National Oilwell Varco, Inc.

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Technology Leadership

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Hege has over 20 years of engineering and product management experience, contributing to quality assurance, research and product development for NOV. While at NOV, she has contributed to the design and development of new products such as mud pumps, permanent magnet motors and heave compensation systems. She has authored numerous SPE/IADC papers, as well as two textbooks on Offshore Hydraulics. In 2001, Hege became Corporate R&D manager at NOV before transitioning to her current position in 2009.

Well, I need to start by warning you guys because I'm from Norway, so if you don't understand my accent, there is absolutely nothing I can do about it. I also get into the presentations when I get started. There are few words that's difficult for me to pronounce like collaboration and commercialization. There you go, I still can't do it, but you will understand what I'm saying hopefully. We'll take it from there.

As I see it, I'm going to talk about the most exciting stuff. The whole day is new technology and the fact that we are a technology leader in our industry. When we talk about leadership or in the technology world, it's not only about the products that we manufacture and sell to our customer and the services, but it's also how we do it internally, how we are a great manufacturer as well and how we're able to make sure that we maintain the leadership, technology leadership also internally in the processes and ways that we're doing that. You heard earlier today, what we are and the slogan that we have. We do what we call purposeful innovation. As an engineer, I want to develop everything. Unfortunately or maybe luckily, we don't have resources to do that. We need to make sure that we put our money and resources and people into the right projects. If there's new product development, we need to make sure that it is a customer on the end that we actually can sell these equipments and that we make sure that we get the best return on our investments that we can.

We do have an innovation culture in NOV. We have been the first out with a lot of the products that today are what I'd say industry standard. The Top Drive, for example, was developed or introduced in the market in '83 by Varco. That's really changed the way that we're drilling. If it had not been for the Top Drive, we could not have done, for example, the shale drilling that we're doing now with long horizontal wells. There is no way that we could have done that. Of course, the picture that you see here is a Cyberbase chair, and I have to have that there because that was introduced in '94 by Hitec, and I'm sort of from the Hitec legacy. This is also industry standard. We've delivered almost 1,000 of these chairs now. They are all over the world and all of the rigs, we have these types of chairs.

On the top drive side and Joe Rovig will tell you more about this tomorrow, but we actually have almost 3,000 top drives out there. Two years ago, we introduced the first 30,000 psi wireline pressure control systems. 30,000 psi pressure, that's a very, very high number and it's been in operation and by the way, API is now raising the standard. API is American Petroleum Institute according to how we defined it. We are also the industry standard in that currently. We are continuing to push that. We will continue to come out with new products that will be the industry standard for saying what I talked about today will probably be what we definitely are doing five years from now.

This is a true number. We have 6,500 engineers almost in the company. Unfortunately, most of them don't work for me or maybe luckily. Most of them work in the business units. It's the business units' responsibility to actually develop new products and new technologies within their business unit. Again, we come back to the purposeful innovation because they know what the customer wants. They're much closer to the customer. They can focus on what's important for them.

Where do I come in? Why do I have a job? The purpose here with 6,500 engineers, how can we collaborate, how can we make sure that we leverage the knowledge that we have all over the world? One example is elastomer and I was told that I should tell you finance guys that elastomer is the fancy word for rubber. I know I said that, I will use elastomer afterwards though, but that's okay, all the different business units are using elastomer in one fashion or another. For example, the Blowout Preventer Group, when we are sealing around, when we're closing the rams and closing around the pipe, that's elastomer that's doing that and doing the sealing.

In our downhole motors in the NOV Wellbore Technologies, we're also making sure it's elastomer inside the motors. We're using elastomer in the pumps and valves when we are in the completion and production and also the flexible risers, that's elastomer. We're using elastomer everywhere. So, what? Well, elastomer doesn't like high pressure. It doesn't like high temperature. It doesn't like low temperatures. It doesn't like nasty materials like H2S and stuff like that. By the way, that's the challenge, that's the type of equipment we make.

