PMPOV113 - Asteroids

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0:00:05.3 Announcer: From the Washington DC chapter of the Project Management Institute, this is PM point of view, the podcast that looks at project management from all the angles. Here's your host, Kendall Lott.

0:00:15.4 Kendall Lott: Hello PMs and welcome to episode PMPOV0113 asteroids. Here with me today is co-host Mike Hannan and a returning guest. 7 years ago, 2016, we published episode number 32. Yes, number 32. So many years, so many episodes ago PM project management in space with Roy Mazel and project leaders at NASA. We talked about the web telescope, Mars exploration, and satellites. Now not only retired from NASA, but a guest lecturer Roy is also back on the podcast feed. Today for us to talk about PM learnings and program management learnings about asteroids or rather asteroid missions, which is exciting as one is coming in in September, 2023 and another in October, 2023. You're gonna see it in the news. Gentlemen, how doing today?

0:01:08.1 Roy Mazel: Just fine Kendall. It's a pleasure to be here. It's been a long time since we've talked, but I'm looking forward to having another conversation about project management, which is one of my favorite topics and the space program, which is an even more favorite topics.

0:01:21.8 KL: And where are you calling in from today, Roy?

0:01:24.1 RM: So I'm calling again from my home in Clifton, Virginia. I retired from NASA 4 years ago after working for 38 years, and I'm enjoying retirement. But I like to get back into the swing of things a little bit by doing events like this.

0:01:39.5 KL: And I have to note, because Mike offered this up before you are also one of Mike's mentors and coaches and he has spoken fondly of you and your intellectual capacity and direction that he got as a young civil servant at NASA back in the day. And in fact, he's the one that helped lead me to you when we had our first episode back number 32. So, Mike, I know Roy is important to you and has been in lectures with your courses now. Where are you calling in and how are you doing today?

0:02:06.6 Mike Hannan: I'm back in the DC area as well. But I was in Maryland, does that mean we're all three within spitting distance?

0:02:10.8 KL: Yeah. And in the same time zone atleast.

[laughter]

0:02:13.9 MH: Yes. Let's just say my career would've taken a much different direction had I never met Roy Mazel, I didn't really know anything about project management other than how you plan out planting a garden or something. So to have the opportunity to cut my teeth on the NASA Space Station program under Roy's mentorship was a great opportunity to change the trajectory of my career for sure, and far for the better. And I'm even more thrilled that while I left NASA quite some

time ago, I was able to stay in touch with Roy and continue to learn from him and share his learnings with all of you.

0:02:44.2 KL: Yeah, and a quick plug for that, by the way, for our listeners, Mike and I both were on a program to work with the civil service, federal civil service. And I think it was a great opportunity for both of us, both the presidential management fellowship program that we were on, but also a chance to work in the government. I think for all PMs different environments is a meaningful learning experience. It is something to learn. I still consult to the government, but we both spent our time in there as young professionals learning how systems work. I think that's the biggest thing I got out of it. Plus just general bureaucratic work.

0:03:15.1 MH: And I may have never mentioned to you Kendall, but Roy was also a Presidential Management Fellow.

0:03:19.9 KL: Were you? I just thought you were sponsoring them, man. You go way back.

0:03:23.6 RM: No, way back. In fact, when I was in the program, it was originally called Presidential Management Intern, PMI, and I believe it was the fourth class. I believe the first class was in 1978, if I remember correctly. And I came in in 1981 and in fact in the science mission directorate, which was the office I retired from at NASA, many of the senior people in the non-technical areas were former PMIs and PMFs. I was in the program when I retired, both the director and deputy director of our budget division were former PMFs, the director, the deputy director, and a branch chief of our administrative division were former PMFs. So the program was quite successful at bringing people in and letting them grow their careers into senior leadership positions.

0:04:20.6 MH: And continuing the PMF plug, one of the former NASA administrators was a former PMF Sean O'Keefe. I think he might've been in the very first class. And oh, by the way, if you're interested about applying your PM skills and you're about to get a graduate degree in any kind of project management or public policy field, the deadline to apply for the PMF program is coming up in October of 2023 here. So check it out at pmf.gov if you're interested.

0:04:48.9 KL: Excellent program. And again, I think the service generally is good to be in, in the federal government for us to learn as PMs and get to follow mentors, right, who've had to live it. And that's what we're gonna talk about today. Though, retired Roy, you're gonna tell us about missions and types of missions that we as taxpayers are shelling out the buckaloneys for. So, talk to us, describe a couple of the missions there or the nature of missions that you wanna talk about today.

0:05:14.4 RM: Okay. Thanks very much, Kendall. What I wanted to focus on today is basically the scientific topic of asteroids and the missions we've used to investigate them. I'd like to just spend a moment talking about why this is important. There are a couple of reasons that it is important to study asteroids. First of all, their remnant debris left over from the formation of the solar system and understanding their chemical composition provides insight as to how the earth and the other inner rocky planets formed. The biosphere of our planet has been significantly modified over the course of our history, in part due to asteroids. A notable example of that is that 66 million years ago, there was an asteroid impact that caused the die out of 75% of all animal species on earth. This was the mass extinction event that ended the Mesozoic era and the age of the dinosaurs.

0:06:12.5 RM: The remnants of this event are in the Yucatán Peninsula. It's called the Chicxulub crater. And that is also supported by the fact that there is a layer of iridium, which is an element that is common in asteroid that is found throughout rock strata around the world. So when you drill down into rock and you're in fact going back in time and you hit the 66 million year ago point, you find iridium spread around the planet. So that's how we know there was an asteroid impact.

