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LUT / The Switch podcast
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Today, we will discuss the development of electric drives and the long-term cooperation between LUT University and The Switch. This cooperation benefits both parties and shows how academic research and industrial product development can create internationally competitive technology. The topic is highly relevant today, since industry's green transition requires more energy-efficient electric drives.

I am Pia Lindh and joining the discussion is Technology Director Panu Kurronen from The Switch. Panu's discussion partner is Professor of Electrical Engineering Lassi Aarniovuori from LUT University. Shall we start the discussion with how this cooperation began?

That works well. Everything goes back to the 1980s, when Juha Pyrhönen wrote his doctoral dissertation on solid-rotor machines. He was appointed Associate Professor, if I remember correctly, in 1990. By a chain of coincidences, I became his first assistant. Naturally, my duties included the calculation of solid-rotor machines. So, things started as research at the university. In my case, that continued until about 1995. After that, I left for a while. Then, Jarmo Alamäki, who had previously worked in high-speed technology, founded Rotatek Finland. He decided to apply the research done at LUT and turn it into commercial products.

Panu, could you start by telling us what kind of company The Switch is?

Today, The Switch is a company of about 220 people that operates mostly in global markets. We don't really have domestic customers. And those domestic customers who receive our products mostly export their end products abroad. So, from the perspective of Finland's economy, we are quite significant because we are fully focused on export. What we make are electric drives for special applications. We don't really operate in standard markets, such as standard electric machines or standard frequency converters. Instead, we focus on cases where our solutions can be applied to special applications.

What was the early phase like? The company had been founded, but there wasn't yet much staff.

It was basically a company with one permanent employee and a few temporary workers. If you bring a completely new product to market, you need to handle purchasing, sales, assembly, testing, deliveries, maintenance and commissioning. That can't be done by such a small team.



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How did the growth start?

This work continued from 1996 to 2000. In 2000, I returned to Lappeenranta under Juha Pyrhönen again. Juha raised a concern that the technology he had developed would not take off unless more momentum was put behind it. So, some of us from the Department of Electrical Engineering invested in Rotatek. A couple of smaller companies and LUT's Research Foundation also joined to support it. Together, we acquired a majority stake in the company. But most of us continued working normally at the university. So, it didn't make the practical work much easier. Perhaps it improved the financial backing a bit. Soon, we realized that things would not really move forward unless we had big industry players behind us. So, we started looking for a potential partner. Eventually, we landed with Vacon, and they decided to invest in us. That's when we were able to move ahead more effectively.

What was VNT Management's role in this?

VNT Management came into the picture somewhat later. We operated as part of the Vacon Group roughly from 2001 to 2003. Vacon New Technologies (VNT) Management was then founded to invest in new-technology companies. We were one of their investments. Later, The Switch was created.

How did that happen?

The ownership base was largely the same across Rotatek, Verteco, a Vacon spin-off based in Vaasa, and Youtility in the United States. All three companies worked in electrical engineering, mainly in the field of renewable energy. The owners concluded that it would be easier if these three companies were placed under the same umbrella. So in November 2006, it was decided to establish The Switch.

What role did the university have in The Switch's early phase?

As I said, the starting point is entirely at LUT. Practically everyone who was in the company up to 2006, when we were still small, was a LUT graduate. Tekes projects were carried out together. A lot of technological support, including testing, calculations and design-related details, was done in close cooperation with LUT to get operations off the ground. In 2003, permanent magnet technology was also introduced. This was partly part of our own history, but it had been researched at LUT at that time. From there, we moved into so-called bigger boots and started making large permanent magnet machines.



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Now, The Switch is a large company. What has this growth story been like?

Over the years, our biggest challenge has been being quite dependent on one large customer. The real growth started from wind frequency converters, with China as the main market. We grew very quickly from a few hundred thousand to over EUR 100 million in turnover. Machines came along as well. We made several different wind power drives. Both frequency converters and machines. Perhaps from Lappeenranta's perspective, a major achievement on the machine side was ScanWind's 4 MW direct-drive wind generator. It weighed about 90 tons. Our leap was from a couple of tons to 90 tons. We stepped into quite big boots. We took risks. And VNT Management played a big role, saying let's try and see how far we get. It will either succeed or not. In hindsight, we can say with satisfaction that fortunately it succeeded.

Let's move on to The Switch's products and cooperation with the university. What kind of technology or products has this cooperation advanced?

Our first joint Tekes project was launched already in 2002. The university supported us, and we started to develop solid-rotor machine technology. That was our mainstay for a long time. We made machines ranging from a few hundred kilowatts up to several megawatts. In the speed range of about 10,000 to 15,000 rpm. This was specifically LUT's core technology. LUT's expertise played a major role not only in design but also in the actual manufacturing of these machines.

Why is high-speed technology competitive?

