Shane McGraw
Hello. Welcome to today's SEI Webcast- Acquisition Disasters: Ideas for Reducing Acquisition Risk. My name is Shane McGraw, Outreach Team Lead here at the Software Engineering Institute and I'd like to thank you for attending. We'd like to make our presentation as interactive as possible so you can submit your questions in the YouTube chat area and we will work in as many as we can.

Our featured speakers today are Fred Schenker and Linda Parker Gates. Fred is a senior software systems engineer at CMU's Software Engineering Institute where he has worked for more than 20 years. He focuses on the improvement of the software acquisition and product development practices throughout the Armed Services and other organizations, has actively worked in software process, architecture, model-based systems, engineering and metrics.

Linda leads the Software Acquisition Pathways Initiative with the SEI's Software Solutions Division. She specializes in strategic planning, change management, technology, transition and performance excellence, supporting numerous government organizations developing and adopting improvement strategies. Now I'd like to turn it over to Linda Parker Gates. Linda, welcome, all yours.

Linda Parker Gates
Hello. Thank you, Shane. And hi, Fred. And hello, everybody. So today, Fred is going to talk with me about the non-ideal outcomes we've kind of come to expect in software acquisition and some things that we can do about that. Some approaches I think kind of from the philosophical to the actionable for managing outcomes that we're likely to get from acquisition efforts.

So, Fred, in your words, what are we going to talk about today? And can you tell us the origin of the work?

Fred Schenker
Sure. Hi. Thanks.

The work that we're talking about today really came from the work the SEI did over the last few years with AMRDEC in Huntsville, Alabama, and specifically the person that we've been working with was a guy named Alex Winston. And we supported a series of technical demonstrations that were built around model based engineering or digital engineering.

One of them, the most recent one, was called Capstone. And it was sort of the end, you know, the capstone, if you will, of seven years of activity. And one of the things that that we noticed when we were at the end of the capstone project was we got experience reports from all of the

from the participants, most of them saying that they wished that they had done some of the model based analysis earlier in life cycle.

And Nick Guertin, Nick and I wrote this paper for the acquisition research symposium last year. Nick and I were talking about it and we couldn't understand why we had to wait for the whole thing to be over for them to have this epiphany. It's not like this was some new thing- we've seen this before.

And we came along in this and sort of thought about this, and we need to somehow motivate contractors to actually try to do things differently. We're calling this value engineering for software. So that's how it came about and who I collaborated with.

Linda Parker Gates
So yeah, that's a really interesting set of concepts to apply value engineering to the acquisition of cyber physical systems. So can you tell us a little bit more about what the status quo in acquiring cyber physical systems looks like?

Fred Schenker
Sure. This graph is sort of it's a caricature. I'm I made this up myself. So there is not real data here. But this is sort of an elaboration or a picture that describes what happens when we acquire cyber physical systems. It's important, I didn't mention this earlier, the customer that we had was the future vertical lift program. So these are what we call cyber physical systems. So we're kind of narrowing the scope of this discussion to these cyber physical systems. And our observation is that we march along building the thing that we're building, whatever it happens to be. We continue to spend money and time and build new things, and we get close to the end, what we call final integration and test and we find out that, instead of being ready to go and qualify the system, we have a huge amount of unexpected issues that surface. And so this is what we call capability complete but it doesn't work. So we we've spent all the money, we spent all the time, and we don't have a working system. And we have to add more or we have to either purchase, you know, three things it's a tradeoff.

So you can either, you know, think the thing that's not working and decide to do that later, you know, in some other aspect, or you can add money and time to fix it. And this is one of my favorite quotes that Nick had was, you know, it's like a metaphysical certainty that this is going to happen. We have we have seen this on virtually every system, including the capability enhancements for legacy platforms that we just don't have the time when we don't get it done in the time that we have. And it costs more. We have to pay more to get it done. And this represents opportunity, I think, for the community.

