1968–2016 • THE ASSOCIATION FOR SURFACE CHEMISTRY RESEARCH

FYF

SURFACE TO SUCCESS

LONG STORY *Paint research that improved the environment*
AROUND THE WORLD *An international perspective on FYF* **INTERVIEW** *Academic big shot with an eye for industry* **SHORT STORY** *Research as commercial development* **LONG STORY** *Loyal partnership contributed to a durable material*

WELCOME TO A MAGAZINE dedicated to stories relating to the multifaceted activities of The Association for Surface Chemistry Research (FYF). Here are opening remarks from FYF as well as SP Technical Research Institute, who also supports the magazine.

The spirit and regulations of FYF as an industry member organization referring to The Institute for Surface Chemistry (YKI) has been to promote technical and scientific research and to disseminate information within the field of applied surface chemistry in industry.

Kicked off by the amendment of YKI to SP in 2012, FYF started a process of closing down. The FYF Board initiated a voucher program for members to undertake research projects with Swedish research institutions, and notably SP. A surplus of the FYF capital was left after end of this voucher program, and the idea came up of using the remaining capital to bringing forward stories relating to FYF activities.

The intentions of the FYF Board were to capture some of the essence of how FYF operated in the cross-field between industry interests on product innovation & development and basic research. It is our hope that via sharing FYF stories about scientific achievements and personal testimonies on collaborations that we may be offering, to a larger audience, examples and reflections for inspiration to industry, academia, society, as well as to the thinking on private-public-partnering (PPP) in general.

We would like to thank SP and Monica Axell (head of Department of Chemistry, Materials and Surfaces) for generously sponsoring this communication effort. We are also grateful for the kind assistance to this project of Annika Bergström (project administrator at SP).

On behalf of the FYF Board,
Thomas H Callisen

As an innovation partner SP perform research and innovation together with, and often form the vital link between industry and academia. SP's mission can only be fulfilled by intimate cooperation and collaboration with industry.

It is therefore a pleasure to see that our collaboration with FYF has generated new knowledge and innovation, and provided benefit for the member companies of FYF. Participation in a shared network provides further advantages in terms of exchange of ideas and experience, and the ability to jointly meet common challenges and needs. SP continue to expand our activities in the fields of Chemistry, Materials and Surfaces. We are becoming increasingly cross-disciplinary in terms of both science and technology. There is no doubt that this will become increasingly important in our work with novel materials and surfaces, a topical illustration of which is the integration of these subjects into an understanding of haptic perception. Key future research areas are Life Science, Nanomaterials and Biomaterials for the Circular Economy.

In the context of a united institute sector in Sweden, we anticipate a continuation of this collaboration with the industry in the future. In addition to our existing deep knowledge in Chemistry, Materials and Surfaces, we will be able to leverage the additional competence to offer an even more varied and cross-disciplinary portfolio.

Head of Chemistry, Materials and Surfaces
SP Technical Research Institute
Monica Axell

FYF–The voice of industry at YKI

The Association for Surface Chemistry Research, FYF, was the non-profit industrial association at YKI. Its prime objective was to promote technical and scientific research in applied surface chemistry. Members of FYF were YKI's most important clients and industrial partners. Membership was open to any company or organization interested in surface chemistry research.

The organisation of FYF changed somewhat over the years, but its prime objective dates back to the formation of YKI in 1968, when the precursor of FYF was formed.

TIMELINE

1963
The Laboratory for Surface Chemistry (Ytkemiska laboratoriet) is founded by The Roya l Swedish Academy of Engineering Sciences (IVA). The purpose is to promote co-operation between industry and academy within the then emerging field of surface chemistry.

1968
Birth of YKI. The laboratory is transformed and the Institute for Surface Chemistry (Ytkemiska institutet, YKI) is created.
The precursor of FYF is formed – The Foundation for Surface Chemistry Research (SYF). The initial members of SYF is a limited group of Swedish companies.

1970s
The industrial group expands outside Sweden to include companies in the Nordic countries

1980s
Further expansion of industrial members within the Nordic countries.

1990s
First members in SYF from European companies outside the Nordic region.
During second half of the decade the first US companies become members.

2001
YKI is re-organised to become a limited company, YKI AB.
FYF (60%) and Swedish government via holding company IRECO (40%) are co-owners.

2005
YKI AB joins SP Group. FYF sells its shares in YKI AB to SP.
Revenue is invested in novel instrumentation at YKI..

2013
YKI AB merges with SP Group to form a new unit, Materials, Chemistry and Surfaces within SP.

FYF TIMELINE

1995
The member organisation (SYF) is transformed into the association FYF. This is due to changes in Swedish legislation.

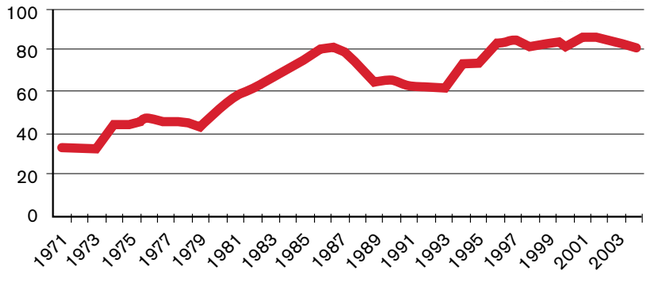
2016
Last annual meeting for FYF members
FYF ceases to exist as an organisation

MEMBERS OF THE LAST BOARD OF FYF:

Günther Lanzinger
TetraPak (chairman)
Thomas H Callisen
Novozymes
Magnus Linsten
AkzoNobel
Roland Ettl
BASF
Göran Bengtsson
StoraEnso
Per Wiklund
Nynas

Number of FYF/SYF member companies, 1971–2004

Source: Karl Bruno



"For many years FYF was one of the owners of YKI and had considerable influence over its operations. The members of FYF were both Swedish, European and American companies from many different sectors, for instance the paper industry, the food industry and producers of specialised chemicals.

Eva Österberg, *AkzoNobel, former chairman FYF*

CONTENT

"FYF has been a huge success. Based on long-term thinking and cross-fertilisation of the research community and industrial partners, FYF contributed to the transformation of a new, exciting science area into concrete value-adding innovations that make lives easier and better. During the last decades, we now have achieved great maturity. The accelerating role of FYF is over and creates place for new opportunities. Please share my pride when saying: "This end is the start of a new, exciting beginning!

Günther Lanzinger, *TetraPak, last chairman FYF*

Water-based paints are taken for granted for most painting jobs today. But giving up solvent-based paints posed a major challenge for the paint industry for many years. YKI spend many decades cooperating with the paint industry all over Europe – cooperation that has enhanced development in the industry and improved the environment, not least for professional painters.

Paint research that improved THE ENVIRONMENT

STARTING IN 1985 Ann-Charlotte Hellgren worked for fifteen years as a researcher at YKI. Her main research area was film formation and formulations of waterborne coatings. Today she is working as a laboratory manager at paint manufacturer Engwall & Claesson. Next to her is CEO Hans Claesson.

