

SEI Podcasts

Conversations in Software Engineering

An Agile Approach to Independent Verification and Validation

Featuring Justin Smith and Suzanne Miller

Welcome to the SEI Podcast Series, a production of the Carnegie Mellon University Software Engineering Institute. The SEI is a federally funded research and development center sponsored by the U.S. Department of Defense. A transcript of today's podcast is posted on the SEI website at sei.cmu.edu/podcasts.

Suzanne Miller: Welcome to the SEI Podcast Series. My name is [Suzanne Miller](#). I am a principal researcher here at the SEI. I am here today with my friend and colleague as of the last six months or so, Justin Smith, who joins us from [NASA](#). He is one of our senior Agile transformation researchers. I want to welcome you, Justin, and I also want to say I am thrilled to get a chance to talk about this topic. We have known you as a customer in the past and really have done some fun work with you on this topic of how do we bring [Lean](#) and [Agile](#) concepts into independent verification and validation. For our audience that may not be familiar with the DoD [Department of Defense], that is a very important process that is one of the steps towards making something deployable to our warfighters. Not just warfighters, but other settings. So thank you for joining us today.

Justin Smith: Thank you, Suze.

Suzanne: Before we get into all of the good stuff, we do like to ask people that are new to the podcast series, which you are, to tell us a little bit about

how did you end up getting to the SEI. I know you have only been here six months or so, but so far, what is the most fun thing about working at the SEI for you?

Justin: Oh, well this, getting to do this is really fun. I was born and raised in West Virginia. I went to West Virginia University and studied aerospace and mechanical engineering, and during that time, really fell in love with the idea of NASA. I did a couple of internships with them, one more on the aero side and one more on the space side, and liked that a little more. Out of college, I went and worked for NASA in the space shuttle program doing crew training.

After the end of the shuttle program, I went and worked for the Navy Yard for [NAVSEA](#), so more of a PMO [program management office]-type role, and became a federal servant then and just was not loving living in [Washington] DC and kind of missed that NASA family and that culture. Crazy enough, I started looking for a job and found a job in West Virginia, my home state, with NASA, which I knew was there, but it was software. I never ever thought I would have an opportunity to work there. In Fairmont, West Virginia is [NASA's Katherine Johnson Independent Verification and Validation Facility](#). I know it was a mouthful. That is why we just say IV&V.

Suzanne: Yes.

Justin: Every now and then, you hear somebody pronounced it *NASA four and five* because on the side of the building there. IV&V looks very similar to Roman numerals IV and V. While I was there, I learned about the SEI. We became acquaintances for a few years there. Over the past few years, I took a real career pivot at NASA and really got into leadership and development. I actually went and worked for NASA headquarters and helped them run a leadership development program, really got into coaching others across NASA, got my coaching certificate, and that sort of thing. I just really fell in love with that sort of work and knew that the SEI was doing that across DoD. Yes, that is how I ended up here. I got really curious and saw there were some job openings last summer and started to inquire. Come January, here I was.

Suzanne: Yes, we are very excited.

Justin: Yes, me too.

Suzanne: Besides podcasts, what is the most fun thing?

Justin: We are going to talk about some of these [Agile principles](#). I think for me, so far, it has been getting to apply some of those Agile principles in areas you might not think they would be applied in; so non-software-development type roles, which is what we did at NASA IV&V. That has been a lot of fun, getting to meet some new customers, travel to some new places. It has just been eye-opening for me seeing this side of DoD, which is really cool.

Suzanne: Let's talk about what we are here to talk about, which is [independent verification and validation](#). In particular, we want to talk about it in terms of software. Talk to me about how is traditional IV&V performed for software, and how do you have to think about it differently when you start to think about applying Agile and Lean concepts to it?

Justin: Yes. It is a great question and something that was very new to me, not coming from a strong software background. When I got to NASA IV&V, I had a big learning curve to learn about that full lifecycle IV&V. That was very new to me. In college, they taught us about how to design projects and you just start early. I saw some of that at the Navy Yard. When I got on the IV&V side was a whole different feeling and experience because that partnership begins very early. Very early on in those design documents, we would start reviewing things and providing that independent set of eyes to see how things were going and report back to the customer, report back to our bosses, the [Office of Safety and Mission Assurance](#) at NASA. That would continually build, so you are doing early lifecycle design. Then once the developer starts producing things, mapping all those requirements, we will start checking those. They start writing code; we will start looking at the code.

