The Future of Work podcast is a weekly show where Jacob has in-depth conversations with senior level executives, business leaders, and bestselling authors around the world on the future of work and the future in general. Topics cover everything from AI and automation to the gig economy to big data to the future of learning and everything in between. Each episode explores a new topic and features a special guest.

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Jacob:	Hello everyone, welcome to another episode of The Future of Work podcast. My guest today is Omar Hatamleh. He is the executive director of the space studies program at the International Space University and he's also the chief innovation officer of engineering at NASA. And from what I understand, you also used to be the former chief scientist at NASA, right? The deputy chief scientist?
Omar:	Yes, actually I was the deputy chief scientist at NASA Ames in 2014. And that was a very exciting position there, being in the Silicon Valley and doing a lot of work and test tube astronomy and the cube sets and quantum computers. It was very exciting times.
Jacob:	Oh man, okay. So, we have lots of stuff to talk about. But before we jump into all of that, why don't you give people a little bit of background information about you? Maybe some of the things that you're currently involved in, what you do as the chief innovation officer? And also, maybe a little bit of background about NASA.
Omar:	Yeah, no definitely. First of all, thanks for having me Jacob. I appreciate the time here, the opportunity. So, I've been with NASA for about 21 years. Stared as a structures engineer and my last three positions was deputy chief scientist and then chief innovation officer for engineering. And now, currently, I'm the executive director for the space studies program, which is an international program involves people from tons of countries to talk about the interdisciplinarity of space and how to engage from different levels.
Omar:	After that, the chief innovation officer basically involves encouraging different divergent ways of thinking. Using open innovation, getting people outside of their comfort zones, using design thinking. So, there's a lot of elements. The basic thing is having people changed their mentality, changing their culture. I think that's the biggest challenge that everybody faces.
Omar:	But little by little, I think it start making progress. Start using some of the tools available in the market and try to formalize as collaborations, to find synergies between different industries, different governments, academia. And form an ecosystem actually, to be able encourage very different and diverse ways of thinking to encourage new things to happen.

- Jacob: And maybe for the few people that have not heard of NASA, I honestly don't think anybody has not heard of NASA but just to be safe, maybe you could give us a little bit of background information about NASA, who you guys are, what you guys are doing?
- Omar: Well, NASA is a government agency. It's been established in 1958 and it basically leads the research for the nation in aeronautics and aerospace. And I think we have about 10 centers ranging from Washington DC where the headquarters is, and we have several research centers like the one in Glen, the one Ames Research Center. And then, we have the operational centers like the Yuma Space Flight center, which the one I'm from. Johnston Space Center, that manages all of the engineering, the mission control, the astronaut training. The, we have centers like Kennedy Space Center, basically, where we have the actual launch, and operations, and to be able to put missions together and launch them into space.
- Omar: So, it's a big organization, and then we do a lot of research in Astronomy, in Earth observation, in planets, in aeronautics, and rocketry, and exploring deep space exploration. So, it's a vast array of things, into that.
- Jacob: I'm sure a lot of people are curious, and I'm quite curious about this, as well. Is applying for a job in NASA just like applying for a job at any company? I mean, job application, interviews, come into the off- I mean, is it the same process, to get a job at NASA as it is for example, at IBM or Coca Cola?
- Omar: Yeah. It's slightly different. It follows the federal Government organization. The same rules. So, typically, most of the hires come from people that have done internships, or cooperative education, where they spend several semesters rotating in different departments. So, you get to know these people, you get to know their work ethics, you get to know their capabilities. And then, sometimes, we have critical hires, where you have to hire some people, in certain disciplines that three's a need for. But, it's the same, essential guidelines at any federal agency in the Government. It's open to the public, I think it is, and follows the same rules and regulations.
- Jacob: You said you've been there for 21 years. So, I'm sure you've seen the company change, since your time there. A lot of people are talking about the future of work and jobs and all that sort of stuff. How have you seen NASA change? Or, how have you even seen just work changing, during your time here?
- Omar: Well, let me tell you about the whole environment, how it's changed. For example, we just had the 50th anniversary of the Apollo program. At that time, it was a competitive environment, when nations were competing for a race to go to the moon. Then, it changed, basically, from a competitive environment, into a more collaborative environment, which is basically the space station. We have several nations, came together, and had this huge complex endeavor of putting the space station in orbit, and being one of scientific platforms that we have ever built.

Omar: Then, actually, we have a third dimension now, which is basically getting in the commercial startups, the small companies, and getting a new dimension to the whole

thing, now. So, what we're trying to do now, is basically like Space X, but it's a lot of technologies that was built at NASA, we have a lot of expertise. So, we're passing along, we're enabling the commercial sector, to be able to have an impact in creating more jobs, creating a better economy, getting the technology and the knowledge, and helping them.

