**Engineering for Long Term Solutions**

George Gants: There we go to recording the event. Hi, everyone. Welcome to Engineering for Long Term Solutions. This is a joint event of Long Now Boston and The Maintainers. My name is George Gants. I'm a member of Long Now Boston and I serve on the board. We are delighted to see you all here tonight. As I just said, this is a very high attendance. We're very, very pleased with it and I know we have a great program for you. Before we get started, I wanted to go over some housekeeping items. We are recording tonight's event, and we ask you please keep your mics muted. We also recommend using Zoom's speaker view for the best audience experience. Please use the chat function to interact with us and with each other throughout the event. Also, the restrooms are down the hall and there are refreshments available in the kitchen. That's a bit of a joke from our old in-person event. So yeah, I know you have great supplies in your kitchen and you know where the restroom is. Long Now Boston was founded as a gathering place for anyone who is passionate or even curious about deep time thinking. In the past five years, we've held more than 60 conversation events on a broad range of topics in science, business, and culture, designed to stimulate long term thinking and to build a community of like-minded long term thinkers. Our community is thoughtful and committed. It's growing and we'd love to be connected with you. Our website is longnowboston.org. We're active on Twitter and Facebook. Please consider joining us as a member and if you'd like to be part of our volunteer group, please just reach out to me to private chat or you can go through the website and get connected to us. I also want to thank our members and donors for their financial support, and to acknowledge our anonymous event sponsor, which is allowing us to offer this event for free tonight. Now I'd like to turn this over to Liliana Coelho representing our partner organization tonight with The Maintainers.   
  
Liliana Coelho: Hello everyone, Liliana calling in tonight. Thank you so much, George, and hello, and welcome. I am the Community Outreach and Events Coordinator at The Maintainers. Long Now Boston and The Maintainers have come together as George had shared to proudly present a conversation melding our two key concepts of long term thinking and maintenance. This event is led by our Maintainers movement fellow Tona Rodriguez-Nickel and is hosted within the Long Now Boston conversation series. The Maintainers is a global research network interested in the concepts of maintenance, infrastructure repair, and the myriad forms of labor and expertise that are necessary to sustain our human built world. The Maintainers movement fellowship is a year-long fellowship that advances the movement for maintenance thinking and action and is composed of fellows whose maintenance repair and care work has substantial connections with the environment. Today, I have the pleasure to introduce you to our movement fellow and event lead Tony Rodriguez-Nickel. Tona is a professor at the Department of Civil Engineering at California State University in Los Angeles and is one of the 2022 fellows. In addition to technical research, he is interested in the broader impacts of technological development. Throughout his Maintainers fellowship, Tona is interested in learning more about the role of engineers and technology as we address climate change and other future challenges. We would like to thank you again for all being here and hope that you enjoy the program. Over to you Tona.  
  
Tona Rodriguez-Nickel: Thanks Liliana. I want to start by thanking The Maintainers and to thank Long Now Boston. They've provided amazing support behind the scenes preparing this event and they freed me to work on the content of the forum. They ran logistics better than I ever could have. I also want to thank the Maintainers for their support during the fellowship. So Laura and Liana, Jessica Andy, it's been great to work with you and the fellows as well, Leila Sam, Max, and Briana, I'm grateful we're working together. Lastly, I want to thank the panelists for making the time to be with us. I'm really excited to hear our conversation today. In particular, I do want to thank Ky for calling in from Europe in the middle of the night. It's, I believe, midnight or so for him. So I met with the panelists last week and after the conversation, one of them called it eclectic and this pleased me because it's exactly what I'm going for. These panelists come from varied backgrounds. They'll discuss a wide range of topics. They won't agree with each other on everything, but I feel this is exactly what we need when we're talking about the vastly unknown future; a variety of perspectives and a large degree of humility to recognize that each of us is probably wrong about a good many things. So I invite you to hear and engage with the panelists with an open mind. So I've asked each of the panelists to provide a short overview, five to seven minutes, and after that I'll facilitate a discussion in which the panelist’s field questions from the audience as well as from each other. So our first speaker is Bill Bullet. Bill is Professor Emeritus of structural engineering at Michigan Tech. He's also the former chair of the engineering philosophy committee of our professional organization, he will be explaining his views about how the engineering way of thinking can be used in a wide variety of sociotechnical settings. So Bill, over to you.

Bill Bullet: Okay, so in the next few minutes, I'm going to talk about what I've referred to as the engineering way of thinking and here the primary issue is the how you deal with uncertainty, make decisions under uncertainty, and of course the effect on the future. So the basic idea of engineering way of thinking is that it's a way to approach design in the broadest possible sense of the term using heuristics in the broadest possible sense of the term to develop, maintain and manage artifacts in the broadest possible sense of the term. So we'll think about these a little bit. So the first one is a heuristic. A heuristics is anything that provides a plausible state or solution or direction in a solution to the problem, but it's potentially unjustified and incapable of justification, and potentially fallible. Billy Cohen, the author of the Discussion of the Method would argue that using heuristics is the universal method. Design. Trotsky's comment on design, the things that succeed teach us little beyond the fact that they've been successful, and things that fail provide incontrovertible evidence that the limitations of design have been exceeded. And so failure, if we have uncertainty, we're almost guaranteed at some point if we do something to eventually get failures. So another way of thinking about this engineering way of thinking is that it's a way to adapt to a constantly changing and highly uncertain world, knowing full well that if you do something, have a variation will lead to failures, and failures are going to have to be looked upon as a way to gain information for future alterations. Selection. A recent author has referred to engineering in the big sense as directed evolution. So if that's the case, then what we're thinking about is how do we adapt to various situations? So the economist Tim Harford has given three principles of adaptation, which, as far as I'm concerned, are essentially what engineering is all about. Try new things expecting some will fail, make failures survivable. So that means create safe spaces, so your system doesn't collapse, or move forward in small steps so that any failure that does occur is not very dangerous. And then make sure that you know when you have failed or you will never learn. So you will almost always need criteria for failure whenever you make a change. How will you know if it worked or not? So uncertainty, of course, that's one of the big things about the future, it’s highly uncertain. So if we're going to alter reality in some way, that's an uncertain endeavor, sometimes exceedingly uncertain. And no matter what you are designing or altering, things won't work as you expect, and you'll get failures, both large and small. The key is, if your system is large, you want small failures. You don't want large failures to occur, or potentially dangerous to the entire system. So let's think about systems for a second. These are examples of cars and bridges. We know how to design those pretty well. We know how to deal with the uncertainty associated with them. Sure, bridges fail, things happen to your car, but nonetheless for the most part, we can handle the uncertainty inherent in those systems and that's many of the systems we deal with every day. Now, bigger systems also, sometimes we deal with them every day such as chemical plants and power grid. Those are complex systems. They're very complicated, with tight coupling, and uncertainty is likely unmanageable for the entire system. Charles Perot's book on normal accidents was basically related to these kinds of systems. And then the last one, the last type, I've broken them up into three things is example the earth climate and the US society. They're complex adaptive, it means that complex components are strongly connected. The problem with complex adaptive, or the difference is that when something changes, the components in the system will change their behavior and the uncertainty is not manageable at system level. So I use the word components, but of course, people are components. So we will adapt to any change that occurs in society or the climate system. So those are complex adaptive systems. Quote from KT Fan that there's no point in criticizing the cook for failing to match the (inaudible) of exactness, which simply states in a simple way that the types of heuristics you need to use are contextual. They depend on the artifact being designed, could be a large scale system could be a car could be bridge, or design, you're going to design or alter and you've got to consider the uncertainty inherent in the system, both types of things. So since we're on the future, I got very short time for a final thought. You're mostly talking here about complex adaptive systems, the climate system, US society, the world society. So some possible heuristics are think globally, act locally, that's not original, environmental movement used to use that one. Diversity in the broad sense is essential. Think biodiversity, evolution requires vast diversity. And many experiments with corresponding criteria for failure are required. Just like in evolution, many things are being tried at various levels, and some are failing and some are succeeding, but the ones that are successful go forward. And then last thing is that anything that is big relative and system size is typically bad, or if not bad, at the moment, dangerous for the future. That's all the time I have thank you all for your attention.  
  