Linda Parker Gates
So let's talk a little bit more about value engineering. I think value engineering principles kind of offer a set of ideas for driving change and new outcomes that you're trying to apply in this context. So can you tell us what constitutes value engineering and why it's important and how we might apply it.

Fred Schenker
So, I'm a rarity at the Software Engineering Institute because I used to work in a manufacturing facility doing manufacturing engineering work. And we used to do value engineering. So the normal application is that you have a contract for something, manufacturing thing, and they want 10,000 some things.

And because of the tooling, you know, it's usually for the government, the government owns the tooling, and because of the tooling, it doesn't work the way that it's supposed to. It produces more scrap than it's supposed to. Like maybe a mold, a plastic injection mold and you have ten cavities that are producing the same part, but only six of the cavities actually produce good parts and you have to rework the other four cavities or throw some of them away. Or you block off the plastic port. The point is that you could invest money in the tooling and reduce your per piece cost.

And that's a that's essentially what value engineering is. And normally the investment in the tooling results in greater savings than the investment. And that net is split 50/ 50 between the organization that's doing the work and the government. So there's a win win for both and it's an incentive for the contractor to improve the operation or the performance of the process.

So that's what we call typical value engineering now. In in the case that we're describing, we're not really able to do that because what we're talking about in these weapons systems is not something that's as easy to produce as an injection molded piece. We're doing things that have never been done before. We're building capability.

It's innovative and it's high risk. And we can't prescribe methods for how to do things. It's just not possible. So what we want to do is, for the thought of this whole work, is to motivate these organizations to apply the principles of value engineering to improve the way that they operate their development operations and to really incentivize that behavior so, that instead of allowing the status quo to just continue on, we actually do things that improve the status quo and make the processes more predictable and help get us our weapons systems on time, on schedule and so on. So that's how value engineering applies to this particular context.

Linda Parker Gates

So there's some there's some innovation involved in these solutions, right? Because you're actually going to be asking acquirers to do things differently and without a prescription. Right But to try to find ways to improve the outcomes. Maybe you can talk about some of those things like finding showstoppers early, some of the things you talk about in the paper and what those could lead us to.

Fred Schenker
Yeah, I didn't I wanted to present this earlier and I, I overlooked that. What we see as the status quo is that there's a huge amount of faults that are introduced during early stages of development requirements, architecture, and because we really don't evaluate that inside of a facility, they somehow escape and are often not discovered until after unit test or during integration and test. And the cost of fixing these defects or faults is dramatically more expensive when you get to the end. Even platforms like F 35, there was a GAO report of in 2020 or maybe 2021 that described the block for I think release of the F-35. And it was something like they reported that from 2017 to 2020, almost 25% of these defects that were found and it was between 500 and a thousand defects, almost, almost 25% of them were found after the software deployed onto the platform.

This is so late in the process; it costs so much to fix these things that what we have to do is innovate earlier in the life cycle. Implement new practices earlier so we can find these things when they're actually injected. Not that we would eliminate 100% of them, but by just you know, 80/ 20, I mean if you get a huge chunk of them it will have a tremendous impact on what happens during integration and test.

Linda Parker Gates
So, this totally aligns with what we are hearing about around the shift left in DevOps and software testing. And I hear the soft side kinds of things because that's the kind of stuff that I do. But you're talking about really innovative ways to deal with cost overruns and delays and limited capability and things like that through mechanisms that are not currently comfortable for acquirers and contractors. So what can we do to motivate people toward this more innovative thinking and sort of a newer way of thinking about acquisition?

Fred Schenker
Well, I think we have to recognize where the target of opportunity is. I mean, earlier I showed you this graph that had the bullseye on it. And I think that's the target, so we want to minimize that and do things that impact that. I think the first thing is we have to recognize the value and I think what we're talking about doing is applying model based analysis, digital engineering techniques to enable early evaluation of the product, much earlier than we have done before.

