

Hugh: To create something in the world that doesn't yet exist, you have to believe that it can exist. You have to have faith. Because whenever you're trying to create something new, everyone tells you it can't be done, right? So you have to have so much faith that you climb over that mountain of the naysayers. If you don't have that emotional, philosophical framework, you cannot create anything new in the world.

Erik: It's easy to talk about the successes, but what doesn't get talked about enough is the struggle. My name is Erik Weihenmayer. I've gotten the chance to ascend Mount Everest, to climb the tallest mountain in every continent, to kayak the Grand Canyon, and I happen to be blind. It's been a struggle to live what I call a No Barriers life, to define it, to push the parameters of what it means. And part of the equation is diving into the learning process and trying to illuminate the universal elements that exist along the way. In that unexplored terrain, between those dark places we find ourselves in in the summit, exists a map. That map, that way forward, is what we call No Barriers.

Speaker 3: Today, we meet Hugh Herr, who Time Magazine described as the leader of the bionic age. Hugh is a professor of media arts and sciences at the MIT Media Lab and co-director of the MIT Center for Extreme Bionics. Hugh creates bionic limbs that emulate the function of natural limbs. A double amputee himself, his breakthrough advances provide greater mobility and new hope to those with physical disabilities.

Speaker 3: Welcome to our new weekly No Barriers podcast series where we continue to explore this extraordinary moment in our lives while remaining true to the theme we have always emphasized. What's within you is stronger than what's in your way. Special thanks to Prudential and Wells Fargo for their generous support of this podcast series.

Speaker 3: Erik, can't wait to talk to Hugh. Hugh, welcome to the conversation.

Hugh: Thank you. Happy to be here.

Erik: This is so cool. We've been trying to reel you into this podcast for a long time, Hugh, so it's awesome.

Hugh: Yeah. So sorry that I'm a difficult person.

Erik: Yeah. Jim and I are friends. Most people don't know, Jim, we call Hugh Elusive Hugh Herr, because sometimes we get a text out of the blue, and then sometimes we can't find you.

Hugh: Yeah. Well, my life can be chaotic at times.

Erik: Right.

Speaker 3: Are you in the lab at all, Hugh, or are you locked at home?

Hugh: I'm locked on my vineyard farm in New Hampshire.

Speaker 3: Okay.

Hugh: And I haven't been physically to MIT since, gosh, March 1st or so. But MIT Labs, so we've tried to convert our houses and our apartment into laboratories, which is indeed an interesting process.

Erik: Yeah. How do you do that? Because you have so much equipment and stuff. How could you ever really do that, truly?

Hugh: We had, I think, two days notice or something, that the labs were closing, and there was just a major exodus of oscilloscopes and robots and all kinds of hardware and software modules coming out of the lab in a very short time.

Erik: So do you literally have all kinds of equipment behind you in your house right now?

Hugh: I do. I do.

Erik: Cool.

Hugh: And my students, they live in these small apartments and there's robots and high tech instruments all around their bed and kitchen, and it's actually very cool.

Erik: Can they retrain them to vacuum their house like those Roomba vacuum cleaners?

Hugh: We don't have to reinvent the wheel, but ...

Erik: So what's that like for you? Because you're doing important work, and then it gets interrupted by this virus and things are totally disrupted. It must have rocked your world.

Hugh: Yeah. Like all of us, I think the ground shifted beneath our feet. And I think many of us, when that happens, we become somewhat disoriented and lethargic. And that certainly was the case for me. I think for three weeks or so, I was about 10% of myself creatively and in terms of my ambition. But now, I'm getting used to this new way of being and engaging once again in a creative sense.

Erik: Well, that's good to hear because you're known as an adaptable person.

Hugh: Try to be, yes.

Erik: Yeah. But you're not some rockstar that just, "Oh, yeah. New normal. Great," right? There's a little bit of lethargy and darkness that, "Shit, man. My work is getting interrupted," and then you bounce back. Then you come back and start being productive again as you adjust to the new thing, right?

Hugh: Yeah. I think a lot of us have experienced the emotion of, with all the tragedy and the suffering and the human death, previously what we thought was important and what we engaged in almost seemed trivial. so that recalibration of what's essential, what's important, how we should be investing our energies now and in the future, I think we've all gone through that analysis in the last month.

