Rationally Speaking #195: Zach Weinersmith on "Emerging technologies that'll improve and/or ruin everything"

Julia Galef: Welcome to Rationally Speaking, the podcast where we explore the borderlands between reason and nonsense. I'm your host, Julia Galef, and today I'm talking to Zach Weinersmith. Zach is the author of one of my all-time favorite webcomics. It's called Saturday Morning Breakfast Cereal, and it lives in the intersection of philosophy, dark humor, and silliness which is Julia's happy place.

Zach's been a guest on the show before several years ago but the reason he's returning today is that he has a new book coming out with his wife Kelly Weinersmith. It's called *Soonish, Ten Emerging Technologies That'll Improve and/or Ruin Everything*. Zach, welcome back.

Zach: Yeah, I'm excited. We'll talk about crazy nerd stuff.

Julia Galef: Excellent. This book, just to give a little more context on the book for our listeners -- reading it is like sitting at the bar with your two nerdiest friends who are slightly drunk and slightly hyperactive, and are friends with a lot of top scientists and have talked to them a bunch for months about the hottest new technologies, and are explaining it all to you, while simultaneously doodling cartoons on a bar napkin. That was my experience reading it. It was great.

Zach: Yeah, I wish I had had that for a blurb. That's exactly what we were going for.

Julia Galef: Excellent. So Zach, let's start by talking about how you chose this list of ten technologies. What criteria were you using? I mean, you sort of give the criteria in the subtitle -- technologies that'll improve and/or ruin everything. But I could name two dozen more technologies that theoretically could have made that list.

Zach: Yeah. It's not meant to be exhaustive. It's stuff we were interested in, but it's also ... We actually originally started with a list of 50.

Julia Galef: Oh, wow.

Zach: Then the very short version of it is that as we got into writing it we found the longer we made the chapters – or, I shouldn't say the longer. The more in depth we made the chapters the more we enjoyed them, and the more it felt like we were bringing something to the table beyond what you can get by a cursory look at Wikipedia or a Popular Science article, and so we just kept drifting towards longer, more in depth, and more humor too. Just more fun. Until there was only room for ten chapters after a lot of hacking.

In terms of the ten particulars we chose, some of it's because we explored certain technologies and they just for whatever reason didn't fit the format. Like they were going to be way too hard to explain well in the allotted space, or they just seemed like they were not a good idea, like a little too implausible even for a book like this. We talk about that a little in the conclusion.

Julia Galef: So you wanted a sweet spot? Not so definite that everyone's used to it and already incorporated it into their model of the world, but not so pie in the sky.

Zach: Yeah, yeah. The way I'd say that is we didn't want to do a chapter on self-driving cars. Not because we're not totally geeked out about self-driving cars but -- one, there's probably already 80 books on that topic.

And two, as we found when we'd research some chapters, if you talk about a technology that's already far along it's really hard to give people the details because the details get really, really ticky tacky. Whereas if you talk about something that's not established, like a space elevator, you can still talk in a somewhat abstract way, about parameters, and I think as a reader that's a more satisfying experience.

The one huge chapter we ended up cutting that we don't even mention in the conclusion was we did an entire chapter completed on nuclear fission technology, advanced nuclear fission reactors. I think we did a good job, but it would've been the hardest chapter for a reader: “Here's the difference between a fast and slow neutron reactor, and between a light water reactor and a heavy water reactor,” and all this stuff. The more established the technology, the harder it is to have a good time explaining the basic deal to someone, I think.

Julia Galef: Right, right. That makes sense. So maybe a good way to get a feel for some of the technologies on your list is to ask you ... Well, it's a two part question. First, I want to know, out of the ten technologies on your list, which of them do you think is the most likely to happen? And then second, which of the ten technologies do you think would be the most transformative if it did happen?

Zach: It's a little tricky because these chapters, none of them are talking about a specific machine. They're all talking about dozens of different approaches to a problem, I guess you'd say. It's like if you're talking about ... We have one chapter on cheap ways you might get to space, and there are probably several dozen new ways you might do that. We're not able to do it exhaustively in the space allotted, although I think we got pretty close.

So I have to be a little careful answering that because some of the stuff really already exists in a rudimentary form, such as reusable rockets or augmented reality technology. Those already exist in some form, so it'd be silly for me to say we'll one day get them.

Julia Galef: Yeah, I'm thinking of unsolved problems that we might be able to solve, that it's plausible enough that we could solve that it made the cut for your book, but that we haven't already solved.

Zach: For one, I would say bioprinting organs is something that will almost certainly inevitably happen, I think. It might not happen the exact way we talk about it in the book, and it might be combined with other technologies, but organ printing or organ manufacturing would save so much money and so many lives. It's an extremely valuable technology and it's also I think something that can be somewhat iterated. In terms of figuring out if you'll get something, I think it's very important to know whether it can be iterated or not -- in the sense that, does a slight improvement matter? I think in the case of at least some organs you don't have to have it perfect, to get someone off dialysis.

Julia Galef: Sorry, when you say, "Does a slight improvement matter?," you mean over our current methods?