0:06:45.9 KL: So dinosaurs might have been really cool but they didn't have scientists and project managers, so it sucks to be them. Right?

0:06:52.1 RM: That's right.

0:06:52.5 KL: That what I'm hearing here.

[laughter]

0:06:53.2 KL: Okay, good. Okay. We're in the right place then. Right place at the right time.

0:06:56.8 RM: So look hopefully we're a bit smarter and in fact, I'll talk a little bit about some of the things that we do, which involve the second reason to study asteroids. So they are potentially hazardous. Okay.

0:07:09.9 KL: Oh, risk management.

0:07:10.8 RM: Yeah. And we have the opportunity to be a lot smarter than the dinosaurs here. So the asteroids that I'm talking about in terms of presenting risk to the earth are what's called near-Earth asteroids. And there are approximately... And every time I see this number, I'm sort of dazzled by it. There are about 600,000 asteroids in our solar system. And as of June 2023, 32,000 of those are described as near-Earth asteroids which are defined as those that pass within 120 million miles of the sun. Okay? Earth orbits the sun about 93 million miles out. Okay? Of those 32,000, roughly a thousand of them are greater than one kilometer in diameter and about 10,000 are greater than 140 meters in diameter. Just to give you a sense of the damage that this could cause, the impact of a one kilometer asteroid would be equivalent to a 9.4 magnitude earthquake 9.4 on the Richter Scale.

0:08:32.2 RM: And I believe there have only been two that have reached that level since we've been able to measure them, or it's roughly equivalent to a 60,000 megaton explosion which would be equivalent to 4 million World War II era atomic bombs. So if we're hit by one of these things, it is gonna be a very bad day for planet Earth. Fortunately, there is some good news about this which I'll get to, but for these reasons, both understanding the formation of our planet and risk mitigation, we believe it's very important to study asteroids. Now, there have been a host of missions that have done this and they're basically in four categories.

0:09:16.2 RM: One is a survey type mission called the Survey Mission, which is basically using a telescope to find asteroids. These telescopes can be ground-based or in earth orbit, such as NEOWISE, which was a repurposed astrophysics mission that's now used to find near-Earth asteroids. Second class of mission is a fly by, which is just like it sounds, you have a spacecraft with sensors on it, fly by an asteroid and make various measurements via spectrometers, measuring magnetometers, assessing its gravity field, it's composition.

0:09:57.4 RM: A third class submission is a lander, which is designed to collect a sample. And finally there is an impactor and in fact a mission, which is not gonna be one that I'm talking about in detail today, but one that was called the DART Mission, which is an acronym for the Double Asteroid Redirection Test was launched almost two years ago in 2021, and impacted an asteroid called Dimorphos almost a year ago in September of 2022, with the idea of demonstrating that we could alter the path of the asteroid. And in fact, the assessment that was done after the fact showed that we were able to do that. So should we detect an asteroid that is going to present a real danger to earth, we now have established a technology for mitigating that risk.

0:10:40.8 KL: That makes me feel like playing with fate, though. You just know that we've set somebody up 150 million years from now. I don't know, God may not play with dice, but I'm having a fear that the scientists are. Hey, do we have asteroids that attach and try and nudge? I thought that... Or am I getting science fiction confused with real science here that where we were trying to put them next to asteroids to shift them?

0:11:01.9 RM: Well, many asteroids exist in what's called the double system, that's similar to double stars. In other words, it's two, it can be even more, but usually two that are orbiting around a common center of gravity. And in fact, the asteroid that DART impacted, which was Dimorphos is a binary asteroid with another one called Didymos. But there have been some ideas that have been put out there about using asteroids to do different things. But what we're really talking about here is sending an earth human made impactor. It's not particularly high tech. You take a big heavy thing and you plow it into the asteroid [laughter] with the idea of inducing a change in velocity, a delta V. And what helps this is that the earlier you detect it and the earlier you launch the mission and the further away from earth you impact it, the lower delta V, you need to alter the course. So in other words, you don't need to throw as large a mass at something that is further away.

0:12:13.9 RM: Okay. If you think about it, that's pretty intuitive. If something really big and heavy is about to hit you in 10 seconds, well, to divert it [chuckle], you're gonna have to have something a lot bigger and a lot heavier. But when it's far away, if you just give it a gentle nudge, you can push it out of the way.

0:12:31.2 KL: It's the reality version of our risk management processes when we're starting a project, isn't it? When you're in the last X% of the schedule and the risk that you plan for suddenly happens, your intervention is likely to be a much greater one than if you talked about it in the kickoff meeting. But I suspect project management is the abstracted variant that follows the physical requirements, not the other way around. We're not the first in the hopper on that one. So having talked about those four different missions, I think you were talking about two specific ones. Tell us about those missions and how they fit in this type structure. And then we can get into how they came about and what we've learned from a project management perspective. But right now fill us in a little bit about these two missions that we're gonna hear about in the news soon.

0:13:10.6 RM: Okay, sure. So the first one is a sample return mission. It was a lander who actually didn't land. It was more of a touch and go. Okay? That mission is called OSIRIS-REx. Now, at the risk of burdening the listeners here, I do think I should say what that acronym stands for, and it is a mouthful. OSIRIS-REx is the Origins Spectral Interpretation, Resource Identification, Security, Regolith Explorer. So like I said, it's a mouthful. The target of this mission is an asteroid called Bennu, and it's a carbonaceous near-Earth asteroid about 1600 feet in diameter. The objective of the

mission was to characterize it. So after it was launched in November of 2016, it arrived at the asteroid and actually spent quite a bit of time orbiting it and characterizing the asteroid, and selecting the best spot to contact the asteroid, with what was called the touch and go sample mechanism.