During the 1970s and 1980s there was growing awareness that painters who used solvent-based paints, especially indoors, suffered from bad health. A number had psychological problems. The cause was petroleum spirits and the other organic solvents that were being used. Then the natural thing to do was to try to switch to water-based paints* instead," says Ann-Charlotte Hellgren.

During the 1990s she was working at YKI with the paint sector and trying to develop environmentally friendly alternatives. Ann-Charlotte Hellgren views this cooperation as a good example of YKI's role of functioning as a bridge between companies' own product development and basic research at universities.

"YKI was able to pinpoint industrial problems and challenges. At the same time we could know enough about what was going on in academic research to be able to say 'that's something we can use'. 'We can start a project and help to develop new knowledge.' "

* Note: The correct scientific terminology is "waterborne" for the emulsions and dispersions mentioned in this article, however, water-based is used since it is more clear for the general public.

> ***"YKI was able to pinpoint industrial problems and challenges.***

When solvent-based paints were developed during the first half of the 20th century, they were in many ways a technical advance. They could withstand wind and weather, were easy to apply and dried relatively quickly. But they also contained something like 30–50 per cent of solvents – substances that evaporated quickly and were inhaled by the painters. Insight in to the risks grew during the 1970s and 1980s. In the early 1990s the authorities, both at EU level and nationally, began to make demands that the industry should abandon solvents. One of the companies that then turned to YKI was the Netherlands chemical group DSM, which produces raw materials from which paint is made.

"For us the fundamental challenge was to be able to make water-based paints that had features that were as good as those of solvent-based products," says Gerrit Dekker, who has been working for more than forty years in DSM's research department at Zwolle in the Netherlands.

"YKI had a reputation as an internationally leading research institute and DSM had a production plant in Sweden, so turning to YKI was no great step for us," Gerrit Dekker's former colleague Jochum Beetsma points out.

"The researchers at YKI had sound knowledge of the new water-based paints. What's more, YKI was coordinating a major European project which a lot of companies developing raw materials for the paint industry were involved in," says Jochum Beetsma.

Paint consists of two important ingredients: the pigment and the binding agent. The binding agent has to hold the small particles of pigment together to form a covering layer that can coat a surface. Pigments and binding agents are viscous and difficult to apply with a brush, so they were diluted with spirits. Now water was going to be used instead – fundamentally a surface chemistry challenge.

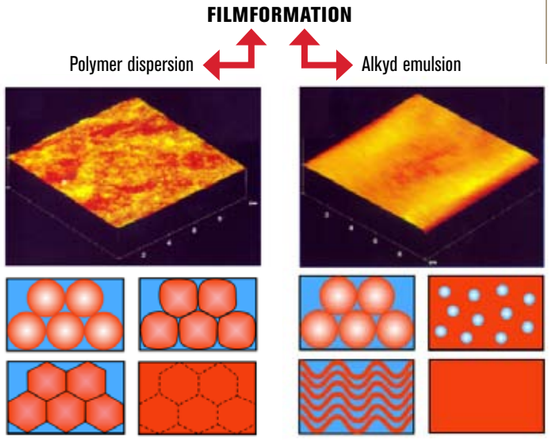
In alkyd paint the binding agent is alkyd, an organic molecule that easily dissolves in petroleum spirit. Mixing it with water is not as simple. You encounter the same problem when you mix a salad dressing – the oil and water (vinegar) want to separate. You can shake a bottle of dressing. But paint is produced in industrial quantities and even if a tin has been standing on a shelf for several years, the paint should still be a homogenous mixture. This is where surface chemists create an emulsion, a stable blend of alkyd and water, an alkyd emulsion. >>>

In the early 1990s DSM was one of the leading companies when it came to alkyd emulsions. The characteristics of the ready-mixed paints could not, however, compete with solvent-based ones and DSM needed support to make further progress. Peter Weissenborn had been working at YKI for two years when he began to lead a paint consortium in 1996. He points out that half of the consortium's funding came from Swedish public agencies, half from the companies involved, many of them members of FYF, ranging from paint manufacturers to suppliers of pigments and additives.

"The aim of the project was to start with the existing alkyd, which was normally dissolved in petroleum spirits and dissolve it in water instead. DSM was the most active supplier in this process. And they had already devoted a lot of their own research to making it work," says Peter Weissenborn.

During the project a new manufacturing process was studied that could create stable alkyd emulsions. To put it simply, the alkyd was mixed with water and different surface active substances, tensides. The mixture was placed in a pressure chamber and heated to about boiling point. The result was a milky liquid, an emulsion. It could be produced in the laboratory and much of the project was devoted to understanding in detail how and why the process functioned, for instance the proportions of the different chemicals and the effect of temperature and stirring on the alkyd emulsion. Then the paint had to be produced and evaluated.

THE THEORY BEHIND FILM FORMATION was one of the main topics that DSM discussed and investigated in collaborations with YKI. The two pictures below illustrates the different films formed by a polymer dispersion and an akyd emulsion at the micrometer-scale using Atomic Force Microscopy, AFM. Source: DSM



"I preferred to have the entire chain of suppliers, from manufacturers of raw materials to paint companies and end users. Then everyone could take part and offer their perspectives.

"We were able to offer DSM and the other industrial companies advanced knowledge about surface chemistry and scientific, theoretical explanations that they could then use to refine the process internally," Peter Weissenborn tells us.

Alkyd paints are one of the areas in which the paint industry and YKI have collaborated to develop water-based paints. A somewhat different challenge was posed by latex paints, also known as plastic paints. These had already been introduced in the 1950s as water-based paints. Latex paints dry quickly and resist fading but for a long time it was difficult for them to compete with solvent-based paints on quality, and they suffered from a bad reputation. During the 1980s cases arose of timber buildings being damaged by damp, especially in Sweden and Norway. This had a negative impact on the idea of using timber for building.

"There was a lot of discussion in the 1980s and early 1990s. There was one spectacular case when someone put a ladder up against a completely new building that had been painted with latex paint and it went straight through the wall. The timber had been eaten away completely by dry rot."

The timber industry was really worried, Ann-Charlotte Hellgren points out. That's why the Kauna project was started, in which the timber and paint industries were working together with YKI and the Trätek research institute, which today, just like YKI, is part of SP. The project studied various aspects, everything from how timber is stored to the choice of painting systems and construction methods. The project was an example of what is called precompetitive research, with participants from both paint manufacturers like Jotun and Alcro Beckers (nowadays Tikkurila) as well as suppliers of raw materials such as Perstorp Clariant (today Celanese).

"In the projects I was involved in I preferred to have the entire chain of suppliers, from manufacturers of raw materials to paint companies and end users. Then everyone could take part and offer their perspectives."