Zach: Right. Yeah, so to give an example from the book actually, we talk about space elevators and in order to have a space elevator you need to make the cable, obviously. Should I explain a space elevator?

Julia Galef: Yeah, go ahead.

Zach: If you want to imagine a space elevator, imagine you are in a boat and you are going towards something that resembles an oil rig. Only it's probably got some boats around it, with a lot of guns to stop people from doing anything bad to it.

And up from the middle there'll be this cable or a ribbon that goes up into the sky, to the point where you can't see it anymore. Then in fact it goes very far out into space, about 100,000 kilometers in some designs, and there it attaches to a counterweight, and the counterweight is very probably a captured asteroid or maybe some space junk we've thrown up to use as a counterweight.

And to a rough approximation it works the way a sling works with a rock on it that you spin around your head. It keeps the cable taut. That's why there's this asteroid. It's also awesome.

Julia Galef: Is the counterweight orbiting in sync with the Earth?

Zach: Right, so you want it in geosynchronous orbit. Without getting too detailed, the counterweight is there to keep the center of mass geosynchronous.

Julia Galef: So the ribbon remains pointing straight up from the Earth roughly speaking, instead of starting to veer.

Zach: Yeah, because if you imagine if it's slightly drifting around Earth in one direction or another it's like a thread going around a ball. It's going to be bad real fast for people on the cable.

I can get into the nuts and bolts of this, but the reason you want it is so that you can ... I'm trying to think of a succinct way to say this. Just very briefly, the example we use in the book is the difference between ... I need to be careful about this, because I don't want to get the physics wrong.

Julia Galef: We'll just imagine you waving your hands while you talk so we know not to anchor too literally.

Zach: Yeah. It works by imagining -- Let me just do it this way, maybe we can get into details later if it flows naturally, but the basic deal is: if you have a space elevator, a reasonable estimate that scientists have made, say it'll cut the cost of launching an amount of stuff to space by something like 95%. It'd be a huge cost savings over the conventional rocket methods we currently employ.

Anyway, the point I wanted to get to was the material you're going to have to make this cable out of is going to be very exotic. It's going to have a very high amount of what's called specific strength -- and for the physicsy people that's something like how hard you can thwack it. How much force you can put on it before it breaks, divided by its density. For the less physicsy people essentially you want something like Superman's hair. It weighs nothing and is really strong.

The reason is ... Well, super strong is obvious, because it's under a lot of forces of all sorts, but you also need it to be lightweight so it doesn't pull itself apart, because it's holding up its own weight. So you're going to need this really exotic material, and you look around at what's going to work. You might think Kevlar would work, but Kevlar is an order of magnitude off from having enough specific strength, and in fact no material you've ever interacted with will work as the cable.

But there is this substance called carbon nanotubes that might work, might just be enough which is a problem in its own right. Just being enough might not be good enough from an engineering perspective, but set that aside. What's holding us up from making this cable out of carbon nanotubes? Well, you need the carbon nanotube to be one solid tube, one tiny molecular tube made of carbon, and it needs to go the whole 100,000 kilometers because the moment you start using shorter chunks and weaving them together you lose specific strength, and if the cable breaks anywhere, it doesn't matter where it breaks. You're in trouble. Nothing good happens when it breaks.

And so you need to have really long carbon nanotubes, and so the good news as of 2013 was we're getting exponentially better at building carbon nanotubes. The problem is that we have not gotten any better since 2013, and in 2013 we were able to make them about half a meter long, which is quite a bit shy of 100,000 kilometers.

And so it makes it really hard to speculate about what will come soon, because if I had only had data up through 2013 I might have told you, "Hey, we'll have this in ..." I think I estimated something like 35 years we'll have the stuff to make the middle part of the space elevator, the hard part. That turns out to probably be wrong. Trying to predict even medium-term stuff gets really tricky.

I could also be wrong in the other direction. Maybe someone discovers tomorrow that you can make really good airplane wings out of ultra long carbon nanotubes and suddenly a market develops and we're off to the races, but that seems to me to be a bit implausible. I would've been more enthusiastic ironically four years ago than I am now.

Julia Galef: Interesting. I'm going to bookmark for the moment the second of my two part question about which technology is most transformative, which I still want to get to.

But I also wanted to ask you something that this is a nice segue into, about what you see to be the main obstacles or bottlenecks standing in the way of some of these technologies. If we have reason to believe that some particular technology should be logically or physically possible, what is usually the most common reason why we don't have it yet?

Is it usually lack of insight, like we just haven't figured out a way around the technical challenges? Is it lack of economic incentive, that if enough people were willing to pay for this thing we probably would've invented it by now? Or is it a legal thing, like this would pose a threat to governments, or we couldn't get regulation?

Zach: Yeah, it's definitely all three in some regards. My bias is that at its most fundamental it's economics. I think when the economics of something get irresistible, those regulations almost always go away or they get loosened. That's not always true. I think you could argue that didn't work out for nuclear, but that's a whole thing that's probably not worth digging into.