- Omar: So, combined with the amazing corporate knowledge that we have, and amazing innovation and agility that the corporate sector has, I think that creates an excellent environment to create more jobs, improve the economy, and so on. Then, what you need to do, is basically, we're going to free up our resources, and go explore deep space. Our next goal is going to be, for example, going to the moon again by 2024. From there, we're going to go to Mars, and hopefully, soon after that, in a decade or so.
- Jacob: You mentioned going from a competitive to a collaborative environment. I feel like a lot of organizations are doing this, as well. Why do you think that's the case? Why was it always about competition before, and now it's much more about teams and working together? What happened?
- Omar: Well, let's look at how technology's evolving. Before, when you had the technology in certain sectors, typically that technology was only applicable to that specific sector. Let me give you an example of 3D printer or 3D manufacturing, for example. People thought, when that technology came out, it was only done for producing components for manufacturing parts, but in fact, there meant to be something that expands all across various industries. For example, now that the [inaudible] industry is using it, substantially.
- Omar: I've heard that some start ups, you can actually program your 3D printer, when you've gone home, and being able to print a pizza or something, and get it ready when you go home. It's being used in the clothing industry, so there's a lot of research, a lot of startups, as well, and companies are working on creating clothing and garments, using 3D printing technologies. So, in the future, for example, most of the clothing will be tailored, specifically to your needs. So, you'll be able to buy the file or be able to design your specific things, and be able to print your own specific garments. They will have, obviously, more electronics embedded in them, and so on.
- Omar: In the medical field, so recently they were able to print 3D printed organs, based on the genetic composition of the person. So, the risk of being rejected is almost negligible. Also, produce casts, producing portions of bones, specifically 100% tailored to the dimensions and the contours of the specific bones. In construction, for example, right now, we have houses, construction equipment. They can construct a house with 3D printing capability, in few days, at a fraction of the cost it used to cost, building a conventional home. So, that's giving access so many people, in so many different locations.
- Omar: For us, of course, when we go to Mars, for example. It's a very far destination from Earth, so it is impossible for us to take all the spares, and all the equipment that's needed for us to be there, for successful periods of time. So, what we're working on right now, is developing 3D printing capabilities. Hopefully, we'll be able to leverage on

the essential resources, and wriggle it to be able to print any components that we need to use, there.

- Omar: So, you can see, for example, this is a technology, and it's no longer applicable to one field. It's applicable across all different fields. I can tell you so many different examples like that. So, nowadays, it makes sense to collaborate between various industries. Because first of all, we have the same problem, you can actually split the cost, you can bring new resources into it, you can have different ways of thinking about it, so the creativity and innovation that comes, because we have a very diverse group of people from different industries, it creates completely different design, and different solutions that would be impossible to create in a single organization.
- Jacob: Very cool. So, really quick, I noticed you're still popping a little bit. Maybe, can you move even a little bit farther from the microphone, just in case.
- Omar: Yep. Okay.
- Jacob: There we go.
- Omar: Is that better?
- Jacob: That's even better, yeah. Okay, so you mention all sorts of different changes that we're seeing, and different technologies. So, now I'm really curious. If you were to look ten years in the future, what do you think the world is going to be like? You mentioned 3D printing of clothing. I'm sure you have all sorts of ideas in your head, around what the world would look like. Share your thoughts on that.
- Omar: Absolutely. But before we talk about what would go on, I think that the environment the conventional environment of the work, I think, is starting to change, substantially. For example, there's research that indicates that approximately by the year 2027, in the United States, over 50% of the employees will be freelancers. I did some studies indicating that, for example, if you have one employee, and you're paying him \$100, 000, the productivity that you actually get from that person is on the average of 40%. So, you're paying for 40%. You pay for 100%, I'm getting 40% productivity from that person.
- Omar: So, the freelancing is certain to become more popular. Employees are preferring it, and employers are preferring it, so it's a commonality between both. It seems like the conventional work environment is shifting, as well. So, let's talk a little bit, now, about the future, and the technology and all that stuff. I think, to give you the best line, let's start talking about the population increase. So, if you look, for example, at the beginning of human evolution, until the year 1800, the whole population of the earth was less than a billion. In the span of almost two hundred years, we went from almost less than a billion to seven and a half billion people. That trend will continue increasing, the estimates are reaching about ten by the year 2050.

- Omar: So, we have vast population increase. That's actually... Increasing that population on the Earth. But, let's look at the technologies, and how the technology's going to have an impact on the work, on the population, and so on. If you look at Artificial Intelligence, which is some topics that people are starting to talk about a lot, and becoming a hot topic. Just to give you a quick [inaudible 00:11:55], I can give a few words about how the evolution, because the Artificial Intelligence is nothing new. It's been in existence since the 50s. But, recently, somehow, everything became very different. The reason for that is three pillars, I believe.
- Omar: So, the first one, is algorithm, we have now much more advanced algorithms that go much deeper, multilayer, compared to the basic archaic algorithms that they used to have, a few decades away. So, the basic knowledge of putting the things together, that reinforced learning, and so on. It's becoming much more complex. The second this is the competition of power. Typical computers, they go through in series, you do a calculation, you solve it, you go to the next one. But, the gaming industry, actually came up, invested heavily in that, and created GPUs, which could have 5 or 6000 cores. Basically, you can run 5 or 6000 operations at the same time, instantaneously.
- Omar: So, that creates a system that's substantially faster. I can do much more complex times, at a fraction of the time. Of course, the third element's going to be the big data. None of that stuff is going to be usable without having the big data, where the systems can learn from, and be the feed stock, and a bunch of conditions to go through it, and being able to determine and to make the analysis and results. So, between all these three now, I think we're in the phase we call weak Artificial Intelligence, which is, some people estimated that it's equivalent to human 5 or 6 years old. It's at the beginning of infancy. You can see all these advances that you see, it's still in the weak form.
- Omar: In about 7 to 10 years, estimates are saying we're going to get to general Artificial Intelligence, where they have cognitive capabilities of maybe an adult human brain. And then, in about 20 or 30 years, we'll get to the super Artificial Intelligence. That's when people are actually nervous about, because there's a lot of uncertainties, in that field. So, all these things are contributing, substantially, to changing the landscape of employment.
- Omar: Look, for example, Intelligence can talk to you as an engineer. If I were to design something, it takes you weeks or sometimes months, you have to actually draft it, to design it, to build a 3D model, and to run the final element, and modeling. To do the testing, the vibration, the thermal. So, that takes you weeks, or moths, even. So, with the very advanced Artificial Intelligence system, you can run all these things, maybe hundreds of thousands of cases, or even millions of cases, in a few seconds. And, it can actually tell you which cases are the best ones for which condition, and so on.
- Omar: So, medical doctors, for example. Recently, with the basic algorithms that we have, in several cases, Artificial Intelligence was able to outdo, out pass, and surpass radiologists and dermatologists in determination of diagnosis. The same thing with Wall Street. I think that comparison, with very seasoned investors, and they put them head-to-head with Artificial Intelligence systems, which is of today's capabilities. Intelligence think, it was slightly ahead of the person that was there for decades with a vast amount of

experience. Same thing with lawyers, same thing with almost any career. Same thing as humans, themselves. Intelligence think we're becoming much more efficient, we're starting to have much more electronics in us.