0:14:23.8 RM: What this basically was, is sort of a leaf blower attached to a frisbee. And the spacecraft lowered itself, the frisbee touched the surface it shot out a blast of nitrogen gas, blowing material up, which was then caught in a mesh-type structure within the frisbee. That was then placed in a canister, which was launched from the spacecraft. And that canister will be returning to Earth on September 24th, exactly one month from the day that we are recording this podcast. And it'll be landing at the Air Force Utah Test and Training Range. And this is supposed to be a fairly sizable sample. We believe we got much more than the minimum, and this will be studied for years, in labs. Not just in the United States, but portions of this sample will be given out to international investigators as well.

0:15:29.1 KL: The orbiter is not returning? That canister is returning?

0:15:33.3 RM: That's correct.

0:15:34.0 KL: Got it.

0:15:34.2 RM: The canister is returning. And one thing we have always tried to do is we have tried to really effectively use the taxpayer's money by leveraging our spacecraft to do additional things where we could. So earlier I mentioned that one of the telescope missions, NEOWISE, was a repurposed astrophysics explorer that was originally designed to look into outer space into the infrared. When that prime mission ended, that was then focused on asteroids. OSIRIS-REx, having successfully launched the sample back towards Earth, is now on a follow-on mission to an asteroid called Apophis. And it will be arriving there in 2029. So we have some time to wait for that, but it's instrumentation. It carries a camera suite, an altimeter, three spectrometers will be used to examine that asteroid six years from now.

0:16:28.6 MH: And, so Roy, share a little bit more about why we should care about whatever we find in this sample.

0:16:36.1 RM: Okay. So in the study of the solar system, which is interesting in its own right, but also in recent years, a key scientific interest area has been exoplanets, which are planets that orbit other stars. There is a lot that is known about how planets form and there is a lot that is not known. Why some planets have an iron core and others don't. How they evolve over time. Why some planets lose their atmosphere, why others retain it. So the information gleaned from these objects, which are remnants of the creation of the solar system, help give us insight into that. And in fact, the second mission, which I'm talking about, that's just a wonderful segue into that, it is a mission called Psyche. Now, pleasingly, that's not an acronym [chuckle] It's named Psyche because it's going to the asteroid Psyche. And this is a what is called a main belt asteroid, which means it's orbiting the sun in between the orbits of Mars and Jupiter.

0:17:52.1 Announcer: So this is not a near-Earth asteroid, we don't need to worry about this one. But it is a highly metal-rich asteroid and it appears to be the exposed nickel-iron core of an early planet that never actually formed into a planet. So we believe that the core of the earth is iron and

we may be able to closely examine an object that is in effect the core of a planet that didn't make it. So this mission is not a lander, and it's gonna characterize the asteroid. It has all kinds of instrumentation, a multi-spectral imager, gamma ray, and neutron spectrometer magnetometer. And it's also doing a technology demo in deep space optical communication. Which, if this works, will allow us to get much more information back from the spacecraft we sent to deep space.

0:18:51.1 KL: And so this one is a fly-by?

0:18:53.0 RM: Well, it'll be orbiting the planet... I'm sorry, the asteroid, excuse me. And this will be launching... So like I said, the OSIRIS-REx sample is returning a month from today. Psyche will be launching in October. There is a launch window on this that opens on October 5th and closes just under three weeks later on October 25th.

0:19:14.8 KL: Apparently God doesn't do good lean six either, we get scrap.

[laughter]

0:19:20.1 MH: Since I was fortunate enough to be mentored by Roy in this, in the NASA world where things like launch windows matter, and your ability to achieve due date performance within a launch window can mean the difference between having a mission and not having a mission. Or even if that's not quite that bad, having a mission now or having to wait 17 years until your next launch window or some other time well into the future. When Roy came to my graduate school class in public sector project management and shared that, it just sounded like stuff I was familiar with, like we all should be. But almost every single one of my students said, yeah, when my projects are late, I don't suffer that consequence. It kind of brought into sharp relief why schedule management and due date performance really can matter. [chuckle]

0:20:08.8 RM: So for missions that have... What are called planetary launch windows, schedule management is absolutely critical. To take a quick contrast, if you're launching something into earth orbit, there are windows depending upon the orbit you need, okay? Whether you're going into equatorial orbit, polar orbit, that type of thing. But there are many windows. If you miss one, you're going to have an opportunity in the very near future. And by that I mean on the order of days or weeks. Okay? To contrast that with a planetary launch window, and let me talk about a class of missions here that I think most people are familiar with, which are the missions that we've sent to Mars, both orbiters and landers. Due to the celestial mechanics, by which I mean the orbits of Mars and Earth.

0:21:01.0 RM: And due to the energy that is available in the current suite of launch vehicles, we have, there is a launch window to Mars that opens once every 26 months. So if you are developing a Mars mission, and these missions, we are talking, hundreds of millions of dollars at a minimum, and often a billion plus. If you miss that window, you can't go a month later, or two months later. You've gotta wait 26 months. And furthermore, during those 26 months, even if you finish your development just past when the window closed, these are not the type of mechanisms, this is not the type of machinery that you can simply put on a shelf, walk away from it, come back two years later, flip the on switch and you're ready to go. It just doesn't work that way. They require... They have to be stored in special environments. They have to be regularly checked, they have to be regularly tested, and you have to keep significant workforce in place and not just to maintain the spacecraft, but also because you don't wanna lose that expertise that you're gonna need for when the spacecraft

is in the operations phase. Now you can clearly pull some people off and divert them for a period of time, but the key point here, and I think the gist of Mike's question, is that when you miss one of these windows, they, first of all, it just delays what you're trying to do. It delays your science, but the cost impact of this is often very significant.