Julia Galef: That feels like a bit of a special case.

Zach: That's a good way to say it. It's a special case. It's economics, and we try to talk about this a bit in the book. There's this question you might ask, which is why don't we have a colony on the moon, for example? And I think to an astronomy person that's maybe a tough question.

But I think to an economist it's quite obvious. There's no reason to go on the moon. There's Carl Sagan-ish "we are nomads" reasons to go to the moon, but there's not really much of value there. There's I think a specious argument made that, well there's a lot of Helium-3 on the moon that maybe could someday work in some sort of fusion reactor. But now you're talking about a fusion reactor that's not even one of the popular fusion reactor designs, and you're going to have to get its fuel from the moon as opposed to the ocean.

So I think if you look into a lot of technologies that we thought we'd have and that we don't, usually if it's not that people just had a physics misunderstanding about what was possible. It's because the economics didn't materialize, and in specific it's because either there's no good economic reason, as in probably the case for going to the moon to build a colony.

Or as we said earlier there's not an iterative way to improve the technology, like the carbon nanotubes. Meaning there's some benefit to small carbon nanotubes maybe for some composite materials, but we don't all get better off if you make it twice as long. There's not double the benefit. Whereas with a computer, 5% better specs and we want it.

Julia Galef: Right. If I'm understanding you correctly it reminds me a little bit of evolution. That as you're making incremental movements in this landscape of organism design -- and by "you" I mean evolution -- you need to be getting some benefit even from intermediate changes, before you get all the way to an entirely new feature. There has to be something that the intermediate stages, the protofeature, does for the organism. In terms of survival advantage, in order for it to stick around.

Zach: Yeah, and I think in principle, public funding of science is supposed to act as that bridge.

Julia Galef: As a patch?

Zach: Right. In theory that's how it's supposed to work. But with some of this stuff, like a cable to space – or, a really good example would be quantum computing. I shouldn't say who, because I don't know if they'd want this repeated, but I was talking to a prominent quantum computing guy and he said probably we won't have a real quantum computer until some government wants to pay whatever it is, $100 billion to make it happen, and then you could have it.

It's probably true for a fusion reactor, for example. There's all sorts of things we can throw money at, but the money will be enormous for some of these technologies. There are limits on what I think the public will bear in terms of trying to bridge those fitness landscapes with public funding of science.

Julia Galef: Okay, well then let's go back now to the transformative question. Which of the things you encountered in the book do you think would have the biggest impact on ... You can pick what you want the outcome measure to be. GDP, human welfare?

Zach: In terms of transformativeness, what I think of is the brain/computer interface stuff. To me that's the most ... I almost want to say upsetting.

Julia Galef: That is a measure of transformativeness, let's be honest!

Zach: Yeah, yeah. I mean transformativeness is upsetting. I feel like the older I get the more I don't want anything to change. That's not really true, but you know what I mean. I'm all of 35 and I'm already seeing cultural things on Facebook that I don't understand and the moment we're actually tinkering with the ways our brains work, you're talking about a pace of change that's ... It means we won't be recognizably us anymore, and I don't know. I find that very troubling.

Julia Galef: Unsettling.

Zach: To me it's very existential. It's like if all humans died out suddenly and there was a race of armadillo people and they went to the moo -- I mean, I guess all humans are dead so we don't care, but if I was the one human left it wouldn't do much for me to know that the armadillo people went to Alpha Centauri or something. Because, maybe this is chauvinist or something, but they're not me. They're not us.

And when you start tinkering with human brains, the first things we'll do if we succeed at this will probably be things like well, we'll be a little smarter. We'll have a little bit better memory. But over time it's going to become stuff that we're not even able to consider right now. It'd be like trying to tell someone from the 1940s about the Internet. It's just too much. There's too much you couldn't anticipate, and if we do that to our brains too we're going to end up as entities we couldn't anticipate. We're not going to be recognizably human anymore, I don't think.

Julia Galef: I know you just said that these changes will be things that our current selves can't anticipate, but could you sketch out an example of what such a change could look like?

Zach: Sure. There's a couple ways you could imagine it. I don't know why this springs to mind. It's just a random example but okay, so suppose you're in a future where you're completely interfacing your brain with a computer. That means your "you" doesn't exist inside your skull like it has for humans for always, for all animals, that have skulls I guess.

So what does that mean? Well that means for one thing, you can't really be killed. You're immortal. It's hard to imagine such an individual has a thought process that's recognizably human, or at least completely recognizably human. I feel like that would drastically change the way you look at your own life and what's valuable to you.

There's other stuff. For example, comedy is my job. I think the basic way comedy works is it's kind of a trick you pull on your brain where you set up a logical expectation and then you twist it in a way that resolves into some other sense, and I feel like it might be the case that a superintelligent future brain just doesn't appreciate a joke.

Julia Galef: And that's bad for Zach Weinersmith.

Zach: Yeah, it'll put me out of a job, which is depressing. But maybe it won't be depressing because I'll just eliminate depression with my brain/computer interface.