Erik: Right.

Speaker 3: But I think it's important to acknowledge that we all go through that first period, which is decreased productivity, probably just trying to figure out how to survive. I think that we've had several guests on the podcast already talk about how to use this as an opportunity and to recalibrate. But I think the first part of that process is just acknowledging that this sucks and you shouldn't expect yourself to bounce back immediately.

Hugh: Yeah, I completely concur. There's this message of be super ambitious and continue to work around the clock and just ignore what's happening within our own bodies and minds and our communities. So, yeah, I invite people to recognize what's happening, to embrace what we're feeling, to not to ... If you don't feel like working and you're able to not work, don't work. This is a moment we need to comprehend and really embrace what we're feeling as individuals and what our family is going through and what our communities are going through.

Speaker 3: So Hugh, tell us a little bit about either now, if you're back into the work, or prior to this new way of life. What innovations were you working on that were really exciting you?

Hugh: What are we doing? One fairly new initiative is paralysis. So we put together a very multidisciplinary team and came up with a number of platform technologies that are very, very exciting and hopefully will get funded. So involves implantable imaging tools to image the spinal cord lesion, imaging chemical species around the injury, and then using those signals and closing the loop towards various ways of actuating. For example, using stem cells to promote cell regrowth, using electrical stimulation proximal and distal to the lesion to enhance motor remodeling.

Hugh: And then we had a whole set of peripheral technologies, implants to the muscles and the limbs and using light to activate muscles in a controlled manner. So that kind of massive project is what I put together early this year.

Speaker 3: Just for our listeners who don't know your background and don't know all about how this lab came to be, can you just tell us a little bit about the mission of what you're trying to accomplish there at MIT and the work that you're doing at a broader scope?

Erik: Yeah. I only knew what biomechatronics was as I started getting to know you. So-

Hugh: Sure, sure.

Erik: Most people are just lost even there.

Hugh: And so I'm a professor at MIT. I direct a group of researchers and we call ourselves the biomechatronics group, and the group is within the media lab at MIT, which falls under the School of Architecture at MIT.

Hugh: So in the biomechatronics group, we develop three fundamental interfaces between human physiology and the built design world. The first is we want to figure out how to attach machines, typically robotic devices, to the body mechanically. So how do you fuse mechatronics to the skeleton, or how do you attach them to the limb or the trunk where the robot can harmoniously and in a dynamic sense operate along with the human to augment physicality and to do so in a healthy, comfortable manner? So that's one interface.

Hugh: The second is neural interface, to be able to communicate between the brain and the peripheral nervous system with the mechatronic device that's worn in the body and to do so bidirectionally, so to be able to measure the intent of the human, how the human wishes to move, and to communicate that to small computers that are attached to the body or near the body, and then in turn have sensors on the mechatronic device communicated into the nervous system. So the human can actually feel and perceive the designed synthetic mechatronic body part.

Hugh: And the third interface is dynamic, to actually be able to build body parts that resemble the shape and the volume and the dynamics of the biological counterpart. So for example, if a person loses an arm, to be able to build an elbow, a wrist, and a hand that truly captures the dynamics of the biological counterpart.

Hugh: So we operate in those three interfaces. It's a very broad set of folks, intensely interdisciplinary. Many areas of engineering are represented as well as design disciplines and art disciplines as well.

Speaker 3: And Hugh, you're a user of your own products, double amputee. Tell us about what you're wearing today and how it works for you.

Hugh: So for the first time in my life, my body is low tech, which is really annoying. So I'm wearing the only powered ankle foot bionic limb that exists in the world commercially. Each limb has a muscle tendon-like motor that powers and stiffens the synthetic ankle joint. Each of my legs has three very small computers and 12 sensors. So the actuation sensing and computation allows me to walk normally on level surfaces as well as steps and slopes and whatnot, as if I had biological limbs.

Erik: And that borderline between the body and the machine is breaking down, right? You say you're low tech, right? But they feel like your legs, right? I think you've told me that or maybe you have to get the next procedure for that to really start to take place.

Hugh: Exactly. Exactly. So my lab invented a new way of amputating limbs.

Erik: Right.

