**GE Aviation Assemblies Challenge – Webinar Transcript**
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**Speakers:**

**Moderator**: Jonathan Jakischa, *NineSigma*
**David Hyde**, *Senior Manufacturing Staff Manager, GE Aviation*
**Tim Stentz**, *Senior Manufacturing Staff Manager, GE Aviation*
**Brad Storck**, *Advanced Lead Engineer, GE Aviation*
**Jay Combs**, *Principal Engineer GE Aviation*
**Scott Jones**, *Staff Engineer, GE Aviation*
**Kevin Andrews, Ph.D.**, *Senior Program Manager, NineSigma*

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Jonathan Jakischa: Good morning to you all and welcome to today's webinar for the GE Aviation Assemblies Innovation Challenge brought to you by NineSigma. My name is Jonathan Jakischa from NineSigma and I will be your host and moderator today. Please note that this webinar is being recorded. The recording and transcription will be made available on the GE Aviation Assemblies Innovation Challenge page.

First, let's begin by reviewing our agenda for today. After I introduce our speakers, they'll discuss the project in greater depth. Then, we'll address your questions during a live Q&A session followed by a brief summary of project information including how to request additional information or assistance.

As we proceed through today's presentation, please feel free to ask questions at any time. We'll keep track of your questions and respond to them during the Q&A portion of today's webinar. Should you need any information or assistance outside of today's webinar, please feel free to contact the NineSigma provider help desk at phd@ninesigma.com. Don't worry if you didn't get that email. We'll have it on the screen for you later on during today's broadcast.

At this time, I'd like to introduce our panelists for today's webinar. First, from GE Aviation, we are joined by David Hyde, Tim Stentz, Brad Storck, Jay Combs, and Scott Jones. Next, from GE GENIUSLINK, we have Lisa Ralph and Jonathan Keith, and from NineSigma, Kevin Andrews is joining us today. Everyone, thank you for participating during today's webinar. First, we'll begin with David Hyde from GE Aviation. David, could you please give our attendees an overview of this challenge?

David Hyde: So good morning. This is David Hyde from GE Aviation. Again, I don't know the audience that is on the call this morning, so let me go through a few items here. I've been with GE for more than 30 years working in commercial engine assembly in various roles supporting engineering and production. More than 20 engine programs. And one thing that is common in all of those engine programs that I've seen through my entire career is this little fastener that we call the b-nut.

So, we have a history, a long history, of using this type of a joint on our aircraft engines and, on occasion, and it's a rare occasion, we have had leaks at these joints, and that is really the nature of our challenge today. We're trying to come up with a different way, some type of solution to ensure that we've got a leakproof assembly or we're able to detect that we've got an improper joint.

So, we're kind of excited. I've never been part of an event like this where it's a kind of a global challenge to folks outside the industry. I've got, like I said before, an unknown audience so I don't know if everyone is in the US or if it is worldwide. But, we're looking for different approaches, different ideas. So, very excited, and we're hoping to find something different and really something that will make a difference and help us either air proof or link proof these fittings. Let's go to the next slide.

Again, not knowing the audience, let me tell you a little bit about GE Aviation. We are part of the larger General Electric Company. GE Aviation is a world leading provider for jet engines and turboprops and we've got facilities for building new engines across the US and some around the world. I work at ... Right now, I'm sitting in a conference room down in one of our assembly sites in Durham, North Carolina. I believe my boss, Tim Stentz, is also on the line. He's out at one of the assembly shops out in Strother, Kansas, and there are some folks in from our Evendale shop as well.

So, our business is kind of broken down into the assembly piece of the new engine side and then also the overhaul and support as these engines get out in the field. So, my role has always been with the assembly side creating new engines, building new engines, and getting them to our air framer customers, Boeing and Airbus, Bombardier, Embraer, and there's a list of others.

But, the bigger piece is once these engines are out on wing with the different airline customers, we've got a huge network to service those engines for the next 20 to 30 years. And, that's probably the bigger picture. So, these engines will come back, they will get disassembled, they will get reassembled, and they won't have the same type of assembly opportunities for issues with fittings that we see when we're building new engines.