0:22:43.9 KL: I'm fascinated by two things in there, Mike, that I haven't thought about in projects before. So schedule here is always a big deal, but this kind of early entry, late exit space, you have the latest and the earliest you can do is interesting itself, but I've never considered anything I've ever had to work with or people I get to talk to often that the materials you're using decay, like it literally could become obsolete while you're doing your project if you missed a key turnaround here or the material itself. And then the other one, Mike, that we do touch on, or you certainly know a lot about, is this idea about the collaborative teams and self-organizing teams and getting resources available. The idea that the human capital, I don't really like that word, but the human knowledge decays. It's really not helpful to have the wrong people around in the different phases or if you need them consistently, and you've missed schedule now, this idea of availability of resources at a pure technical level, not just the number of people available or the... But the type or their quality. It's fascinating to me, and that's a whole level of risk that I don't think we often consider in the non NASA space, perhaps, Mike.

0:23:51.6 MH: Yeah. In fact, tell me if I'm on track here, Roy, based on my understanding of like missions that go wrong, like the Apollo 13 mission, if you don't have the people in the room that actually designed what's on that spacecraft and know specific down to the micron maybe, but now we're in an unexpected situation where that knowledge is crucial, I would call it the decay of the knowledge. All right. And the brain drain, really.

0:24:15.8 RM: Yeah. Mike, I think your comments are precisely on point. The people who are involved with this, we talk about, aerospace engineering in general, but there are so many subspecialties here for both the design of the spacecraft, specialized manufacturing techniques, science planning, what has to be done in the operations phase. That, like I said, I think your comments were absolutely spot on. If you lose that, due to a delay, then you're in a whole additional level of risk.

0:24:51.9 KL: Well, to expose to our listeners, we wanna bring you in to talk about it from a program and project management perspective. Although, frankly, as lay people who are just curious about the universe, I could talk about all these things forever or listen to you talk about them forever, and the people that you've met. But let's talk about it a little bit these two projects are somewhat different in terms of how they approach asteroids and what they're doing. Both of them having follow on potential work, both of them producing value to us for human knowledge and specifically around some risk mitigation. Just understanding our own solar system. But one is launched and one is returning, with respect to what we're talking about, how are there any lessons learned between these two? Let's... I was wondering if we could take us to some lessons, what might have gone wrong or right, and how that compares between the two. 'Cause they seem kind of different to me, even though they both have asteroids at the center of the project.

0:25:40.9 RM: So let me talk about that a little bit. Let me just give the listeners sort of a little top level set of parameters here. Both of these missions came in at just a little bit over $1 billion. Serious money here. But there was a substantial difference in how you would look at them in terms of program management success. The OSIRIS-REx mission, which is the one returning the sample,

had actually, and this is something we do not often experience on space missions, highly technical work. It came in at 1.16 billion and had a development under-run of about $30 million and it launched on schedule. This stands in contrast to Psyche, which will be launching in October, which was actually quite close in terms of total cost of $1.11 billion. However, its development cost grew from 682 million to 814 million, which was a 19% increase due to a 14-month launch delay. So this reflects, Mike, this is just what we were chatting about a couple of moments ago. It was a significant delay and 19% growth in development is a non-trivial number.

0:27:02.8 KL: But we don't have a loss in value other than one year of scientific knowledge, unless it's gonna collide with Earth, but you said this wasn't a near-Earth one? [chuckle]

0:27:10.4 RM: No, but there is another impact in line with what we were talking about. Because it was delayed 14 months and because of celestial mechanics between the earth and the target asteroid, and due to the energy levels available in the launch vehicle, that 14-month delay in launch translates into a three-year slip in the arrival to the asteroid from 2026 to 2029. Now, as I said, this is not a near-Earth object. This is one that we are investigating more out of scientific curiosity. Nevertheless, a three-year deferral of getting those data sets back is a major disappointment to scientists in the field. And you have some of the rest. Now, again, this is highly specialized and, I think most people who are interested in this will stick around and if they thought it was worth it in 2026, they're still gonna think that same thing about 2029. But you also have... You may have people who want to move on to something else due to a delay of that magnitude. So it was not just the cost impact, which was significant, not just the launch delay, which was significant, but it was also an even greater delay in the arrival at the target and the onset of the collection of the scientific data.

0:28:35.4 MH: And oh by the way, none of us is gonna live forever. But I think of how many science buffs, not just NASA employees, but people who are truly curious about this and greatly value the knowledge that promises to come from it, who unfortunately may no longer be with us. And I think even that is kind of a shame.

0:28:55.5 RM: Yeah. If I may inject something here, and I was not originally gonna address this, but just, Mike, in view of what you said. One of the things that enabled the success of OSIRIS-REx, was fairly on in the mission, they dealt with an extremely difficult and an extremely sad challenge. The principal investigator passed away unexpectedly, fairly early in the mission. But what he had done, which is something I would argue is important all over, but particularly when you have programs and projects of long duration, is that he had a deputy who was completely ready to go, and was able to step into that role in a seamless manner. So I think sometimes a topic like succession planning can get lost in the day-to-day challenges of bringing a project to successful conclusion. But in fact, as they say, stuff happens and a circumstance like that is one that nobody wants to deal with, but they were ready.