Hugh: And we call this an agonist-antagonist myoneural interface. What we do is, for every robotic joint that we want to control in the external world, we create one muscle pair, an agonist attached to an antagonist, where when the agonist contracts, it stretches the antagonist and vice versa. We then put sensors in those muscles that are able to move dynamically and communicate that sensory information to the external robotic joint. If we create an AAMI, for example, for the ankle joint, for a person that's missing an ankle joint, when they think and they move their phantom ankle joint, those AAMI, agonist-antagonist muscles, move dynamically based on their intent of movement. We then measure that intent on the muscles and communicate that to the robot.

Hugh: Because those muscles are moving dynamically and because muscles and tendons are rich with biological sensors that tell the brain the positions of our joints, the speed with which our joints are moving, and the forces or torques in our joints, because we create these biological muscle constructs and they move dynamically, the person actually feels their phantom limb moving as if it's a physical limb moving.

Speaker 3: Wow.

Hugh: And when they look down and they see the robot moving and they actually feel it like they felt their biological limb when they once had a biological limb, what then occurs is what we call neurological embodiment, where the person has a non-tool-like relationship to the mechatronic limb and they say things like, "The limb is me. I have my body back," which is really, really profound. We're at that point in human history where we can have such intimacy between the built design world and human physiology, where we can actually change identity and what a person views as their body, where that identity actually includes what we design and build, which means that our bodies and our morphologies can be designed in the future.

Erik: Because I know you're working with exoskeletons, that was a big thing, are you still pushing that technology as well?

Hugh: Absolutely. I have a spinoff from MIT, a small company called Dephy.

Erik: Yeah.

Hugh: And I'm a co-founder with two of my former students, Jeff Duval and Luke Mooney.

Erik: Yeah.

Hugh: And we're developing an leg exoskeleton that's basically a redesign of boots and shoes. It's a shoe that's bionic, that's motorized, that has computers on it and sensors, that

injects lots of mechanical power into the walking gait, the running gait, and to jumping and leaping and so on.

Hugh: So with that Dephy exoskeleton, which call the ExoShoe or ExoBoot, we've shown that we can reduce metabolic energy to walk. We've shown that we can augment jumping height and running and so on and so forth. So the dream is that, in the near future, when you go into a shoe store, you'll finally see something that's novel. Shoes are one of the oldest technologies in the human timeline, but there's been really no innovation in shoes.

Hugh: If you look at a shoe that was designed and built 3,000 years ago, it's largely what shoes look like today. So for the first time, you'll be able to go in a shoe store and see something that's very new. And when you put it on, you're going to feel something that's really quite remarkable. The only thing I can compare it to is when you're at the airport and you hit the moving walkway and you start chugging along, and then the walkway ends and you're like, "Gosh, walking is so strenuous and slow."

Hugh: These exoskeletons, it's like wearing that moving belt at all times.

Erik: Because you said when you lost your legs that you felt like a "cripple" or people were trying to force you into that definition of yourself.

Hugh: Right.

Erik: But, right? So technology can totally shape your identity and your whole life, right?

Hugh: Right. Absolutely. We live in a time, and of course in our past as well, where we just accept disease and disability as part of the human condition. We accept our genetics and that's who we are.

Erik: Right.

Hugh: It can't be changed. In this century, that invariance will no longer be, will no longer be entrapped or constrained by our genes as much as we have in our past, will no longer be constrained by our innate physiologies and athleticism that we were born with and our cognition and so on and so forth. We'll be able to use technologies to really redefine who we are as individuals.

Erik: Perfect.

Hugh: And I think it'll break apart these very narrow views that we have of what a human being is, what beauty is, what intelligence is. We have such narrow views of what an intelligent man is and woman is and what a beautiful man is and what a beautiful woman is. And my hope is that'll just be blown to bits.

Hugh: In this new world, if you want a third arm, you can have a third arm. If you want to think fundamentally in a different way, you can do so. If you want to go to a different planet and run on the surface, you can do so. So ...

Erik: I've heard you talking about the Paralympics in one of your talks. That's so cool thinking about people just running like 50 miles an hour and maybe flying could be an event. It'll just be insane, right?