Speaker: Thanks, Bill. I look forward to digging into this during the Q&A. I want to pause for a second actually and maybe Gary, because I see that we're starting to get questions in the chat and we have a different way that we're going to be managing questions. Is it possible? Can I put you on the spot right now to jump in? And just tell the audience how we're managing chats?  
  
George: Yeah, I'll do that. This is George. We have the chat for conversations, people with each other, but when we get to questions and answer, Tona, you're going to have a live ask app. The link will be posted in the regular chat. That link will take you to the live ask site where there's a process for putting questions in specific questions, and looking at the questions and seeing what's there. So it can help screen questions and prioritize questions and that'll be a big help for, for Tona and the panelists to kind of walk through that rather than the chat which can become very cumbersome. Let's have the chat be the place for people to chat and the questions for the panelists. We can pop into the live ask app and Tona has posted that link in the chat.  
  
Speaker: Thanks for posting that. I guess what I wanted to emphasize is that if you ask a question on the chat, and you want it to be for the speakers, we might just miss it so if you really want to make sure that the speakers can see it and respond to it, throw it in that live ask interface as well. So Thanks, George. Next is Guru Moldovan. Guru is the Director of Programs at the National Academy of Engineering, and a member as well of the Maintainers advisory board. He's the author of the book titled Applied Minds, How Engineers Think and he'll be talking about important challenges in contemporary engineering projects, and how these challenges should inform our long term thinking.   
  
Guru: Thanks very much for this opportunity. I wish to make two basic points today to kindle the conversation. The first relates to a shorter part of my presentation today on the politics of recognition. The second one that includes a little bit of a story is on the politics of project management. Engaging with both of them is going to be a part of the endurance test and engineering for long term performance. The first point, good engineers know that maintenance is both life and larger than life. I will argue that maintenance requires a bit of a showmanship to attract attention and it requires to assume the proper place in our civic and career priorities. Just see how maintenance as a word trends over time on Google ngram that shows the frequency of the word use since 1800. We can see a robust decline in the use of maintenance as a concept and potentially as a sensibility. If you deepen this a bit its worse, engineers have gotten into the habit of likening themselves, known and celebrated and promoted as innovators. That looks like a major rebranding exercise that's underway. When a vast fraction of engineers maintain and oversee existing systems. Engineers, by and large, don't run around disrupting things, they avoid   
disruption. Consider how engineering creates value in a plethora of pathways of which innovation and design is just one among the many roles, in the slide one among the 14 roles, and I'll highlight a few of them. Sure, engineers are driving research and development and also in designing products that provide improved buyer and end user experiences, so called product differentiation to use the business school lingo. But they also directly create value, even if little or no innovation is required to do so. In the first column, you'll see some typical responsibilities that many practicing engineers will be instantly familiar. They create efficiency improvements by seeking to minimize the human effort, materials energy, environmental disturbance, and altered a specific outcome. They conduct performance forecasts to justify their financial investments, do feasibility studies, preliminary designs, prototyping, identify data gaps, and do simulations and make sure that they're replaced with justifiable assumptions. They lead formal quality assurance systems that are critical to real and perceived risks. And they check and recheck the accuracy of earlier predictions and to ensure compliance with standards. In the second column, you will see some more how engineers guide reliable technical collaboration and this is oftentimes informal, undocumented work. And you'll see regulation and community engagement are also part and parcel of this technical collaborative considerations. So within this value creation cosmo's is a politics of identification as in how engineers are looked at, and the politics of identity; how engineers present and project themselves. Let's get to my second point, which is on project management. It's about an enterprise level issue using maintenance as a case study and this is from the forthcoming book manuscript of mine. We all know of and are victims of delays associated with infrastructure that construction projects whether its ports or developing census systems or tax software consume far more time and resources than anticipated. These mega projects that is a billion dollars or more are getting bigger and longer, with no end in sight. I'll give you an example from the UK since one off for participants as for one of our speakers from the UK. The West Coast mainline of the UK was first created in the 1830s. It's a busy 400 mile corridor between London and Glasgow and it links to Birmingham, Manchester, Liverpool, Edinburgh, kind of a serving a mix of commuter and freight rails. And major maintenance project was initiated in 1998 to improve the tracks, bridges, tunnels, signals and whatnot. Two British firms Rail Track and the Virgin Rail Group worked on the essential upgrade to introduce new high speed tilting trains, the Pendolino system. However, lacking concrete goals and an implementation plan, the program quickly went off track, the cost exploded the schedule was off kilter, the specialty engineering groups didn't talk to one another derailing teamwork. In 2002, four years later, the final project expenditures soared from an anticipated 2.5 billion pounds to an absurd 14.5 billion pounds. By then, railroad had delivered only one-sixth of the project. Rail Track faced bankruptcy and pulled out. The public sector sector had to intervene, a nonprofit took over the project management. A group called Network Rail was created and followed through on the requirements with a renewed focus on outcomes monitoring and accountability. More delays and cost overruns are just simply unacceptable. In 2007 practical requirements management turned the project around successfully delivering on the first two phases. The results showed increased range speed, frequency, better punctuality, and decrease journey times. But the excess cost of 6 billion pounds from the previous efforts was avoidable. The key point here is in many live large scale infrastructure projects often such as transit, water treatment systems and whatnot, designers and installers don't necessarily talk to the maintainers at the outset. In Washington, DC, where I live and work we have seen something similar since 2004, the Dulles Metro Project. In December 2004, for the first phase was projected to cost about $1.5 billion. With an estimated finished five years in 2009. By March 2007, that original $1.5 billion dollars had grown as high as $2.7 billion with a completion date of 2013. Ironically, the new Innovation Center Station near the Washington Dulles Airport itself seems to have a maintenance problem. It was expected to be completed at least three times in the past, now deferred to summer 2022, expect it to be delayed again. Among other frustrations that I have, the out of compliance wheel and axle systems of the 7000 series Metro Cars, the famed train system that was pulled out of service after some accidents. Indeed, 90% of all mega projects have cost and schedule overruns according to Ben Fluberg, an Oxford scholar. In real cost terms, you will see Suez Canal had 1900% cost overrun, the Sydney Opera House was 1500%, the New York State the Verrazano Narrows Bridge was 280%, the Boston Big Dig 200% percent. Oftentimes, and this is notable with big bang infrastructure projects, including the $1.5 trillion law that was passed in the United States officially launching the era of terror projects, one has to see through force sublimes as Fluberg calls. The first is technological, which provides an excitement for engineers right to push the envelope of what's possible long, the tallest, fastest, but not necessarily the cheapest. The second is political, which provides a rafter that the politicians seek from building monuments for themselves and for the causes they stand for. This generates, of course visibility and votes. The third is economic sublime that provides delight to businesses, contractors, trade unions and all the money that flows through the entire supply system from investors to lawyers to developers to landowner, you name it, the entire system is getting the sublime. The fourth is aesthetic, which provides the pleasure that designers and communities seek from good design. Consider Eiffel Tower, consider the Golden Gate Bridge, it's good to have those kinds of things in your community. The core of maintenance, care, repair, refurbishment, renewal, all gets hijacked by these sublimes. As many of you here know very few subjects are as relevant and as neglected is care and maintenance both fulfilling acts for our careers, corporations, and culture. Indeed, a maintenance over a systems lifecycle may consume more than it took to make a new system, but the result is often a catastrophe avoided. Engineers, as you can see from here, are full of such half jokes. Today's innovations are tomorrow's vulnerabilities; without maintenance, of course, failures flourish. I'll argue again that we need a bit of a showmanship to articulate the value of maintenance here. In summary, we need to grapple with the essential politics of recognition, and the politics of project management and how we deliver those projects to responsibly channel the core practices of engineering if we are to make any attempt against (inaudible) problems. Thank you.  
  