"Small holes formed easily in coats of the early latex paints. This meant that rainwater could penetrate into the timber but at the same time found it difficult to escape," Ann-Charlotte Hellgren tells us.

"In principle what you had was a coat of paint that didn't keep water out but would not let evaporation through. As a result the timber rotted."

Ann-Charlotte Hellgren, whose task in the project was to study the latex paints, realised the possibilities of using an atomic force microscope to examine the chemical processes in coats of paint.

"It was the ideal technology, being able to make high resolution studies of particles of latex that may only be a few hundred nanometres in size. It gave us greater understanding of the latex paints and how they coated surfaces.

"We later used an atomic force microscope for many other projects with the paint industry. And it was also very important for studying paper surfaces, as the coating materials used resemble paints."

Today the quality of latex paint is better and it works very well on timber. But one recommendation from the Kauna project is to use an undercoat on exterior timber panels – preferably a water-based alkyd paint. The use of solvent-based paints has declined drastically in the last few decades. Anti-rust paints and paints for exterior window frames still have to be very durable so these are often still solvent based. But in Ann-Charlotte Hellgren's opinion it is impossible to assess the impact of YKI's different forms of collaboration with the paint industry on developments.

"At this level there are rarely concrete results that lead to something entirely new. Often you acquire knowledge that you can add to the jigsaw puzzle later. But partnerships between YKI and industry have definitely helped to develop our knowledge."

So how did the alkyd emulsions turn out? DSM considers that the collective European project with YKI, which came to an end a few years after the millennium, was a success. It contributed to the company's own development work on raw materials for water-based paint.

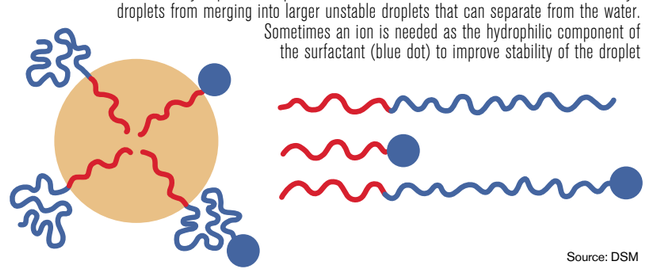
"The project added to the development of our understanding of alkyd emulsions and helped us to hold on to our leading global position in this area," says Jochum Beetsma.

Work continues on developing alkyd emulsions so that they are even more environmentally friendly.

"During the last ten years DSM has developed a lot of alkyd emulsions. The next stage is that we are developing alkyd emulsions that are totally biologically based so that even the alkyds are produced from purely natural raw materials," says Gerrit Dekker.

Peter Weissenborn (at the top) worked as Area Manager Coatings at YKI at the end of the 1990's. He worked mainly in the form of consortia of leading paint and raw material supplier companies. One of these consortia included the Dutch FYF member company DSM, where he collaborated with **Jochum Beetsma** (middle) and **Gerrit Dekker** (bottom)

WHEN PRODUCING AN ALKYD EMULSION, the alkyd resin is turned into very small droplets (yellow dot) in water. To stabilise the droplets, surfactants (red-blue lines) are added to the bulk water. Surfactants (surface active agents) contain both an oil-soluble component (red) and a water-soluble component (blue). The oil-soluble, hydrophobic, component extends into the oil (alkyd) droplet, while the water-soluble, hydrophilic, component extends into the bulk water. This inhibits the alkyd droplets from merging into larger unstable droplets that can separate from the water. Sometimes an ion is needed as the hydrophilic component of the surfactant (blue dot) to improve stability of the droplet



Source: DSM

MUFFINS, MAYONNAISE AND DISCRIMINATING JAPANESE CUSTOMERS

Källbergs Industri bases its production on eggs and surface chemistry know-how has been important for the company for many years. One of the many projects in which the company cooperated with YKI placed baking muffins on the menu.

"Muffins are spongy cakes that contain a lot of surface chemistry – which is probably not what first comes to mind when you are eating them," says Christer Rosén, technical director at Källbergs Industri, who goes on to point out that from a surface chemistry point of view muffins can be described as a mixture of emulsified oil and stiff foam.

Eggs are normally used in baking muffins. But what is the effect on the finished product if the qualities of the eggs are changed? What impact does it have on shelf-life, appearance and flavour.

"When you modify the active surface substances in the yolk by using an enzyme an egg acquires new properties that are potentially interesting. We had been using our knowledge about this for a long time when we were making the ingredients for mayonnaise, but we wanted to test it for baking muffins."

The company therefore launched a joint research project with Lund University and YKI. Anna Fureby was the researcher who was responsible at YKI, and now at SP.

"We baked muffins, did some tastings for flavour and made a number of chemical analyses to test for instance how the fat was distributed and how starches behaved. Modifying the yolk had major effects – on what the muffins felt like when you ate them as well," says Anna Fureby.

Källbergs Industri is one of Scandinavia's leading manufacturers of egg-based ingredients with customers mainly in the food industry but also in pharmaceuticals. The company is cooperatively owned by Swedish and Danish farmers, and has long viewed research and development as an important competitive factor. Membership in FYF has been one recipe for commercial growth.

"We have worked with YKI on many different projects for several decades. Some have involved troubleshooting and minor development schemes. But there have been major projects as well, like the muffins one, for which we have applied for external funding," says Christer Rosén.

Christer Rosén was hired by Källbergs in 1997 and since then he has represented the company in FYF. He describes the many informal contacts he has had through the years warmly. He points out how simple it has been to ring up researchers and discuss surface chemistry questions. During one period the quality of the company's products was questioned by customers in Asia. They buy powdered egg whites to make products like surimi – a fish or meat paste that is quite common in countries like Japan and Korea and which is mainly seen in the west in the form of crab sticks. Discussions with YKI taught the company about the gelatinisation properties of egg whites, which are so important for preventing the surimi from crumbling. "The way the raw material, the eggs, is stored plays a decisive role for one thing," says Christer Rosén.

"Japanese customers are very competent and they make very high quality demands. When we were talking to them it was a great strength for us to have YKI behind us."

The long relationship with YKI has also helped to make mayonnaise Källberg's most important business area today. Different kinds of ingredients for mayonnaise are exported to twenty or so countries. The muffins project, which was completed a few years ago, has not had the same commercial success – at least not yet.

"We are a small company and YKI has broadened our own research resources. In some cases our cooperation has had a direct impact on our business. But it has often been a case of long-term development of expertise that we have only been able to exploit at a later stage," says Christer Rosén. ●●●

EVERY DAY AT the production facitlity in Töreboda more than one million eggs are cracked and separated into their different components.

Despite YKI's closure he still believes in development

As YKI's last chairperson he had a hand in the institute's closure. But Per Lindberg, President and CEO of BillerudKorsnäs, can still see a major need of surface chemistry expertise in the forestry industry. He describes the legacy from FYF, BillerudKorsnäs's continued cooperation with SP and the company's own investment in R&D.