Hugh: Yeah. So the Olympics today are a celebration of what biological bodies that haven't been hacked too much can do at their extremes.

Erik: Yeah.

Hugh: And the Paralympics, in some of its events anyways, is a human machine activity. And if you ask today what's the most popular sporting activity in the United States, it's a human machine sport. It's race car driving, NASCAR. So human machine sports can be really, really exciting. And I think when you involve technology that's really integrated with human physiology, it's going to be very, very compelling.

Hugh: And that will lead to a future in the Paralympics where the Paralympics will be far more popular than the Olympics. In fact, the Olympics, I predict, will be utterly boring, because the jumping heights, the running times, and so on in the Paralympics will just far exceed the Olympics. It'll be like, "Oh, yawn. That's what ordinary bodies can do. What a bore." So, yeah.

Speaker 3: Well, Hugh, when we started this conversation, we were talking about you locked up in your vineyard, which by the way doesn't sound so bad to be locked up in a vineyard but-

Hugh: That's very true.

Speaker 3: Even for the first few weeks of this period, you weren't feeling super productive at 10%. And eventually, you got to a point where you said it's a good time to take stock of what matters most. And here you are, talking big picture about the future of what society is going to look like and painting a pretty compelling vision.

Speaker 3: So in your time at home, where have you come to terms with the things that matter most to you?

Hugh: There's immediate concerns, immediate needs of our communities. And of course, we need to do everything we can as individuals to help people that are suffering so dearly, physically in their health as well as economically. And then there's the broader term issues that humanity faces in healthcare and climate change and the threat of war and all the major issues that we face.

Hugh: So in the immediate terms, some members of my lab are developing technologies to help with the COVID situation. My postdoc Matt Carney, working along with colleagues in the sourced community, are developing a reusable mask that's N95 in terms of its capability, but it could be reused over and over again. So that design is being finalized and we're talking to major manufacturers to get it mass produced.

Erik: What can the rest of us do? Because I've heard you talk a lot about what it means to be a pioneer, right? And a lot of people, most people, don't have a PhD, right? So I've heard you talk about the idea of pioneering more as a mindset, and while we're hanging out here, we can all figure out how to be a little bit of a pioneer in own community.

Hugh: Yeah. I think there's so much need out there. Just try to do something, anything.

Erik: Yeah.

Hugh: All the small acts of kindness add up to major force and major movement. We do small things, like we had a small stock of N95 masks that we donated to hospitals. Anything one could do. If you're on a farm, help generate food and deliver it to food banks. Donate money to food banks. There's so many areas that we could contribute.

Speaker 3: I'm curious, in some of the times that I've talked to you, Hugh, you've mentioned that, in your own personal history, there was a point in your recovery process that you looked down at your missing limbs and thought of them as a blank canvas to create something new, or something like that in those words. I'm just curious, how do we get our minds to think in this way of what's the newness that could come out of this, rather than just crumbling up in a ball and giving up and feeling sorry for ourselves?

Hugh: Yeah, absolutely. It's helpful in our adaptive spirits to take adversity and tragedy and try to turn the mirror and look at it from a different perspective on what good could come out of very challenging times. In the COVID situation, the obvious is we're not polluting as much as a human race and skies are clear, and for the first time, areas in northern India, as I understand, can see the Himalayas. First time in decades.

Hugh: And so my hope is there will be great good that comes out of this COVID situation. I think all of us are asking, "Do we really need to get on the plane that much? Can we not use these very powerful technological tools that we're now using for this podcast?," which would afford us not only to pollute less, but also to spend more time with our loved ones.

Hugh: I think the level of cooperation globally has been extraordinary and I think will be a very deep lesson for the community. In terms of antiviral agents and vaccines and masks and so on, scientists and engineers are just talking and they're like, "The hell with publication. The hell with career. We got to solve this." And you have Chinese scientists talking to US scientists, talking to Russian scientists, and just the rate at which change is

happening is just extraordinary because of throwing out the constraints that we put on ourselves in the past.

Erik: And diving into your story around that, the way you've told me, the story is that, and it makes total sense, that at first you just looked down at this loss and went, "This is just crushing, right, wailing, depressing, just crushing." And eventually, there was some kind of, I would almost describe it maybe to you as an awakening, where you looked down and there's this shift from, "Okay, all I see is loss," to, "Now, I'm starting to see this inkling of creativity and hope and maybe even freedom or a new way of looking at things," right? So that was a personal shift with you, right?