Let's see. Volume-wise, a little bit more about GE Aviation. I mentioned we are a world leader. So, one of the stats I find interesting is every two seconds, there's an aircraft that takes off powered by a GE Aviation engine. And, at any moment in time, there's over 300,000 people flying on aircrafts that are either GE or CFM powered. So, that just gives you an idea of the number of engines and aircraft and so on that are involved with this effort. Let's go to the next slide.

All right, so the goals for the challenge that we've got out here, I think we touched on them briefly but we're looking for ideas that are going to make a difference for us. They can be technology, they can be a different process on how we torque the joints or how we assemble the joints. We're trying to make sure that the b-nuts are leakproof when we assemble them, but we're also looking for ideas that might enable us to detect if we have a joint that has an issue. So, it's not just focused on only the assembly piece.

So, we'll talk about it in just a moment. We'll go through what our process is to actually build the engines using this type of a joint and that might highlight some opportunities or answer some questions there. Let's go to the next slide.

All right. So, I won't read through this, but the b-nut assemblies are typically on our fluid or air systems on the engines. They provide alignment. They'll take the two ends of a fitting, they'll properly mate them so it's either a cup and cone type fitting or a flared fitting. They'll provide a clamp on that to hold them in place And, we typically provide some type of redundant feature to prevent them from backing off once they are tightened. So, there is what we call a safety cable that will prevent them from backing off.

But, the issue is these could be in high-pressure lines, these could be in drain systems, so there's a variety of applications. Some of these are inside the engine. We might have b-nuts that are connecting oil supply tubes inside of a sump. Primarily, most of them, however, are outside of the engine, a little more accessible, a little more visible.

Part of the process for assembling these would be to take a tube or a manifold that has these b-nut fittings on them, connecting the b-nut fittings to the mating component, and there might be five, six, or more b-nuts on one tube. For example, there's a manifold on one of the earlier photos that you saw. There are 18 b-nuts on each one of those manifolds.

So, you'll hand connect the b-nuts first. That'll assure your manifold is roughly positioned for alignment. Then, you'll go back and you will install the clamps or whatever other devices are going to secure that to the engine and position it. Then, you'll go ahead and tighten your joints and torque your joints, and the last thing you'll do is go ahead and tighten your clamps now to secure your tube or your manifold into position.

So, there is some flexing of tubes permitted. There is a bit of alignment that these joints provide, and sometimes you'll end up with potentially a cross fitted, or a cross threaded fitting. So, those types of things are fairly easy to detect but it still on occasion becomes an issue.

When we put these together, the environment on the shop floor is that you may have a technician that's working by himself doing all the assembly, all the tightening, all the torqueing, or he might be working with a partner, more than one partner. In which case, you've got several people looking at it, several sets of hands on it, and then again, the opportunity to make a mistake when there are more people touching it is probably a little bit higher. So, there's a lot of redundant checking that we built into our process to assure that these things are tightened.

One of the other significant items to consider when you're tightening the b-nut assembly on an engine is that it's a process where you have to provide anti-torque work on the adjacent fitting while you're torqueing the b-nut. In many cases, the tube that you're connecting the b-nut to is fairly fragile and it will twist. You can damage it if you simply apply the rotational torque to the b-nut. So, you have to provide an anti-torque using a wrench. So, usually it's a two-handed operation.

Let's see. When we get done with assembly, on some occasions we are able to pressurize and test a few fittings. However, that's very rare. Most of the fittings are not able to be pressurized. So, the only test or the only inspection that we've got is you put your hands on the fitting and verify that it's not loose. That does not ensure that the fitting does not leak. That is simply to make sure we haven't missed torqueing the fitting. But, this is the same process that we've been using on almost all the engine programs that I've been tied to for the last 30 years. All right, let's go on to the next slide.

Jonathan Jakischa: Great. Thank you very much for that. We'll turn now to Kevin Andrews from NineSigma. Kevin, could you share with our attendees some additional details about this challenge?