In order to make sure that we can collaborate across the business units, across borders, we need to have a system in place where we can do that. I guess that's where me and my group comes in. We are a relatively lean organization in corporate, and we want to stay that way. What are we doing? We are arranging what we call technology forums where we get people, either we get them to Houston or to Denmark or wherever we are, and we have small meetings where we discuss elastomer or instrumentation or corrosion or all the challenge that we have on the technology side.

Another thing that we have is something that we call Technology Village. Technology Village is an online system where all the engineers in all of NOV can go in and say I'm an expert in elastomer. I use that as an example again. So I'm really good there and by the way if you have any questions, you can pose that question out there and I will answer you or I can shoot up frequently asked questions and things like that, so this is a way for us to leverage all the knowledge that we have, so we don't invent the wheel again, because we probably have somewhere else in the organization that has seen this challenge already and we can help them.

We also have a system, where we are capturing ideas, and this is a system we call NOVel idea and here it's not only the engineers that's talking together in an online environment, everybody can add an idea here. If you're an engineer or sales person or service person or whatever you are, you can add an idea in there. I guess you can even be finance, not sure about that, but you do have access though.

We evaluate the ideas or the business units evaluate the ideas on a regular basis and they take one or two or whatever is the good idea and then move it into the new product development process. All the ideas, by the way, will remain in the idea bank. So, if there is one idea, that is maybe not ready yet, we should wait a couple of years. We still have the idea there. So, we can pull it up whenever we need to.

The developing ideas or NOVel system is our new product development process and it's using Stage-Gate process, but this process ensures us that it is the best project or product that we are developing. Again, the purposeful innovation, we don't have capacity and we should not go after all the ideas, we need to go after the good ideas. Every idea that's going through and into the development phase, we do have a business plan. We're teaching the engineers and by the way, when we're developing the business plan, it's not only the engineers being involved, it's marketing people, sales people, manufacturing people, operation people, everybody to make sure that we are making the right decision and start spending money on making a prototype and then launching it to the system.

Here is the really difficult word again, commercialization. Lydia talked about it, we have different training classes internally in NOV and this is what we call NOV Ventures. This is where we bring our technical people into our one-year program. We have four modules, each module is one week, and we trained engineers, who are starting to develop new ideas, but also to make sure that we have the idea go through a business plan. Finally, we need to get it out in the market with the commercialization side. Every idea that is going to be our product has to go through this process.

Here we are in Houston last week I think, where we now have the fifth class that we are putting through this program. We have between 40 and 45 students every time and we are working with the University of Texas, which is really, really good in this aspect. Several products that I will talk about later on that links to automation has been evaluated by this program and that's NOV's products actually being out in the markets and we're making money on them already.

This is a way to train engineers that we are doing the right thing that we're not just going off of the coolest, nicest thing, we need to make sure that we are making money on it first. We are putting a lot of effort into this and we even have our CEO presenting for the class and of course that's always something that everybody likes.

The next I'm going to talk about is the university partnership and there are several ways that we can work with the universities. This is actually from Trondheim, Norway. This is where I got my Master's degree in engineering. I am almost feeling like old now. What we did here was that we partnered with the student organization. In Europe, there is a big competition every year. It's 95 universities being a part of this and they're coming together and its 3,000 engineers or students being enrolled in this. They compete with them on who can make the coolest thing and since we are the main sponsor, we could actually say this is what you're going to do.

Some of the technological stuff that you will see here, they are actually making a blowout preventer handling system and they are also

making an autonomous rig. This is one way of working with the universities. We're also working with MIT, training our engineers that are senior engineers on the more specific topics. We're working with the universities when it comes to research development, that we want to have done. We are working with universities. We are teaching the students about the drilling, but the main purpose there, that's actually the autonomous rig. It's supposed to stop within the red line and did, so they were successful. But again, it's all about making sure that the students really like our industry and that they would love to come and work for us. If we can do that and develop new products at the same time, we are free to do that.

As I mentioned in the beginning here, purposeful innovation or technology leadership is not only about the products that we get out there, but it's also about how we are doing it internally. Process excellence and manufacturing excellence is very important for us. If we can do it smarter and save $1 on how we are manufacturing and we can sell it for the same price, you know probably better than me that that's $1 on the bottom line.