Tona: Thanks, Guru. So our next speaker, moving right on, is Donna Riley. Donna's Head of the School of Engineering Education at Purdue University and she's done extensive and important work as an author an activist in the intersection of social justice and engineering. So Donna is going to broaden the subject now and provide a critical analysis of the practice of engineering to make us think about the broader context in which engineering operates. So Donna, I hand it over to you.  
  
Donna Riley: All right, thank you, Tona, and thanks to both Long Now Boston and The Maintainers for inviting me to this conversation. This is a super exciting opportunity for me. I educate engineers and I don't have enough time to think about these concepts so I really appreciate the opportunity to set aside some time and really think a little bit more deeply about long term thinking. So with that I just have a couple of thoughts. The first is that in framing the conversation about long term engineering solutions, where my brain went immediately was to ask about what the problem is. So Gary Downey has written about this maybe 15 years ago now where he spoke very effectively to a group of chemical engineers, and I'm a chemical engineer by training and he convinced chemical engineers that they need to think more about problem definition, need to think harder about problem definition. I think that obviously when we contemplate along now, it really does change the definition of the engineering problem. So for me, one of the things I've worked on is engineering and social justice, so one of the things that I think immediately is about the power relationships of who is involved in that practice of problem definition. So my first question for us is who defines what our long term problems are? I think that, you know, in the ethos of engineering and tech, we have a bunch of futurists out there. What do you want to talk about Elon Musk, or someone else who's sort of high profile in the news or other futurists, we have them telling us what we ought to want, the future that we ought to be dreaming about, and those futures tend to focus very narrowly on tech and then many engineers have gone about realizing those things. The fact that I have a phone called a droid, the fact that there are actual hover boards around are sort of evidence of engineers aspiring to create those futures that others have dreamed. But at the same time, it also projects a kind of an arrogance and privilege that, you know, last summer, we had this sort of space race going on, where we saw multiple billionaires launching themselves into space. And, you know, of course, they're creating a future that's only for some, and perhaps even abandoning the planet that we have. So when we contemplate along now, I think we really need to ask about a future for whom and what is the quality of that future and who wins and who loses in those scenarios? Another group that I think defines some of our problems presently are shareholders. And that has caused a shortening of the time scope that we are, I think, in a large way, as a society focused on quarterly accomplishments and unable to respond to something longer than that. And then also, then we have this experience of our collective response to disasters. And these disasters are often framed as being unanticipated, unforeseen, somehow fast or sudden, but Scott Knowles, who is a science historian at Drexel reminds us that, in fact, these are long disasters, these are disasters that are long in the making, and things that we can with the right perspective, expect. So how could this be otherwise? Well, I think we need to first ask about who needs to be with us in contemplating along now. Who needs to participate in developing better problems and then also to think about the structures and systems that need to change, that need to shift in order to support a different, a different way of being if we want things to be otherwise. So one of the things that bothers me the most about engineers, and I say this as an engineer, and as someone who educates engineers is that engineers tend to be ahistorical and as a result of that, engineers are quick to consider implications of new technology, but are not as good at thinking about the antecedents of technology, that is the social and political and economic contexts that give rise to technology, whether that's in history, or in our present. As a result, engineers often cite unanticipated consequences when in fact with a different frame of mind, you might be able to anticipate some of these things. It's funny that Bill brought up Henry Petroski because I also thought he would be a good person to go to in thinking about this. And in particular, Henry Petroski has talked in very concrete terms, if you'll pardon the pun, about the Tacoma Narrows Bridge collapse, which engineers I know I was shown the video of the bridge collapse when I was just starting out in engineering. And one of the things that Petroski points out is that in fact, similar bridges failed for similar reasons in the 19th century, and he argues that 20th century engineers, had they learned engineering history would have been able to not design the Tacoma Narrows Bridge in the way that they did and would have learned from failure. However, I think it's more complicated than that. It's not just the nuts and bolts part of history that matters. It's not just the material history, it's also the social history and I think that engineers are missing critical understandings that could help us frame problems for the long term. So as an example, we can think about the Flint water crisis, because before there was a Flint water crisis, there was a Flint governance crisis, there was a Flint economic crisis, there was a Flint racism crisis. And so if we were to merely replace lead pipes in Flint, while that might be a place to start, it does not solve the problem in a long term sense. It does not solve environmental justice problems for the long term. Until we can really fix the economic disparities, the racial injustice and the governance crises in Flint I don't think that we're going to get to a long term engineering solution there. And I'm citing colleagues Jana Lumpar, new and Ben Polly there. So engineering solutions that have to be much broader than merely technical solutions. So there are other shifts, right, that I don't have time to get into, but I think one of the things is that we need to move from human solutions to ecosystem thinking, we need to move from merely technical focus to a sociotechnical focus, or I would say even an ecotechnical focus, whatever that might mean and that we need to move from engineers and engineering expertise and really think about affected communities regardless of the of the type of expertise that communities hold. Communities hold local expertise that engineers often discount or ignore entirely and I think that that requires a shift in what we think of as engineering. At the same time, there's sort of two things that have to happen. One is our definition of engineering is too narrow, we need to broaden it and at the same time, we need to be open to non-engineers contributions in the space. People who have no nexus with engineering also have things of value to bring. And that right there is the crux of the main dispositional shift that I think engineers need to make. Again, saying this as an engineer, engineers need to be less arrogant and more humble. And that is all I have to say to you. Thanks.   
  