- Omar: One of the technologies, for example, we have at NASA, we developed with GM, is a glove that enables people to be able to do repetitive tasks without being tired. So, instead of a person doing the job for a certain amount of time and getting tired, you can do it for much, much longer. So, all these things are telling you that you need less and less people to be able to preform the jobs and the tasks needed to do that. Mission Control, for example, we used to have many more people in the back room controlling and helping, aiding the people in the front room. With the advancements in technology, you see less and less people doing that. Being able to take advantage of the amazing competition of capabilities that are available.
- Omar: So, all that stuff doesn't mean people aren't going to have jobs, but there's going to be a shift, obviously. There's going to be a big shift because initially, there's going to be a phase, where there will be jobs for people, because technologies typically create new jobs. Right? Just, the problem is, and we had this discussion, before, a lot time ago, about the industrial revolution. People were concerned that the emergence of this new automation and machines were able to displace a lot of jobs. And, that wasn't case, it was very different. It was actually... More jobs were created, and wasn't an impact.
- Omar: I think the problem we have right now, is we're competing on an intellectual level, as well. So, it's not longer on manual labor, but intellectual capabilities. So, that actually opens a new dimension of things that we never explored before. It makes things a little more different.
- Jacob: I have so many questions for you about what you just said. I was trying to taking notes as you were going through all of that. So, the first thing that popped into mind; tell me about this glove. What glove is it? What sort of routine work are we talking about, here? So, I'm really curious, are there other areas, and I'm sure there are, inside of NASA that you can share where you are using AI, and what are those areas? What are you guys doing?
- Omar: So, the glove, for example, if I give you the example. If you can grab a tennis ball and squeeze a tennis ball until you get tired. Probably, you get tired after ten, fifteen, twenty times. So, this glove, is has imitators embedded in it. It enables you, maybe to do it for 100, 150, 200 times without having an impact on your ligaments and your muscles and your joints. You's be able to extend the reach. This is just an example of what can be done, not only now, but in the future. It's beyond imaginations of things. So Artificial Intelligence, for example, I can give you some examples; astronomy.
- Omar: So, astronomers. They have a lot of data points, actually, that they collect from dishes, and they have to go through it manually, sometimes it takes long, long periods of time. With the emergence of artificial intelligence, they can go through all these kinds of things, and all this manual labor that they have to go, and repetitive manual labor can be done with this artificial intelligence. So, that amount of work will be deduced,

substantially. They orchestrate in more fun things, as opposed to just being doing repetitive work.

- Omar: It could be done also, artificial intelligence, like I said, in designing things, and finding trends and connecting dots in ways that were difficult to find before. It's pervasive technology, that's going to be embedded in every single industry, every single aspect of our life, substantially.
- Jacob: The other thing that you mentioned, which I though was interesting, and actually, I've given a couple talks on AI, so I spent some time looking at the history of AI. But, a lot of people don't know this, and you mentioned this, that AI is not new. It has been around since the 50s. So, can you talk a little bit about that? Because I feel like a lot of people assume that this is a new concept, new idea. It came out of nowhere and everyone's talking about it, but it's been decades.
- Omar: Definitely. First of all, in the 50s, the basic assumptions and the algorithms, the mathematical assumptions, to go into these complex mathematical models were very basic. If you try to emulate some of the human brain, it's an extremely complex way of doing things. First of all, the basic models were very simple, and they were completely erroneous. They were not even remotely close to what they were supposed to do. Then, the compositional power that we had, was very, very basic, as well. It took forever. For a long time, people actually gave up on these kinds of things. They said, "This is not working properly."
- Omar: Until recently, a bunch of researcher came in, outing a lot of research, a lot of funding into it. in the last decade or even a little bit more, I've seen amazing transformations in these mathematical models and algorithms, that we're able to do a much, much better job than what we had before. Like I said, that, combined with the three elements, now, with the amazing competition power. So, the cool thing about the gaming industry is, not only do they develop these kinds of things, but they develop it in a way for the gaming industry, that it's very cheap.
- Omar: So, a lot of labs around the world can use it now, so you don't have to be a lab with a lot of funding, with a lot of resources, because these things are available at decent prices, so it opens the doors for so many Universities, for so many labs and researchers around the world, to be able to be engaged in that field. The more people that get engaged in that field, the better results, the better accuracy, the better progress you try to make in this field. Then, the big data, every day we have a tremendous amount of data being created.
- Omar: So, if you want to teach, for example an algorithm, how to identify a cat. Then, you have to show that algorithm it has to go through thousand or thousands of pictures, [inaudible 00:21:10], for that algorithm to be able to recognize the cat. That this is a cat, that this is so on. So, the big data is a third dimension that we definitely need to be able to make the progress. All these three things were not available in the 50s. And, that's why the synergy and the center of gravity is improving substantially.

