the same abstraction for data centers to make the relationship between compute and power more linear—these are 'containerized datacenters'.

The reason we need all this IoT is for transparency. Even in advanced societies, there are glaring inefficiencies—if you look at many academic buildings at Berkeley, you find that there is a huge caseload power demand, and equipping a building with lots of sensors and collating the data shows that most of the caseload (even when no-one is in the building) comes from computers still siphoning power when 'off', same with HVAC, and more. A big part is that as a society, we're very poor at truly putting devices to sleep.

Interesting to think about algorithms to determine energy use within buildings over time—if you're scheduled for a hot day, instead of waiting for things to heat up and then cooling during middle day when it's hot, why not cool significantly overnight and then not at all during day so while the temperature may warm up it's never too uncomfortable—trade-off between cooling and gained productivity example.

Power is another dimension in algorithm design, because often number of computation steps donesnt' conform or match perfectly to time taken in real life, and so structuring algorithms to optimize for actual wtime will be important in the future, as well as computer steps.

Keep in mind that energy infrastructure is distributed, and so it's important to optimize for doing nothing well across every step in a distribution pipeline, from power station to household, which is often neglected.

Randy Katz, EECS Professor at Cal, Vice Chancellor of Research, **urban tech**

- Given your position as vice chancellor of research, do you ever think about how most empirical scientific research is not reproducible? Misaligned incentives in that journals only take positive results and citations and publications are valued over all push people to p-hack and forego interesting but challenging problems?
  - Did that ever bother you when you were considering a career in academia, and weighing it against industry?

Social sciences movement data sets opening for peer review, leveraging existing platform and internet to get larger data sets
Ted mcgwell social science realness
Transparent and reproducible social science research
New sites for people to read and rate as opposed to publishing business and monopolies on houses making money in journals, kind of social networkings with likes on a paper

Committee of 1000
Being fixed now because technology is allowing crowdsourcing, and scientific publishing has become more centralized and now that universities have more budget, there are fewer publishers (elviezier) journal market share, monopolies getting more common, second guided age of monopolists and we care more about our time

  - Will this change anytime soon?

- When you envision your future city, with the ability to 'do nothing better', all datacenter being 'containerised', and IoT seamlessly moving data in 'cloud fleets of buildings', what are the biggest scientific challenges in getting there—quite literally, tough, unsolved problems? What could the next generation of computer scientists interested in energy problems work on in their PhD thesis to accelerate progress? What are the highest priority problem spaces?
  - Scientific:

Cities as complex adaptive systems where you can't easily change one thing to influence behavior
Parking was a pain in the ass before and so more cars on the road
Equity issues about who can take uber and public transport is worse—optimisation criteria now vary based on subjective factors
Bus from SF to the valley—personal optimisation vs global optimization or people living in Cupertino

—> research topic in the future in counterfactual algorithms; mapping/routing algorithms are very greedy and the idea of sending an explorer down a suboptimal route to check how that affects learning of route speed data for models to see if that affects everyone else in any substantial way

—> the fact that reward functions are subjective as doing one thing necessarily leads to this other change
—> Berkeley is very traditional in its academic sense and isn't as much on the cutting edge whereas most Stanford professors are *part* of the cutting edge—the guy wanted to always be an academic for the sake of being an academic and so just went out and did exactly that

Military and Defense

Army of None

On War and the industry's future

—> Interesting to look at quick adoption trends throughout history that went uphill against infrastructure (public schools, electricity grid, cars, mobile phones, ATMs) and see how they came to be, and, crucially, how they got distribution
—> interesting to study tech innovations being widely adopted due to superiority (maxim machine gun)