Tona: That’s quite a bit. Categorizing that is all I have to say is that it's a little bit humble. A lot of lot of good stuff in there that I look forward to talking about. We'll move on to our last panelist, our last panelist is Ky. Ky Whiting. So Ky Whiting is a lecturer and researcher at the Catholic University of Leuven in Belgium. He's a scholar of stoicism and author of the book Being Better and he'll explain how stoic ethics can inform contemporary global challenges, help us live better, as well as encourage us to take action. So Ky, I hand it over to you.  
  
Ky Whiting: Thank you. Let me try and share the screen. Can we see it? I think so. So I found myself nodding the whole way through this talk. So that's good, because I can try and be even faster than I was going to be. So I guess it's a very long term view. I mean, stoicism is about 2000 years old. So I quite like the idea that is something that we're really looking at. Like what does ancient wisdom have to say if anything about sustainable living? Given that you've already introduced me, what I will say is that I am also an engineer. I find engineering is interesting because it has the what and the how, and sometimes engineers misunderstand things. They'll say, what is it we need to build and how do we need to build it? And they'll tell you that as a why you need to you need to build that? And I'll say, why do you need to build a bridge? And they’ll say we need to build a bridge, because we need to cross a river. I'm like, no, you need to build a bridge because you want to see somebody on the other side of the river. It's not that you just want to go up and down running it up and down, up and down, and literally cross it. You actually want something on the other side and that is the why. So this is why I'm really interested in what the stoics had to say is like, what is a good life? Why do we live? Is it to exist or is it to do something more? So the key stoic idea I want to focus on here is that they said we don't just exist, that we should want something more than just breathing and walking around. We should want a life worthy of being lived. So a lot of people ask me on podcast, Keno. What do you mean by good life? Surely, that's only for the Roman Statesman Seneca and Marcus Aurelius, the Roman Emperor, the stoics didn't talk about the good life being nice or pleasant, they said the life worthy of being lived. And they believe that every human being just for being human being had the capacity, whether they chose to or not, it's a different thing, to live a life worthy of being lived. To make correct judgments and live in accordance with nature, to be at one with, they would say the cosmos, which Guru nicely said as well. They also said that humans are naturally sociable, that the idea is not that we're just the best player on the basketball court, but we keep the ball up in the air for the rest of the team, so to speak. So we are the best player because we, we work hard to make the team work well. So it's not just about us. And they also said that the only thing that we need to really live a good life is our character, even if we're not wealthy, wealthy, even if when we're not in the best social status. If we're not born with the most wonderful privileges that we could name here today, we can still build a character that gives us a life worthy of being lived and that they said is the life that we should aim for, regardless of our circumstances. I think that when they talk about what a good life consists of they say what kind of character is the character you need to achieve a good life. You'll say, wisdom, so the knowledge of what is good or bad or neither. So it's not an idea of that, you know, that is wisdom outside of you as though, you’re corrugating a character that is incapable of being anything but wise, that you are able to moderate yourself for the sake of the whole community, that you're able to face difficult circumstances with a sound mind with sound judgment and you know what is fair and you distribute resources accordingly. To me that's sustainable development, to know what to do, to know what is good, what is bad, to know we have to be self-controlled. To take courage when we have defined a long term solution in a very short space of time, and to know that, as Donna was saying, that being a good engineer isn't just about putting the nouns in the right place, but also asking people about what they have to bring to the table and to make it a participatory process. Why? Because you recognize that it's not that's just you that might know something, that somebody else also has something of knowledge that is worthy of being said, and worthy of being considered. So what is this got to do with the player? For me, it's the idea of what's best for you what's best for others straight to say, if you think that what's best for you is only for yourself, you've missed the point that is what is best for all is best for you. And the Roman Emperor said it like this, what cannot be good for the beehive cannot be good for the bee. And it's that kind of thinking. But there's no one size fits all. So it really depends on who you are. Being a British citizen I have commitments potentially to my queen, I've just celebrated the jubilee, that a US citizen may not have and when you have a US citizen voting for a president, I don't have that obligation. So that's me participating in a way as a British person in terms of my citizenship, but I couldn't do that in the US. And same thing happens when it comes to sustainability. What are my skills? Where am I? Who am I with? Which committee am I in? What is the skill set I have? What is my ability to reach out and ask other people and bring them into the project? It's not just saying, oh, I know everything there is to know. How do I build my network? How can I help them make the right choices? So as Stoics, we are expected if we were to call ourselves so to be knowledgeable about the world, not knowing everything, but to think very carefully about what knowledge consists of and why it's valuable to consider the facts in front of us. And it doesn't just mean quantitative facts, but also what's going on in our reality. What is our current role? Are we an engineer? Are we a son? Are we a father? We have multiple hats in a multiple day? What is our role right now? Who we've how can we best help those around us? So you know, it's a simple example. If you're an architect you might design an eco-building. That might be your contribution to society. If you're a resident in that building, it's unlikely that you're going to redesign it, but what you might think of is, how do I save energy? How do I use that space? What do I buy in my home? Do I recycle my trash? How do I recycle so it doesn't go into a landfill? How do I do what I'm called to do it in my role? So this is one example that I really like. I like it because it's the eco mosque and in a mosque, what do you do you pray five times a day, you literally are called to go, depending on how the sun is actually in the sky. But they said, okay, we need to pray, but we can do something more than that. We can highlight God's beauty. I think we forget, as engineers, beauty it's actually really important. I'm glad (inaudible) mentioned this. Having a beautiful bridge, does kind of lift the community. They said that when you're there and have been there spent some time there it's the idea that your connection, you're not closed off in a mosque with no windows thinking only about you and God in some very conceptual way, but actually seeking God while you're standing there and while you're kneeling, and while you're going through your ritual prayer, but also the technical sense, there are heat pumps. There is a massive screen saying how much carbon they've saved in the day. When they talk on a Friday, which is the main day where talks are held, it is talking about the connection to the environment, it's not just talking about heaven, is about saying, okay, I have one eye on heaven. Well, what am I doing right now, to build my community to build my relationship with God? I've seen for example, with lots of birds’ nests there, because they're feeding the person, they're caring for them. And children I've heard literally are sitting on one of those benches talking about the environment because it just has me interesting in the mosque so it just goes beyond sort of this kind of my spirituality is personal and it's only for me to my spirituality has a personal element, but I am in a community and we can be spiritual together. Thank you very much for your time.  
  