The paper we manufacture is not just something you can fold into a square or make a bag out of. We want to challenge plastic, we want to challenge glass and metal as packaging materials.

"To put it in more commercial terms: we want to change views of what a fibre-based material should be able to do. And what a company that makes paper for packaging should be able to supply."

BillerudKorsnäs produces packages and packaging materials from paper pulp. The company employs just over 4,000 at eight paper mills in Sweden, Finland and the UK, and has a turnover of SEK 20 billion. A cardboard box hangs in its head office north of Stockholm that contains an aeroplane that is ready to fly. On the reception desk stands a bowl full of mobile phone cases made of paper printed with the company's logo. They are admittedly advertising products but they illustrate the company's fundamental ambition – to identify new areas of use for paper, preferably to replace existing products made of plastic, metal or glass.

"On the one hand it's a commercial challenge, we are trying to broaden our market. But it would also lead to greater sustainability in our value chains and help to reduce the impact of carbon dioxide on society."

BillerudKorsnäs was established in 2012 through a merger between Billerud and Korsnäs. Since then the management have invested heavily in research. The number of product development projects has more than doubled. The R&D budget, like the number of R&D staff, rose by 200 per cent between 2013 and 2015. From a low level, however, as Per Lindberg points out.

"We are still allocating too little to research but the R&D budget is beginning to approach one per cent of turnover. Today we employ about sixty people in R&D. I hope that there'll be more than one hundred in a couple of years, and in the long run even more.

"We are convinced that we have to make a genuine investment in research. Otherwise we'll end up in the situation where we are supplying packaging that a lot of others can make as well. Then the first choice is to offer lower prices. Instead we are going to compete on performance, a classic game plan."

For many years BillerudKorsnäs was a member of FYF. Cooperation with YKI and later with SP has contributed to the development of processes in the company's plants.

"A typical problem in our paper mills is produced by sediment, pipes and pumps get blocked. We have been able to get help with that by using surface chemistry solutions."

Collaborative surface chemistry projects have also helped to develop the quality of paper materials, in particular barrier packaging, in other words protection from the surroundings. This is an area of research that Per Lindberg considers is going to be even more important in the future.

"The largest task facing us, if we disregard industrial processes, is developing our products. If we are going to be able to replace plastic with bio-based materials we have to produce better barriers – against acid, against fat, against water. That's where you need to know about surface chemistry."

BillerudKorsnäs's investment in R&D has not merely involved allocating more resources. In recent years the company has also expanded its cooperation with institutes all over the world.

"Even if we develop our internal capacity and know-how, we are not going to be able to do everything ourselves. We need to improve our expertise, both in specifying what we want, applying outcomes and managing projects.

"In the past we have not looked much further than to Stockholm, perhaps Lund and Göteborg as well. But now we are working systematically to find new global partners on the basis of the issues that interest us."

Per Lindberg was chairperson of the YKI's board between 2011 and 2013. He was involved in making the decision to close YKI down and to allow its operations to continue within SP. A natural development in Per Lindberg's view.

"There was nothing wrong with the expertise that YKI had internally. But the board's view was that the institute was not strong enough in the long term to meet its clients' needs. Specialising in surface chemistry was no longer enough. Today you have to combine surface chemistry know-how with other adjacent research areas if you are going to be able to offer sensible industrial solutions. So it was natural for YKI to become part of SP."

The need for surface chemistry expertise has not declined for BillerudKorsnäs. But more than ever before the company is looking for suppliers and partners with broader skills, and these include research institutes, Per Lindberg points out.

"Towards the end YKI became a little too specialised as a partner and supplier. This doesn't mean that surface chemistry know-how has become less interesting for us or the rest of the industry. But the way we operate has changed over time. Today we have to work with suppliers that can offer broader research and solve larger problems. SP with its extensive expertise under one roof works well for us in this respect."

PERSONAL FACTS

Per Lindberg

Born 1959

Education
1981–1985 MSc (Engineering) Chalmers University of Technology
1986–1990 PhD (Engineering) Chalmers University of Technology

Career
1990–1997 Research post, Chalmers
1997–2001 Management consultant, Applied Value (USA)
2001–2005 CEO, Korsnäs
2005–2012 CEO, Billerud
2012– CEO, BillerudKorsnäs

Other positions
Chair of Skogsindustrierna, the organisation for the forestry industry sector. Member of the Swedish Academy of Engineering (IVA).

Family
Partner and four children from his previous and current relationships.

Leisure activities
Skiing and golf.

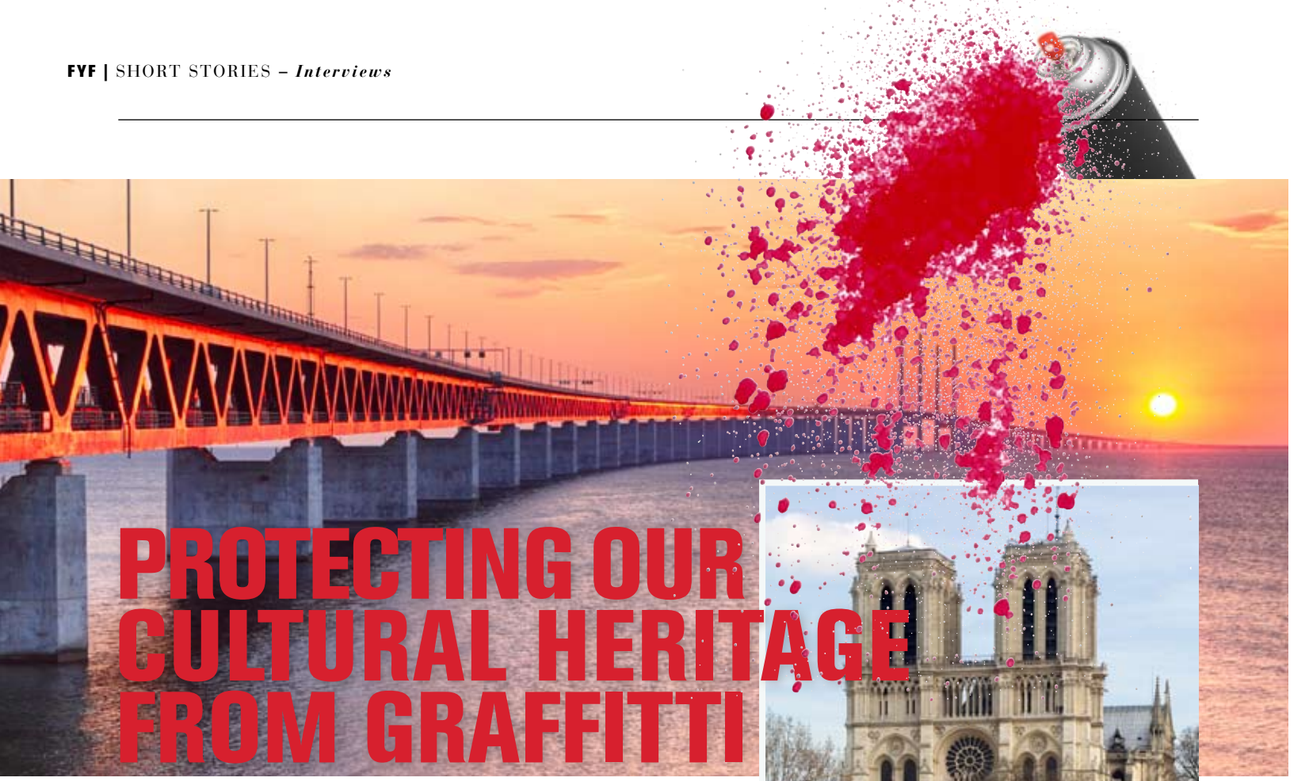
Unexpected talent
"I like doing up houses, especially carpentry work. A few years ago I and my partner bought a house on Cuba. It's seen a lot of wear and tear but is very charming, like a lot of other things on Cuba."