- Jacob: Okay. So, when you look at the world of AI, do you think there's a lot of hype in it? Or is a lot of concern and discussion around it real? So, for example, the elimination of jobs, being able to create human intelligence by 2030 or 2040. We talk about driverless cars. Is all of that sort of stuff actually going happen, or do you think is maybe a little bit overblown, and everything will be just fine, in the future?
- Omar: Well, it is actually both. I think, in my opinion, it could be both happening. So, first of all, the work week, the whole work week right now at a standard, is 40 hours, 5 days a week. In my opinion, this is almost like a random number, because right now, and eventually, you can do so many things, and you don't need to do the job, and so many days and so many hours per day. So, I think, the transition will be, essentially, is to having less amount of days, working less hours, and being able, hopefully, people spend more time doing the things they enjoy, and being able to capitalize on the technological transformation and advances, to be able to improve their lives, the quality of their lives. I think that would be the best one.
- Omar: But the more we keep moving forward, and like I said, with the big population increase, and getting that advance technology beyond imagination. I think that's where the biggest impact will be. Even the current economical models, I think they won't be sustainable, anymore. Where you have a huge population increases, we have billions of people, potentially, if that is the case, potentially, will not have any jobs. And, the current economic models might be breaking down. So, we need to look into what is going to be the next economical models. People, to be able to psychologically, to be satisfied, they need to feel that they have self worth. That they are contributing, that they're producing something.
- Omar: So, it's all these things. So, it's going to be from the psychological, from the technological, from the economical. It's going to be something that policy makers, CEOs need to be working substantially on that and be able to predict what's going to happen in the next 5, 10, 20, 30, 40 years, according to which advances we're starting to see. Another thing, Jacob. I think we need to definitely build a bridge between industry, academia and Government, because all of us need to be working together. If technology is improving so fast, if somebody's studying a technical degree, in five years, potentially some of the things you studied for the first year might be a little bit slightly different by the time you graduate. So, we need to be constant rejuvenation and constant update and cycle and the loop between all these people, the academia industry and Government, to be able to produce a better workforce in the future.
- Omar: A lot of people actually ask, as well, what will be the skills needed in the future?
- Jacob: That was going to be my next question.
- Omar: Yeah. It's going to be very difficult to predict. It's going to be easy to predict in the next five years, but we're talking about, maybe 15, 20 years. It becomes more challenging because in the next 10 years, probably, the majority of the jobs don't exist today, yet. So, it has to be jobs that will be created, depending what technologies, depending what ecosystems they're coming across. But, I think that the skills that need to be developed in everybody now, is- Like before, people used to go to college, study a degree and then

that's it. They never went back to college. They never read anything, or research papers. I think that fact is completely gone, now.

- Omar: So, you need to constantly be learning, constantly be adaptive. You need to be able to change and get out of your comfort zone and try new things. You need to develop, also, the jobs that will be more [inaudible] impact is jobs that misstates, or needs to be creative, have emotional intelligence, probably. Having decision making capabilities. So, any job in that field might be a little bit more difficult to penetrate, initially.
- Omar: We don't know what's going to happen in the long future, but trades like that will be needing adaptability, constantly, and being able to adapt to the new environments. Because, if you look at the work environments now, people who have been working for 15, 20 years, it's very difficult to change way they do their job. It's very, very difficult to do that. So, I think this mindset will need to change, and people need to be more adaptable, more flexible in order to be more sustainable and maintain these technological changes that we're having.
- Jacob: I've one more technology question for you, and then maybe we can switch into some of the non technology stuff, like ways of thinking, you mention design thinking. The last technology question is more around, which technology are you paying attention to, that you think are going to have the greatest impact. So, you mentioned quantum computing, you were talking about AI, you mentioned 3D printing. Which areas are you paying attention to the most? And, which ones do you think are maybe a little bit overhyped?
- Omar: I can give you 5 technologies that I think are definitely going to be big impacts. The thing I'm looking into right now, look at the internet, for example. It was basic technology, but out of that technology, we have almost 7.5 trillion dollars in economy. Look how many millions of millions of jobs were created because of that technology. So now, we have artificial intelligence, we have drones, we have autonomous systems, we have quantum computers, for example, we have 3D printing. So, these are basic technologies, but I'm interested in knowing what are going to be the ecosystems, that are going to be developed across, around all these basic technologies, because all of these will need support systems, support technologies, support startups, support industries.
- Omar: Let me give you an example of driverless cars. So, driverless cars are going to have substantial impacts on the positive and on the negative, as well. It's going to create jobs, it's going to take a lot of jobs from different places. For example, the driverless cars, when you talk about manufacturing, car manufacturing, on average, people in the United States have two cars or three cars per family. But, if you have a car that's autonomous, it can go from one place to another by its self, then obviously you don't need three cars, you only need one car, and the car will take members of the family, and be able to pick them up, and be coming... Because right now, we only drive to our work destination, and we leave the car in the parking lot for most of the day. So, you can have one car that takes care of the whole family and drives by its self. [Immediately 00:27:56], you're used to the amount of cars between 50 to 70%.