The breakthrough of the high-speed technology market has been expected for 30 years. And perhaps we are still waiting. It is a very promising technology and makes the operation much easier for the customer, because no gearbox is needed. You need less space and can operate at the same speed as the driven device itself. But the problem is that it is new technology. Therefore, entering the market is more challenging than with well-known technologies.

Listeners may not know what applications these high-speed machines are used in. Could you explain that a bit?

Most of our machines have been used in various compressor applications, including over-pressure and vacuum applications. But there are also test devices and energy storage systems. The range is actually quite broad. But the main application area is definitely different types of compressors.

How do you see the future of high-speed machines? Will their use increase or decrease? Or will new fields emerge where they are applied?



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I would say that the green transition will be a strong driving force here. As we move away from fossil fuels, heating systems need to change. Large heat pumps are a good example. They run with compressors at about 10,000–20,000, even up to 30,000 rpm. When this new technology is needed, one option is to use geared drives, which make systems large and expensive. The other option is to use high-speed technology and achieve smaller – and fully speed adjustable – units.

You mentioned that The Switch has developed permanent magnet synchronous machine technology extensively. What are the main applications?

For us, it has been very much related to wind power technology. For example, generators for large wind turbines. But we have also had other applications. One example is an energy storage system using compressed air. A large diesel engine block was used as a piston compressor to charge an air reservoir. Then, when the air was released from the reservoir, the same unit was used as a piston engine driving a generator. So, energy is stored in the system as compressed air. There are also a few other energy storage systems and various renewable energy applications, such as tidal generators and wave power generators. Now, we are also actively looking at industrial applications where our technology could be used.

You already talked about research projects. How has LUT supported The Switch's development over the years?

The Switch has participated in nearly twenty Business Finland (formerly Tekes) projects. LUT has been involved in most of them, either as the main applicant or as a research partner. This has been a very significant contribution to our product development. Without it, the situation today would be quite different. Of course, as the technology has developed and matured over the years, we may no longer need the same level of support. But especially in the early phase, LUT's help was absolutely irreplaceable.

Can you give some examples of these research projects or their results?

They have focused on developing solid-rotor machine technology, its bearing solutions and cooling. On the permanent magnet machine side, large structures and how they should be implemented have been studied. For frequency converters, our other main product area, quite extensive research has also been carried out. Not all research leads directly to products, at least not immediately. Sometimes, the situation changes a few years later. In some projects, we have concluded that the technology is good, but too expensive at the time. When component prices change, a technology that was previously too expensive may become viable.

What other cooperation has there been besides these research projects?

Our R&D team has about 40 people working on the design of frequency converters, permanent magnet machines and solid-rotor machines. Everyone in this team has at least



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an engineering degree. Most are M.Sc. (Tech.), and there are also people with postgraduate degrees – both doctors and licentiates. About half have graduated from LUT or Lapland. Roughly speaking, about 25% are engineers, about 50% are M.Sc. (Tech.) and about 25% have completed postgraduate degrees.

This is a considerable human capital contribution to design. And it comes specifically through this route. It also helps that LUT is a so-called industry-friendly university. When projects are carried out, they are not done solely from a basic research perspective, but also with an eye on practical applicability for commercial use.

The Switch has supported LUT students' career paths into business. As you mentioned, you have many LUT graduates. How many summer trainees or thesis students do you usually recruit?

Last summer, we had four summer trainees from LUT just in our department. They were doing design work and tasks such as electrical calculations, thermal calculations and mechanical design. For junior students, we also have assembly work. We start from the basics. You don't begin with design. First, you see what is done and how it is done. After a couple of years, you may do more than just assembly work. There is a wide range of tasks related to testing, design and assembly. Across all three Finnish sites, we have about 10 positions open annually.

Where are your sites located?

We have two factories, in Vaasa and Lappeenranta, and our head office in Helsinki. Vaasa and Lappeenranta are roughly the same size, with about 70–80 people in each. Helsinki has about 20 people. We also have a couple of sites abroad, in Norway and China, with a total of about 50–60 people.

I understand that you try to build a continuous path where summer trainees become thesis students and the cooperation continues. Is this your practice?

Absolutely. We operate in such a narrow field that it is often quite difficult to find ready-made experts. It is therefore easier to bring in students and let them grow into the role, starting with summer jobs. After that, they may move into longer employment, do their master's thesis and grow into the roles we have. This is good for the employee, but also for us, because finding ready-made experts for specialized tasks is difficult. There is not always formal training for all these roles. So part of the training must come through doing the work. Summer jobs are partly training. They are the onboarding of new employees.

You mentioned that you have many PhDs working for you, and a PhD involves a dissertation. Do you currently have any dissertations in progress?

We currently have one doctoral researcher and two master's theses underway.



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How do you see the cooperation at the moment? Could it be expanded, or is it fading?

This is actually our first dissertation carried out alongside work. Until now, all our PhDs have joined us already as doctors. In that sense, this is somewhat new for us. But it certainly increases our knowledge and understanding of the things we do. It is challenging for a person to start a dissertation while working. That may be the biggest hurdle, because it requires a lot of dedication to the dissertation in addition to the job.