You yourself have a background in research. An in addition to having been YKI's chair-person you have also been a member of the board of the forest industry's research institute Innventia. What is needed if collaboration between industry and a research institute is going to work well?

"From the research institute's point of view it needs a good organisation and the ability to present what it can offer effectively, to the forestry industry for instance. This can involve everything from energy technology, more efficient processes or surface chemistry expertise. What is important is selling broader solutions instead of specific skills. What industry needs is the capacity to make good use of knowledge and act as project manager."

How do you view the model for cooperation between industry and a research institute that existed between FYF and YKI/SP? Could this provide inspiration for the future?

"Yes, most research institutes have had stakeholder associations, like FYF, and they are still highly relevant. When the Swedish research institutes are now in the process of restructuring it is important that they are not governed only by politicians or research councils. Industry should be represented in some way that can help to steer the institute in the right direction." ●●●



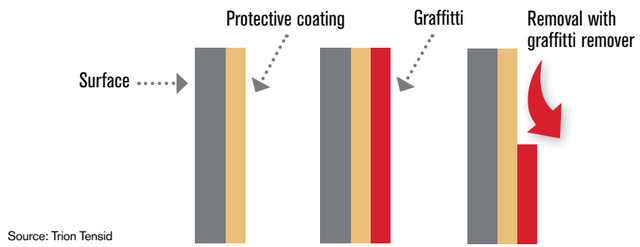
PROTECTING OUR CULTURAL HERITAGE FROM GRAFFITTI

STOCKHOLM'S ROYAL PALACE, the Öresund Bridge, Notre Dame and the Marble Arch in London are some of the buildings protected by Trion Tensid's anti-graffitti coatings.

Tags and other forms of graffitti disfigure buildings all over the world. The cost of getting rid of them amounts to about SEK 1 billion each year in Sweden alone. Many property owners prefer to cover facades with an anti-graffitti coating, often a layer of transparent wax. Graffiti cannot adhere to the wax surface and can be washed away simply using hot water – without any permanent damage to the facades.

This works for normal aerosol sprays at least. But the paints that taggers have now begun to use, like ink markers and anti-rust paints, are more difficult to combat and really test this protection to its limits.

SACRIFICIAL ANTI-GRAFFITTI COATINGS, including wax-based dispersions, form a transparent barrier over the wall or surface being protected. If the surface is vandalized the coating can be removed (sacrificed) taking the graffiti with it.



Source: Trion Tensid

The new paints penetrated the anti-graffitti coating and adhered to the facades. We had to develop a product with greater resistance," says Thorbjörn Bengtsson at the Trion Tensid chemical company, which exports anti-graffitti protection all over the world.

The company turned to Martin Andersson, one of the researchers at YKI. They started to cooperate and Vinnova provided funding for a joint research project. YKI developed new knowledge of what happened at molecular level when paint ends up on an anti-graffitti coating, by filming the process for instance. The researchers could then suggest some chemical additives that enabled the wax-based coating to cope with the new paints as well. "YKI helped us to develop a much better anti-graffitti product. But although we are a small company, this cooperation also provided us with greater understanding of our own product so that we can now offer our customers much better help," says Thorbjörn Bengtsson. ●●●

The path to an environmentally friendly FIRE FIGHTING FOAM

Some fluoride based chemicals, PFOS, can withstand very high temperatures and form dense films. For this reason they have been used as fire retardants for a long time. In recent years, however, the authorities, in both Sweden and the rest of the EU, have drawn attention to the risk they pose to the environment. Traces of fluorine based fire fighting foam have been found, for instance, in ground water. The manufacturers of fire fighting foams are looking for something that can replace fluoride.

Tat's right, the trend today is to shift away from fluoride based fire fighting foam. Alternatives often work well in many cases but their performance is still not good enough to cope with the most serious fires at airports or oil refineries," says Jan-Erik Jönsson, head of R&D at Dafo Fomtec, which produces fire fighting foam for different applications.

What's the challenge?

"We devote large sums to our research into developing new fire fighting foams which are as environmentally friendly as possible and offer the highest possible performance. To begin with we produce new promising substances in the lab and then you have to go out and test them on real fires. That takes a lot of work and it's expensive as well."

Dafo Fomtec has been cooperating with YKI in a research project. What did you do?

"We developed a chemical screening method together with the researchers. Screening provides early indication of which substances offer good extinguishing capacity. So now we can select the candidates we are going to go on working with while they are still in the laboratory. This method has speeded up our development work. And we have also been able to limit the number of expensive tests with real fires."

What was the result?

"Well to some extent thanks to this cooperation we have already developed a fluorine free foam. But it still suffers from some "teething problems" that we are trying to deal with."

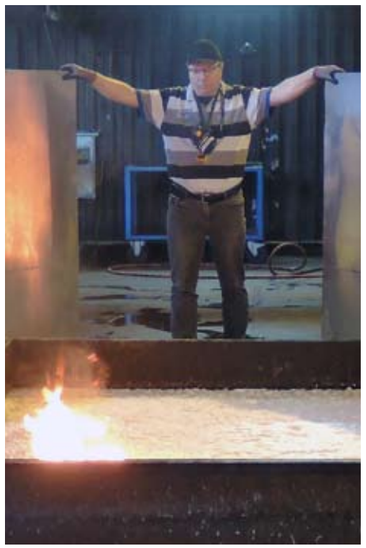
Why did you choose to become a member of FYF?

"In a small company like ours with only sixteen employees it is difficult to bounce ideas around internally. FYF has given Dafo Fomtec access to both instruments and also advanced expertise, at YKI to begin with and then in SP. And if we have had any questions, we have always been able to get in touch with the researchers."

Are you going to be able to develop fluoride free fire fighting foam that will work for the most severe fires? So that foams based on fluoride can be phased out?