- Omar: Then, the discussions are actually around the neighborhoods, having fleets of cars for a neighborhood, or so on. So, we're talking about substantial reductions in the amount of cars that need to be produced. So, the question is, what's going to be the impact on these car manufacturing people? Insurance, for example. If these cars will never get into an accident, they're 100% safe, eventually and it will never be stolen, so what is the role of insurance companies, in these kinds of things? Most of the insurance companies, it's a big source of income for them, is ensuring these automobiles and cars and vehicles. So, if you only need to insure a fraction, and then eventually, maybe [inaudible 00:28:40]. So, what's going to be impact on the jobs for these fields?
- Omar: Hotels, for example. Right now, you can drive, for example, from San Francisco to Los Angeles. It's about a six hour drive, or so. Instead of sleeping, and staying at Los Angeles, if you had to have a meeting and come back, you can have your meeting and come back in your car, you can sleep while your car is driving you back. So, what's the impact on the hotel industry? And the garages? But at the same time, these technologies are going to be creating new jobs, because they're going to be servicing companies that will need to be adapted and work for it, to be able to help these technologies. For example, if you're going to stay in your car for prolonged periods of time, you probably need to eat, so maybe there's some way of printing food or being able to produce your food during the long drives.
- Omar: Maybe, a mobile office, better communication, and mobile office environment. Maybe, entertainment systems, that are beyond what we have right now. Security, obviously. So, cybersecurity will be essentially completely paramount for the success of the driverless cars. So, we'll be creating more jobs, in that field. So, you can say, this is the technology, for example, single one, and it's creating jobs, but at the same time, it's displacing so many different jobs, at the same time. So, the question is, where is the balance going to fit, eventually? Is it going to be more on the losing jobs, or more creating jobs. And, that's a question we'll have to see, actually, as we go along.
- Jacob: Yeah, that's a very good question And, I feel like, a lot of people today are focused on the elimination of jobs, and they never talk about the creation of jobs. I think that's hwy there is so much negativity around it, because we're very obsessed with the jobs that will be removed. But, not with all the jobs that are going to be created. So, I'm really glad that you brought that up.
- Jacob: I wanted to switch gears a little bit, and talk a little bit around how you encourage different types of thinking, because in your LinkedIn profile, which I thought you had a very interesting way that you described your role, and you said, "Empower the organization to develop creative thinking, to tackle moonshot challenges and develop capacity to innovate." So, let's talk about the first part of that, which is, "To empower the organization to develop creative thinking. How do you develop creative thinking? Are there exercises or trainings that you guys do internally?
- Omar: One of the things that I do is I teach something called design thinking workshop. So, what I try to instill in people is, completely think outside of the box. Don't take the normal assumptions. I've done an investigation, actually, in teaching the class so many times. One of the elements that I ask people to design, one of them is designing a

wallet. Then, I put up a picture of a wallet, and I tell them to come up with an idea how to design the wallet. Then, 100% of the times, people design a conventional wallet, like the one you were showing them. So, [inaudible] it was anchoring their thinking process, because they were seeing that wallet and that was everything that they were concentrating on. For the last few classes I did, I didn't' put up the picture. I said, "Design a wallet." And the wallet could be anything, and the ideas were completely creative. Completely out of the box. That was the most creative classes I've taught, was the last few ones.

- Omar: When I took that picture, and the conditioning of the image, by encouraging people to think completely in divergent ways, and not condition themselves about what's going on in front of them.
- Jacob: This is a Stanford exercise, right? I think I've...
- Omar: Exactly. So, there is multiple ones. The wallet is a good one. Because it applies to everybody. Everybody knows the same... Everybody has a wallet of some sense. You can do the same thing, talk about cities, how to design cities, how to design products. It's just a way, basically, of involving the customer in the loop, because a lot of times, people do designs from one area, and they don't involve the customer in the loop, and that one is starts failing to do things.
- Jacob: For people that want to see this, I think they can go on to the Stanford website, right? To see the wallet design challenge? I think it's like a public template, that somebody can download.
- Omar: Yes, exactly. Except, the wallet is one of them, the methodology has been developed between Harvard and Stanford, they have amazing literature. But, the examples, there's tons of examples, one of the ones I like to use sometimes is the wallet, because like I said, it's something common between everybody. Everybody has their wallet. It's simple to pass the message, and teach the class and the work shop to get the idea.
- Jacob: Okay. It sounds like you teach employees this concept. But, how does it become applicable into real world, how they're doing their jobs? Because it's one thing, obviously, to do something in a class, it's another thing to actually take those concepts, and apply them in the real world, when they're doing work for NASA. So, how do you translate that?
- Omar: It's something very important, and I think it's imperative to a lot of organizations, it's something called Group-Think. So, when you have, for example, 5 engineers, or you have 5 business people, or you have 5 medical doctors, then it's like having one person, because all of these people are going to have the same mentality, the same way of thinking. So, one of the ways I encourage people to do is actually diversify the group, as much as possible. That's when you start to have create [inaudible] is completely creative.

- Omar: So, imagine if you have an engineer, you have a scientist, you have a business person, you have a lawyer, you even have an accountant, artist. So, the idea you'll be able to get will be 100% different. Then, if you have people from different generations, as well. People from different cultural backgrounds. It's completely diverse, the ideas you will be able to get. So, that's something very essential, very important, is diversifying your group as much as possible. That's when you start getting ideas outside of the box.
- Jacob: I'm glad that you mentioned that because I have a new bike, that's coming out in January of next year, on the future leader. I talk a lot about this idea of diverse teams, which I don't think we pay enough attention to, in the business world today. But for a leader, I guess, how do you ensure that diverse team? Are there certain criteria that you look at? If you're not a part of a diverse team, do you encourage employees at NASA to speak up and say "everybody on this team is the same, and looks the same. Maybe we should get some other people in here." How do you encourage that, so that people don't get in trouble, so they're not scared to speak up?
- Omar: It's trial and error. Hopefully, you keep trying until you get something that works out. But, talking about speaking out, for example. So, one of the elements, when you're doing brainstorming is we teach people how to not judge any idea, beforehand. So example, if people are brainstorming and somebody comes up with an idea, and I say, "No. I don't like this idea. This is not going to work." Then, that person comes up with a second idea, and I say, "You know what? That's not what I was thinking about." And then, the third time, that person is not going to contribute anything, he's going to shut down.
- Omar: So, what we do is we try to encourage everybody to come up with ideas, and we don't anything. We say, "Yeah. I like your idea and actually I can combine it with that person. I can combine it, this idea, combine it to a third concept. So, it's even the way you run these kinds of things and the way you deal with people. I think it has a lot of difference, it makes a big difference in the way you harvest things. There is a lot of psychological elements that go into creativity and innovation, as well.
- Jacob: How do you guys structure your teams? Is it, I know for example, Amazon, they have their famous two pizza rule, where no team should be bigger than two large pizzas can feed. Do you structure your teams in any particular way?
- Omar: It depends. NASA is a big organization, and every director, and every organization does it in a different way. Some people try to leverage a lot on open innovation. Open innovation, by the way, has been incredible. So, right now, for example, if you have a challenge, if you have a problem, not only can you leverage with the employees that you have in house, but you can put a challenge, and actually have hundreds of thousands of people looking at it and producing solutions. That would be something incredible.
- Omar: One of the cases I read recently, is a potato chip manufacturing company was having an issue with extra grease. They were struggling, because to remove the grease from the chips, you need to shake the potato, and that results in the potatoes breaking to pieces and it's not attractive when you open a bag of chips with broken pieces. So, they put an open challenge, on one of these open innovation platforms, the results, actually, the