Kevin Andrews: Thank you Jonathan. So, in looking at defining success in terms of a proposed approach, it's important that you provide confirmation that the b-nut assembly is assembled properly at the time of assembly and any time after that initial assembly. Preferably that your method would offer some visual confirmation. You could show that the assembly will still function through multiple tightening cycles of the fastener. And, your approach may include a system-level solution such as a method or process to test the entire circuit to show that it does not leak. Your method should be easy to use, it needs to be effective in tight spaces and for various sizes of fittings, it should be repeatable and reliable, it needs to have a clear path for deployment in a manufacturing setting, it should be cost-effective for wide scale deployment, and preferably, it should not require component design changes which would require recertification of the aircraft engine design. Next slide.

So, in terms of your submission, what will the evaluation team be looking at? You're going to be evaluated based on the following: greater ease-of-use, proof of effectiveness or evidence that your solution could be effective, proof that there are no false positive or false negatives, quicker time to industrialization, how quick could your solution become a standard operating practice or be commercialized for implementation. Greater ease of deployment, could it be implemented in many locations? And, greater portability that the solution could go with an individual who is moving around and doing the assembly work in the plant. Next slide.

So, what's your opportunity here in this challenge? There will be up to three cash prizes of $10,000 US each and there is a discretionary pool of development funds up to $50,000 United States dollars that can be awarded by the GE team as described. So, there could be up to three respondents that would receive an initial cash prize of $10,000 and then those initial cash prize winners would be eligible to receive additional funding for a six-month period using the total pool of $50,000 as a development award in which you could continue the development and or commercialization of your entry, provided that those winners enter into a development agreement with GE, the sponsor, and according to the rest of the details noted here. Next slide.

So, in terms of the challenge, what timing are we looking at? We launched this challenge on June 7. We are here today on July 28 conducting the webinar. The submissions for the contest are due on September 13 at 5:00 PM Eastern Daylight Time, and we intend to announce winners in October of this year.

Jonathan Jakischa: Great. Thank you for that, Kevin. Now, it's time for frequently asked questions. These are questions that have either already been asked to NineSigma or questions about NineSigma projects in general. Our first question. Where can I procure samples of the hardware?

Kevin Andrews: GE's torque spec P12TF2 lists fittings that are similar to the AN929 and in looking for AN929, you can find a variety of vendors that offer those for aviation. One example is aircraftspruce.com at the link listed (http://www.aircraftspruce.com/categories/aircraft_parts/ap/menus/ha/an.html). They offer small quantities of the aluminum tube fittings and related parts that you can purchase and actually handle.

Jonathan Jakischa: Okay, great, thank you. Our next question. Where can I find drawings of representative hardware components?

Kevin Andrews: So, along this line, referring to that vendor mentioned in the first question, they offer drawings at the following link (http://www.aircraftspruce.com/catalog/pdf/an929tech.pdf) and the two illustrations on this slide are essentially those documents with some general guidelines for dimensions and then a table of the specific dimensions for the parts as they scale.

Jonathan Jakischa: Okay. Great. Thank you for that, Kevin. Now, we're going to open up today's webinar session to questions from our attendees. Please continue to submit your questions through the Q and A chat box. This is an excellent opportunity for you, our attendees, to pose your questions directly to representatives from GE and NineSigma and to get feedback right away. We'll take the rest of our time today to go through your questions and answer them live. If, however, we don't get to your question, don't worry. Any questions submitted during the Q&A portion of today's webinar will be addressed as part of the transcript. Likewise, if you think of a question related to this challenge, be it a process-related question or a technical question, you can still get assistance and information from NineSigma. We'll have that information on how you can request those answers coming up in just a few slides. With that in mind, we'll begin with our very first question, and I think this would probably go to David from GE. Would proposals around engine hardware be accepted? David?

David Hyde: Let me take it off of mute here. So, our effort really is not to try and redesign the engine with new hardware. If there is a submission or someone has an idea, we'd probably be interested in seeing or hearing what that is. But, that is likely not to be one of the solutions that we are looking for, for our existing engine programs.

