



Software Sustainment and Product Lines

featuring Mike Phillips and Harry Levinson as Interviewed by Suzanne Miller

Suzanne: Welcome to the [SEI Podcast series](http://sei.cmu.edu/podcasts), a production of Carnegie Mellon University's Software Engineering Institute. The SEI is a federally funded research and development center sponsored by the U.S. Department of Defense. Today's podcast will be available on the SEI website at sei.cmu.edu/podcasts.

My name is [Suzanne Miller](#). I am a principal researcher here at the SEI in the Agile-in-Government program. I am very pleased this morning to introduce you to my colleagues and good friends, [Mike Phillips](#) and [Harry Levinson](#), who worked with me in the Client Technical Solutions Division (CTSD) of the [Software Solutions Division](#).

So, gentlemen, before we get into talking about sustainment and product lines, give me a little bit about what brought you to the SEI, what kind of work excites you about being at the SEI? We will start with Harry.

Harry Levinson: I am Harry Levinson, and I spent about 25 years in commercial industry. A lot of it was banking, data communications, but I decided to come to SEI to work on very large projects. Right now, I have been here 13 years. I have a portfolio of different [command-and-control-type systems](#). A lot of them are finishing up development, trying to figure out how to go into sustainment. Some of them are in their second and third generation of, we could call it, modernization.

Suzanne: One thing I want to bring up, both of you have worked in research areas, but our focus in CTSD is actually to help government clients use some of the technologies that we have either promulgated or invented here at the SEI to deal with things like these large projects. So we are not going to be really talking about this sort of esoteric research that sometimes goes on here. We are only talking about applying those concepts in a real environment.



SEI Podcast Series

Mike Phillips: I think that is a good way to think about it. I call it field research or applied research, partly because often the groups that we are working with are willing to be leading edge and trying out things that have been thought through but have not really been deployed that many ways. And every time you have new deployment it is a little different, or a lot different, than the one before.

Suzanne: Give us a little bit about your background, Mike.

Mike: I am Mike Phillips, and by heritage, you know Harry mentioned 25 years in commercial, I had 26 years in the Air Force associated with flying and then with acquisition. So, it is the acquisition piece that kind of plays more. Although, one of the things we were doing in the Air Force at the time that I reached the latter part of my career there, was [Total Quality Management](#) (TQM). That led me to interest in process improvement. And so, [Process Improvement](#) was what brought me to the SEI, things like the [CMMI](#) [Capability Maturity Model Integration] effort was part of what I did, but the intersection that I was associated with at the SEI was bringing together software engineering and systems engineering.

One of the themes of today is this intersection of ideas and why that is really important, because we find that most of our clients do not have a single issue. They have something that it is at the intersection of several different problem sets. And how much of our research from the past can be used in different ways and unique ways for each customer is one of the values, I think, of conversations like this.

Suzanne: Let's talk about the intersection of the two things we have brought together here. One of them is [product line practices](#), which is an older technology of the SEI that has been around at least 15, possibly 20 years now, and then [software sustainment](#). Talk for a minute about what is different—when we say *software sustainment*, we use that very specific term as opposed to *maintenance* or *operations*. What is it that is different about software sustainment from the overall maintenance cycle of a large hardware system?

Mike: I think that is a great question because, in fact, what is evident in the laws that are currently there associated with sustainment are all built on that structure; that is, *How do we sustain hardware?* Which typically means, *Bring it back in after it has gone through some bruising and fix it.* That often means put a new, exactly same part, back in, or shine it up and fix corrosion and things, like, is part of the sustainment end of the lifecycle.

Software is totally different. It is not appreciated for its difference. Software continues to evolve, and it is going to evolve across the whole lifecycle. That will happen whether you intend it or not. So how you take care of that kind of difference makes software sustainment often very unique from hardware sustainment. A term that we have started to use, because we think it helps



SEI Podcast Series

people think differently, is that it is part of [continuous engineering](#). Maintenance, often, and engineering, are often not thought of as being in the same bin.

Suzanne: Right. *Engineering is the beginning of the development, not at the end of the development*, is one of the things that is mental model that is common.