best solution came from a violinist. So, the violinist actually came up with a tone that actually was hitting the natural frequency of the grease, and it was being removed from the chip without impacting the potato chip, its self. Omar: So, you can see, you can come up with amazing solutions. You don't have to have as many employees working on things, because you can leverage on the huge amount of vast resources that you have outside of your organization, with the emergence of these new open innovation platforms. Jacob: Do you guys do that, internally, at NASA, as well? Omar: Yeah. Exactly. We do some internally, we do some of them externally. As I said, the power of crowdsourcing has been incredible in every single thing that we do, not only in companies like Uber, like Facebook, like everything. Open innovation, I think, has been incredible in bringing crowd sources to help with solutions and technologies. Jacob: Okay. So, it sounds like part of your job, as you said, you encourage this kind of unique way of thinking. The main way you do that is through these workshops, these programs that you teach around thinking out of the box? Also, through diversity. Are those the two main pillars you use? Omar: Also, there's other ones. For example, the more you read about articles, recent articles, read books. So, we do, also, series of... Once a week, we have brown-bag lunches, where we talk about, maybe an article that has to do with innovation, with creativity. For example, there is so many cases I can tell you that don't involve spending a penny, in solving big problems. There's a, for example, a bike company, an electric bike company in the Netherlands. They were having a rat of 60 or 70% return, because it's a very sensitive equipment, with a lot of electronics. People in the shipping companies, what they were seeing when they were shipping bicycles, they were rough in transporting

Omar: Actually, the company almost ran out of business because most of these component on bicycles were coming back to them, damaged. So, one of the employees came up with the brilliant idea. He said, "Why don't we actually print a picture of a LCD TV on the box, instead of the bicycle. That gives the impression to the shipping people that they're transporting a TV" So, by doing that, it's a simple idea. Almost, eliminated the problem, completely, that they had.

Jacob: That's awesome.

them from one place to another.

Omar: Another example, is there's also a small town in one of the European countries. They were having problems with speeding cars. They put a lot of fines, big fines, and it wasn't having an impact on reducing the speeding cars, and there was a lot of kids playing, so they were concerned about potential accidents. So, one of the people in the city council came up with an idea. They said, "Instead of punishing people for speeding, why don't encourage people that don't do this damage, or just don't do speeding? We encourage them by positive reinforcement. So, they started recording all the plates of the cars, and

the ones that were not speeding, they put them into a pool, and at the end of the month, they got a check from the people that were speeding, for the collections of the money, that they collected from people who were speeding.

- Omar: So, by doing reinforced learning, reinforced, actually behavior, as opposed to taking money from the people, that also solved the problem substantially. WE can talk for a long time, I have so many examples about that. But, sometimes innovation doesn't require you to spend so much money. It just could be a simple idea. That could have a big impact on solving a big problem that you've been having for years.
- Jacob: Those are great stories. So, I guess, for people listening, maybe for leaders, or even for individuals, if they want to encourage this innovative thinking, you recommend those two things. Teaching design thinking in new ways of approaching problems, and also focusing on building diverse teams.
- Omar: Yes. Also, reading as much as possible. Cases, innovation cases, creativity cases, from different magazines, innovation magazines. Also, I noticed it's very essential who you surround yourself with. If you have creative people in your organization, and these people are talking and showing you what they're doing, it's a contagious thing. So, people would definitely start thinking differently. So the more examples you show to people, they start rewiring the way of thinking and they start thinking about things in a different way, completely. So, it's who you engage with, who you surround yourself with, what literature do you read, how diverse your team is. How do you capitalize in the tools that we have today, in open innovation?
- Omar: At the end, it has to do with leadership, as well. So, a lot of organizations, for example, say "I want to be innovative. I want to create so many creative innovative products" A lot of employees come out, and they come up with these concepts, but everything stops in the middle, the in between middle management is what stops everything. The reason is, because they're afraid if they actually take risks that they're jobs will be at risk. I found out that the best way to tack these kinds of things, by actually, the executives having a new performance evaluation, mandatory actions, "This is something you need to do." But, at the same time, have they're back up, have their back.
- Omar: So, if something happens, they need to understand it's not going to impact their job, it's encouraged, to take risks. If something happens, your job is not going to be at risks. When people feel comfortable, then you have a whole cycle happening, from the top to the bottom, and we have things happening in organizations. Otherwise, the whole system will break through. So, it's the leadership, the organization, the way you think about things. It's a puzzle, it's like Lego. It's like different pieces have to come together to be able to come up with the best results.
- Jacob: The other thing that you're talking about, is this idea of moonshots. So, can you talk about what those are, and how you encourage people to reach for those?

Omar: So yeah. Moonshots essentially came from going to the moon. So, at that time, it seemingly looked like an impossible task to go to the moon with the technology we had.

With that determination, and work, and the technology development and funding, we're able to do something that seems completely impossible. So, that's where the term moonshot came. Moonshot's something where it creates multiple orders of value, compared, [inaudible] 10X. It compares to having maybe 10%, 20% or #0% improvement, you create something that's actually ten times better than what you have right now.