"With the advances we have made in recent years I'm very hopeful that we can get there. But it's going to take a lot of slaving away in the lab!" ●●●

JAN-ERIK JÖNSSON, Head of R&D at Dafo Fomtec, is testing new potential fire fighting substances.



DISHWASHING DECONSTRUCTED

Most dishwasher detergents no longer contain phosphate. From an environmental point of view this is excellent, as phosphor is non-renewable and contributes to eutrophication. But phosphate-free dishwasher detergents subject dishes to more wear and tear and after a great many cycles in the machines leave scratches on glass and decorative features that is referred to as glass corrosion.

Kemibolaget, which has been a member of FYF for a number of years, wanted to develop a gentler detergent and therefore started to collaborate with YKI and SP. The washing cycle was analysed step by step to gain greater understanding of what happens in the dishwasher and how different forms of food residues are removed. As part of this cooperation hundreds of trial washes were made with different versions of detergents. This did not lead to the development of a new consumer product. But even so, Leif Löf, product developer at Kemibolaget, is pleased. The company learnt new methods of evaluating the effect of new substances on glass corrosion at an early stage of its product development.

"We gained a lot of knowledge about how to develop new products and how to test them. In that way the cooperation started us thinking in new directions," Leif Löf tells us. ●●●

Through its long-term relationships FYF has facilitated exchanges between industry and the academic world. Their importance cannot only be measured in terms of greater industrial competitiveness. FYF has contributed to scientific progress as well. Even if the association is now closing down, the need for exchange between industry and academia is larger than ever.

LONG-TERM RELATIONSHIPS FOR SCIENTIFIC AND INDUSTRIAL DEVELOPMENT – FYF'S LEGACY

"In a small company like ours with only sixteen employees it is difficult to bounce ideas around internally. FYF has given Dafo Fomtec access to both instruments and also advanced expertise, at YKI to begin with and then in SP."

MARTIN MALMSTEN, former CEO of YKI 1998–2003, nowadays professor at Uppsala University (top). **Göran Bengtsson**, member of last board of FYF and for many years the technical director of the packaging business division in Stora Enso

Cooperation between FYF member companies and the researchers at YKI has helped to create new environmentally friendly products, more efficient production processes and a substantial amount of knowledge. As the quotation from Jan-Erik Jönsson, head of R&D at Dafo Fomtec (see p. 14–15) indicates, small and medium-sized companies in particular have benefited greatly from their membership of FYF. The cooperation between YKI and the member companies has also been important in offering new perspectives, as Måns Collin, former CEO of the specialty oils producer Nynas, a long-standing FYF member company, points out (see p 26–27):

"The great benefit for us as a company was we never left them (YKI) without having learnt something new. The researchers could describe the systems we were studying in a way that made it possible for us to identify a solution ourselves."

Statements like these are often heard when it comes to collaboration between industry and academia. Researchers provide their knowledge and industry refines and commercialises it. The cooperation between YKI and FYF is no exception. But there is also an exchange in the opposite direction. FYF has provided an arena in which academic researchers can discuss genuine industrial challenges and this has enabled research to develop. The former head of one of YKI's sections, Lennart Bergström, today a professor at Stockholm University, says, for instance, that research

> *"The great benefit for us as a company was we never left them (YKI) without having learnt something new.*

cooperation between industry and academia has to be based on two-way communication. One of the benefits of membership in FYF was that each company had a chance to consult YKI's researchers once every year. Per Claesson, a professor who was working at both YKI and KTH from the early 1980s describes (see p. 29–31) how this kind of consultation often inspired the development of academic research.

"Sometimes certain problem areas came up again and again, and none of us at YKI could provide satisfactory answers. That's when I began to wonder how one could get to grips with a problem at a fundamental level."

As one of YKI's owners and source of co-financing for its research, FYF has also exerted a strategic influence on the institute's operations. The membership fees were managed by FYF's board and allocated to activities at YKI. In this way the member companies were underwriting the institute's operations. Jan-Erik Nyström, who worked with research issues for many years in AstraZeneca, and was a former member and chair of FYF's board for five years puts it like this:

"FYF's task was to manage the membership fees and capital so that both the member companies and YKI would benefit. FYF had to safeguard the interests of the member companies. But part of our role was to sustain YKI as well," says Jan-Erik Nyström.

As one of the owners, FYF nominated several of the members of YKI's board. Eva Österberg, who chaired FYF's board for several years in the 2000s remembers that the chair of FYF had a great deal of weight in YKI's board.

"FYF's board received regular presentations of how YKI's various projects were developing. And FYF Member Days were arranged in connection with FYF's annual meeting so that we could find out what the member companies thought," says Eva Österberg, former head of research in AkzoNobel.

In other words FYF played an important role in the balancing act between basic and applied research that has to be maintained in every industrial research institute. The association ensured that YKI's operations did not – from an industrial perspective – stray too far towards basic research. Martin Malmsten was YKI's CEO from 1998 until 2003.

"FYF laid down explicit requirements about how YKI's strategic investments could be linked to customer benefit and industrial potential. In this way FYF contributed to the greater commercial focus at YKI," says Martin Malmsten.

According to Martin Malmsten for a long time the role of FYF, and its predecessor SYF, was to support YKI. This changed in the late 1990s when FYF adopted a more active stance and made demands about YKI's research programme.

"FYF called for the initiation of strategic research activities in both material science and the biosciences," says Martin Malmsten.

FYF's position and the firm personal commitment of the individual company representatives to YKI's operations helped to provide YKI's management with a strong negotiating position in its dealings with the government. This involved applications for research funding as well as when YKI and the other industrial research institutes were being restructured and required to operate commercially in the late 1990s.

"When YKI was negotiating with the government during the process of turning YKI into a company, being able to rely on FYF's great commitment and its strength as a sole owner was incredibly important," says Martin Malmsten.

> *"The trust and relationships built over years with senior representatives at the FYF member companies were very important. It gave YKI researchers an opportunity to regularly tap into industrial trends and relevant business challenges that our clients faced.*
>
> **Peter Alberius** *CEO YKI 2008–2012*

Surface chemistry is an area of science that has applications in many branches and this helped to make YKI's operations interdisciplinary at a very early stage, as was the case for FYF as well. The association consisted of a broad spectrum of companies, geographically, in size, and not least in the range of sectors they came from. For this reason FYF offered a unique venue for contacts, between the member companies as well. Göran Bengtsson, a member of FYF's last board and for many years the technical director of the packaging business division in Stora Enso, remembers many interesting meetings with industrial researchers from totally different sectors.

"YKI and FYF reflected a research field rather than a branch and this offered interesting possibilities of learning from each other. As a member company we came into contact with questions and solutions to problems from other member companies that we would otherwise never have heard of other or been able to apply to our own problems," says Göran Bengtsson.

Even though FYF is now closing down, the ideas behind the association will survive. Göran Bengtsson maintains that the dual model, where industry raises problems that researchers can work on, will offer an excellent method in the future as well.