It's not, and this is the way that we, I mean, so we need to build, and we are doing it, model based systems engineering is a step forward compared to the way that we used to do things, but we could be doing more with the model based analysis. So if you look at the types of things that are found at the end, which we can do because we have 30 years of experience from programs that have experienced these problems, it's the same things over and over again.

We have issues with timing and latency. We have bandwidth problems. These are things that are very difficult to discover early in lifecycle without the help of modeling and analysis. So we need to change the culture, which is a difficult thing to do because you can look at other parts of the world, Europe, Russia, China, the culture there is much more centered around model based analysis than it is in the United States.

When we bring when we bring people into our organizations, out of college or whatever, from other organizations, it's often the case that we have to go through and train them in these methods. It's not like the model based way is the way that they're taught throughout their education. So the culture of even the very base level is just not up to where it needs to be.

So I think that's at the root of identifying the value and building this competency into the early part of the lifecycle. I think it's also important to recognize that just because we're doing modeling and we're doing analysis, it's not like a locked in certainty that we're going to find these issues. There's a huge amount of competency that's required on the part of the modeler and experience. It's actually part of the problem because you can look at data from other organizations outside of the United States and find data that is very promising. But if you look at the companies that we're talking about, they are major defense contractors, we're not seeing this practice being applied. So there is not a lot of data.

And we really have to get people to jump in. The fact is that if we don't do the model based analysis, we're never going to start to find these defects early. So we have to actually begin to change the way that we do business. Some organizations will be more comfortable doing this than others. I think there will be a churning early on where there will be some organizations that are faster to iterate than others.

I think there's opportunity to take a model based environment and build it into your CICD pipeline so you could actually build the model based analysis into the natural building of the product that you do all the time, identifying these issues automatically earlier in lifecycle. So that's where the value is. I could talk about what could be improved.

Linda Parker Gates

Yeah. Well, you know, I was just going to go there as well because you are talking about culture change and culture change is hard, we know that. But what's interesting about it is that even when the status quo is pretty bad, change is still scary. And so we still need innovators to kind of lead the way and produce early data and show us some early results.

But we're still going to have to pull people along. I was going to ask about, what kinds of f things you might be able to recommend for sort of addressing some of that reluctance in terms of cost avoidance or risk reduction or some of those things.

Fred Schenker
Well, we I mean, the culture issue is one that is going to take a long time to overcome, I think. Maybe it'll be just resist, resist, resist and then jump in. I don't know. Somebody's going to have to start and really change the status quo. And then it'll be a trailblazer for others.

So, the thought is, that by identifying that target as some huge amount of money. In many cases it's been hundreds of millions of dollars. So if you can use that, or a portion of that, as the seed for an incentive for a contract so they can get a reward for doing the right thing and achieving the goal of getting to the end and having it actually work without having to create a new contract to finish the thing.

So, that's how we're thinking about applying value engineering to the acquisition process. There are issues there with the fact that it's nobody wants to recognize, and I'm speaking about contractors, because they don't add that as part of their proposal. They all go way aggressive on how much it's going to cost to do integration and test, and the government who accepts these proposals and should know better by now. They all don't want to accept that this extra cost is going to happen. So we sort of have to get over that and either we're going to use to this process that we use for managing risk within the government, or anywhere, and we think that this could be a risk analysis or a risk mitigation method.

So the application of effort early in life cycle to identify these defects allows you to certainly reduce the likelihood that you're going to find these issues later and also the impact of the defect of the risk also. So this chart that you're seeing now illustrates that. And it's not normally the case that you that you are able to do this by doing mitigation activities.

Normally when we mitigate a risk, we just reduce the likelihood, but we don't change the consequence. But in this case, we actually have an ability to reduce the consequence as well. So if we're able to recognize that the money that we're going to burn at the end of the contract is somehow risk money and we can apply that risk money to reduce the likelihood and severity of

this occurring then we have the opportunity, I think, to provide the incentives to improve the status quo. That's the that's the notion anyway.