Tona: Yeah, you landed right on time there. Thanks, Ky. And thanks as well to all of our speakers. So with this, we end the formal part of the event. We end the formal presentations and now we'll start the question and answer forum. So I'll turn it over to George in a second to explain how, again, the asking of the questions will work, but the idea here is to create a dialogue between the panelists as well as among the audience. So George, can you go over it one more time the live ask and then then we'll get started.  
  
George: Hi, this is George. The link to live ask is in the chat and a couple of places and when you click on it, it will bring you to a separate website that has the ability to ask questions, you can kind of see this number of questions in there rather already people are responding. You have the option of liking or unliking a particular question to elevate it’s status. It sounds like there's one question in there with a three and that's a question for Donna, might be a way to start the process. So it's, it's actually fun. It's easy to use. You just go in there you ask a question, you'll get some other questions and kind of liven up the conversation a little bit. So, Tona, that's it and I'd like to ask a question of you. How do you feel about the immense amount of tech? What came out at you and the four speakers and, you know, you as someone that organized this conversation, probably some surprises, probably some new things and maybe you could help kickstart the conversation with the panelists. And actually, maybe it would be a good time for Gary to spotlight the panelists and bring them into a single frame. So, Gary, you could probably help facilitate that. And so how do you how do you feel about hearing those, those four different voices?  
  
Tona: Nothing like being put on the spot to provide a concise synthesis of everything that's been happening? You know, I’ll start with Ky. I really like this idea that we ought to rationally think about what our decisions entail and decide given our particular setting. I want to tie this all the way back to Bill, because I think what happens in these forums a little bit is that you forget what the first person talked about. But this does have parallels to what Bill is talking about in terms of his engineering way of thinking, in terms of the local character, of how we take decisions, as well as the fact that we ought to be proceeding rationally through our decision making process. Bill I think provided some very abstract notions that I think will be good to flesh out in terms of details, but who helped give us an idea, especially for the non-engineers, what is engineering and what does an engineer work entail and what are some of the difficulties? I think where I want to end is with Donna's very important contribution and that is a thought about I mean, how did you put this about who decides, which is related to Ky's question of why? Why do we do what we do as engineers and for who do we do these things? Like, who are we serving? And what is our role? And how do we manage ourselves through this through this process? So I think that the panel as a whole helped highlight the role of the engineer, as well as the broader thinking that we really need to be holding on to as we move into longer term thinking. Bill does a good job telling us that non-engineers can learn from the way that engineers think about the world. And Bill you and I have talked about this a little bit. This has been one of your projects, not just pulling, say, the social sciences, in the humanities, and teaching that to engineers, but also taking what we know as engineers, how we think and how we approach the world, and teaching that to non-engineers, because ultimately our life is so heavily mediated by technology that it's important to have this two way dialogue. So really, I'm grateful for all of you for bringing all these different topics of conversation. And, you know, I want to turn it back to the panel maybe, to encourage you to talk to each other about it, since part of my role here is to stay out of the conversation a little bit, and to let you talk to each other, but if you need I can see some specific questions here.   
So maybe I'll start with this. I'd like Bill, what you talked about in terms of I guess you have this idea of think globally, act locally, in terms in an engineering design sense. I'm wondering what you make of Donna's questions. What ultimately would be some of the limitations to what the scope of this local experimentation should look like? Because on the one hand it's important to test out a lot of different solutions in kind of ways where failure won't affect us too much. But what are the limits behind the scope of experimentation? Are there some things that just shouldn't be out of balance, or should everything be in balance?  
  
Bill: So I'm going to start it out by saying, there’s a certain irony here that we're talking about long term solutions and yet, we're Maintainers. So what if actually, the long term solution is to maintain the system as best you can, by making small alterations in it, seeing what happens, and then altering it again. And that means that the future is very uncertain and where you're going to end up you can't absolutely be sure. That's how regular, that's how biological evolution works. It's got no set goals, but yet it gets there. It gets somewhere. And so I think, based on that, I think the answer to your question is that any experiment, any motion, any movement that you're going to make in a system, if there's much danger of it, potentially collapsing the system and causing significant damage to the system, that shouldn't be done. And you of course, would say, well, how do you know that's going to happen? Well, you don't, that's the problem. Things are highly uncertain. So one of the steps on adaptation was, take small steps, do small things, don't try to do huge things to whatever your system is, unless it's a fairly straightforward, relatively simple system. So what small? I don't know. Depends on what system you're thinking about. What's big? I don't know? Depends on your system. So I'm going to give one example. And then I'm going to stop. Right now with the baby formula fiasco in the country. And if you look at the system, of baby formula making the United States 40% of it, is controlled by or control, this is run by Abbott. So once the FDA shut down Abbott plant they pretty much set the whole problem in motion. Whether they were correct shutting it down, I have no idea, but in reality the system was too small. It needed much more diversity than it had. So at any single event like that wouldn't collapse it. So that's an example. That's, that's my statement for now.  
  
Tona: And it's nice to have examples like that. What I'm going to do is move over to this live ask and start taking some of those questions and the first one actually may relate here. So Donna, there's a question here to you. It says that it sounds like you want to bring values into the center of the engineering conversation, and make sure the voices are there that need to be there. So can you say more about that?  
  