Julia Galef: It is both the problem and the solution.

Zach: But going back to the armadillo people thing. It's like if a version of "us" is doing cool stuff in space, or whatever futuristic thing we're excited about, and it can't understand a joke, it can't appreciate a pretty song or a poem or something, it doesn't do anything for me. It feels like it's all pointless.

So in terms of transformativeness, making all of human existence feel pointless, that's pretty transformative. I say that as someone who's excited about this technology, and furthermore as excited about some of the specifics. The idea of being able to boost your attention span or your focus or your intelligence or memory. I want those things, and I know that if they came I wouldn't want to be the first one getting the surgery, but I might want to be the 50th one. So it would be transformative in a way that I think would ultimately be kind of depressing.

Julia Galef: And where do you think brain computer interfaces score on the weighted score including both how transformative they would be, and -- I guess, how much of an economic incentive there is for them, since that's the proxy for likelihood?

Zach: I would say there's a huge economic incentive. I actually feel like the economic incentive is the scary part.

Let me give two examples of that. One is just the obvious example of the arms race of intelligence. I'm sure as you're aware, I read recently that something like a fifth or a quarter of elite scientists will admit to taking nootropic drugs, brain enhancers like modafinil or Adderall. I've heard cocaine. So there's already an arms race happening.

BCI would just probably take it to another level if it were perfected, so there's incentives in that direction. If you believe Tyler Cowen that you can't even be average anymore, BCI creates weird dynamics where if you can't be average that means you have to have this technology in order to compete, and maybe at some point even to have an okay job.

And so the problem is much like with the smart drugs. Once 25% of people are doing it, you're pretty highly incentivized to do it too, and not just peer pressure. Economic pressure.

And another example ... Frankly that's the nice version. That's the version where you take modafinil and you discover secrets of the universe. A more depressing version is one proposal we read about, which I think was meant positively, was we could have say some kind of ... We heard the word “electroceuticals” used, so let's use that. Electroceuticals meaning something that acts like a drug on your brain but is done via say electric or magnetic fields.

Suppose there were an electroceutical method that detects when you're drifting and focuses you. There's a nice version of you wanting this, which is say you have a dangerous, low paying job, like you work in a meat factory. It would be really helpful to you probably to have a machine that says, "Hey, you're drifting and you're holding a machete, or an ultra sharp knife." Or if you're doing surgery and you lapse in focus, that'd be good.

Julia Galef: Or a truck driver. Well, probably at this point we won't have truck drivers anymore, but just for example.

Zach: Yeah, but jobs like that, or flying a jet plane into a warzone. There are jobs where plausibly it would be a good thing for you to have. But the scary thing to me is, well, suppose you're working an office job and it's possible to detect when you're drifting. Maybe that's good -- or maybe there's a nice version where you work fewer hours because you're just so focused.

But to me that seems like an ugly direction that this could take. As a general way to think about it, there's an extent to which you're offloading metrics and control over your own brain which obviously isn't going to be a bowl of cherries let's say.

Julia Galef: A different way to look at the transformativeness question is ... Well, to zoom out a little bit, you may already know this but I did not realize until pretty recently just how uniquely transformative the Industrial Revolution was. If you look at graphs of GDP or productivity or life expectancy or percentage of the world not living in absolute poverty, any metric of human wellbeing… and you look at that over centuries, the graph is pretty flat until just about the 18th century. When it just rockets upwards in this hockey stick graph. And we've been on this steady upward clip ever since then, thanks to technology developed in the Industrial Revolution like the steam engine.

And the technology that we've invented in the last, say, 50 years has kept that growth going, but it's still sort of at the same rate. Even computers and the Internet, none of that produced another kink in the graph such that we're rocketing upward at a different significantly higher rate than we were before. So I guess I'm curious whether you think any of the technologies you looked at and talked to scientists about have the potential to spark something analogous to the Industrial Revolution that could be like a phase shift for our growth.

Zach: Yeah, potentially. This gets into difficult to predict future stuff of course.

Julia Galef: Sure, totally.

Zach: The way to say it is if you went to someone in the 18th century and you said, "The technology that makes looms work a little faster, that's going to result in people starting to cure cancer 250 years from now," that would've been a non sequitur. I say that to say there might be something now that seems trivial that ends up being the most important thing and we're just not thinking about it.

That said ... We have a chapter about fusion reactors. It's probably the most well known technology we talk about, but we did try to get into the nitty gritty of what's holding it back and what's going well.

Something I like to think about: when you talk about increasing GDP stuff, up until I want to say the late '60s, increasing GDP was deeply tied to energy use, and it wasn't until that period that they kind of disentangled.

I don't necessarily think that was just technology. I think a lot of that was environmental movement concerned about efficiency type of stuff. And this is totally speculative. I have no science. I have no evidence. I have nothing, but it's something I think about from time to time, which is: well, what if we were in a world where we could just be completely profligate with energy? Not just us as people, but people running factories or people working on the future.