Linda Parker Gates
Yeah, that's interesting. And I guess in drawing down the risk, the consequences and the likelihood, as in that chart that you showed, we also are going to have to probably change the spending model, right? So, there may be more of an investment upfront, but it would offset those big spends at the end by quite a bit. By orders of magnitude, perhaps. Is that right?

Fred Schenker
Well, that's actually a cultural issue. The I mean, if we think about shift left, we aren't going to be applying different kinds of resources at different times in the life cycle than we did before. So, if we have to build an environment to do model based analysis then we need those kinds of people to get in there and build the models of the things that we want to evaluate, which is an investment in the infrastructure of the project.

And it's done much earlier. Most organizations create these labs, these tools for doing simulation. These are mainly hardware in the loop. We're talking about a software focused virtual laboratory that that we can use to test out models and really simulate the behavior, the architecture of the of the platform early in life. So, the reason why it's cultural. Sorry, I know you were going to jump in there.

Linda Parker Gates
No, go ahead.

Fred Schenker
The reason why it's cultural is that you're absolutely right. That means that now we're going to be burning more money earlier in lifecycle, which is going to be difficult for a program manager to accept because our managers have been around the block. They know that there's going to be this flurry of activity at the end and they're trying like heck to squirrel away as much money as they can to prepare for that eventuality.

And this is sort of completely counterintuitive to the way that they think about how they how they should manage the project. I mean, you're talking about burning money early instead of saving that for application late. But the whole point of it is that you're reducing the effort that you're going to need at the end. And that's what that shift left implies. That's, I think, the answer to that question.

Linda Parker Gates
Yeah. That's I think, really powerful. What I was going to ask, is in the paper you talk about ACVIP, and I wondered if you could describe ACVIP for us in terms of how it relates to cyber physical systems and also value engineering.

Fred Schenker
Well, ACVIP, that's Architecture Centric Virtual Integration Process, is an acronym developed by the Army through the engagement with future vertical lift. It's a form of model based analysis. As the title implies, virtual integration, it's primarily there to be used to evaluate interfaces and the interconnection of the components of the platform. And that is an approach that can be taken to do early lifecycle evaluation of a product. As part of the work that we did with the Army, we actually built materials that would help organizations implement ACVIP as part of their process.

It was originally, I think, started earlier, before the future vertical lift platforms, maybe ten years ago. And so that's what ACVIP is. We think that the principles of model-based analysis are built into ACVIP. You can do more than that. But it's focused on embedded computing resources. So that's exactly what we're talking about for these cyber physical systems.

Linda Parker Gates
Is this digital engineering basically?

Fred Schenker
It is, yeah. And it certainly could be. I mean, it could be more digital engineering. It could be I mean, there are things that it has to be recognized. For example, many people think because the model-based analysis is not necessarily the same models as what you use for model based system engineering. So, there is a misconception that you're doing duplicate effort to model things for your model based systems engineering, and then build duplicate models for your model-based analysis. But these models based analyzes are used for completely different purposes than you use for model-based systems engineering That misconception is present. These are all parts of what you would call digital engineering, and you would even include things like we described with the pipeline as potentially part of that.

Not everybody's going to want to do that. What we are focused on are doing the activities early in lifecycle to find these showstopper defects, these defects that cause you to go back to the drawing board late in life cycle and just kill your schedule. So that's what we want to use the ACVIP or model-based analysis to do.

Linda Parker Gates

So, what are the implications of all of that on the way we write contracts or the kind of language we would have to include in a contract.

Fred Schenker
So, I mean, it is a bit sticky, right? Because it's not clear that anybody actually recognizes this or wants to admit that these overruns are going to happen. But we would need to write incentives like award fees. Things that happen during the execution of the contract so contractors would need to somehow be able to demonstrate that they are actually doing what they need to do in order to get this award fee. And then that's a sort of like a rule turn, if you will. But then we need there to be like a really big thing for the end of contracts. For whatever you did before, if it didn't work and you still have that overrun at the end. Okay. Well, then we blew some money early in lifecycle, but if you actually save hundreds of millions of dollars by getting to the end, doing all the good work that you had to do, and finding all those things, then there should be a significant incentive for them.