If we can really increase this, it's very valuable for us. When it comes to process excellence, of course we are traveling around to the different facilities and we are implementing Six Sigma and Lean manufacturing, cellular manufacturing. This picture here is from our flexibles plant in Brazil. If you also have been into the flexibles plant in Denmark, you will see that the layout of those two manufacturing plants, even if they're making the same product is very, very different, because the one in Brazil is brand new and they have optimized the sign on the layout of how we can do that.

Another thing that we're doing is that we have something called [AIMS], which is monitoring the machines. All the machines that we have internally in all our manufacturing facilities all over the world are monitored. We can now, if we have a bottleneck in the production, go in and say okay, we need to replace this machine or we need to do something else. We have almost 50,000 machines in the system. We can even compare onefacility to another facility and then we say okay, this facility is performing a little bit better, how can we get this one up to the same level?

The good thing of doing that the one that's doing the best manufacturing starts to compete for what he is doing, even a little bit better on that and that's how we continue to improve ourselves. We are manufacturing a lot of different stuff. We're making everything from control systems to artificial diamonds that we use in our drill bits. We're making fiber glass pipe, we are making blowout preventers that weigh 500 tons, I mean metric, not in that stuff that you guys are using over here, but when we are doing this -- and it's also important to make sure that we are actually implementing new technology when it comes to the production time or the production phase. How can we do it faster? How can we do it smarter? Is there anything that you can change in the material, for example, that will make it easier for us to produce faster? This is constantly a focus for us and all the business units have their own manufacturing excellence group that's really looking into this and we are absolutely focusing on it.

By the way, being best in manufacturing is also a competitive advantage and we really try to continue that. I am saying that this is definitely a competitive advantage. This is the coolest slide I have just so you know it, because this shows something that no one else in the industry can say, we have everything. We have everything from the drill bits, all the way off to drill strings and that can be a normal drill string or it can be a wider pipe, we have the top drive, we have the drawworks, we have the mud pumps, we have the pipe handling equipment and we have remote control systems and we have the brain and the brain is the blue thing there which is the control system, which really links everything together. No one else can say that they have everything from the drill bit and all the way to the top.

You've heard that we say that we have automated systems and it's always a definition of what's automated. I would say, we have had remotely controlled systems and we have had semi-automated systems for many years because what we are doing is that we are sitting very comfortable in our driller's chair, the Cyberbase chair, and we're remotely controlling all the machines from this chair. What you're seeing here is something that you call multi-machine control system. This means that one guy sitting in the chair can operate eight machines with use of one joystick. By doing this, we can optimize the process. Our control system and our software can do this much more smoothly than one guy, so this means that we can trip in faster or we can trip out faster. Under the well is 20,000 feet or 30,000 feet long. That can take days to actually trip out of the hole, change the drill bit and go in again. This means that we're saving the operator and drilling contractor a lot of time on the rig. If we can do this more efficient, we are helping the customer.

When it gets really exciting, because the multi-machine control we have had for three years or maybe more, is when we're connecting what's happening downhole to topside. What this is showing is a pipe that we call IntelliServ pipe and it's actually a drill pipe that has a coax cable inside it and it transmits data to the surface up to 2,000 times faster than what we used to. What we are normally doing is using mud pulses and using sort of a more signal sending it up. Here we have a coax cable, so now we're introducing Internet to the downhole well. This means that we now can have sensors down the hole that actually is sending real-time information to the topside and we can control the drilling

machines, meaning the top drive, the drawwork and the mud pump automatically from what we're seeing here. We're doing this already, but we just started this adventure. This really changes the way we're drilling. This is the new big step in drilling and drilling optimization which is to link downhole and topside.

What we are doing now is making machines smarter. This is of course our top drive again, we love that machine. The challenge when we have a 20,000 feet long well and/or even 10,000 feet long well, it doesn't need to be that long and we have a long horizontal well, it's a lot of friction down there and that drill string that long actually acts like a spring. What we do when we have that, you will see the top drive is actually rotating at a constant speed, 60 RPM, but if you see the drill bit is actually stopping and then it spins off very, very fast again and it stops on that part doing it. This is something that we call stick-slip. You can imagine that by having that happening downhole, we don't drill as soft as we could have.