0:30:02.6 MH: That's great. So more program and project management challenges between OSIRIS-REx and Psyche.

0:30:08.5 KL: Yeah. So, how did it come about that something came in under budget in a government program?

0:30:12.4 RM: Okay, so that is... [chuckle]

0:30:13.7 KL: And then how was it only a year late and another one, I mean, let's talk about this, what happened?

0:30:17.6 RM: Okay. All right. Let me touch on OSIRIS-REx first, and let me talk about some of the key factors that made that a program management success. First of all, very often in the space program, we talk about the term heritage hardware. Okay. Where you use stuff that has been used before. But I will tell you that that can often be overplayed. People propose a mission, well, we're using heritage hardware. Well, okay, is it built by the same people who built the first hardware? Is it built in the same environment? Is it built by the same people? Is it tested in the same way? Does it see the same regime? And very often what's called heritage hardware doesn't really fit a particularly rigorous definition of it. However, in the case of OSIRIS-REx, it did. The development contractor for the spacecraft, it was Lockheed Martin, and they had recently developed several other planetary/solar system missions, including Stardust, Juno, GRAIL, MAVEN, Odyssey, and the Mars Reconnaissance Orbiter.

0:31:26.7 RM: So they had some hardware that they had personally produced and they had experienced teams or people from experienced teams in that area they were able to draw on. So when they claimed they had a lot of heritage that they could leverage, that was the truth. And they were able to do that and they made very effective use of that. A second thing that the project did very effectively, and I'll just say for a moment, when one of the most respected aerospace engineers I have ever worked with was asked, "At its core, what does NASA do?" His answer was two words, "Risk management." That's what NASA specializes in. And in the case of OSIRIS-REx, they had a very, very robust risk management process, okay? Particularly with respect to the employment of new technology, which is often a problem. They emphasized identification and mitigation of risks early in the design phase.

0:32:32.0 RM: And what they insisted on themselves rather than have somebody impose it on them, which sometimes needs to happen, is they got higher level review through an independent review team to identify hotspots and develop risk maturation plans. So as a result of all this, they started by tracking 200 risks, only 30 of them materialized, and a very small number were unexpected. So they were well prepared to handle that. Very much related to that, is they recognized, and this is part of I think the culture of the project, which is something I'll talk a little bit more about later. But they recognized that a key challenge would be maintaining technical integrity despite pressure to stay on schedule. This is always important. And quite frankly, one thing that has been one of NASA's and aerospace contractor's great strengths, but can also be a weakness, is that can-do attitude.

0:33:32.8 RM: We've got something that looks impossible and we need it done for six months. And you get a whole bunch of people jumping up and saying with all sincerity, "We're on it. We'll make it happen." That's a good spirit to have. But the fact of the matter is, sometimes that's unrealistic. So you have to maintain your integrity in face of that schedule pressure. And the risk here, is that if you get into reaction mode, rather than anticipation mode, some fixes are gonna be poorly thought out. So it's the type of thing where you want that upfront planning and they were able to do that very effectively. One specific thing is that the project systems engineer talked monthly to each element lead to better get insight into potential problems. So this was a very, very hands-on systems engineer who just was out there and talking to the element managers to see what was going on.

0:34:34.1 KL: Let me hold you up there real quick, a comment and kind of a question for you and I to kick around a little bit. I haven't been on a lot of even super technical projects that can be described as technical at all frankly, but I'm remembering having well over a 100 risks documented on trying to roll out an enterprise architecture for IT, something abstract. You're telling me we have a multi-billion dollar project here that's gonna fly hundreds of millions of miles away over a period of years. And it's like, "Well, we started with 200 risks." I come up with 200 risks just trying to get my company to pivot on something, right?

[laughter]

0:35:09.5 KL: Mike, what's going on here? Only 200. So kudos to NASA about knowing how to boil it down or boil it up. I'm not quite sure which one it is. Condense it up to only 200, amd it becomes 30. I'm stunned with their risk management, which then you've tied to this whole communications and staying in touch. That's one comment, Mike, you can comment on my comment there, but the other one I was just thinking of, we talk about this concept of the technical integrity in the face of schedule pressure. I'm thinking, Mike, of so many things you've talked about in portfolio management and flow about one of our roles is to keep this executive pressure off of us. The pressure causes us to try and do too much, too fast, and nothing gets done, no completions, higher risk, higher failure rates, all this. And in this case, I am imagining a lot of it is political, Congress wants to know what happened with the money and is it on target? And the political, literally capital P, political appointees care about their tenure. But a large part of what you're describing is inheriting the environment, the actual environment and conditions of space and of testing and things. Mike, what do we do to keep that balance of schedule risk and maintaining technical integrity?

0:36:21.3 MH: I came across a concept a few years ago called the U Curve, and essentially the U Curve is just saying if you give somebody unrealistic time to do something, unrealistically short, where the only way to have any prayer of doing it is to send them immediately into mad scramble mode. And even if everyone knows the risk that, the probability of success is low, but we're gonna try. They've shown that it's disastrous, that you actually get very poor work quality, workmanship, lots of defects. On the other extreme of the U Curve is you give somebody too much time and then you have things like Student Syndrome kick in, right? Where, "Well, I don't have to worry about that till the final exam," or, "If I do anything at all, I'll check into it to make sure it's relatively straightforward and then if so, I'll forget about it for a while."