And I'm thinking like 25% or something of that big nugget that you are going to have to pay at the end. So, it's like huge amount of money for doing no work or for doing good work early in the lifecycle. So that's sort of the contractual thing. But I'm not going to know. This was a thought piece. We were just trying to stimulate the thinking in this area and the issues with the FAR and how contracts are written, that all has to be worked out. So we just want people to start thinking this way.

Linda Parker Gates
Yeah. And to unstick some of these norms. Its noble work because I think he's saying somewhere that the current the status quo for contractors is kind of no lose. You keep working, you keep getting paid kind of thing. So what you just described is a way to motivate away from that status quo, even if it's not particularly painful.

Fred Schenker
That's correct. The current situation is that it's all cost plus. So you pay whether you are successful or not successful. I remember a colonel that I used to associate with when I was supporting ground vehicles. He said that I'm either going to pay them and they're going to screw up and they did it, or I'm going to tell them what to do and if they screw up, at least I had something to do with it. But if I just leave it up to them, then I have no control over the outcome. So the fact is that the contractors are going to get paid no matter what for what they spent. And that's entirely appropriate.

The nature of the work is high risk nobody would propose a fixed price for doing any of this work. It's absolutely vital to not lose that so that so that we don't force people into doing stupid

things. But at the same time, we have to change the culture so that we build these mechanisms for continuous improvement and into the way they do business.

Linda Parker Gates
So I want to just take a minute to ask or to remind folks who are listening that if they have any questions, they can put them in the chat. And Fred, I was going to ask if there was anything else you wanted to talk about that I haven't asked about.

Fred Schenker
I think the one thing I wanted to talk about is that when we think about process improvement, I think the way that you should think about it is to work smarter and not to work harder. So I think when we want to do is we want to work smarter earlier in life cycle.

That's a way to improve the quality of the products that are coming out of the development process. And if we choose not to do that, what we find is that we're going to at the end, when we get to an integration test, we're going to wind up working harder because we'll have to deal with whatever we find when we get there, which has usually overwhelmed the integration and test people.

And when you put people under that pressure, they have deadlines and they're finding these things. There's a lot of pressure to produce in very small amounts of time. You wind up making careless mistakes, which adds to the backlog of things that need to get fixed. Your people burnout. They don't get any sleep. It can turn into a nightmare.

And I just wanted to throw those buzzwords out there. About working smarter and not working harder because that's really what we're trying to accomplish.

Linda Parker Gates
Yeah. And then I think also kind of understanding the implications of changing the way people are working because this is a known phenomenon in change management. You might see some initial declines in productivity at first or reduced results of whatever type. And before you get to that payoff, the improvements are working smarter, working better, there are some upfront costs even just in the way people approach their jobs, because changing, as we were talking about earlier, change is hard. And it's a people problem, you know.

Fred Schenker
Right. We have this learning curve. Right. So there is that dip in productivity that we should expect. And then but eventually, when people learn how to do the jobs in new way and we take

it, people take advantage of it and we get better. You know, there's always these knee jerk reactions to stop and or change or whatever.

Usually you have to do it a couple of times before you make any changes. It's a problem with innovators that they're not patient and they don't allow that change to actually play itself out. So you need the innovation, but you also need the steadfast, the building on things that are known to work.

Linda Parker Gates
So you're working on a new paper. Do you want to tell us what's in store? What's next in your thought process?

Fred Schenker
Well, we talked about the incentive mechanisms and somehow identifying ways to provide work fees for contractors. But you have to ground that in reality. So there has to be some way of gauging the competency of the contractor with respect to doing this work. I really hesitate to say something like maturity model but something that you could observe by whether or not seeing certain activities were happening. Like, for example, the standard way that we review designs for these systems is in PowerPoint. Okay.