Jonathan Jakischa: Okay. Great. Thank you, David. Okay, our next question coming in right now, how do you currently assemble these fittings? I think will stick with David for this one as well.

David Hyde: All right, so, the first photo that you saw when I was speaking earlier, that showed a fuel manifold that had 18 different b-nuts on it that connect the fuel nozzles on the engine. So, as I described before, you have to roughly place the component, you have to start the fittings by hand to ensure that you're not cross threading anything, and that also gives you an indication that your tubes are aligned because alignment is important. If you start with misalignment by more than 10° or so, it will be very difficult to get that fitting to provide the alignment that you need. So, that gives you an indication that your hardware will align properly.

So, now your fittings are hand tight. They're not tightened with the tool you get. Now, you go ahead and you'll get all of your components on that manifold that are going to secure to the engine so that that tube doesn't just sit there and shake. Once those are installed and in place, then you'll go back and you will tighten your fittings, you'll perform the torque on the fittings, and then you'll go back and tighten the clamps to secure the manifold.

Now, torqueing process for that right now, most of our engine programs use something we call triple torque, and I believe that's in some of the documentation that's on the site (GE Aviation Assemblies Challenge – Supplemental Data.pdf). And, the triple torque assures some type of seasoning occurs on the fitting and it will also give you an indication if there's a problem with the hardware because you're torqueing it, you're breaking torque, you'll torque it a second time, and then you'll come back, and you'll check torque. Usually, on a manifold like this with, you know, 18 fasteners on it, you will do each fitting torque, then you'll come back, and on each fitting, you'll break torque and re-torque one at a time and then you'll come back and do a final check torque on them all one at a time. You will not do all three steps for one fastener immediately. So, that provides some level of error proofing as well to make sure that we haven't missed it simply by touching those fasteners multiple times.

Jonathan Jakischa: Okay. David, our next question builds a bit on what you were just saying about technologies and approaches that you guys have used currently for dealing with this assembly issue. What are some of the difficulties that you're encountering with current processes and technologies?

David Hyde: I guess the nature of the b-nut having a leak is the fact that it's a rare event. It doesn't tend to occur regularly. They tend to be different fittings on different engine lines. So, it's hard to identify a systemic cause. So, we don't know if there's any one solution that would safeguard against this. So, that's why we're kind of casting the net fairly wide to see what different ideas might be out there, including just inspection as well as torque application.

Some of the difficulties would be the fact that the way the engine is built, there might be several hundred b-nut connections on the engine. It could be difficult to identify to the technician who is performing the torqueing operation which specific b-nut he is supposed to be torqueing. So, there's an opportunity for someone to miss the specific fastener with all three of the torque processes. We have clearance issues on the engines because, again, these are flying, weight is a very big consideration, the tubes and connections are very tight to each other, so access to not only torque the fitting, you might only get 30° worth of rotation at a bite with a wrench because you are running into hardware beyond that. And, you also have to provide anti-torque at the same time. So, there's a lot going on in some tight areas.

And then, I mentioned earlier also there are some fittings that are internal to the engine. A very, very small percentage, but again, you want to make sure that those are absolutely leakproof so that you don't end up having to go backwards and disassemble the engine to come and address that at a later time.

Jonathan Jakischa: Okay. Our next question from our attendees, is the b-nut restricted to be aluminum or also stainless steel or nickel alloy?

Bradley Storck: Yeah, so we rarely use aluminum fittings. The majority of our fittings are Inconel or a stainless steel are the two most common materials we use on the commercial engines.

David Hyde: Primarily elevated temperatures, the environment that they have to survive in.

Bradley Storck: Yeah.

David Hyde: Okay.

Jonathan Jakischa: Okay, great. David, you kind of touched a little bit on this next question. You mentioned the tight spaces and running into adjacent hardware. Do you have approximate sizes or dimensions of the largest and smallest tight spaces that a solution would have to operate in as well as the size of the smallest and largest of the b-nut fittings themselves?