Hugh: Yeah, you're exactly right. Initially, you look down and you see loss and you might say, "Why me?" But I was fortunate to, in a very short time from when my limbs were amputated, to look down and say, "Wow, there's a space there and I can create anything in that space. Hm, what might that be? And might it be extraordinary, might it be powerful, may it be beautiful, may it be enabling? May I transcend beyond this societal view that an unusual body is flawed and be an example that one can be unusual and be perfect, be expressive, be powerful, even sexy?"

Hugh: So again, what I said earlier, that we often in society have a very narrow view of what success is and what is sexy and what is a body, what a body should be, and what a brain should be, and my own personal experience, it's been a lot of fun to break apart those viewpoints and those paradigms and tease out a new world that says, "You can have any body type and you can do extraordinary things and you can make it beautiful."

Speaker 3: And at that time when you had that realization that Erik talked about and you just talked about, you were not a scientist, right? You were ...

Hugh: No, I was worse. I was nearly a dropout in high school. I was just squeaking through. If I got a C, I would celebrate. And the reason, I was always focused a thousand percent on being a top extreme athlete in the world of rock climbing. So all my energies were focused on athleticism.

Hugh: And then the accident occurred and all that intensity and deep thinking and that laser focus was put elsewhere. And initially, it was rebuilding my own body and my own capabilities. And then from that learning experience, when I started climbing better with synthetic limbs than I had achieved before my accident, that powerful lesson that technology can actually not only heal, but transcend human, innate physicality.

Hugh: I took that lesson and I started developing technologies for others. That led me from the horrible student to an MIT professor. I still can't believe that that has happened, nor do my high school mates. I went to a high school reunion years and years ago, and they're like, "What happened?" They're like, "You cannot be the same person."

Erik: Did you come back as a seven-foot tall Hugh Herr? I hear you do that with your legs a lot.

Hugh: On occasion. One time for Halloween, I walked around with my feet moving in the opposite direction, pointing backwards.

Erik: I love that.

Hugh: Just as an aside, people don't notice feet. The experiment is I went to a busy city corner on a Friday night and I just stood there, and the experiment was how long would it take for someone to notice. And it took a long time for someone to notice that my feet were backwards. Anyway.

Erik: And then when they saw that, was their mouth hanging open?

Hugh: Yeah. Before they realized that it's artificial, they were aghast.

Erik: It's amazing that you got back into climbing and in some ways became a better climber than when you had feet, but-

Hugh: What do you mean some ways, Erik?

Erik: Well, you-

Hugh: What are you talking about?

Erik: You told me there are certain things that are hard, like heel hooks and stuff. So I'm using your words against you.

Hugh: Fine. Fine.

Erik: But the cool thing is that you really figured out that you were an inventor, right, that you loved innovation? And you did that because you had to take time out of climbing and you had to redirect your thoughts. And in that struggle, you became an inventor, right? Because you started going back and tinkering and building legs and trying to figure this stuff out because they were so lame, right?

Erik: So you're a persistent person, right? So how do you have persistence in your life in terms of, "Okay, I'm just going to hammer forward with my plan," but yet, at the same time, how do you allow fate or circumstance to guide your direction and your future? It seems like a tricky balance.

Hugh: Yeah. I think I'm an honest person in that I focus my energies on areas and problems that I deeply, deeply care about. So passion is the absolute fuel to the fire for that laser focus, for that energy that gets you through very difficult times, that energy, that spirit that says, "I'm not going to give up until this is done." You have to be pursuing a lifestyle and working on problems that you really care deeply about.

Erik: Yeah.

Hugh: So I think that's the number one lesson.

Erik: And you're a scientist, but it seems like you're also an interest, though, because that's an artful way of living, right? It's not just science. It's not just hammer forward on your goals. It seems like you allowed fate and circumstance to really shape your life and to learn things through your experience, and that's, I think, a good lesson for people now.

Hugh: Yeah. Erik, I don't know what I am, to be honest. Yeah. Maybe the best description is I'm a designer, but I'm influenced by engineering and science and art and I'm able to coalesce many different ways of thinking towards the achievement of a goal.