We take pictures of aspects of the design to copy them into PowerPoint, and we present them during design reviews. So I think it would be a more mature organization that would actually use the model during the design review as a means of, and I'm not trying to suggest that that is the answer, but I'm just saying that there are aspects of the way the work is being done that would demonstrate more maturity in the company or in the level of somehow you could feel more comfortable with the contractor's competency with respect to digital engineering. So the new paper that we're working on is exploring that, is trying to identify what metrics or what of what behaviors would lead you to think that this contractor would be better at doing this work than that contractor or somehow being able to measure and, not for the purpose of grading contractors, but really just what should you be doing? And how can we just raise the awareness of what ought to be being done in order to make everybody better?

So that's what the new papers is about.

Linda Parker Gates
That's exciting. And, you know, I've done some writing on organizational agility, which is the application of agile concepts to organizational processes. And so it's not strictly software development, agile software development, but what you start to find is that when the organization starts to behave in ways that you're describing, where you get to try some things

out early, see if they're working, have good metrics and be able to kind of evaluate and pivot, you know, from the beginning of a project to the end, you might be able to not only innovate, but identify things that work well and that you should continue with without making this the long term commitment or even have the understanding that you might have needed for traditional process improvement where you kind of know exactly where you want to go.

Fred Schenker
Yeah, I agree. And certainly starting small is the way to go. I mean, I've been critical of the future vertical lift platforms in that I really think that when you talk about a platform level implementation of something like this, it's much more difficult than just working in a subsystem or even component level. So I think that you can bite off more than you can chew.

So developing good techniques on a prototype to then scaling that up, I think, is the right approach. I did want to mention that in the work that we did for Future Vertical Lift, we produced some guidebooks for ACVIP which might be of interest. I think one of them is approved for public release that was on modeling and analysis and one that's on acquisition.

So this is for the government. It is currently going through the public release process. It's available for a distro D kind of way. But we were working on a Distro A for that as well. So that's a resource that's available for people that are really interested in potentially applying these techniques to their own situation.

Linda Parker Gates
Excellent. Excellent. All right. So let me Shane, can I ask you, do we have any questions from the audience that that Fred can answer.

Shane McGraw
No current questions to go with so you guys can kind of make maybe any final thoughts and we can wrap up, then we'll give people but another minute to add anything. Lastly, if not, we can wrap it up.

Linda Parker Gates
All right. Fred, any last thoughts?

Fred Schenker
I really appreciate the opportunity to speak to you guys today. The paper that we produced was picked up by the Naval Engineers Journal in their fourth quarter of 2021 publication. So that was more airplay play than we were expecting. I think it might be influenced by the fact that Mr. Guertin is now in a senior DoD position for DOT&E.

But I do think that it's great that we can get this out there. And I think there is huge opportunity here, and we just have to jump on it and try to make it better for everybody. I'm hopeful that there's going to be a lot of impact here.

Linda Parker Gates
So I agree, Fred. It's visionary. And this is hard. You know, these are hard problems when you're this far kind of out in front of something. And I appreciate that you and the honorable Mr. Guertin have taken the time to sort of start this conversation through your writing and speaking. So thank you.

This was a lot of fun and I'll hand it back over to you then Shane, I guess.

Shane McGraw
Great. Fred. Linda, thank you very much for your discussion today. We appreciate you guys sharing your expertise. And again, we thank you all for attending. On exiting please hit the like below and share the archive if you found value in today's talk will be found at the same URL. Also, you can subscribe to the YouTube channel by clicking the SEI seal in the lower right corner of the video window.

Lastly, join us for our next live stream, which we March 18 and our topic will be Ask Us Anything: The Zero Trust Edition with Greg Touhill and Chase Cunningham. Registration Information will be on our website tomorrow and you can look for it there. Any questions from today's event please send to info@sei.cmu.edu. Thanks everyone. Have a great day.