Mike: Often, in our sustainment communities, they have that this is about fixing things, and it is about sustaining in a similar mode. So, breaking that old mental model of just fixing a bug or something like that to, *You are evolving it, and you are often modernizing it in some significant way*, is very different.

Suzanne: So, the [Defense Science Board](#) is just finishing up [a project looking at software acquisition issues](#). The early brief from that report highlights software sustainment as one of the big issues. One of the things that they said in that report is—and it goes back to your point about engineering—we need to stop separating development from sustainment in software. It is exactly that evolution that you are talking about, and not something that we need to think about as, *We are done with development, and now we just have to correct defects*. It is modernization. It is evolution. It is taking account of different contexts that we might use something, different environment it might get subjected to. We have got all the security stuff that affects us in ways that we didn't think about 20 years ago. Lots and lots of issues make this a continual effort. So, how does the SEI's work in product lines contribute to thinking differently and to taking a different approach to software sustainment?

Harry: Actually, there are probably two different ways to think about it. Product lines give you an asset library. They have a lot of opportunity to deal with the variation of different products. As things change, they're designed to be able to, maybe, swap out different components that have different functionality.

The other challenge that we are finding with product lines is that it extends the life of the software base. As each of the different systems is developed out of this product line, there are many more systems that are out there that have different configurations and different environments. As you say, the adaptations that the software needs to make to be useful out there increases. And so, there is this continual churn of changes to the software that are necessary to keep the product line viable.

Suzanne: One way I think about it is, you have got this very rich test environment for this core set of assets. Then, as you evolve, you are making mindful decisions. One of the things I always took away from the product line practice work is mindful decisions about variation, *Where do we allow for variation? Where do we want to minimize variation? How do we want to accommodate*



SEI Podcast Series

variation, is one of the things that the product line practices work gave us some strategies for dealing with.

Harry: The challenge is that if one of the products identifies a defect that affects other products, how do you bring that back into the common baseline and share that, either fix or improvement, across the product line?

Suzanne: It is not just *how*, but also *when*.

Harry: It is *how* and *when*. Testing becomes a key factor here in terms of long-term planning.

Suzanne: Right, so things like automated test environments, where we can do regression testing all the time and make it easier to do things like that. Product line practices fits into that, because I can build a suite of tests that are with known variations. I build a new test when I have a new variation, but I also can run against all the variations that are known.

Harry: It becomes a necessary component for a successful product line for sure.

Suzanne: What is some of the work you have done with clients in this area, where you have seen opportunities for this, either the challenges of successes, of trying to marry up those two concepts?

Mike: In the one that was the basis for [our article that led to this podcast](#), a particular company came up with a concept, a way to operate a particular capability for, in fact, the Navy first, OK, was where they got their start. Now it has evolved and is going to other services as well. So, one of the challenges that we have in the DoD environment is, *Gee, you know, how do I treat this when I'm going across various lines?* And in sustainment that has its own set of challenges when you do that.

But, what's so delightful is to watch how this core capability, as Harry said, can continue to evolve and that we think of that; somebody used the term that I love, and that is the trunk of the tree is the product line. The branches then are the specific differences that are needed to provide the particular functionality for the particular system that grows off of that root core. And the one that we have been focusing on, about 70 percent or so, is in the trunk.

Now, what is cool about that when we move towards sustainment is there's also laws that say the government has to be able to, no matter what happens to the contractor, maintain the capability. Now, in software, that means continue to evolve that capability as well, because often the sorts of changes that are required are what the user sees. It is out at the end of the branch, where the user is saying, *Hey I need it to look this way on my equipment so that I can do the job that this particular system is being asked to provide.*



SEI Podcast Series

Suzanne: So, the product line gives us that stability, but it also gives us a place where everyone can bring their issues, and they can be adjudicated in a way that allows the entire community to evolve. That, to me, has been one of the underutilized aspects of product lines. In the past, product lines were used a lot for particular organizations, commercial space, for competitive advantage. This is really looking at, *How do I build a community that is all stakeholders in evolution of this product, but we allow the recognition of the variation.* We are not trying to standardize on a single product, because we know how that works. Everybody has got a different idea about what it should look like. We have never had success, that I am aware of, in government of having all the services work on a single product for very long before you start seeing, *But I need this.*

Navy, for example, can only do things to evolve when they come back from deployment, when they are in the dock, especially when there are hardware/software swap outs. Air Force and Army have a different cadence, so you have got all those kinds of things that play into this space.