Donna: Yeah, that's 100% correct. I've given whole talks on that subject. I often call it engineering principles, the idea that engineers should have principles, but get that funny play on words. Anyway, so but so but which values? And that's the conversation. I think that what engineers often are taught that we're supposed to be value neutral, or value free or objective in some way. And what I think that ends up doing inadvertently, is supporting the values that are the dominant values in a given nation in particular. Engineers often serve national interests, right? There's a lot of engineers working in the defense establishment working in various ways. So I think that that those values end up being implicit and they get made invisible by this notion that engineers are supposed to be value neutral, when in fact we're nothing but and I'm very mindful of the fact that I'm talking to some number of people in Massachusetts, where there was a very active chapter of Science for the People that dates back about 50 years. Those folks were very clear about trying to reveal the implicit values that were in science and engineering at that time and to really raise questions about that. I'm thinking if you're looking for another sort of co-hosting event, it might be cool to have the Long Now people in the Science for the People people together. The other thing that I think this all relates to, to get back to what Bill was saying is, you know, thinking small is a nice experiment for thinking long, in the sense that I think about Schumacher 's book Small is Beautiful. There's something to be said for in these kinds of vulnerabilities that are created by our kind of large scale capitalist value system that is working quarter to quarter to please shareholders and then we create these vulnerabilities that don't create maintainable systems long term. And one of the things It would be more robust and more resilient would be to have a large number of small scale community based engineering activities. Ways to provide for one another in community where the values are visible, shared, community based, and can be negotiated perhaps in a more equitable way, at least you'd hope. That's not necessarily true, but I think it provides that possibility.  
  
Tona: Maybe a follow up here? How do you do that? How do you as an educator, bring these topics into engineering? And perhaps how you can talk about this as well, because you talk about similar challenges like how do you bring a talk of the virtues to people that aren't necessarily ready to listen to it? How do you combat like hedonistic consumption, that kind of dominant mode of the day?  
  
Speaker: I think going back to again, pointing out to engineers, and people in general, because people do understand, I think, engineers, the way engineers are actually well understood, because people see things go out, they see a city being built, they see a bridge being built, and they see the value of that, or what they think is the values and saying to them, it's not just to get to the other side, it's for a purpose beyond that. I don't think I see the economy as is evil system. I see it as people making poor decisions and saying they're making poor decisions because they're misunderstanding what is valuable. And yes, of course, in a private corporation, you need to make money. But why do we offer services of any description? The idea is that we want to please, on some level, our clients, and of course, our shareholders. We don't want to offer something of no value whatsoever. So it's sort of peeling back the onion and going well, what's behind that? What's behind that? Why do we want to offer for example, a good car, they go because people love cars. I'm like, if people could click their fingers and get to America, or get to the other side of the country, they wouldn't use a car or plane again, they will literally just click their fingers and do that. So it's not about the car. It's about getting from A to B in the most efficient way possible. So how can we make public transport for example and low carbon for public more efficient, more comfortable? How can we give people what they actually want because they don't want a car and Henry Ford proved this to people when he said before you kept asking me how many more horses you could put on the wagon and now you don't even think about horses. It's kind of showing people that pull back and ask yourself what you really want that car for? Of course, there are issues, you know, some people would want a car because they like driving. There's always going to be people like that and there's also going to people go I like to status. Why do you like the status? And why do you like driving? What is the excitement that you get? Do you feel excited when you're in a traffic jam in LA? They're like, no. So then you don't like driving. What you like is racing sort of take your car to the track. So try to point these kinds of things out. It's just highlight. And don’t ever say this, make the normal, strange, and the strange, normal. I'm sorry, if I put words in your mouth. I feel that from what I've heard from what you say, that's the kind of thing that you're getting engineers and the general public to do.  
  
Donna: I mean, the one thing I can give a more sort of nuts and bolts answer from a pedagogical perspective, which is to really meet students where they are. I think that there's two things. One is, I'm going to try, Ky, you can correct me here, but I think Seneca is a stoic philosopher and Seneca said, we learned not for school, but for life. Right? If I can loosely translate, right that the idea is that there is this pragmatic purpose to what we're doing here and to help students connect to that. I find that when, you know, we educate a lot of first year engineers at Purdue, when they're coming in from a high school education, from their home environment from their communities, they have a broad perspective. One of the things that happens over those four undergraduate years of engineering education is that their experience of world gets narrowed, right? So if you can find them when they are still thinking broadly about these things, that I think goes a long way because you can connect engineering to all of these other subject matters, right? Engineering is a completely open field if we let it be, right, like we just have to not narrow it. So that's my piece of advice.  
  
Speaker: So I completely agree with engineering is wide open. And that's part of what I have been working towards the engineering way of thinking. I'm retired now, but I was on the Gen D

Ed council that manages Gen Ed. I was at Michigan Tech. So Gen Ed was essentially designed to make sure engineers got some Gen Ed. I'm fine with that. I had no problem with Gen Ed at all. But I thought that Gen Ed also should have non-engineering students have some engineering of some sort. That's partly what you're saying, but the other side of it is if we can get engineers to think more like you just described, we get other people think more like engineers, or at least understand how they think we'd probably be a lot better off in the way we approach problems. So I completely agree with that and I would argue it ought to be a two way street.  
  
Donna: Yeah, and the other thing that I would add is sort of a distinction between general education, which seeks to cover a number of content topics versus liberal education, which tries to train the mind in critical thinking across disciplines, which then builds a kind of intellectual power, ability to ask questions, that kind of thing. I feel like a lot of our kind of large public universities in the US went the way of general ed, when they really ought to be more focused on giving people a solid introduction to how people think, in each discipline. That's where I get a little bit unsure about engineering, because I am not sure that we have a coherent way of thinking. I know that your talk described how engineers think, but I think we borrow a little here a little there and I'm not sure that we've thought enough about philosophy or even cognition to really say definitively like this is how we train engineers to think. I think we can observe the effects of engineering education, but I'm not sure we are as deliberate about it as we could be.  
  
Bill: To a certain extent I agree with you, but what I would argue is that if we do the engineering way of thinking correctly, we ought to be evolving engineering itself. And so we ought to be having engineers think more about things they don't now think about. But in a sense to do that we also have other not have to have other non-engineers think about engineering, and I do think engineering does have a way of thinking, but it's hidden underneath everything, you know, believe me, I have to convince lots of engineers that what I'm saying actually makes sense to them. And I can usually do it, but it takes a while. They don't really believe that the way they're thinking can be used in a much, much broader way and they're going to need to have a much, much broader thinking pattern in education. So we'll leave it at that.  
  