David Hyde: If you build the engine in a specific sequence, you will have access to the fittings. If you have to come back to it later and address a fitting, there might be several layers of hardware installed over the top. And so, your clearance can be greatly reduced, or accessibility can be greatly reduced. Our engineering standards on assuring we have accessibility to get tooling in to turn these, I'm not really sure.

Bradley Storck: Yeah, I think our assembly practices call for a minimum of 30° wrench sweep. So, that's kind of the tightest space we strive for. And, the second part of that question on b-nut sizes, we have these coupling fittings on 3/8 inch up to about an inch tube diameter. That's kind of the realm we use these b-nut couplings on.

Jonathan Jakischa: Okay. We're also getting some indication that some of our attendees are having some difficulties with the audio connection. We apologize for that. If you weren't able to hear the conversation, don't worry. This is being transcribed and is being recorded, both of which will be made available after today's webinar. So, if you missed out on a little bit of the conversation, don't worry, you will still have access to it after the fact. Moving on with our next question, how often are b-nut assemblies inspected after the initial assembly?

Jay Combs: So, as Dave stated, the inspection would occur, we would assume, with that third torque. That would be our check torque. From that point on, we would do a pressure check that would just look for new leaks that would be obvious in that area. That is it. There's no stripe marking taking place to indicate that it has been torqued, so there's no visual indication. It's only a process check.

David Hyde: Now, let me add to that. The engine will go through a functional test after it leaves our facility. So, the engine will indicate if we are going to have a leak somewhere. So, that will be the ultimate …

Jay Combs: That is the ultimate test.

David Hyde: We want to make sure we put that in there.

Jay Combs: Good point.

Jonathan Jakischa: Gentlemen, thank you. Okay, our next question. For how long is a single tightening of the b-nut expected to be effective? So, I guess they're kind of going at what's the lifetime of that b-nut once it's assembled onto the unit?

David Hyde: I don't think it's ever expected to disengage on its own because of the safety cable. Is there anything that you have on that?

Bradley Storck: No. I mean, from a lifetime of the engine perspective, they are designed to do just that. There'd be no replacing them at any point unless they are damaged in some sort of way.

Jonathan Jakischa: Okay. Great. Okay, our next question coming in just now. Okay. The entry requirements mentioned that a successful solution will show the assembly will still function through multiple tightening cycles. How and why do multiple tightening cycles affect the assembly's function?

Scott Jones: I'll take this question. This is Scott Jones. Throughout the engine's lifecycle, the engine has periodic maintenance that is performed where the engine will be partially or fully disassembled, refurbished, and then returned to service. So, these b-nut fittings will encounter several of these repair cycles throughout its lifetime.

Jonathan Jakischa: Okay, very good. Thank you. At the moment, we have a bit of a lull for our next question, so I will take this opportunity to remind our attendees today that this is a great opportunity for you to ask your questions to the NineSigma staff as far as process related questions on how you go about submitting your response, what sort of information you can include in your response. You can also ask technical questions of the GE staff on the call today. Great representatives to answer your questions.

So, with that in mind, we'll go ahead and proceed with our next question. With zones of difficult access, what types of confirmation that a b-nut assembly is assembled ... Excuse me, assembled properly, are preferred? Essentially, what sort of confirmation indicators are you guys looking for that the assembly has been properly completed?

David Hyde: I guess at the moment, regardless of how much access we have to the fitting, our only indication is when we first thread the fitting on, is it aligned properly? And then secondly ... I'm hearing some feedback. Okay, secondly would be the torque that we apply. So, we do have a final torque value and we break torque, we approach that torque again, we hit the final torque value, and then we'll go back and we will check torque a third time.

Jonathan Jakischa: Sorry, we seem to have lost you there shortly. Could you please repeat what you were just saying?

David Hyde: Is there still feedback online?

Jonathan Jakischa: It seems to have cleared.

David Hyde: All right. Our validation is manual... I understand there's no phone that is on in the room.