0:37:07.7 RM: And so obviously you want your teams at the bottom of the U Curve, which is hopefully a pretty wide bottom, there's something called a sense of urgency which does motivate people, but not to the point where you're taking all sorts of risks and shortcuts and Hail Mary passes and things like that. And so if you take the NASA challenge of the launch window, but then also ensuring technical integrity, I think it takes leadership courage to say, "Look, we want people to stay at the bottom of the U Curve. Then if we ever feel like we're gonna risk things one way or the other, then let's reposition things so we're back in the bottom of the U Curve." What do you think, Roy?

0:37:49.0 RM: So this is obviously a very significant challenge on many projects, and I think especially on those that are highly technical. It is so critical that the organizational culture be one that encourages absolute free communication without retribution. That the idea here is that the main thing is achieving project success through project and organizational excellence. And what that

involves is when schedules are laid out upfront to really take a look at them and be sure that it can be done.

0:38:26.3 RM: In types of cost estimating, there are the triangular distributions of schedule where you have least amount of time, greatest amount of time, and then you've got a point somewhere in the middle of them, which you think is most likely. And then you assign a probability curve to that. But I think what's really important there is the communication from project leadership all the way down into the lowest level to be sure that it is realistic and if it isn't that you have a culture that somebody can say so and be praised for saying so not be criticized for it.

0:39:01.3 MH: And didn't they find out that that was one of the major contributors to the Challenger disaster in 1986?

0:39:08.6 RM: That's exactly right.

0:39:10.3 KL: I have clients now that talk about this, but I would be intrigued in learning more about that, 'cause I have clients that have this very same conversation. The management is aware of it. And so the question is how do you create that behavior, which we think is through how people experience the organization, like role modeling and activity is ultimately it. Not writing down the rule book about it, but how do you actually get people to be willing to say things where it is allowed to say that's wrong? That's the other problem. People are unwilling to say it's wrong. Say that's not right, that's not gonna work. But then that's not a problem. So people can actually critique and there is no cost to something indicating that that might not be the right solution. I think there's two parts and it's really interesting how an organization can have that so deeply.

0:39:53.9 RM: I'd go even further and say when you have a complex system that you're trying to engineer, like a spacecraft, you might have 15 people in remote subcontract... 15 different subcontracting firms doing their little piece parts of the overall system and some junior engineer and each one says, "This is probably nothing but" And then you put the 15 probably nothings together. And actually that could be a real problem at the system level. And so even discouraging, this is probably nothing, but I still feel I should say something. If you discourage that, think about the catastrophic impact.

0:40:29.8 KL: Fair enough. So tell us more on a comparison about that's how that worked well, and what worked well on one and not the other.

0:40:38.2 RM: Okay. So there were some problems in Psyche that led to the 14 month launch delay the cost growth and development and then that slip in the arrival at the target. And I would just like to make one sort of preface type of comment here. OSIRIS-REx was the NASA Management center for, that was Goddard Space Flight Center in Greenbelt, Maryland. And for Psyche, it's the Jet Propulsion Laboratory, in Los Angeles, Pasadena, California, just north of LA. There are gonna be some criticisms I'm going to note here about Psyche, which was managed at JPL. And I'm going to cite some stuff that appeared in the independent review board's report. But I do wanna say one thing upfront. JPL is an organization that had an extraordinary record of technical success. Most of the Mars missions, including the always impressive Mars landers have been managed by JPL.

0:41:40.3 RM: They have some capabilities at that organization that are unique in the world. If you need deep space navigation, JPL is the place you need to go. The new Horizon's mission to Pluto

which is incredibly far away from the earth, the deep space navigation was done by JPL and after a journey of nine and a half years, it arrived within 500 miles of the targeted point. I mean that's nothing short of astonishing. JPL is populated with a set of extraordinary people who have done amazing things. But that said, there were some problems on the Psyche mission. Now if you look at what was written up about it, the proximate cause of it was the late delivery of the navigation software. If you don't have the software to hit your target, you're not launching.

0:42:35.2 RM: That was the proximate cause. But as is often the case, and in fact when people do things like accident investigation, there is the proximate cause and then there are the underlying causes. And I think here, it is the underlying causes that are the most important from a project management perspective. So first of all, in some respect on this mission, JPL was a little bit a victim of their own success. They have managed a lot of space missions for NASA mostly in space science, but some in earth science as well. They have a strong record of getting both directed missions and in winning competitive missions. They have a very large portfolio. And in fact, in the Psyche independent review board noted, and I quote here that JPL's current development flight project is the broadest and most demanding in the history of the laboratory.

0:43:35.6 RM: But at the same time, JPL lost several highly experienced people over the last few years. This is also something we touched on a little bit earlier. Here is a quote from the independent review board. "A significant erosion of technical acumen among JPL personnel responsible for overseeing project and that the senior lab leader's attention was diluted across too many projects to sufficiently probe the progress that was on Psyche." Now we talked a little bit earlier about how impacts can spill into other things. Well, in some cases they could expel into other projects. Because there was a lot of concern about the size of JPL's portfolio and that it contributed to a delay on Psyche. That was an important factor in NASA's decision to push back the target launch date of VERITAS, which is a JPL managed Venus orbiter. And that mission was pushed back from December, 2027 to no later than 2031.

0:44:43.3 MH: So they delayed it to offload management so that they didn't have their attention so far diluted.

0:44:49.0 RM: That's right. And the JPL was able to where you can have good staffing matchups.

0:44:53.6 MH: Sure.

0:44:55.3 RM: Get more people in the nearer term, this is the classic. We've all been through this in our professional lives and our daily lives. You got too much stuff on your plate so you have to set priorities. Somebody has to make the decision to take something off that plate.