Speaker 3: How did the lab end up in the architecture department? It seems like a mix of design and science and all that coming together.

Hugh: Exactly. So the Media Lab falls under the School of Architecture at MIT and [crosstalk 00:33:32].

Erik: It seems like an odd fit.

Hugh: Yeah. The Media Lab is MIT's nexus combining science, engineering, design, and art. So the Media Lab is just filled with top designers, often doing design through the lens of science, through the lens of art, and so on. So it's a wonderful, wonderful creative environment for sure.

Erik: Hugh, you also had a really cool story about when you lost your legs and you start redesigning or designing legs. There was a lot of frustration, but eventually you iterated some legs. And you went back and you climbed an incredibly hard rock face. And I remember you telling me once that, when you look, and this is a visual thing, so as a blind guy, I'll have trouble describing it, but when you're way back looking at a face, it just looks impossible. You have to get real close up to it before you can see all the weaknesses and all the ways that you can attack it.

Erik: And so tell us that story.

Hugh: Yeah, it is very true with climbing. Often, the mountain looks just impossible. But you have to keep the faith and put one hand in front of the next and one foot in front of the next. And it often turns out that, when you're actually there, it's not as difficult or challenging as it seemed when you were looking from far away.

Hugh: And I think that's a great metaphor for life. Just when you're faced with enormous challenges, what seems to be just an impossibility, just put one foot ahead of the next, keep the faith, and have an attitude of exploration and keeping on.

Erik: Yeah, because I think people right now are checking out, right? And we were saying that's fine. That's perfectly fine, right, just checking out a little bit from the world. But that story to me says, "Hey, in certain ways, you want to get close up to this thing and attack it and keep moving forward in some way, because maybe it's not quite as daunting as it looks from a distance."

Hugh: Yeah. What is the saying? When in doubt, climb higher.

Erik: Right.

Hugh: Right.

Erik: Yeah.

Hugh: Yeah. And another hope I have for this COVID situation is that it brings us together as humans. With technology and social media and whatnot, we have this strange lack of intimacy, which is driving a decline of empathy. So I'm hoping we're being forced to stay home and be with our loved ones and to really reconnect and to remember the tremendous gift of human connection.

Speaker 3: Well, Hugh, it's been a real pleasure having you on our podcast. I'm glad that we were able to sneak some of your time. I have one more question, which is perhaps the most important one, which is how are you applying your knowledge of design and science and aesthetics to the production of wine?

Hugh: Yeah. It's a wonderful hobby. It's called Mermaid Hill Vineyard. You can look it up on the internet. Our long-term goal here is to make natural wine. I don't know if you guys have heard of natural wine or tried it. So natural wine [crosstalk 00:37:12].

Speaker 3: Tell us what it is.

Hugh: In a typical wine making process, right, there's many additives, many, many, as you can imagine. But in natural wine, you do nothing. You don't even add yeast. You rely on really gorgeous, immaculate fruit and a bio diverse landscape. It's a new movement in wine and wine making. There's a renaissance now happening in the wine world where we're deviating from these silos called Merlot and Cabernet and so on and we're really blowing apart these very narrow views of what wine is and how it should taste. So it's really extraordinary what's happening in the natural wine world.

Hugh: Actually, the northeast of the US, there's a vineyard or two that's really making tremendous ground in this area. So, yeah, please go out and try some natural wine.

Erik: I will.

Speaker 3: Awesome. And so is that a little bit more like a hard cider then, just take the apples, let them ferment on their own, and take the grapes, let them ... That kind of idea, pretty simple?

Hugh: It's simple, but it's also less simple. A lot of the additives are controlling agents. They dictate the final product and make sure the final product is stable. When you don't have all the additives, it's an organic substance and it's very, very dynamic. It's exciting because you don't know where it's going to end, whether it'll be extraordinary or god awful. So-

Speaker 3: And whether it's the latest wine that we can purchase or the newest innovation, tell our listeners where they can go to learn more about either of these things.

Hugh: So my vineyard is Mermaid Hill Vineyard. You can find us online. We are not selling across the United States yet, but we're in local grocery stores and farmer's markets and restaurants and whatnot in New Hampshire.