By the way, the driller probably doesn't even know that they have this stick-slip. Because of what he sees on the top side is that the top drive is rotating efficiently. What we're doing here is that we are making drilling applications, drilling apps to help them solve this problem. What you're seeing here is what we call a comprehensive well model, it's a mathematical model that we can -- and we program all this into the software, so we can get rid of the stick-slip. When you see the blue line now in the middle here starting to move, imagine that if the drill string itself -- in this case, it's 3,200 meters and see now you are in feet, it's more than 10,000 feet. It has a constant speed at the top but at the bottom, it's really fluctuating. Going from zero to up to 130 RPM downhole. If you have used a drill and you have all that happening, you know that's not very efficient and that's what's happening here, you have the stick-slip.

Of course we can push green button saying soft bit, which is our product name. We will eventually see that we get rid of stick-slip through vibrations. An experienced driller should maybe have solved this but an inexperienced driller didn't have the clue that they have the problem in the first place. We're really putting smarts into the machine now to help the driller drill faster and to not get so much wear and tear on the equipment downhole, so we can constantly help them do a better job and that adds value to the customer. Other things we can do here, we can find out what the downhole pressure is and we can detect if we have an early kick detection and things like that. We're making a lot of drilling applications around these things.

So far, I've talked about drilling, but I have not forgotten about completion and production either. Here you see a picture of our shale play and you see a lot of equipment. I'm convinced that we also can do a lot more automation in the completion and production wells. What we have already made semi-automated, it's actually the coil tubing units that you see here. It's what we call the Amphion control system. By the way, the control system there is actually based on the control system that we have on our land rigs and so we're not inventing the wheel again, we're just using the same technology, transferring it to another business unit and can reuse it.

But what's interesting here? You see all these machines and the way they're communicated today is via walkie-talkie and saying "hey dude, open up that valve or close that valve," or it's not automated at all. We think that we can help the customer again to automate and making sure that the machines talk to each other so that they can do it more safe, more efficient and faster than what they have done so far. There is a buzzword, and I'm sure you've heard about it too and that's called big data. On purpose I didn't want to use big data but that's actually what it is. It's got a lot of data. You've seen now that we are actually starting to gather a lot of data from downhole. We are sending up much more data even from the downhole about the well, we're also getting a lot of information from the equipment that we have and we have a relatively large installed base of equipment.

If we're gathering all this data, there is a lot of data. We send them out to this big data center, and by the way if we don't do anything with that data, it's not worth anything. The whole thing with the big data is to make sure that our system can analyze it because we are too slow to process all that big data, so we need to have systems in place so we can analyze it, and that's what we're doing here. The machines can identify something is wrong. We can go in, we can dig into the problems and we can see that we have something with this top drive, maybe our bearing is starting to get worn out so we need to change it for the next rig stop or whenever they have a drilling stop. This is also our big initiatives that we're working on now. We know there's going to be more data coming in and we as humans are not smart enough to absorb it, so we need the machines to help us there.

This is my new playground. I hope to get an office out there and you see it's -- I was going to say it's almost like Norway, but it's not. We actually have hills and mountains and stuff. This is our new test facility, R&D technology center. It's out close to Navasota, so it's a one hour drive from here. What this will give us is the ability to test the equipment wells, which we've done before of course. We can test the equipments together so we can have system integration tests. We can test all these drilling apps that we're developing now and connecting what's happening downhole to the topside. I hope to get an office out there soon and we can test and play and this is really the playground for engineers, so I'm looking forward to that.

Technology leadership, what that means for us, definitely purposeful innovation, make sure that we put our money in the right projects, in the right systems. We do have an innovation culture that we have put a lot of processes and systems in place to make sure that we continue doing that. Finally, we are making the machines smarter and that will give us a competitive advantage compared with competitors and we really think that that is the future to make the machines smarter. Thank you.

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