- Omar: That's why, to do that, you have to think completely different. You have to go back to the basic, to the drawing board, and start coming up with completely new things. Look at, for example, at the smart phones, when it first came out. That was completely a moonshot, almost. Because people used to have a simple phones. So, the smart phones, the creation of the smart phone, actually, that was, in my opinion, one of the moonshots that changed completely, these industries in creating this evolution in communication that we have today.
- Omar: Same thing in medicine, same thing in any field, as well. Unfortunately, these moonshots are much, much more difficult. The majority of it will fail, but if you have some of them that succeed, that will change completely, 100%, your industry.
- Jacob: How do you deal with failure, at NASA?
- Omar: Failure, the thing is, I see failure in two different ways. Obviously, when you have people or astronauts on a rocket, going to launch, if you fail, that's absolutely not acceptable. But, there's a lot of times, a lot of ways you can fail before you get there. You learn a lot from it, actually. Just to give you an example about failure, about errors from nature. So, the monarch butterflies, for example, so there was a genetic error, from one generation to another, and that enabled the larva to eat some milkweed, which is a poisonous plant.
- Omar: So, because of that, when the larva ate that once, because of the genetic composition, the genetic error that happens, a lot of them to do that without poisoning them. So, what transformed into monarch butterflies, then the predators learned over time that these butterflies are poisonous, and they just left them alone. From something, a mistake, created something that essentially saved the whole species. There is a lot of things and benefits to failing, and from making mistakes, as long as you learn from them and you don't repeat them again. I think that it's not a bad thing. It's just, the problem is, at the end, collectively if you keep making mistakes at the end, then that's absolutely not acceptable. When it comes to sending people and sending humans to different places.
- Jacob: When employees at NASA fail, and of course, we're not talking about sending a human into space, but doing a regular project, thinks they're working on here on earth. If an employee fails, how do you deal with it? They made a big mistake, what happens to that employee? How do you then treat it of address it?
- Omar: That's like any other organization. It depends, who is the employees, who is their manager? Is he a leader or a manager? What kind of mistake did he make? Did he make

multiple times. So, it's try dynamic. It's multiple dimensional. It's very difficult. I can tell you about my personal experience, dealing with people. If they make a mistake, I say, "It's okay. We can learn from it." And, we try to actually have corrective action and make sure that never happens again and we share those mistakes with other groups, so people can from each other.

- Omar: I don't see it as a bad thing, initially. If you're actually going to be punishing people making mistakes, then you're going to be able to restrict people from doing a lot. They're going to be actually afraid to take any risk. Without taking risks, you can't do much. You have to take risks in order to be pushing the envelope and doing something that's going to be different.
- Jacob: Do you guys have a certain risk framework that you use, to help you decide where to make your investments, or which decision to make? How do you approach that?
- Omar: Definitely, NASA has huge corporate knowledge in these kinds of things, there's presently tons of people, that's what they do for a living. Sometimes, they buy a risk by investing more in certain areas or not. So it's a big field. Obviously, we deal with that every day, because the space business is a very risky business. No matter what you do at the end, you have to accept a certain element of risk. Otherwise, you're in the wrong business.
- Jacob: Yeah, there's always going to be risk. Are you able to share any of that framework? Like, some of the steps that go into it or some of the things that you think about?
- Omar: Yeah. There is a lot of analysis, [inaudible] and tech analysis, hazard analysis. So, depending on what component you design, you can see, for example, what the failure modes for that kind of thing, how critical they are, how many redundancies do you have? So, it's a big framework that people can do. It's big specialists that work in these fields and areas.
- Jacob: Okay. Another things that I know you spend a lot of time thinking about is innovation. How do you define innovation? What is it? And. How do you encourage your team, your employees to be innovative?
- Omar: So, innovation, in my opinion, is basically using the resources that you have to create new value. Sometimes, people refer to innovation as when you create something that maybe you spend 10s of millions to develop a new technology. Obviously, that is an element of innovation, but innovation could be just using some of the resources that you have right now, and create something completely different, that creates better value than what you had before. Or, it could be thinking of an idea that actually can solve a problem, like the one we alluded to, earlier before.
- Omar: Innovation has a lot of segments. All collectively, it's how you make better value at your organization. How do you make things better, cheaper? Create something that is much, much better than what it used to be, before. I think all that stuff, collectively, is an element of innovation.

Jacob:	Yeah. I think innovation is a huge topic. Sometimes, I think people confuse invention with innovation.
Omar:	Yeah. Exactly. Invention could be an element of that.
Jacob:	Not necessarily the same thing.
Omar:	No, definitely. Innovation could be something that's not an invention. But, an invention could be part of innovation. It's a [inaudible]
Jacob:	What is it like to work at NASA? So, is it free food, open spaces, gym memberships? What's the environment like there?
Omar:	It's very exiting. Obviously, you're working on leading edge technology to sending people to different planets or to study the latest sciences in different fields. So, it's very exciting, from that perspective. But essentially, it's a Government agency. So, sometimes. When I go visit Google, Facebook, and some of these high-tech companies, and you can get the free food, the environment is very different. Obviously, we can not do that in Government organizations. But, each ones have advantages and disadvantage. But, it's very exciting job, very exciting organization. I think it's one of the ones with the highest job satisfaction, across the federal agencies. It's incredible, everybody there is very motivated, very hard worker. Together, I think amazing things are happening.
Jacob:	What do you think people listening to this, who are not working for an engineering organization, or space companies like NASA, what can they learn from some of the approached or the ways of thinking that you guys have, internally? For people out there who are traditional business environment, business jobs, what advice would you give to them, based on what you've learned at NASA?
Omar:	I think it goes both ways, actually. One of the things I like to do every month is go to a completely different company, outside of my industry, and I see how they run their business. What governess models they have, and I've tried to learn from them. So, it's something that's both directional. We learn, because we don't do everything, we're not the best at everything, obviously. But, a lot of the things are being done much better in different industries, in different organizations. So, I think the best way to do it is to try to have benchmarking, collectively. So, the people from different industries, from different Government organizations, start having benchmarking and try to learn from each other.
Omar:	See, how do you guys deal with failures, how do you deal with creating new value? How do we learn from each other? Can we learn from your mistakes? Can we learn from your successes? Can we work together to try, and solve these kinds of things? So, I think that is the most essential element, is actually, do it on a big scale, and benchmark, and learn from each other.
Jacob:	Do you think there are any practices that you guys use at NASA, that other companies don't? Whether it's decision making, whether is it an approach that you have to

problem solving, maybe it's even a way that you approach leadership or a perk that you have. Is there anything that you think is unique to NASA, that no other company out there has or does.