One of the technologies we talk about which is almost certainly completely implausible, except under particular circumstances, is -- there's a potentially better form of going to space on a rocket, where you use an incredibly high powered laser to shoot energy into the back of the rocket to get it to get more acceleration per unit of fuel. But I think we calculated it requires the equivalent output of 50 large nuclear power plants at the same time.

So that in and of itself, nevermind the technical hurdles, is a huge barrier, because energy is dear. So I wonder, if we got into a scenario where energy cost almost nothing, if there would be surprising new things we would do? And I say that not knowing what they would be, but I just wonder given the history of human life improving as we get more access on an individual basis to energy… I wonder if there's ...

I say it this way. Suppose nuclear fission power went the way people thought it would go in the '40s, I don't think anyone ever seriously thought, as is sometimes claimed, that it would be too cheap to meter, but I think something like that could've happened or it could've gotten so cheap we wouldn't think about it. We wouldn't be concerned with efficiency. We wouldn't be concerned with pollutants or CO2 issues. It might be a very different world. It's hard to say. I don't know. It might be different in ways we aren't thinking about.

Julia Galef: Yeah, I agree. I had actually thought of fusion as a potential answer to that question as well. Although I wonder also if brain/computer interfaces could fill that role if they could make us significantly more intelligent. I could see that being a catalyst.

Zach: Yeah. When I say this I always feel like a jerk, but there is just very good evidence that increased IQ equals increased productivity, so if you could twiddle that knob for everybody… There might be weird social effects we're not anticipating that would be terrible. Maybe nobody would want to work if we were all super geniuses. Though I guess economics would say that the janitor would make millions of dollars a year so maybe it will work out.

Julia Galef: Yeah, it's complicated. This is actually a good segue into another two part question that I wanted to pose to you: Of the technologies you looked at, which do you think is least risky, and which do you think is most risky to society or civilization as a whole?

Zach: I would say least risky has got to be organ printing or maybe precision medicine. Any of the medical stuff. To the extent we can come up with some way it's bad, the good so outweighs it. With organ printing you could say well, it's going to change the way we think about our bodies, and that's probably true. I don't know if it's negative but it's weird. On the other hand there's, whatever it was, 122,000 people in the US waiting for an organ. It's very hard to say, "Well there's an ethical conundrum with giving you an immediate exit from dialysis."

Julia Galef: With our conception of ourselves.

Zach: Yeah, so I think it's hard for me to imagine a serious downside to that. You can get a little philosophical about how it's going to make culture, I think, strange to people of our generation, if in two generations they have this sort of stuff. But that's our problem.

In terms of dangerous to society, not counting the stuff that might make us inhuman, something that we thought about -- and this is part of the space launch chapter but also part of asteroid mining -- is there's a sort of physics problem with bringing stuff home from space. Which is that if you have a whoopsie, you just got a ballistic hunk of metal coming at the planet. And it's not terribly different from dropping a nuclear bomb.

So we came to the conclusion that probably the utility of asteroids is not to bring stuff home, but there are scenarios where that might be true. You might want to bring stuff home. But if you did, think about it like this. Suppose you wanted to bring back a relatively small hunk of metal, like, say 1,000 tons of iron. Do you trust another country ... I mean I don't know if you trust your own government to prosecute bringing that home, somehow -- but do you trust Vladimir Putin to bring that home?

Bearing in mind that the physics of this stuff is pretty Newtonian. If you wanted to deorbit into a city with a bomb big enough, it really wouldn't be that hard. Or not a bomb but with an object with the energy to deliver a bomb-like explosion. It wouldn't be that hard, and as far as I can understand it there's no way around that.

With an ICBM, with a nuclear warhead, a nuclear warhead's kind of a ticklish mechanism. Things have to go just right, or it just blows itself apart and it doesn't react properly. So literally if you can shoot a cannonball hard enough at the tip of an ICBM and actually hit it -- that's the hard part of course, but if you could actually hit it you could disarm it, and you would either get a minor explosion, or you'd just get some nuclear junk scattered around. But you wouldn't get the real danger of a nuclear bomb.

But if you have 1,000 tons of tungsten falling toward New York, the solution to that problem might be worse than just letting it hit. You might be able to deflect it with an enormous amount of energy. You probably need nuclear weapons to do it. So this problem of how gravity works is a little freaky. I don't know that there's a good solution. You have to have really stringent laws about what people would be allowed to do if space is cheap to navigate.

Julia Galef: Right, but the laws would have to be between countries.

Zach: Oh absolutely.

Julia Galef: We would all have to have some way to follow and enforce the laws, which we've never successfully done before.

Zach: No, and the other thing to consider, and we talked about this very briefly, is: it's not just that we'd have to cooperate. It's that the first nation that solves this problem, the first nation that builds a space elevator or some ultra cheap other method of going to space, has the greatest military advantage in the history of humanity. It's like you get to fight every war from the top of a mountain. Almost literally.

The greatest and least creepy Heinlein novel is *The Moon Is a Harsh Mistress*, and one of the plot points is that the moon people are able to rebel because they can just launch rocks from the moon. It's 1/6 gravity and no atmosphere. It's very easy to shoot stuff down at Earth. It's almost literally like being at the top of a mountain, so you could have fewer people but you still win.