Erik: Mermaid Hill. You can put a prosthetic mermaid tail on the wine bottle.

Hugh: Absolutely. Absolutely. For sure.

Erik: Hey, I have two more questions as well, quick ones. I won't keep you too long. But first of all, your life as a scientist, as a designer, as an engineer, there's tremendous amounts of failure. I think you told me even most of your life is failure. I've even been to your lab and seen this shelf with all these parts that just led to nowhere. So how do you shape this idea of failure in most people's lives? You probably have a cool perspective.

Hugh: Yeah. I don't view it as failure. I view it as an exploration. My group, we imagine something, we design, we build it, and that process can take months or years. And it finally has manifested, the idea is manifested, has crystallized into the physical world, and you try it and you have these expectations of how it's going to behave. And often, as you state, Erik, it doesn't work as one anticipated.

Hugh: But it's often very exciting when what you design and build behaves in a different way than you expect, because that knowledge, that experience and that knowledge, puts one one step closer to the goal, to what you're trying to achieve. So I view every time we test and what other people would view as a failure when the test doesn't bear fruit, it's not even in the right vector, direction of where we wanted to go, as exciting and as exploration, because it expands knowledge, and therefore, we're that much closer to our desired horizon, our desired dream.

Erik: That's so cool. So you have a vision in mind, but maybe it doesn't work out, but maybe it leads to some ... Has it ever led to some new area where you're like, "Wow, I never even [crosstalk 00:41:33]."

Hugh: Yes.

Erik: "I wasn't planning on that, but now I'm learning something that maybe leads me in a new direction."

Hugh: Yeah. One analogy is a puzzle, right? And you get one piece of the puzzle, and that's very exciting. And you thought you would get all pieces of the puzzles immediately by a certain timeframe, and you don't. You might just have a tiny, tiny piece. But instead of regret and saying, "Oh, I failed," it's exciting because you're one step further. You know a little bit more.

Erik: Yeah. And then how about faith? How does faith play into your life? I know you don't maybe necessarily have a religious faith. But being a scientist and inventing these creations, there's just got to be this tremendous amount of faith. But that's hard to live with, right? Because you're trying to envision things that don't exist.

Hugh: Yeah. Sometimes, people view creativity as this pure intellect, this unemotional property of human beings. I don't at all. I think one's emotional framework is essential to being a highly creative human being. And it's what you touched upon, Erik, that to create something in the world that doesn't yet exist, you have to believe that it can exist. You have to have faith.

Hugh: And you have to have so much faith, because whenever you're trying to create something new, everyone tells you, everybody and their mother and father tell you it can't be done, right? So you have to have so much faith that you climb over that mountain of the naysayers, everyone that's telling you it can't be done.

Erik: True.

Hugh: You have to believe, believe without seeing, right? You have to have that faith. And if you don't have that, you can't create anything. If you don't have that emotional, philosophical framework, you cannot create anything new in the world. So we often say people that are creative geniuses are crazy, right? They said something would exist that was just outrageous and outlandish and they were laughed at, and they did it anyway.

Erik: Yeah.

Hugh: A lot of the great creators in human history, all of them in fact, were laughed at. Edison would try anything. One experiment, he took a tube to one of his ears and put the other end of the tube and the base of a pendulum. And the experiment was could I think and move the pendulum? And he was fearless. He would try anything, and he did not care if people laughed at him.

Hugh: So that fearlessness is critical, as well as, again, the faith that something that doesn't exist in the world can exist and should exist.

Erik: So when you were sitting there in the hospital after having your legs amputated, there's obviously darkness for you. But was there a glimmer of faith in terms of your life, your future? What was that like? How did that translate to that bigger concept?

Hugh: Yeah, I was fortunate because I had parents and families and friends that were very uplifting. My father said, "If you want to climb, you're going to climb. Period." And at the time, I was in the hospital bed, addicted to Morphine, with legs that had just been amputated. Just to have a father to say, "If you want to do it, you're going to do it" is very, very powerful.

Erik: Because that's a leap. That's faith.

Hugh: It is. It is. And it's risky, right? He took a huge risk, because he didn't actually know that it would be possible.

Erik: Yeah.