Jonathan Jakischa: Okay. Go ahead and please proceed, David.

David Hyde: All right. So, we are manually going to assemble the tube which will give us a tactile validation that we are aligned properly. We'll run the nut up, and then we will apply torque. And, using the torque, break torque, torque, and final torque strategies, that's our only indication that we've got a seasoned, good joint at that point. The next time we'll find out ... Verification will be when that engine is running at test.

Jonathan Jakischa: Okay, very good. And, David, thank you for bearing with us during those audio difficulties. Our next question, you've indicated that a failure of a b-nut is not a common event. Do you have an estimation for approximately how frequently this occurs?

David Hyde: I don't want to get into statistics on this, but there will be several events during the course of a year where we are detecting these at test. And, that’s, we've got, what, 15 active engine programs right now. So, it is not a frequent event of any kind. But, it can be an expensive event, which is what's really driving us.

Jonathan Jakischa: Okay. All right. Our next question. Why is automation not involved in this process?

David Hyde: Automation could be involved. Technology could be involved, but the challenge has always been how do you operationalize that technology? So, the engine right now is built by technicians. 95% of the torques on the engine are done with a handheld quick wrench. We have clearance issues, flexibility in terms of how many people are working on the engine. We have variation in the cycles at which the engine is being built. So, it's very difficult to build this engine like an automotive assembly line. So, we don't have a lot of automation in the assembly process of the configuration hardware, which is what this is. We do use some automation in some of the major module assemblies, some of the servo machinery assembly. But, typically not in the installation of the configuration hardware on the outside.

Jonathan Jakischa: Very good. Thank you, David. At this time, it looks like we don't have any additional questions coming in from our attendees. Attendees, if you have any questions, now would be a great opportunity for you to submit them. If you don't, don't worry. I've got some more information coming up for you on the next slide where you can request information outside of today's webinar. I do believe we have our next question coming in. Please bear with me for just one moment. Next question is, is there any indication that a b-nut is being cross threaded or is cross-threaded? Such as the b-nut seating angle being incorrect, tactile feel during torqueing is different.

David Hyde: The answer, is if you are diligent during installation and torqueing process, you should be able to detect that it is cross threaded. If you are distracted, if ... It can be missed. It's easy to miss, but it can be detected. You can feel it, you can see it, you have to look close, but it is possible.

Jonathan Jakischa: Okay. Our next question, I think we'll actually turn to Kevin Andrews from NineSigma to at least lead into the answer for this one. What is your consideration about—and, the submitter indicated industrial property, but I believe they are asking about intellectual property. Submitter, if that is not, in fact, an accurate assumption, please let us know and we can address your question again. Kevin, with that in mind, IP?

Kevin Andrews: So, along the lines of intellectual property, you maintain ownership of your intellectual property as you are submitting your response. If you are selected as an award ... Prospective award winner, you'll have to agree to the terms and conditions that are in the official rules. So, please take a look at the official rules posted on the challenge website for those details. And, if you have further questions, or specific questions, please ask us through the Provider Help Desk.

Jonathan Jakischa: Okay. Great. Thank you, Kevin. All right, at this time, it doesn't look like we have any additional questions coming in. So, with that in mind, I will go ahead and ... My apologies. We do have another question coming in. Standby for just one second, folks. Here we go. Our next question, is the leakage a visual indicator, a leakage being a visual indicator of the b-nut failure or being improperly seated on to the fitting? David?

David Hyde: Leakage visual indicator. I don't know how you would visually detect a leak unless the engine was testing. And then, you're not going to be out there seeing it. So, usually a system check will tell you.

Bradley Storck: Well, there is part of the test process to do a visual check for a leak when you first wet motor the engine on far enough. So, there is a possibility for evidence of leaking fuel or oil at that point.

Jay Combs: We also have the end process leak checks where we use nitrogen to pressurize the system with a leak tech.

Jonathan Jakischa: Okay. We do have another question. Okay. Can you please confirm that the wire lock is installed only after the system has been torqued and that it is not attached to either half of the nut during installation? Is that accurate?