Julia Galef: So this compounds the risk problem. Because the more incentive there is to be first, the more you've got an arms race dynamic, where taking your time to find safe ways of doing things and to build up a system of international governance and cooperation, there's a huge temptation to toss that by the wayside -- because you just really need to get there first.

Zach: Right. Some of these concerns I think are embedded in the technology in interesting ways. We read a bit about space elevators. The amount of space it occupies in the book is relatively modest, but we read a lot about it. And a common proposal is that we'll do it as a sea base. And there are physicsy reasons to do that, because it might help you a little if you need to dodge something. You can move the cable very slightly. And also there are spots in the sea that are very peaceful in terms of weather.

But the other thing is scientists tend to be very cosmopolitan, and in the case of space elevators there's a really good reason which is it would really be nice if we all went in on it together, so it wasn't just one group that had it. That might be the least bad solution to the problem. It certainly wouldn't solve a problem of terrorism, of small groups of actors just trying to cause mayhem, but something like that might be plausible if at some point we realize we can do this. The best thing for the world would probably be if as many nations as possible could go in on some sort of agreement to build the thing together in international waters. Whether that's likely… I don't think.

We did a little research on the early space stuff. The 1967 space treaty supposedly governs a lot of space, but it's kind of a silly thing to even talk about. We're talking about governing the rest of the universe, and so the stuff in the '60s is very utopian. It's very Kennedy-ish.

I think Kennedy laid out in his famous speech at Rice University that we should use all space to benefit mankind. Like come on, we're going to all just agree to use all the ... We can't agree to use *Earth* to benefit each other, but we're going to agree to use the rest of it? It's just completely implausible. So I think cheap space travel opens up a whole world of problems. It's hard for me to imagine it doesn't open up great wars, unless we somehow have evolved our ethics to get beyond squabble and distrust.

Julia Galef: Since we're talking about risk, there's a different kind of risk I'm also interested in your take on. We've been talking about macro-scale civilizational risk, but there's also this issue of the risk to the users of the technology. Like, having spacecraft that come with some non-negligible risk, or space missions that come with some non-negligible risk of the passengers dying.

And I wonder… Earlier in this conversation we were talking about bottlenecks or obstacles that prevent technology from being developed. I wonder if another bottleneck is just that we're not tolerant enough of risk at the small-scale level.

It's kind of ironic actually, because personally I feel like we're a little too cavalier about risks at the society-wide level, like risks that could destabilize or wipe out civilization, but then also at the same time I feel like we're too uptight about risks at the level of a handful of people potentially dying. Which is of course terrible, but we accept that level of risk all the time for much more mundane stuff that has less potential to expand the frontiers of our knowledge. Like driving trucks, or something, that also kills a bunch of people every year.

I'm wondering if you think that being too averse to risk is a bottleneck for some of the technologies you've looked at.

Zach: Yeah, I just want to pull up the name of a book that I think we referenced briefly by Randy Simberg. He wrote this book with the greatest title of any book in history. I think it's Randy Simberg.

Julia Galef: Oh, I know the one you're talking about. Shoot. It's a long subtitle…

Zach: It's like the longest title in history, but I just can't remember it.

Julia Galef: I found it. It's *Safe Is Not an Option: Overcoming the Futile Obsession with Getting Everyone Back Alive that is Killing Our Expansion into Space*.

Zach: Yes. *Overcoming the Futile Obsession with Getting Everyone Back Alive*. And I should say it's a funny title. I think he's basically right, and one of the arguments he made was that a lot of times, risk aversion doesn't actually mitigate risk. He discussed some cases I think with the Space Shuttle, where basically escape hatches were built in the design, which actually make it substantially more dangerous, because it's just one more thing to break.

Julia Galef: Interesting.

Zach: So there's that, but yeah -- I think your general point that we're probably more risk averse, being dangerous, but I think at least in some regards these are humane issues for sure. For example if you look up what was done early on to find the polio vaccine, there's a lot of testing on children. This is pre-IRB, pre-FDA.

Julia Galef: Oh, yeah. I'm talking about risks that adults opt into, knowingly.

Zach: Oh, okay.

Julia Galef: Just for the sake of discovery and exploration and adventure. Like the explorers of ages past, and Ben Franklin who flew a kite into electric storms… People took on risks because it was exciting.

Zach: Yeah, I honestly don't think ... I see society maybe getting more risk averse or at least more bureaucratic, but on the individual level I don't know that I see that. If you look at the Shuttle disasters where NASA funding was affected by that sort of thing, by people getting killed... I personally believe if we had a space base anyone could go to and launch a ship from, there'd be Richard Branson people. It would be like, "Oh, there's a one in three chance of survival. I guess I'll go."

I think there are a lot of people like that, I really do. And I think a lot of the risk aversion is ass-covering in nature, so it ties into bureaucratic or governmental stuff. I think if we had a system where you could just go if you had the money, I'm sure there would be rich, crazy people, as was true in the age of exploration, who would just pay to outfit a ship with adventurers. I think those people still exist.