- Omar: That's a very good question. Obviously, we're very good at systems engineering. I think we're, at JSC, Johnston Space Center's one of the best in the world at systems engineering. How to put different systems or components together to produce some big vehicle or big thing. We're very good, for example, at risk analysis, at the safety and emission assurance, because we have to deal with that every single day. Also, it depends on your organization. For example, if you're talking about flight director, then the governess model's very different from a person, for example, at a design organization. So, depending which organization you are, it's going to be very different. The governess models and the way you deal with management and so on. But, if I have to choose two I would say, definitely systems engineering and safety analysis, risk analysis, and all these kinds of things, since they're at the core of what we do.
- Omar: This is at Johnston Space Center. At other places, they do more research and science and stuff like that.
- Jacob: Earlier, you talked about changing mentality, and you were talking about vulture. I know this is also a struggle for a lot of organizations. What do you do to change someones mentality or way of thinking? I suppose, this comes in a lot of different ways. It could be for leaders, who have a very hard time adapting to new ways of working. So, for example, I think you mentioned, 21 years ago, it used to be very competitive, now it's collaborative. I'm sure there was some leaders who just had a very hard time at changing that way of thinking. Or maybe, it's an employee who having a hard time changing their way of thinking. What do you do? How do you get people to se things differently and sort of make that mental switch?
- Omar: I think that's one of the most difficult cultural elements that people struggle with. One of the things that people, typically, if you're in the innovation field, where people tell you, "Hey. It's not broken why should I fix it?" So, it's very, very difficult to do these kinds of things. My opinion, I see two approaches you can do for that. The first one is try to incrementally, try to push little changes into what their trying to do, and show the people that you're dealing with that by doing this little incremental change, compared to what used to happen, look at how much value and how much benefit and how much advances you were able to do.
- Omar: The other one is actually to do it more drastically, where you have bigger measure and bigger changes. Then, when they see the value at the end result of it, people start embracing, more and more, the change. But it has to do with so many different elements. Younger generations, obviously, is more susceptible to being more creative and doing things and changing things. If somebody has been doing it, the same job, for 20, 30 years or 40 years, it becomes much more challenging to be able to change the mentality or the way they do things. But in these cases, you have to do it incrementally, it's very small steps. Eventually, it will show the value from being able to embrace new ways of doing business.

- Jacob: Well, you've been at NASA for 21 years, you said. How do you keep yourself excited about the job and keep yourself engaged in the work that you're doing?
- Omar: The thing, is every few years, you need to look for a new challenge. Because, every time, for example, you get an assignment, you're very excited, you have so much energy. You're actually questioning things, and actually these questions might bring so much value because as an outsider, you're coming in with different perspectives. People, there, have been immersed into that environment, that it's difficult, sometimes, for them to see what's happening. So, when you come with this energy, and everything's exciting, and you learn. I think, people need to switch jobs, maybe after every 3 or 4 years, to keep the momentum going, to keep you excited, to keep you challenged, and being able to keep things interesting.
- Omar: Otherwise, eventually, you reach a point that it becomes stagnant, and there's not much progress being made. So, I think definitely, in my opinion, it needs to change every 3 to 4 years, to be able to keep the momentum going.
- Jacob: Well, I know we are just about out of time. Is there anything else that you want listeners to know, or any last parting words of wisdom that you have for people tuning in?
- Omar: No, I think, eventually, we have a very exciting future. It's going to be incredible, the amount of advanced we've had in technology, how much benefits is happening to society. I think, it's overall, all of these technologies will be for the better. There's going to be some challenges, some risk, but I think all these elements will be able to make people, maybe live longer, have better economic lives, better incomes, more comfortable societies. So, I think, overall, it will be a benefit. Its incredible to see how much advances we've done in the last 100 years, when the main transportation was horses. Noe, we're going to the moon, and we're talking about driverless cars, or even driverless flying cars. So, imagine what the future will hold in 20, 25 years from now, I think it's going to be something very interesting.
- Jacob: Well, where can people go, to learn more about you or some of the work that you're doing, or some other projects that NASA has going on? Anything that you want to mention, for people to check out, please feel free to do so.
- Omar: Yeah. So, NASA has an amazing website, it outlines all of the missions that we're doing, in terms of going, missions to mars, or new satellites mission or new science, new technologies. We also have a spinoff book, that we produce every single year, that shows the technologies that were developed for space, how they could be applicable to creating economies, and jobs on earth. That tells you what the value from space is, sometimes, people ask, "Why are you spending so much money in space? We need it for the economy." But, most of the research has indicated that for every dollar you spend on space, the return is from 3 to 6 dollars, in terms of creating value, creating jobs, and creating new technologies. It creates more businesses. So, you have to look into all these elements, as well.

- Jacob: Well, Omar, thank you so much for taking time out of your day to join me. I found the conversation fascination, and I hope people enjoyed it, as well. So, thank you very much.
- Omar: Thank you very much, Jacob.
- Jacob: And, thanks everyone, for tuning in. Again, my guest has been Omar Hatamleh. He is the executive director of the Space day program, at the international space university, and he's also the chief innovation officer of engineering at NASA. He's on LinkedIn, you can find him there. Also, make sure to check out the NASA website. I will see all of you next week.