Mike: Well, one of the things that is worthy of mention here is how much more cost effective—and that is a big word in the military environment—is *How do I make this long-term sustainment as low in cost as it can be?* Typically, we say that something like 70 percent of the actual dollars are spent in the sustainment phase. So, *what do we want to do?* Well, we want to make sure that that core capability is preserved in the most cost-effective way. A product line, in this particular case that we are describing here, means that a given correction is being applied to multiple systems. By doing that, in this particular case where there are two services sharing the responsibility, they split the cost. So already there are savings. Our product line experts have said *once you get past two systems...two is kind of like break even, because it does cost more to worry about two systems at the same time, that is, there is a factor there.*

Two is effective, and three, you start really getting the benefit. In the particular system we are looking at, there are approximately six elements: six times that portions of that product line have been used to support, sometimes by a prime contractor, other times the contractor who came up with this idea is a sub to another contractor for the particular system that this is getting put into. So, it is all benefiting that bigger picture.

Suzanne: What are some of the challenges of bringing product-line thinking into this arena where you have got different contractors, different government agencies, all members of this community that are trying to evolve this system, what are some of the challenges that you have to overcome so that that actually will work?

Harry: I just want to expand on a couple of your thoughts there, in a sense that is related to your question. What we have seen in a couple of cases, the product line is developed by the



SEI Podcast Series

contractor. In order to meet some of the laws, the government becomes more involved as the product goes into operation and sustainment.

The government has this challenge, I believe, not to break the product line. A lot of the natural ways that government spending is set up is to have individual programs. When you start to group these product-line systems together, it is unnatural for a government organization to be able to respond in a product-line approach. Mike has been exploring this concept of partnerships with—between—the government and contractors: [PPPs \[Public-Private Partnerships\]](#). I will let you expand on that a little bit.

Mike: Yes, I think that that intersection, again, is very common. From my experience in the military, we focused, I focused on my program. The program that was sitting just down the hall from me had his own problems. We were not trying to find ways to do things that particularly cooperated. One of the beauties of the one that was the basis for this is the three programs that are within one service have all said, *You know, we have a common problem. A common solution can be created in a sustainment environment where we all operate from the same government location, and that we share the same prime contractor.* Both of those are important, or else it becomes very difficult as you start multiplying the number of intersecting pieces, it just gets harder and harder to do...

Suzanne: And intersecting stakeholders.

Mike: Intersecting stakeholders, exactly.

Suzanne: This is in the case where more is not always merrier. That is interesting to note.

Mike: That is right. That is one of the benefits that has come about. Typically, public private partnerships are built up of one prime contractor and one organic capability teaming together. So, if you tried to increase the number that had to play nice together, it does not matter whether its two contractors or two organic capabilities, there is just more stress on it because there are different cultures at each site that just happen.

Suzanne: Where do you think this is going? What is the future of this for product lines and sustainment? Is this a solution for more than just the one case? Do you see potential for this outside of very particular domains? Some of the things we do really are to solve a big, but sort of singular problem. Where do you think this fits?

Harry: One thing that is going through my head right now is there is another way of looking at this challenge that the government has tried, and to some success in certain situations. That is [open systems](#). Open systems has been called [OSA \[open systems architecture\]](#). [MOSA, modular open systems architecture](#), I think, is the more recent one.



SEI Podcast Series

In terms of trying to solve some of the problem, the government takes a little bit more control of the architecture and defining the modules to enable multiple contractors to play in this type of system. I think there are different economic models that could probably be set up to enable multiple solutions, multiple systems to take advantage of multiple contractors and come together with a common set of software and enable this variation. We talk about product lines, but I think there are other solutions that have been tried over the years.

Suzanne: And they can work together, right?

Harry: And they can work together.

Suzanne: A modular open systems architecture could be the base for that trunk.

Harry: That is correct.

Suzanne: Right? Where, if we are intentional about that design before we get to sustainment, right? I didn't ask you this question, but I am assuming the time for deciding that you are going to have a product-line approach is not typically when you are already in sustainment.. So, this is a case where it's already in sustainment?