Julia Galef: As long as the government wasn't prohibiting it.

Zach: Yeah. And my wife is a parasitologist, for example and there are all sorts of stories about parasitologists who want to bring ... I probably shouldn't repeat this, but who want to bring some species home from South America or Africa, and they bring it in their bodies to get it through customs.

Julia Galef: Oh god. Oh god.

Zach: There are still crazy people.

Julia Galef: I wish I didn't know that.

Zach: Yeah, I wouldn't do it. I'm kind of a stay at home on the boat type. But yeah, I don't know that I agree that on an individual level there's that risk aversion. Up until the early 20th century there were people quite dangerously going to Antarctica or exploring the Amazon, and that was as dangerous as going to space I'm sure. I think that dried up just because there's not much to really explore like that anymore.

I think that impulse is still probably quite available, it's just we don't have a place for those people. But if you could say, "Hey, do you want to take ..." I mean one good example, there was a project called Mars One which was, "Do you want to take a one way trip to Mars?" Kind of for a reality show... I shouldn't say it this way, but by kind of sketchy people. It's not like it's by NASA.

And they got 4,000 people to sign up, for a one way trip. And surely you must know, unless you're just not thinking hard, you'll probably die on Mars away from your family. But people are willing to do this. I don't know that we're on the micro-level risk averse to that extent.

Julia Galef: Yeah, I guess I did mean on the societal level. Is the government willing to fund things that have a non-negligible risk of killing people?

Zach: To me that's what's exciting about the cheap space travel is that the government has to be risk averse. They're representing our assets, to an extent, do you know what I mean? So it's reasonable that they're risk averse. But if you have ... Elon Musk is planning to become king of Mars or something and he's ready to risk his life doing that. I think there is a quorum of people of that sort who for better or worse, once it's an option, will go around exploring the solar system.

Julia Galef: Cool. Well, last question about *Soonish*: I'm just curious for you personally how your attitude about technology changed from doing all of this research. If you compare yourself now to Zach two years ago or whenever, before you started compiling your list and investigating these technologies, do you feel more or less optimistic now than you were before

Zach: There's two parts to that. There's one, how has our impression changed? And two, are we more or less optimistic?

Our impressions totally changed. One thing that probably shouldn't have been, but was a bit shocking, was every time we dug into a technology, pretty much universally it turned out our preconception, wherever we had gotten it, was totally wrong. And what we thought was the hard part turned out to just not be that interesting.

And then conversely there would be things that were really difficult that we just hadn't even thought about, and so it messed with my worldview, almost. I feel like I got a little more reticent to have political opinions, if that makes sense, because I'm like, "Oh my god, I've just learned about how rockets work and it turns out I totally didn't know what I was talking about, so how do I think I know about how tax policy should work?"

Julia Galef: Have you heard of Gell-Mann amnesia?

Zach: No.

Julia Galef: Murray Gell-Mann who's, I think he's a physicist.

Zach: Yeah, I know him.

Julia Galef: He commented once that there's this funny thing that happens where if you read anything in the popular press about a subject that you personally happen to be an expert in, you discover how off-base it is. And you're like, "Oh god, they're just misrepresenting everything and misunderstanding everything."

And then when you read about anything that you're *not* an expert in, you kind of forget that. And you just take it as truth. And you forget that there's no reason to expect that your particular field should be an exception and maybe you should be more uncertain about everything.

Zach: Yeah, it totally messed with my worldview, so I like to think it's made me a little bit of a better skeptic. I'm more reticent to think anything, which is hopefully not too paralyzing but it's probably at least a good impulse.

Julia Galef: Well I appreciated that you guys were willing -- despite acknowledging the perils of making predictions, right upfront in the book, I appreciated that you were nevertheless willing to say, "Here's a thing that *could* happen. Here's reasons to think it might happen."

I think it's good to speculate, and to put very rough levels of confidence on things, instead of being compulsively agnostic.

Zach: Yeah, I totally agree. I think the way we say it is: we are skeptical but optimistic, and so there are things we want to happen and we'd like to happen. And also things we're scared of, and we just try to ... Almost like with each chapter, just -- holding the universe steady, if this technology changes, what might it do?

That act of holding the universe steady is kind of a cheat, but we always do it when we're predicting the future.

Julia Galef: Totally.

Zach: We don't think of all the different things that are going to happen, because you can't. You can't predict one thing. You certainly can't predict 50.

In terms of optimism about things getting done, I would say… not too different. Because when you learn a lot about technology it gets you more excited but it also informs you of all of the perils and difficulties.

Julia Galef: So -- on net, about the same?

Zach: Yeah, I would say about the same, but because there's a balancing, not because of a lack of change.

Julia Galef: Interesting.

Zach: Well… I take that back. I'd say maybe I'm a little more optimistic. About some things I'm more optimistic -- like the precision medicine chapter, to me, it was almost shocking the new technologies coming out. I think we briefly touched on something called circulating tumor DNA, which is the apparent fact that at least for some cancers you can detect solid tumors via blood tests.