"I am a keen advocate of joint research on fundamental problems as well as methodological development and cooperation around expensive instrumentation. And this kind of collaboration has economic value for both industry and for society," says Göran Bengtsson.

In our global world with its widespread and complex social challenges there are many who place their faith in interdisciplinary cooperative methods and cross fertilisation. Those who seek cooperation between industry, academia and the state can find inspiration in YKI and FYF. Their collaborative model offers a concrete example of how this kind of cooperation can be organised. And this kind of long term cooperation benefits both industry, academia and society at large. ● ● ●

CONVERSATION AND POSTER presentation at the FYF Annual Meeting 2006. The annual meetings provided an opportunity for the member companies to share experiences and initiate new collaborations.

QUOTES AROUND THE WORLD
– An international perspective on FYF

The prominent research at YKI attracted industry from countries around the world. Many of these companies also chose to become members of FYF. Four representatives of FYF from different companies was asked for their personal experiences. What caused them to turn to Sweden and YKI in the first place? And how was the membership in FYF and close collaborations with YKI researchers over the years of benefit to their companies?

ROLAND ETTL, Global Technical Key Account Manager, BASF Ludwigshafen (Germany)

"BASF joined FYF at the end of the 1990s, around the year 2000. The main reason was that the Nordic research institutes like YKI, STFI (today Innventia) and KTH were at the scientific forefront in paper chemistry, an area of high quality research we could not find in Germany. During this first phase BASF learned more about YKI's other research fields and later on projects in other areas followed.

The projects BASF ran with YKI always focused on fundamental understanding and principles. In the beginning the projects were related only to paper chemicals and their interaction with cellulose fibres and coating pigments. In more recent years there has been greater focus on developing analytical tools and their application in complex environments.

Our involvement with YKI supported our own internal product development. The joint projects helped to confirm our knowledge generated internally although they were not always crucial for the success of our internal projects.

For me personally, the collaboration with YKI and FYF gave me an excellent opportunity to meet other colleagues who were interested in surface chemistry and to gain access to new up-coming technologies. On the one hand, FYF membership was good for networking, exchanging general information and gaining new insights as well as various comments. But the time that could be spent on FYF and YKI topics was always limited and came on top of our daily work. Also the FYF members work to some extent in the same field so we sometimes have to guard our tongues when we discuss the final details. But, generally speaking, an advisory board like FYF plays a welcome role in managing the interests of the member companies and closing the gap between basic research and industrial needs." ●●●

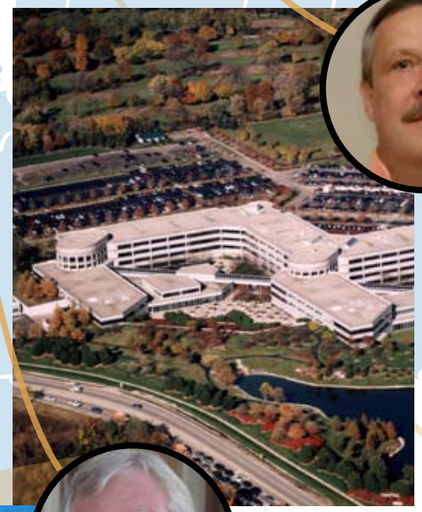
TINA HELLAND, R&D Manager Binder, Jotun Decorative Paints, Sandefjord (Norge)

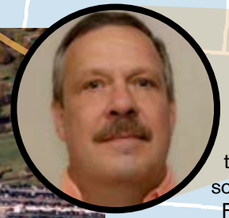
"Jotun has been a member of FYF and worked with YKI since at least the beginning of the 1980s, although I believe our co-operation goes back even further than that."

When water-based outdoor paints were developed it was important for us to understand more about their surface properties and specially water sensitivity. Thanks to our collaboration with YKI, Jotun increased its knowledge about surfactant migration and film formation, for instance. This knowledge has helped us to develop storage stable and weather resistant water-based paints.

One of YKI's major advantages compared with other institutes is their great knowledge about paints and coating. This helped us to get to the bottom of the issues we were dealing with. Other institutes can also offer access to analytical instruments but they did not have the same degree of expertise about paint.

FYF offered us a dialogue with YKI and a possibility to ensure that the institute focused on the needs of industry. We were also able through FYF to meet companies from other sectors as well and we could collaborate on problems that we shared. ●●●





ERIK PEDERSEN, Research Principal, Kraft Foods, Chicago (USA)

"Kraft Foods joined FYF and YKI around 2000. The primary reason was that YKI had unique capabilities. I would call their instrument park probably the best in the world. They had virtually everything, and they could work to solve the problems that we had.

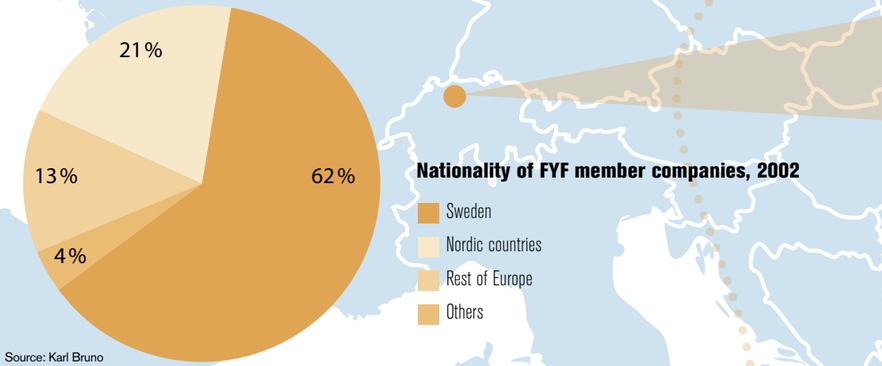
For Kraft Foods the collaborations were largely around problem solving like improving the stability of emulsions and suspensions in e.g. salad dress-ings, processed cheese and mayonnaise. At one point we encountered a packaging problem with a product sticking to the tin, where we sought to understand why.

In 2006 I joined the FYF board. This gave Kraft Foods access to the Excellence Centres supported by Vinnova and The Knowledge Foundation. Kraft Foods joined one of them, CODIRECT, which I also chaired for five years.