At the university, we have discussed a lot about how to motivate company employees to do dissertations. How have you arranged this? Do you, for example, allocate part of working time to scientific work?

Yes. It depends on our normal workload. But in practice, one day per week of working time can be used. It can be used for a dissertation, a master's thesis done alongside work rather than on a scholarship or even a bachelor's final project. Typically, one working day per week can be used entirely for this. And the rest is done in one's own time.

There is also a steering group for coordinating LUT–The Switch cooperation. How does this steering group support LUT's research or projects?

The Switch has been a LUT key account for about five to six years. This cooperation includes annual planning where we discuss recruitment, studies and research projects. We also look at how we can jointly promote these and create mutual benefits. Not only for us but also for LUT. Cooperation must always be two-sided. If only one side benefits, it is short-sighted.

How often does this steering group meet, and who are its members?

We actually have several different steering groups. There is a group for teaching cooperation, where researchers from The Switch give industry-based lectures. This group looks at where we can provide support. Another group deals with research projects. Then there are separate groups for recruitment and summer jobs. On top of these, there is a joint management group. These groups meet once a year, review what has been achieved and decide what should be done in the following year. We move forward on an annual basis.

As you said, both sides must benefit from cooperation. How do you see the advantages of close cooperation between academia and industry?

It is mutually beneficial. But perhaps we have a better opportunity to support LUT in development projects by bringing an industrial perspective. This includes assessing whether ideas are commercially applicable and whether there are customers for them. We can also point out if something could be done differently technically, or where we see risks, for example, in manufacturability. It is common for university research to be purely scientific



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and not see practical issues as clearly. An external party working with these things daily can spot pitfalls that may arise and help steer projects in the right direction.

Information is exchanged between university research groups and your company. Have you seen any difficulties in this information exchange between academia and industry?

I wouldn't say there have been any real difficulties. Of course, it requires close cooperation. Steering group meetings are typically held every few months. Our own work is quite busy. So it perhaps requires more initiative from the university side. If help is needed, they need to be able to ask.

University research must be at a level that benefits you. How is this ensured in practice? How are research topics developed together?

Quite often, we are asked in advance whether a proposed project topic would be of interest, and we can comment at that stage. We also have the opportunity to propose topics that interest us and where we would like academic research as a basis before applying things in practice.

Do you think the quality or expertise of university research has increased through this cooperation?

I strongly believe so. It is clear that the range of topics has expanded. For example, in solid-rotor machine technology, a lot of research has been done on new bearing solutions. These are a prerequisite for new applications. A spin-off from LUT in this field is also an example of this.

This cooperation accumulates knowledge and skills in the community. How do you see the continuation of this knowledge accumulation?

It naturally requires more joint projects. I would say the biggest contribution we can bring to university research projects is practical applicability. Ensuring that research produces knowledge that is genuinely useful for industry. As I mentioned earlier, LUT's strong capability for industrial cooperation is very good for us.

LUT's Department of Electrical Engineering and the electric drive laboratory are globally known for high-speed electric drives.

Tests that could not be carried out at The Switch's own facilities have been done at LUT's laboratories. This includes endurance tests where devices are stressed to see how far they can be pushed while still operating. This is a good example of how we can compare calculation results with reality and see how well they match.



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LUT now has a high-speed test facility. How do you see its necessity?

As mentioned, we have already used it at least once, and probably several times. It is not needed constantly. It is needed when we examine something new or verify our calculations. It is absolutely essential for us.

Cooperation has taken place on many fronts, but could it still be developed further?

We have been cooperating for over 20 years across many different areas. Our mutual advantage is that people know each other well. That comes partly from student days, but also from these joint projects. This makes cooperation quite easy. If there is a need, we know whom to approach and how. If we think about developing our cooperation further, it is more about fine-tuning than major changes.

Academic applications often require letters of support and recommendations. How have you approached these?

Generally, very positively. We usually don't refuse them, especially if they seem to support our work and future development. We are happy to be involved. That's important to us.

If we move to electric drive research, what broader research themes or areas do you think LUT should study?

If we consider our technology, I think we are already at a fairly good level technologically. The bigger issue is finding new markets and applications where the technology could be used. For this, we have sometimes asked for help with market studies. This is not purely a commercial matter. You must also understand the technology and think about the applications where it can be used. In addition to identifying players, you must also understand where the technology is technically applicable, so you know where to look for opportunities. That is perhaps the main point. There are also individual product development topics, but we cannot really discuss those publicly.

How do you see The Switch–LUT cooperation ten years from now?

Hopefully, we will be at roughly the same level as now. And hopefully, we will also find new things to develop together.

As we heard, long-term cooperation has benefited both parties and will continue in the future. We encourage companies to contact the university for cooperation without hesitation. Thank you to our listeners and guests.

Thank you from my side as well.

Thanks to everyone!