Speaker: Let me hand it over to Guru because you wanted to say something. Before that, I will just say, Bill, one thing that you have taught me is taking a little here and a little there is actually part of the way that engineers think. It's a very pragmatic mindset that other fields actually don't use. So we'll kind of support your point of view there with that little tidbit you've taught me before.   
  
Guru: The fact we're having this conversation now, you know, points to the fact that we are talking about one of the oldest cultural processes, the history of humanity, okay. The engineering act of know-how this far older than the scientific act of know-what. Here we are talking about designing and everything and some of the examples that I talked about as we are still completely clueless on how to deliver major projects, oftentimes maintenance playing a major role in this. So we're talking about a lack of capability, even a competency in effective short term thinking, let alone these long term horizon projects that we're talking about here. I think, one of the one of the points to keep in mind, or at least what I talked to when we have fellows at the National Academies is like how do you avoid premature lock in, which ties into Donna's earlier points? How do you to carefully incorporate values you just need to put in some speed bumps in the process and they might seem anti-efficient for whatever it is, and I know some chat comments on optimization are being made now. I think the deliberate act for slowing down. How do you avoid premature lock-in, because if you're going to design with the communities here, you really need to let your requirements, cost control, and logistics evolve a little bit rather than them being prescribed. I think too often, that's where we blow up our project management capabilities and we see the delays and overruns as a universal fact, right now. And that also involves our engagement with how we go about mentally discounting, or the kinds of the cognitive act of discounting. And why we emphasize something, which kind of is a related point earlier, went on short term thinking, we overemphasize short term thinking while being incompetent at it and the same time, we don't have a longer horizon here. So I think, how do we simultaneously influence behavior change while working on these gargantuan projects is something to think about, and we have not made a good effort I think.  
  
Speaker: Since you brought up these mega projects, I'm curious if you have any opinions about a transition, say to clean energy. That kind of transition will be humongous. I mean, it will involve mega project. So what are the implications?  
  
Guru: I personally have not thought about that subject here, but of course, I'm learning as I'm growing here. I think one of the items to think about this as a fairly basic one, which relates to what computer science researchers called first step fallacy. Just because we can climb a set of stairs or climb a tree, you can get a confidence that you're going to get to the moon. And just because you get to the moon, you can build up a confidence saying that you're going to cure diseases or reverse engineer the nervous system or so. So there's something deeply going on her. My fundamental thinking around this subject is why do we make a big deal out of these magnificent projects? I mean, I know getting to the moon, Buzz Aldrin called it the magnificent desolation, but I'm more fascinated to the magnificently mundane, which is how do you get good at a collection of activities that define engineering in the most boring fashion? That is focused on the vexy, not the sexy. I'm talking about quality assessments, reliability, usability, testability, scalability, maintainability, all those elements that seldom get presented as a package, even to engineering students, or young professionals, even though that's what ends up defining their work in the most subliminal, invisible way. So I think a collection of concepts or rather, a concept of operations, as systems engineers would call is what's fundamentally required to even think about energy transitions here, and we do not currently have that what would a system try to achieve and how would you go about evolving the requirements rather than doing a fixed, locked in design approach? That would say, yep, we achieved net zero and x in 2050, but at the expense of perhaps some community development issues that Donald likes to point out here?   
  
Donna: I have some very disjointed thoughts that I'm going to just jump in on here, like, first of all, so Massachusetts, I used to live there. So I, you know, I miss it clearly, because I'm feeling all nostalgic about it, but that's just it says a whole bunch of these municipally owned small hydro operations. And what's so cool about that is that you had this energy deregulation thing that happened in the US, and things got bigger and bigger, but you still have a lot of these small local hydro plants that are very small. I don't know if you can call them plants because they are so small. But I feel like there's some real there's some real lessons there about how those are managed and collectively owned, because they are public utilities, right? And I think that you can compare that to kind of a different marketplace of electricity where you're trying to do something large scale. I'm not sure it has to be large scale. I think it can be evolved in a small way with some thoughts about how do you coordinate how do you share, how do you get things on a grid, how do you manage the grid, all those kinds of things still have to be discussed, but I feel like there's a strength and a robustness to those small renewable operations that we kind of forget all already exists in a lot of communities. They got wiped out in others. But then the other thing I want to say about large projects that I think, you know, the big dig is an interesting thing because one of the things that kind of created the cost overruns and time overruns on that project was they made a political commitment from the beginning to not displace anybody. And so there was this like social justice commitment that was at the core of some of the things that caused some really interesting technological innovation, like freezing everything under the tracks on the tea, or whatever they did, right. That was hugely expensive and also kind of interesting from a like, whiz bang engineering perspective. But I think if we were to go back I think that would be an interesting case study to sort of go back and say, well, where do we go wrong, where did we commit too soon, what were the alternatives, how could we have still negotiated that social justice commitment without having these other cascading effects down the line?  
  
Speaker: I think we should always consider the possibility that any of these large scale projects like that, when we think about them at this point in time, and try to design them, there's an enormous amount of uncertainty with what will happen. And even if anybody makes the prediction as this is what will happen, then they're almost for sure wrong. There's some probability distribution of what we'll end up with at the end of it, be at cost or be an actual project. So I think Donna's idea that maybe large scale projects aren't the way to go. And remember, the heuristic that I suggested was, if something is too big for the system, then it's too big because its failure can be catastrophic or can be extremely costly if not catastrophic. The trouble is we humans seem to be willing to listen to some sort of leader or some sort of fairly large scale government and we do things in a big nature because they're big. I think that thinking more like Donna suggested that maybe we don't need it that big. Maybe we can do smaller things is exactly the way to think.  
  
Speaker: Tom, I see that Ky has his hand up.

Speaker: Yeah, I'm about to turn it over to Ky and I do think that we need to kind of wrap up this formal part, then we can maybe go to the open bar. Another option George is there's been a question that's percolated up here in the live ask about balancing long termism with inequities and moral harms and the present that I think is really fascinating. And I think it might be nice to get to some more of the audience questions. So let's let Ky answer and then we'll figure that out in just a sec.  
  