Mike: No, the other way around. The contractor has to be source, I would say. I am not aware of any that have ever been actually spun up by the government alone to be a product line, partly because there is not a value to the government of having a product line, per se.

Suzanne: Of owning the product line.

Mike: Right. Now, intriguingly, if you get into sustainment and then the contractor says, *I am done. I want to move onto something else.* There may be a new world that says *No, we already have these three working pretty well together. Let's maintain that product line as a government entity.*

Suzanne: Government owned.

Mike: Yes. It could happen. To date we have seen a couple. I am told by the product line teams that there have been a couple of attempts to do that, but government isn't the place that this happens most frequently.

Suzanne: It is not a natural fit.

Mike: Correct. It is not a natural fit.

Suzanne: So you start thinking about a product line...The contractor thinks about it as part of development, as part of a long-term strategy. So, the modular open systems also are something

SEI Podcast Series

that comes in early, typically, in terms of looking at how the systems going to evolve. That could be a future research area: how do those two things fit together or not fit together? There could be things that we don't understand yet that make them not compatible; that happens too, right?

Mike: A thread that is related but isn't exactly in the same category is this notion of the importance of the architecture for moving into sustainment and into sustainment that includes modernization. Those threads, as we have looked at our various quality attributes (thus far, we have not captured a thing) a quality attribute called *sustainability*. Perhaps we should, because it is built upon a few different things [other] than modifiability per se. It is close, but nevertheless there might be a reason to think about that differently, so that it's easier. We say that now the lifetime of some of these systems is going to be very long...

Suzanne: ...it's decades.

Mike: Decades, but the software is not going to last that long. So, to the extent that we can make the architecture support the evolution in an effective way, product lines is simply one of the ways that that can give benefit to both sides.

Suzanne: So, if you are talking to a program manager you met at a symposium and they asked you the question, *How do I improve my sustainment efforts? I've got a program in sustainment and we are long past the point of it being designed as a product line.* What are some other kinds of advice that you would give them to help them in approaching, thinking, about their software sustainment?

Harry: One of the very difficult challenges as we talked about at the beginning is, what is software sustainment? The concept that software is always changing is very difficult for people to accept. A sustainment operation has to think of software as being soft, as being malleable, right? It is going to change, and we have to define our processes and implement our processes to enable the software in change.

One of the concepts that I love, but it is really hard for people to accept is, *welcome changing environments in an agile world.* [That] is a way they talk about it. If you set up your processes appropriately, you can accept finding those blatant defects and blending those with new updates to make the users happy.

Suzanne: I think your point of accept it—accept that the software is never done—is probably one of the messages I would give to somebody: If you think you are done, you are fooling yourself because the world is going to change. The technology is going to change. The people and their skillsets are going to change. So, all of those affect the software that is running, whatever system it is that you are dealing with. Until we decide to actually retire, replace that

SEI Podcast Series

system, you've got to have resources that are tuned to taking care of that. That is really where that cost comes into play.

I want to thank both of you for joining me today in talking about this. It is a subject we talk about in the halls. So, it is good to get a chance to bring some of this out for the rest of the community. I think that the SEI's focus on sustainment as an area that needs more attention. I think it is very appropriate. It is reinforced, as I said, by that [Defense Science Board report](#) that is coming out. So, we are in the right space for helping people so that is a good thing.

So, thank you for talking about this work today. I want to point people to insights.sei.cmu.edu, which is where [blog posts](#) related to this are going to be found. You can look for [sustainment](#) or you can also look for [Mike Phillips](#) as an author, and either way you'll be able find it.

Mike: Some of these.

Suzanne: We will provide links to some of the resources that we have mentioned in terms of the blogs and such in the podcast and the transcripts. So, people will be able to get to things that way.

This podcast is available in three places as I mentioned earlier on SEI website itself at www.sei.cmu.edu/podcasts. It is available on [Carnegie Mellon University's iTunes site](#). It is available on the [YouTube Channel for the SEI](#). As always, if you have any questions, please don't hesitate to contact us at info@sei.cmu.edu. Thank you.