Which is incredible. Because -- people may not know, a big difference between more and less dangerous cancers is just how hard they are to detect. So part of why it's easier to deal with leukemia is it's in the blood. It's bloodborne. There's not like a secret tumor hiding somewhere in your body. So if we have a diagnostic that just says, "Hey, there's a tumor with this genome in your body somewhere. Go look for it," that's potentially enormous.

That whole paradigm is just really exciting. It makes me ... I'm not one of these "we're going to live forever starting next week" type of people, but I am optimistic that maybe within my lifetime there'll be something like a tricorder. It'll be a much more painful tricorder. It'll take like 18 samples from different tissues. But it'll give you a relatively quick readout on what might be killing you right this second. So I guess I'm optimistic about some things and pessimistic about others.

Julia Galef: Awesome. Well Zach, before I let you go I'd like to invite you to nominate a pick for this episode, so some book or blog or article or movie. Something that has influenced you in some way. What would it be?

Zach: I assume we're talking about nonfiction mostly, right?

Julia Galef: It doesn't have to be.

Zach: There are two books. Can I give one fiction and one nonfiction?

Julia Galef: Yeah, sure.

Zach: Because I'm kind of a humanities guy on the sly, so I hate to leave out the literature.

Julia Galef: You're like a parent who doesn't want to choose between his favorite children.

Zach: I know. I do feel that way. Let me just say with the caveat that there are too many to choose from, and I worry I'm going to be insulting a friend who wrote a great book by not mentioning it, but there's a delightful book by ... I should say delightful and underappreciated. I want to also select a book maybe your audience hasn't heard. An underappreciated book by Jonathan Dowling, who's a quantum computing guy.

He wrote a book called *Schrödinger's Killer App*, which is kind of a goofy title but is essentially a book that if you are a layperson who can do a little math and logic is the closest I've found to being able to teach me what quantum computing is.

My sense is there are other quantum computing people who would be like, "Well this part isn't quite right according to me," but from my perspective as someone who is not a quantum physicist it was just delightful. And incidentally Dowling's also a great storyteller and that's in there too.

And most shocking of all, it's a book by CRC Press which is a group I love but they don't usually publish, I don't think, books like this. This is like a pop sci book. It's a very thick pop sci book, but there it is, and so you usually expect these thick technical books and this book has a bit of that but it's very accessible -- to a nerd. I don't want to oversell it.

Julia Galef: Well I think my audience is disproportionately nerds, so that's very on point.

Zach: To a person who enjoy a little discrete math at some point in college, this is accessible.

Julia Galef: To someone who flirted with discrete math and topology.

Zach: Exactly. Exactly. And may I just recommend, there is a somewhat forgotten piece of fiction but it's one of the best books ever written. It's hard for me to say it changed my life, because the way in which I think great books changes your life is kind of subtle, or happens by accumulation or reflection, but… an almost forgotten book by a woman named Beryl Markham, that's M-A-R-K-H-A-M, called *West with the Night*.

It's a collection of fictionalized personal stories and it's really the only book she ever wrote. She put out one other book, which is cobbled together and is I think done to make money and just mostly garbage so it's not worth reading. But *West with the Night* is the kind of book you pick up and you can't stop reading it and it's not because it's suspenseful. It's because it's just so beautifully, perfectly executed.

I found it ... I was reading an old book of Hemingway's, it wasn't complete letters, but it was a collection of Hemingway letters and he mentioned it as this book that makes all of us look like garbage. And I'd never heard of it. I'd never heard of Beryl Markham so I went and got an old copy of this book, and sure enough the Hemingway quote is on the blurb on the back -- so I guess it must have had a resurgence after his letters got put out.

But this is my little rant. I think as nerds we often overlook literature as either a frou-frou thing or a luxury that we don't have time for because we're in the serious business of being nerdy. But it's a book that's just good because it's beautiful, and I think it'd be nice if people in the sciences, people with a bit more logical bent made a little time for that sort of thing too.

Julia Galef: Cool, well we'll link to both of your favorite children. The fictional and the nonfictional ones.

Zach: Thank you. Thank you.

Julia Galef: As well as of course to *Soonish* and to SMBC. Zach, thank you so much for joining us -- and congratulations on your book launch. I feel like, also, congratulations on making it through writing a book with your wife, which must be up there in the grand list of relationship trials by fire. Like trips to IKEA.

Zach: Can I just say, I've been surprised by how surprised people are! But I totally get it.

I normally love picking on my wife, but let me just say, having a reasonably mature person who can communicate and think rationally to work with is invaluable when doing anything.

Julia Galef: That actually came through in the little comic illustrations of your working relationship sprinkled throughout the book. So I'm not surprised but glad to hear that. Cool, well thanks so much for joining us, Zach.

Zach: It's always a pleasure. I'd love to come back again sometime.

Julia Galef: This concludes another episode of Rationally Speaking. Join us next time for more explorations on the borderlands between reason and nonsense.