Ky: I actually just submitted a paper on this in my non static work about energy transitions and to go back to what everyone said, it's not about energy. We don't want energy, per se, we want the services that energy provides. So then you start to ask a different question like, what is it that energy gives us? And how can we avoid the moral harms that occur when we cannot have that energy provision? We don't have access. So again, I mean, Richard has made this argument that we're asking the wrong question. What we need to be asking, and this is back to my work, I do on material services, like, what is it that energy and materials consumers always get forgetting about is like, energy is waveform like without materials, you'd have no energy, how could you even transport it without the cables, for example? So it's asking yourself, like, how do energy and materials combine to provide what humans want in terms of services, which lead to things like human flourishing? Not necessarily, because I give the example of, you can have shelter, and you can have an abusive partner. So you still don't have all your human needs met because you're in an abusive relationship in a shelter, but your material needs are met. So I think when we ask ourselves, like, how do we have a clean energy transition, we're asking the wrong questions like, what is it that energy provides us that we would like? And how can we do that in a way that meets our material needs? Because it goes beyond, you know, human needs beyond that, without going encroaching upon the planetary boundaries? And then we can get to the question about moral harms because when we say, what is it that is harmful when someone doesn't have energy? And I think that's the problem that engineers have when they don't ask the question, what Donna and Guru and Bill has been highlighting throughout, like, what is the question beyond that? Because this if we just talk about energy transition, we're looking for me in the wrong direction, because then we're talking about efficiency of energy provision, rather than for example, efficiency of service provision, that regardless of how the matrix of the energy network looks like.  
  
Speaker: Yeah, I mean, this is I think you really hit the nail on the head Ky. Several of us were nodding along here. And I want to say something more about that in a second. But let's see, I want to wrap up and kind of respect people's times for this official first part of the event, the formal part. Maybe George, you could ask your question, and then the panelists can kind of field your question, as well as this kind of long term versus short term, in sort of a closing statement of sorts.  
  
George: Yeah, maybe this will get to it. I'm hearing a theme that the world we live in today from an engineering perspective is much more complicated than it used to be. Things are going faster, things are bigger, more technological, and more systems, more integrated systems. There is a lot out there that engineers are having to worry about. And part of what comes out of that is that we have to be able to expand the engineering mindset. So it's not just about, you know, tinkering with stuff to get it to work. It's about values, it's about culture, it's about the virtual achieving what it is that we want, rather than what we think we want. So there's a whole lot wrapped up in that. And my question for the panel is, is that a fair assessment that we need to look to a broader sense of what engineering and maintenance really is, because we're in a much more technological society. And if we if we don't expand, and we don't enable thinking across boundaries with different kinds of communities about different issues that, you know, we're not going to be able to get ahead of the problems that we're facing. So I just wanted to pose. Is it a more complicated world and is that part of the challenge of engineering in the future?  
  
Speaker: I would argue that it's not more complicated. It's more complex. Complicated we can handle. We're not comfortable with complexity where all the entities are tied tightly together and if we do one thing we might push another part over the edge. So pretty much except for saying it's complicated, I agree with you. But still back to what I said before. Absolutely, engineering has to think more broadly. Engineering has always been on values, but now we need to probably think about how we're going to approach values and what values we want to approach. So yes, but I also don't think we're going to get there unless everybody takes some engineering. And I don't mean, much, a little bit, enough to not call what is engineering science, for instance. Science looks at the world and has a different way of dealing with the world than engineers do and people have to understand that and right now most people don't. So to make the changes you suggested and I think are needed. It almost has to occur broader than just engineering, even though I don't have any doubt that you're right that engineers have to alter their way of thinking. I'm not suggesting a way.  
  
Speaker: Maybe we will do a final round. Guru, do you have a comment on that last question?  
  
Guru: Again, a meta point here, I think if we are able to communicate that engineers are dual citizens in the world of both disasters and blessings, they have to bridge wonders and worst case scenarios. And I think we would have done a better job. The trouble begins when we tried to make it a little bit more exciting. I not everything in life has to be exciting. And I think the entire idea of public understanding of engineering is something a lot of engineers engage with, has to confront this idea here. A lot of engineering is invisible, unthanked, unfunded. Yep, the civilization keeps running in one way or another. So I think, ultimately, what matters is I mean, to add to Bill's point is good science is peer reviewed, but good engineering has to be reality refereed. Ultimately, that's the determinant here. It has to interface with real consequences and be responsive to it. So again, a meta comment, trying to bring together a couple of threads here.  
  
Donna: I'm gonna suggests that it's both more complex and more complicated and annoying. As a consumer, I feel like I am annoyed by the number of products that have planned obsolescence, non-reparability, all that kind of stuff built in. And those I consider to be complicated with the sole purpose of making me buy another one. I hate that. And so there's something there I think about how we've made our lives both more complicated and perhaps also more complex.  
  
Speaker: And Ky, do you want to do you want to wrap up?  
  
Ky: I think that Guru and Donna have said anything I was gonna say, so I have nothing to add on that particular comment.  
  
Speaker: All right, well, let's um, let's wrap up here the formal part. Liliana, do you want to do the honors?  
  
Liliana: Thank you all so much for coming tonight. Thank you Tona, Bill, Donna, Ky, and Guru for this incredible discussion. I have notes scrambled here and there with arrows all over on my paper. Thank you so much for giving us so much to think about. A big thank you to the Long Now Boston folks, to George and Kim and our hard working behind the scenes production team of Gary, Mary, and Annarag. I'm going to post some other items into the chat, but then otherwise, I'll pass it to you. Thank you so much, everyone, we really appreciate you coming tonight.  
  
Speaker: That's great. And thank you, Liliana, you did a great job in helping pull this together. It was a really a great experience of for us. So we have a tradition that went the formal part is done, you know, we go down to the bar, and we gather up and then we and then we really dive into the issues because that's where a lot of good stuff happens, but we actually have a special treat tonight. Today is June 6 and June 6 is a special day for a small growing organization that got started in London a couple of years ago. This organization, I don't know if you can see that, but that's their poster. They are planning the greatest party the world has ever seen celebrating the wonders that humanity has been able to create and the terrific things that have we've accomplished and that party is going to be on June 6, 2269. Now that is 246 years in the future, but we better get started now. We've heard some of the complexity of the problems that we're having to deal with and we want to get on the right track with those problems. So we have really wonderful things to celebrate in 2269. And so this is their special day and their founders, Mike and Pete have a little message that Gary is going to run.   
  
Message: Hello, it is noon on June 6, 2022. That means that there are exactly 247 years to go until the greatest party of all time to be held in the year 2269. I'm Mike and that is Pete and we're the team behind 2269. We want to wish George Gants, Bill and the whole team at Long Now Boston, all the best and the group at Maintainers as well. Happy one day to all of you. Enjoy. Have a give yourselves a great day. Cheers. Cheers. .   
  
Speaker: Okay. That is the sign for us to get ready to hoist the glass and thank them for what they're doing. And if you are ready, let's raise the glass and let's give everybody on mute for a second, I want you all to unmute so we can all hear this and I just want to give a hip-hip hooray to our friends in London with 2269. So let's hear it everybody. Thank you very much. And that I think is a great way for us to relax and go to the bar. Oh, I see some people grabbing their libations.

End of audio.