Traditionally, that was done in a very [waterfall](#) manner. NASA, they were relatively new to Agile projects, and that was a very new challenge for us. In 2016—I think I have the dates right there—I started working on the Orion multi-purpose crew vehicle, which just flew recently on a test mission, [Artemis I](#), which was really exciting to see that come to fruition. I had a lot of pride there. But when I started out there, I came over to the team as the deputy project manager. There was a lot of churn within the team and confusion because things were different from the previous mission, which was Exploration Flight Test-1, to Artemis I, which, at the time, it was not called that, but that is not important. What I was quickly seeing, and everybody was trying to bring up, is the developer switched methodologies. They moved to a [SAFe](#) [scaled Agile framework] version of Agile development. That was very different for us. We did not have a lot of experience at that at our program with that sort of thing. Our analysts who were some of the more senior analysts in the program, were really good at what they were doing, really

passionate about this sort of thing, were just kind of confused at times with what was going on there. This idea of a project being developed using an Agile methodology and then us having to go do some of the methods that we had spent 25 years crafting, it was not syncing up. There were all kinds of challenges associated with that that we unpacked over the next year. That is ultimately how I came in contact with the SEI.

Suzanne: When we think about Agile, we think about *iterative*: We are going to see the same thing again and again as we improve it; and *incremental*: We are going to deliver incrementally. From an IV&V viewpoint, that is really different because you are building up that evidence log, if you want to think about it, to say, *Yes, it is safe to send this up into the air, in this case, up into space in this case*. That incremental delivery piece is one of the things, at least in other IV&V places that I have come in contact with, drives IV&V people crazy because it is like, *Well, wait a minute, you are telling me that you want me to tell you now if this is ready, but I have not seen everything else? How do I know that you are not going to change something later? How do I know?* All those questions. So those were some of the things that I am anticipating you had to deal with.

Justin: Absolutely.

Suzanne: So what did you do?

Justin: First things first was we had to learn what Agile was. A lot of the team did not even know what it was. That is when we hired SEI to come in and teach, I think it was [Agile in Government](#) at the time. We had a couple of instructors come in, Will was one of them. [Will Hayes](#), specifically, and we learned about Agile. At this time, we had this mindset around Agile of like, *This is bad*, because, again, from our perspective, we could not do the job the way we wanted to do it. So we are like, *Agile is bad. This is a bad thing*. We learned about Agile and we learned about SAFe and what the developer was doing. And quickly realized like, *Man, it would be nice to have a consultant from SEI help us out*. So we reached out. Will Hayes made the connection. And we ultimately brought him on as a consultant that helped us through this transition.

Again, I was a huge skeptic. Will and I have great laughs about this from time to time. I was a very big skeptic around this idea that this was going to work and that we could somehow adapt our processes and methods to make this work for us, to get to a place where we could say, *Hey, we feel confident in adding some assurance for the software. We feel confident that it is going to do*

what it is supposed to do, not do what it is not supposed to do. And if something goes wrong, the software is going to react accordingly. From there, that whole process played out over the course of about six months. Through some of the coaching, we recognized that in this particular case, it made the most sense for us to apply some Agile and Lean principles to the way we did business. So in other words, become Agile ourselves, which I remember when that first happened, I was like, *This is the dumbest idea ever. This is never going to work.*

Suzanne: I remember reviewing the slides that Will was preparing to help you get through that. And he was like, *I do not know if these guys are going to buy it.* Yes, it was a big shift.

Justin: Yes, it was a huge shift. It was a huge shift. But again, it was that we did not know what else to do. So it was like, *If you cannot beat them, join them* type of deal. We decided to try to implement some of these principles. We tweaked some of the other ways we would do work, and we would do those tweaks as core foundations to this Agile IV&V approach.

Reflecting on the whole experience, there were a couple of ways we could have attacked this problem. This was just the one that seemed to work for us was to become Agile, because we did not have infinite resources. We could not embed ourselves with the developer in this particular instance. And so we really tried to attack it from a risk-based priority, and Agile helped us do that in the end. In the end, looking back on it now, I cannot imagine doing it any other way. I have done it with a couple other teams in NASA IV&V, different flavors. I know my former colleagues right now are attacking these challenges as more and more projects are taking on an Agile development style.

Suzanne: Give me a couple of examples of things that somebody who is doing traditional IV&V would recognize as being, *Oh, that is different.* What were some of the things that you do with Agile IV&V that those traditionals are going to go, *Oh!*

Justin: Yes. You talked about that lifecycle, that building of evidence. Traditionally, and again, I was not around for a traditional view, but from a great project that helped push me through this was...It makes sense, so from an independent verification and validation perspective, you would receive documents, you would do your thing, run your methods, do your different approaches, you would deliver a message. It is some sort of milestone. That could be months, six months, maybe a year. You had time. You really had

some runway. Analysts could go do their thing in isolation for weeks, months at a time. They find some really good stuff. We find some issues over here, errors over there. We communicate those back to the developer along the way, have a big data dump at the end of, *Hey, here's everything we found*. So that changed, obviously.