0:45:14.6 KL: It sounds like somebody... It's almost like you went back to consult with them about the way to get more throughput was to slow something down and take the delay, take the hit somewhere so you can get something else off the plate.

0:45:23.9 MH: In fact our very last podcast episode, Kendall, was about deloading the system.

0:45:28.9 KL: So that was the mitigation to still get it off the ground a year late, but still off the ground and keep the other mission flying. So there's a portfolio interaction there. What did they determine was a root cause?

0:45:40.2 RM: Okay, that loss of institutional expertise was a root cause. Another one was that on the team itself, the independent review board concluded there were too many inexperienced managers on the project and they left certain key positions unfilled. And I will tell you, when I read the IRB report, this really astonished me. For a substantial period of time, they did not have a chief engineer, which is on most space missions, is not somebody who's doing the hands-on work, but this is somebody who has sufficient experience that they are guiding the engineers below them, the systems engineers, the subsystems engineers, the element engineers.

0:46:23.0 RM: And consolidating the information they get from them to have a total understanding of what the project status is. To me, that's somewhat astonishing. They also noted that the workforce suffered from a lack of mentoring and a high rate of personnel turnover. And one other challenge that's faced by JPL, and they're certainly not unique in this. They're in the Los Angeles area of California where you have a lot of aerospace in the Silicon Valley area where you have a lot of information technology. There are a lot of companies that have high demands for technical workforce and it's a very competitive environment. And a lot of these companies are prepared to pay to get the expertise they need. So when you're operating in that type of competitive environment, it's difficult, it's harder to get qualified people and maintain them.

0:47:20.9 KL: That is the first time, Mike, in our conversation, I think it's the first time I have ever heard published and by an independent organization, an actual case for management. We were missing that layer that we all like, I don't know why the hell there's a manager there anyway, he's passing the report through and directing us. And there's other reasons to have management. Often, I believe often I observe that they serve another part of the department's mission, not the mission I'm trying to perform or my clients are trying to perform, that this was in two parts, a case for management. You needed someone who does do integration and sees the oversight. And you talked about mentoring right here at the hundreds of millions of dollars level root cause for a major scientific, engineering feed.

0:48:08.7 MH: Yeah. And maybe double down on our mentorship capabilities.

0:48:12.4 KL: Now the other project did not face that, we had it staffed. There is mentor. We didn't see that break.

0:48:17.7 RM: We did not see that. Yes.

0:48:19.0 KL: Yeah. Fascinating.

0:48:20.8 RM: And when you look at that type of thing, talk about root causes. Clearly this type of thing, talking about staffing, it also relates to communications. The report noted that staffed members that raised alarms did not feel their concerns were acted on, across multiple levels of management. They didn't feel they had the authority to solve the problems. And this was particularly interesting point to me. The report suggested that the mission had a culture in which one would have to prove a problem existed before it would be addressed. Now, I don't remember this precisely, but I had read something, in the business section one day. It's one of the major car manufacturers that they have a ground rule in their factory that no matter what you're doing, if you see a problem, you have the authority to shut down the assembly line. Now you're gonna have to go talk to somebody about it. [chuckle] The idea is that they trust their employees to know where a

problem exists and will listen. They don't have to prove that problem right away.

0:49:31.3 KL: I'm stunned by this from a risk mitigation perspective. If that's true, and we were to take that to risk, that is the same as saying we can only devise risk management. We can only address the risk, when we see it happen. That's the very opposite of risk management.

0:49:47.9 RM: That's right.

0:49:49.2 KL: I have a risk register, which is a list of everything that's gone wrong now.

0:49:52.8 MH: It's a risk recovery management.

0:49:55.7 RM: So a few minutes ago, and this is another excellent illustration of what you just made, and Mike, your comments of just a couple of moments ago, Mike, you spoke to the loss of Challenger in 1986, and one of the things that was noted in the report on that was that on the morning of the launch, there was the launch readiness review that morning, and in discussions with the contractor, particularly about the solid rocket motors, which were the frozen O-ring, was the cause of that accident. What was a very strange and unconventional dynamic in that meeting was that NASA wanted the contractor to prove why they should not launch in freezing temperatures. That stands in sharp contrast to the characteristic approach of explaining to us why you think it is safe to do this. It completely flipped it on its head that it was almost like at that point, given the NASA culture I grew up with, it wasn't NASA talking because the people in that room were on the side of, let's go and do this, and you tell us why we shouldn't. Rather than you demonstrate that this is safe.

0:51:10.3 MH: And I'm no auto industry expert, but I've heard lots of examples of anyone having the authority to shut down the line. It's gone well beyond automobiles to all sorts of manufacturing environments. I've had some smaller scale engineer to order manufacturing clients, and everyone always has the authority to shut down if they see something unsafe or poor quality might propagate through the line. I've even seen some stats that if everyone's just trigger happy and being extra cautious that we'd have 80% of our stoppages be unnecessary. In fact, it seems like it's more like 80% are necessary. We're only 20% overcautious. That's why there are still quality issues in a lot of manufacturing organizations. [chuckle]

0:51:55.5 KL: I was about to say that we hit a variant on this. This is a specific example of episode 94. We talk about cognitive bias. This is management escalation, sometimes known as lying for political reasons, but it's an external force on PMs, but it's an escalation. And the response was, I'm willing to listen. We're going this way, but I'm willing to listen. There can be a consequence for that just by shifting the verbiage or shifting the position that we look from. Plus you got into the organizational aspect, which is, and a willingness to allow that to happen without consequence. Roy, I was thinking as you reflect on what you have seen in many of these projects, including these two that we're about to see in the news, what would you say are the key characteristics of why NASA has these horrific tragedies notwithstanding, had such an incredible record of being a global leader, but an incredible record of success in its research, its science, its engineering, and its delivery. What's going on in the project and program management space that is worthy of emulation or understanding?