David Hyde: As I understand the question, the cable is applied after torque is completed and that is usually probably the only thing we visually check at the end of the process. Unfortunately, you can also apply cable to a b-nut that has not completed its torqueing operation. So, it could be snug, and you could put the cable on it and it might go undetected.

Jonathan Jakischa: And, we have an indication that Tim would like to add something to that question. Tim, please. Okay, unfortunately it doesn't seem that Tim is able to answer at this time.

Tim Stentz: Okay, so having a slight delay. So, yes, the ... Ideally, the cable or retention feature does go on after the tightening process occurs. But, that is part of the problem and we are having this competition, essentially, for the detection of loose hardware. Which means we don't always detect it in assembly, for whatever reason. It may be cross threaded, it may be a galled-up feature on the b-nut itself. It may be not tight enough. Maybe it was two steps into the three-step process and was missed for some reason and then the safety cable was applied. So, unfortunately, it can be a false indicator of the integrity of the system. You look at the b-nuts, they're safety cabled, and maybe one of them is actually loose at the point.

Jonathan Jakischa: Great. Thank you, Tim. We do have another question. This question is, is there a target price? And, I believe the submitter is asking is there a target price for the individual solution, not necessarily the individual procedure that you guys are requesting. David?

David Hyde: I don't know if we really considered a price or a cost for the solution. I guess it would depend on the nature of the solution. But, a more preferable solution would clearly be something we could buy many copies of, use it widely across our assembly sites, possibly even in the field. So, cost or price would certainly be a consideration. I don't have a numeric value.

Tim Stentz: This is Tim Stentz. I'll add on to that. And, this is why a robotic or automated solution is somewhat less preferred in this case. It's certainly possible to design a system that could mechanically or automatically install all of these fasteners on an engine. That price would be super high, and it would be tailored for that particular type of engine. And, likely, you may only have one or two copies of it. So, in the case where, for example, you have a high-volume engine and you may have a dozen parallel lines working to build engines, it would become not feasible to install a dozen copies of that highly automated system. So, as Dave indicated, the more portable nature, the less expensive, the better in this case because of the diversity of b-nuts that occur across the mix of engine models that we make.

Jonathan Jakischa: Great. Thank you, gentlemen. Okay, we seem to have gone through all the questions that have come in. We do have a request for the link for the b-nut dimensions. That will be made available following today's webinar. Thank you for that request. With that in mind, we'll go ahead and proceed with closing up today's webinar with some reference material as well as sources of information for you if you need assistance outside of today's webinar.

So, what can you do today? Attendees, you can obviously visit the challenge page, GE Aviation Assemblies Innovation Challenge page on NineSights. You can visit that by going to ninesights.com and looking at the contests tab. While you're at NineSights, you can register with the community. That will enable you to receive updates about new projects that are coming online.

Now, say you need some assistance outside of today's webinar and you want to know how you can request additional information, be it process related or technical. Your first line of information is to contact the NineSigma solution provider help desk. You can reach them by email or by phone. The email addresses phd@ninesigma.com. Once again, it's phd@ninesigma.com. Likewise, you can reach out by phone at 216-283-3901. The number once again, 216-283-3901.

The last piece of information on this page here is very, very important. The deadline for submissions. The deadline is Thursday, September 13, 2018 at 5:00 PM Eastern time. Please be sure to submit your proposals in advance of that 5:00 PM deadline. We won't be able to accept late submissions, so if you find yourself needing assistance, please be sure to reach out to the Provider Help Desk as soon as possible so that we can get you the assistance that you need to ensure that your proposal is received on time.

Once again, today's webinar was recorded. The transcription and recording of today's webinar will be made available on the challenge page very soon. So, thank you for your patience while we get that together. So, that will conclude today's webinar. To our many panelists from GE, thank you for your time and expertise. To Kevin Andrews from NineSigma, thank you for joining us as well. To our attendees, thank you for your time and we look forward to reading over your proposals. Thank you all very much. Have a wonderful day.