We are getting in there and the developers are not really operating at that cadence, and we started seeing releases come out at different times. There are huge gaps in requirements that are missing. And you go back and you say, *Hey, whoa, this requirement is missing*, like, *We know, that is not going to happen for two more releases*. It was just that huge gap of disconnect that we had from that jump, that shift from waterfall to SAFe that really threw us off our rocker. There was that frustration that was built in because folks could not do what they thought they needed to do because, again, when they did their job to the best of their ability, and then the developer is like, *Yes, that is not right, we were not involved in PI [program increment] planning, we did not understand what they were going to do when at that time, so...*

Suzanne: Program increment planning.

Justin: Yes, sorry about that, program increment planning. We did not really understand what they were going to be doing when, because we did not understand Agile then. It is part of the learning. That was one of the first red flags for us was when we started to try to do what we would normally do to meet their schedule cadence, things were missing.

Suzanne: Yes. The way I talk about it to people is, you are moving from a *nothing is done until everything is done*. That is the assumption of a IV&V guy, is, *When you give it to me, everything is done, and now I can look at the complete picture and look back and find the gaps and everything*. Now we move to Agile and we say, *Well, let's get this increment done, and this increment done, and this increment done*, and there are going to be gaps that allow for learning. That is what we are trying to do is increase the learning pace and be able to make changes that are necessary to get a better product. What that means for an IV&V guy is he has to shift his focus from, *Here is the whole big picture* to, *All right, what is it about this small piece that is relevant for me to give a message about and...just let it go, Louie, let it go...* in terms of the requirements that are not there yet.

Justin: Yes.

Suzanne: That is what I see as being the biggest mental shift, is from large

batch to small batch.

You did some things, I have seen some presentations that you have given, and you did some things to help people with that by using that risk-based approach. Please talk for a minute about some of the things like the heat maps and things that you did to help the IV&V people understand, *You are making progress, even though you can't see everything at once?*

Justin: Yes. As part of that implementation of those Agile and Lean principles and us becoming Agile ourselves, was to try to break our work down. Logically, for us, we ultimately looked at the capabilities, which was very different. It was a theory that IV&V had been playing around with for a little while. I think we were one of the first teams to really make it successful because it made a lot of sense from an Agile perspective. Because if you started to look at the software and capability chunks [were] much smaller, as opposed to like all of the guidance, navigation-control software, you just look at a piece. And so that was a huge step, as at the same time trying to bring in that risk prioritization, to understand that, *OK, if you look at all these capabilities, in this case for Orion, there are a lot of them out there. We only have so many people with so much money that we get every year to do this job. And so we had to make some decisions, we had to evaluate those risks associated with those various capabilities.*

You mentioned the heat map. One of the things we came up with, which, again, I will talk about this perhaps it will be one of the big takeaways, key concepts if you will, were retrospectives for us. It is where all of our innovations came from. One of those such innovations was this heat map. How do we visually see how we are making progress? How do we visually see the fact that this risk or this capability was super high risk, but we did some analysis throughout these various releases, and that risk slowly comes down, because again, we will revisit capabilities...

Suzanne: Multiple times.

Justin: Multiple times when we have to, to drive that risk down. I actually just saw, just probably within the last month, I saw the Orion Artemis I heat map. It was awesome. It was like almost all green. It was so cool to see what had happened over a five-year band of that group of individuals that have mostly remained intact, whittling down risk over time to help add that assurance and provide confidence back to the developer of the program and, ultimately, safety and mission assurance that, *Hey, we think this software is going to work. We think these capabilities are going to do exactly what they are*

supposed to do to make this a successful mission.

Suzanne: I hope that the V&V people in the audience are as excited as I am about what you have done because I know that shift from IV&V in the large to IV&V in the small is big. I guess the message that I take away is there are methods to deal with this. You have to just start thinking...the big shift is thinking small batches. The approach that you guys took of, *What is the small batch for us, not just what is the small batch for the developer, but what is the small batch for us?* I think, is a key to actually making that work.

Justin: Yes.

Suzanne: So this is something. Orion, a very complex [cyber-physical system](#), highly regulated. And DoD, we have the same kind of challenges. When you think about it, what are the big things that if I am a DoD IV&V person that I should be thinking about doing differently if I am getting engaged with a program that is using Agile methods?