0:52:56.4 RM: There are a few things I'd mention. The first thing I would note is to have a strong

organizational culture of listening to team members and reviewers. And when I say listening, I mean really listening. We have all seen examples where you're talking to a manager or leader and they solicit your opinion, but the reason they're soliciting your opinion is because they read that was the right thing to do in some management textbook when the fact is they've already made up their mind. They don't really care what you have to say, but they are just going through the motions to make it seem participatory and inclusive. What I'm talking about is a culture of really listening. That's the first thing I'd mention. As something that goes hand in hand with that are frequent in-person communications. Now I recognize partially due to technology, partially due to the aftermath of the pandemic we operate in a world now that is quite a bit different than we operated in 5 years ago, 10 years ago, 20 years ago.

0:54:06.2 RM: But the fact of the matter is face-to-face communications just encompass a higher bandwidth than other forms and certain things can be conveyed during the course of the discussion that can't be conveyed in other ways. And one thing that goes along with that from a project management structure was that it was relatively flat. When I first started as a program analyst, I reported to a branch chief through a division director to an associate administrator to the NASA administrator. That's not many layers for an organization of that size. The opportunity to speak to people personally was always present. Those things are all clustered around the theme of communication. The final two points I'd make are structured around how an organization is staffed and how it behaves over time.

0:55:11.9 RM: I think it's really important that when populating a project to treat every hire as a critical hire, you need to have a good match between the skillset and the requirements that you need. You need to assess your hiring and you need to really define the work and then fill it with the right people. If you get a well-qualified person who's a good fit in the organization and have a supportive culture, your chances of succeeding are going to go up dramatically. So I think that hiring aspect is critical and that's of course a major role of management and leadership. The other thing that is just critical for the best project leaders pay it forward. And by which I mean they use their opportunity to lead a project to ensure that the project, in addition to succeeding on its own merits, is used as an opportunity to develop the next generation of leadership.

0:56:17.5 KL: I want to jump on one thing there that you just really blasted into my brain. I appreciate this idea of helping my organization or getting my clients to help their organization by having that next generation, by leading the next one. We talk about this a lot. It's in all the LinkedIn news we talk about it, but actually your pay it forward, I'm going to pen it that I heard, pay it forward to collect it now. Because what you said was we're going to mentor... First have project success and then you're creating that next generation. They're ready. They've had the information, but that makes them want to be engaged now. It changes the attitude now. I think of it as utility. Your compensation comes as your salary, your benefits, and what do you get psychically out of being around here? What I heard you saying was their psychic compensation of feeling a part of something through the act of having been mentored.

0:57:08.2 KL: I get it. That as a project leader now, not just goodness for my organization, I get it for my project now because what I heard you say, you mentioned that it was a failure in one of the areas when they missed that it may have cost them a lot there. So that's all I was saying on that saying, well Roy, I hope if you come up with another presentation, we want to hear you again and if we get a chance to talk about some of what you've learned in another context. I know you've talked about being able to review some reports in the national academies of sorts and guest lecturer for

Mike and his work. And I think a lot of what you said there is helpful to me to think about my own clients and some of the models that I use with them. This is fantastic to hear the role of culture for me in something as scientific and engineering and political, frankly as NASA. We're back to culture. We always say culture is important, but to be very specific about how it aids us, what are the mechanics of that happening screams why we need to pay attention to it and learn the mechanics of creating a culture that's meaningful for the value that we have to produce. Be it rocks and dirt, but it's rocks and dirt from 300 million miles away.

0:58:13.2 RM: Yeah. It's rocks and dirt from which we can get a lot of information.

0:58:18.7 KL: And I want on that note, since you mentioned a month from now, it is today we're recording the day after the Indian Space Agency, congratulations to them. Landed on the South pole of the moon to collect... To put a rover out and to collect. Congratulations to the scientific community and the engineering community, frankly, of the world and to of course India for rising to that challenge. With one other note, I couldn't believe that I may be wrong, but if I am not mistaken in my morning news haze, they just did that on $140 million.

0:58:53.6 RM: Okay. I am not sure.

0:58:55.7 KL: But the point is it was cheap. We have learned much. Humans have learned much. The Indian Space Agency must have learned much.

0:59:03.3 MH: Amazing. Love it. Thanks guys.

0:59:05.6 RM: Always a pleasure. Maybe another seven years from now, maybe less.

0:59:09.7 KL: Thank you. Wow. An argument for management. You so rarely hear that. But it turns out even the most technical of organizations like NASA improves its chance of success when it has management that can integrate information and who chooses to mentor people. And of course, lessons learned to compare across projects is a very valuable PM tool. Well, and plus, well science is cool and Space Projects the coolest. PMPs if you've listened to this whole episode high the to PMI, PDU Reporting Centre and claim a PDU, selecting online or digital media and manually enter provider code number 4634 and select Empowered Strategies and the name of the episode, PMPOV0113 asteroids and select the ways of working in the new talent triangle. I am your co-host Kendall Lott reminding you to keep it in telescope. Did you hear how I did that? And get it done.

[music]

1:00:10.6 Announcer: This has been a final milestone production sponsored by Empowered Strategies. Final Milestone.