Hugh: So, yeah. Extraordinary.

Erik: Yeah. That's a good example of faith. I like it. Thank you.

Speaker 3: Well, Hugh, thank you again for joining us. It's been a pleasure speaking with you. Thanks so much for all you've done over the years for No Barriers. We're thrilled to have you on this podcast and have you as a part of our No Barriers community.

Speaker 3: If you're listening and something caught your ear and you want to go back and find some details, you can always find our show notes at NoBarriersPodcast.com. If you're wondering what you can do to help spread the word about No Barriers, other than sharing this podcast, we have launched a new curriculum for middle school students that they can do at home that is all focused on social-emotional learning, persistence, resilience in today's uncertain world. It's self-guided. We have teachers working with the kids as well. We encourage you to check it out at NoBarriersUSA.org.

Speaker 3: Erik, another great conversation. What resonated with you today?

Erik: I love Hugh's story. I think it's really applicable for so many of us right now. First of all, we're all struggling a little bit. And back to the theme that Paul Stoltz introduced a few weeks ago, there's science, but there's art to it as well in terms of how do you take the struggle and, as Hugh said, use it as exploration, right? It's not like where we're just on pause right now. We're trying to maybe use this as a new way of exploring the world in a way that we would have never maybe had the chance to do.

Erik: And what comes from that, right, is that that's not failure. That's adventure. That's exploration. And I think that's a great mindset to have right now. And I also think the other thing that he said was cool to me is this idea that, hey, we're only at 10% of our

productivity at first, right? Because we're checking out a little bit. We're overwhelmed. But eventually, that ends and you get up to that face that looks so daunting and you climb it.

Erik: And that's what Hugh did. In the '80s, he climbed the hardest rock face ever climbed. And that was because he got up to the face and he looked at it and he saw the weakness. It's by getting close up to this thing, by turning into it, that you explore and discover and figure out the way forward, not by necessarily just checking out.

Speaker 3: Well said. Well said. Well, as someone who absolutely loves watching sports, I am really excited to see the future of Paralympics as described by Hugh Herr. I think that we're all going to be watching a lot more of those, just as he said. So that's pretty exciting.

Speaker 3: Another great conversation. Thank you so much for your time and for listening. Please share this podcast with others. And as always, remember what's within you is stronger than what's in your way.

Erik: Cool. And let me just do one little addendum, and that is that, Hugh, one of the cool things is that you're part of the No Barriers family. I met you back in the '90s with Mark Wellman, and we were together in the early days of No Barriers as we grew this movement. And you were tremendously just part of building this thing.

Erik: And we climbed one of the Fisher Towers called Ancient Art, and it was a really cool experience to get to know you back then. You were still a PhD student, I believe. So you were climbing with your prosthetic legs, Mark Wellman, paraplegic, climbing with his pull-up system. I was using my hands and feet to scan the rock. And you led us up to the top of this crazy little tower, and we were what Mark described as an all-gimp team. And I thought that was really, honestly the way that No Barriers began for me.

Hugh: Yeah. I'll never forget that day.

Erik: It was cool, too. Remember it was snowing? And I think one of your legs almost fell off on the face.

Hugh: Yeah, for sure. For sure.

Erik: Because you had these tights holding one of your prosthetic legs and, I don't know, one of your tights got loose or something. And yeah, your leg almost went flying down the face.

Hugh: Just an average day at work, right?

Erik: Yeah, that's awesome. So thanks for being a part of this thing.

Speaker 3: Thank you so much, Hugh.

Hugh: Thank you so much. It's been a pleasure.

Erik: All right, buddy.

Speaker 3: Take care.

Erik: I'm coming to visit your vineyard soon when we get out of this COVID thing.

Hugh: Please do.

Erik: All right. Later.

Hugh: Bye.

Speaker 3: The production team behind this podcast includes senior producer Pauline Shafer, executive producer Didrik Johnck, sound design, editing, and mixing by Tyler Cottman, graphics by Sam Davis, and marketing support by Megan Lee and Karly Sandsmark. Special thanks to the Dan Ryan Band for intro song Guidance, and thanks to all of you for listening. We know that you've got a lot of choices about how you can spend your time, and we appreciate you spending it with us.

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