Justin: Yes. I think again, the way we did it was one way. I think there are multiple ways to come at this challenge. First of all is understanding the problem at hand or the challenges your team is facing. For us, that was working with the team to understand from a leadership level all the way down at the analyst level what the challenges were. I would start there, to understand truly where are people struggling, where do they feel like they cannot do their job? That will start to build up some of that trust amongst the team, that psychological safety that ultimately an Agile-driven approach to anything has to have to survive. I would ultimately start there.

The other thing that I think was really important for us, in our case, was that partnership. Sometimes IV&V is very much viewed as an us-versus-them thing. Early on, that trust, there was a lot of trust between the program with the Orion program office and us. There was trust between the Office of Safety and Mission Assurance and us, as well as the director at IV&V, all the leadership chain down through. That is a big deal too. I think that partnership and understanding and people understanding that IV&V may or may not be a requirement for your program, for Orion, it was a requirement. Some of the DoD programs have that requirement. Ultimately, there is some sort of partnership that can be agreed on without really impacting that independence.

Suzanne: One of the things that I have been known to say to people that are worried about that is, *Independence does not mean isolation.*

Justin: Exactly.

Suzanne: We know, this has nothing to do with Agile. It is just, we know there are ways to be independent and still be collaborative.

Justin: Yes.

Suzanne: Good IV&V shops, that is their goal, is to use the collaboration to help their partner understand where the risks are, so they can fix them before we actually have to go out in the field. That is the ultimate goal is to keep things from going out in the field that have defects and especially failure modes that are going to impact the mission.

Justin: Everyone is on the same team here.

Suzanne: Exactly, exactly.

Justin: We are all on the same team. We all want the same success.

Suzanne: But you have to build trust.

Justin: Exactly.

Suzanne: You have to build trust for that to work. I agree, that is a key message in that. I will see if you agree with the statement that, as you said, trust is a foundation in Agile methodologies anyway. So it should not be a surprise that we are trying to increase the trust between the IV&V and the Agile developers, so that we can get that fast-feedback learning loop going. IV&V, in my mind, can be a real addition to that learning loop because that fast feedback is coming from someone who does have an independent view. I know, as a developer, I have gotten my head buried in the sand a couple of times, where I needed that independent view to be able to see the forest for the trees. Getting that early and constantly has to be a blessing if you can see it that way.

Justin: Yes, when you think about traditional IV&V and what we were trying to do, that shift was so different, where we would deliver all those issues at a review or some time that the program had established, we would get up there and somebody would give this presentation of hundreds of issues we found. And that is great. So what? What does that mean? Does that mean the software is good?

Suzanne: Are they actionable? The problem that I saw in traditional IV&V is you had all those issues coming up. I could see the looks on the developers' faces going, *Man, if I had known that two months ago, I could have fixed that. How come I have to wait until this big review to find these things out?* Because now it is going to be a lot harder to go back and fix these things, the ones that really need to be fixed. Not everything has to be fixed, but the ones that really need to be fixed. And so moving to the Agile approach, where I get to hear about the issues almost when they occur, that just accelerates learning like nothing else.

Justin: The other thing we saw in that same instance of the learning and getting it to them faster was the impact. Because coming at it from this capability perspective, our analysts develop such a strong system understanding. We almost had a three-month stand down for them to really learn about the system, write these capabilities out, and so many of them came and told me that that was one of the key contributors was just understanding in a much deeper level what the system was actually trying to do. We saw an overall decrease in the number of issues. A number of issues were coming down, but the ones that we were submitting to them were impactful. They were big-ticket items that they could put in their backlog to decide, which is their prerogative, when and where to fix this, when and where. *Maybe we cannot address this for Artemis I, but this is a big deal, we can tackle this and put this on the backlog for Artemis II.* Again, the timing thing was huge because we moved from this months out-of-cycle phase because they were doing releases and we were always behind to bring it down two weeks where we could sync up with them, biweekly cadence, we would work with different teams on the government program side, and they could get them to the developer where they are most applicable. It seemed like a much smoother fit once we got this up and running.

Suzanne: I know that we are going to be doing a blog post on this topic. Those of you that are looking for more details will get some more details there, and you will actually get to see a heat map example and that. I do not want to build up too much, but this is an area within our group, within the Agile transformation team, we are taking this on as one of the areas that we really can have an impact, especially in the DoD, is to help these organizations that are doing IV&V apply Agile techniques to themselves and apply those techniques to the Agile developments that they are part of. Having you here with this experience is amazing for that.

I want to finish our conversation today by talking about transitioning these.

You have had this great experience, you are one guy in one program that has had this great experience and this transformation. How do people that want to have that experience, what would you suggest they do to approach Agile IV&V for their systems? We don't have many SEI resources yet in this area, but what can they look forward to in terms of SEI resources in the future?

Justin: Yes. Well, the one thing that comes to my mind is mindset. It is all about the mindset that you take on as a leader, as a team. We have already touched on trust and that psychological safety. That would have never been possible without that existing in IV&V. I had an amazing office lead, Wes Deadrick, who is now the program director. He gave us a lot of freedom to go try some very risky things. I say us, my project lead, John Bradbury, was crucial. He had decades of experience in IV&V. Some of those conversations that we would have about this mindset shift and the different approaches that we were going to have to coach the team through, they were just crazy at the time. It was that constant working through that, talking through that, strategizing. If folks are trying to attack this problem, it starts at the top—to strategize, understand, to build that trust, to understand the challenges, the requirements, what do you actually have to do? What has to be done?

We knew what we had to do for the most part. We found things along the way, but it serves as some sort of starting guideline. But yes, I think those would be the key founding principles for me, that mindset shift that starts to happen, it has to start at the top to build that trust within the team because ultimately, those are the people that are going to be out there doing this analysis. Whatever approach you decide to take to sync up with an Agile developer, which could look very different than what we did. We really wanted to try to do the integration route, but we just could not make it happen financially.

I think there are various ways. I mentioned retrospectives a little bit ago, so I would say think about some of the Agile ceremonies, different things. Daily standups started working for us. I mentioned a little bit ago about where our analysts would be working in isolation, we brought them together. There was a lot of cross-collaboration. *What do you see as an error here? What do you see over there?* Because they were sharing...These capabilities were overlapping. There is some overlap there, and they could work together as teams. We actually had Scrum teams that would tackle these when we played around with different things. Ultimately, we tried [Scrum](#) for a little while, but [Kanban](#) made a lot of sense to us with our backlog. Again, thinking about that, you think about that scope, your requirements, what you actually have to do. Think about how to visualize that. Another Agile principle, I think, they could

take a look at are backlogs. Coming up with backlogs and getting that work, what you want to do down, again, then you can build a heat map out of it if you wanted to.

Suzanne: Sure, and prioritize it.

Justin: Yes, and prioritize it.

Suzanne: Yes, yes.

Justin: It is just kind of baby steps. I think that was the biggest lesson I learned when Will was helping us out was just take those first steps. That Agile mindset, a part of that is that continual learning, the growth, and, like I mentioned, we achieved so much in our retrospectives. They were not like a traditional retrospective. We had the classic, *What went well? What did not go well? What we would do differently?* But we would spend a couple of days after that building on those topics. All of our innovations were coming from those retrospectives.

Suzanne: Got you. *What can we do about that?*

Justin: Exactly.

Suzanne: Yes.

Justin: *What can we actually do about them?* We took that time, we were gathered as a team of about 30 people at the time and made that actionable. We saw some really cool stuff. I think people had a lot of fun doing it. That is one of the things I am most proud of, of that experience of transition with that team, was how much fun people seemed to be having, which is awesome.

Suzanne: Yes. It always is. You are here now. Agile IV&V is not your only thing that you have to do with us. What is next for you? And think about what do you want to come back in six months or a year and talk to us about? What are you thinking about?

Justin: I would love to talk more about this, what are we going to learn over this next six months to a year. With engaging of different customers in this area, what is that going to look like? Are there different techniques we can try? I mentioned mindset, that is something I am really passionate about is that Agile mindset and applying that to non-development projects. How can

you use Agile concepts in other areas of DoD, program offices, things of that nature? That is something that I am really excited about and hope to talk about in the future. Yes, it is a great platform to share stories and share experiences like this.

Suzanne: Excellent. I will look forward to those conversations. I do want to thank you for talking with us today. We will include links in the transcript to resources that we have talked about and a few we have not because I know [you have some things out there that we will make sure people know about](#). As a reminder to our audience, you can get this podcast just about anywhere. You can get it on Sound Stitcher, oops, SoundCloud, Stitcher—separate things—Apple Podcasts, Google Podcasts, and my favorite, the SEI YouTube channel. So we hope that you will watch it and that you will give us a thumbs up if you think it is a good thing. Justin, I look forward to you being with us again to talk about more exciting things in our Agile transformation.

Justin: Thank you so much, Suze. Appreciate it.

Suzanne: Thank you.

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