The FYF model was good. FYF had an influence on the research areas at YKI, and YKI researchers requested funding for instruments that they might not otherwise have been able to acquire. Interactions with other companies led Kraft Foods to new collaborations and business interactions. Personally, YKI and FYF allowed me to expand my network in areas that would have been otherwise difficult." ●●●

PATRICK GANE, VP global R&D, OMYA, Oftringen (Schweiz)

In my role over the past 20 years as VP global R&D my personal chosen responsibility has always been to place Omya at the forefront of fundamental scientific endeavour associated with the products and materials in its portfolio, and then to use that fundamental knowledge in a way that has expanded Omya's impact in a whole range of new markets. The key has been to motivate the scientific enquiry to the highest level of publication, and then using our own interpretational skills to extract the maximum in application. Understanding the basics of the hydrophobic interaction, leading to ground-breaking interpretations, is just one example, enabling not only the main target of papermaking pitch and stickies control to be improved, but additionally to launch activities in areas such as novel coatings, drug delivery vector technology, availability of micronutrients and other actives in agriculture, and waste water management, to name but a few. It required the right partnership to realise this mammoth vision, and I established many collaborative working groups around the world with Universities and Institutes, including my own Chair at Aalto University, Finland, to drive it forward. At the pinnacle of these collaborations in so very many cases has been the cooperation between my industrial research group and that of the SP-KTH partnership - a success story in every respect. ●●●



Nationality of FYF member companies, 2002

- Sweden
- Nordic countries
- Rest of Europe
- Others

Source: Karl Bruno

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Knowledge about surface chemistry has not only been important for the traditional chemical industry. For many years Sandvik, an engineering company, cooperated with YKI, for instance on ceramic materials. One successful project managed to reduce the time taken for one manufacturing process from several days to a few minutes.

"One of the advantages of cooperation between industry and higher education is that industrial companies have access to tailor-made PhDs.

LOYAL PARTNERSHIP *contributed to a durable material*

Sandvik is one of the world's leading manufacturers of machine tools for working with metals. Many of these tools have to withstand extreme forces. Today most cutting edges are made of hard metal coated with a thin layer of ceramic material.

GUNNAR BRANDT AT SANDVIK, a FYF member company, worked together with YKI to improve manufacture of silicon nitride based cutting tools.

"This means that the surface is very hard-wearing while at the same time the support has great resilience, an unbeatable combination," says Gunnar Brandt, who have been working with R&D at Sandvik for many years.

During the 1990s he was responsible for developing Sandvik's use of ceramic materials, both research and manufacture. One of the most promising of them was silicon nitride. This material has to be ground into a fine powder and mixed with water. But for a long time managing these nanoscale particles led to bottlenecks in Sandvik's production.

"The particles were really fine and easily formed lumps. Sometimes we had to grind the powder for several days. We talked to different suppliers but were unable to get help from any of them," Gunnar Brandt tells us.

The close relationship between researchers and industry through FYF have been characterised by many fruitful collaborations. One example was the Vinnova-supported competence centres, i.e. consortia that included industry, academies and research institutes. Between 1996 and 2006 Sandvik participated in one of these centres that was dealing with powder metallurgy and surface engineering called the Brinell Centre. One active stakeholder was YKI.

"Grinding silicon nitride was one of the specific problems we raised in our discussions with YKI. This had to be related to surface chemistry. Can you take a look at that? How can it be so problematic?", says Gunnar Brandt.

The question was posed to Lennart Bergström, today a professor at Stockholm University. He had then been working at YKI for just over ten years and had acquired extensive knowledge about ceramic materials and about silicon nitride. To begin with, Lennart Bergström's focus was on basic research but he gradually broadened it to solving problems in industrial processes. He had also worked for Sandvik for a time and understood the company's challenges.

"We could see possibilities of being able to work with the company and Sandvik had a great interest in ceramic materials. They are also used to cooperating with researchers from institutes and academia."

The question was raised at one of the regular meetings between Lennart Bergström and Sandvik's researchers and engineers. He soon realised that the problem could be understood in surface chemistry terms. His extensive knowledge enabled him to provide an explanation at molecular level of why it was so difficult to separate the nanoscale particles that had formed lumps. But he could also suggest ways of speeding up the disintegration of these 'agglomerates'. For instance raising the temperature during grinding shortened the time required by about ninety per cent.

"This measure made it possible to reduce the time for grinding from days to hours. We benefited greatly from that. It not only cut our costs but it also improved the quality of the silicon nitride and led to less waste during production," says Gunnar Brandt.

This example offers a clear illustration of YKI's relationship to industry. Sandvik was facing a difficult challenge. Lennart Bergström, with his thorough knowledge of surface chemistry research, could resolve it with relatively simple means. And what made this possible was also the trustful relationship between Sandvik's engineers and Lennart Bergström.

"As an academic researcher you cannot always view it as one-way communication, that we should be providing the knowledge and industry always be at the receiving end. There is a lot of knowledge in industry as well. It may not always be expressed in the same way. But if we researchers pay attention we can acquire it and make use of it," says Lennart Bergström.

During the 1990s awareness had developed that closer cooperation between Swedish industry and academia was needed. Inspired for instance by the Fraunhofer Institutes in Germany and the NSF Research Centers in the USA, Vinnova launched a series of competence centres in 1996.

"The Brinell Centre and the other competence centres were intended to provide an arena in which academic and industrial researchers could meet each other and discuss issues with industrial relevance," says Anders Marén, who is responsible at Vinnova for the Brinell Centre.

YKI also played an unusually important role in the centre with Lennart Bergström acting as its director, for instance.

"In the Brinell Centre the coordinator was YKI, normally a task taken on by a higher education institution. But we could resolve this because Lennart Bergström was partly employed by KTH," says Anders Marén.

The evaluations carried out later showed that Sandvik and the other companies involved in the Brinell Centre developed their operations in different ways. One of s everal important results was grinding silicon nitride. However production of this particular product has come to an end at Sandvik.

"The completely ceramic materials did not fully meet the expectations we had at the time. But they are still used in applications that generate high temperatures, for instance treating some materials that are used in the aviation industry," Gunnar Brandt points out.

One lasting benefit for Sandvik was, however, the rise in expertise. Like many of YKI's doctoral students through the years Lennar Bergström's PhD students at the Brinell Centre later found employment in industry, two of them at Sandvik.

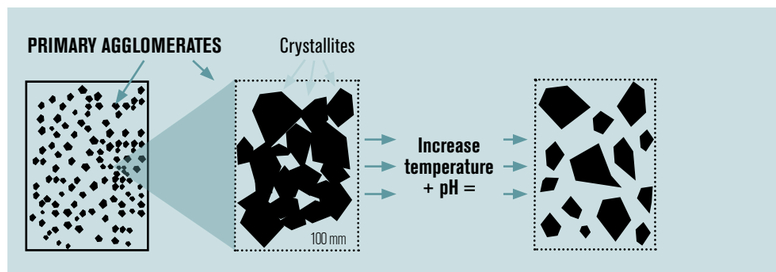
"One of the advantages of cooperation between industry and higher education is that industrial companies have access to tailor-made PhDs. We had been working together in the Brinell Centre for several years so we knew these doctoral students and the skills they had acquired. This was very positive for us, it was a new way of recruiting," says Gunnar Brandt.

Gunnar Brandt, who spent a long time working with R&D at Sandvik remembers its productive collaboration with YKI. Sandvik continued to be a member of FYF for many years.

"The collaboration with YKI's researchers meant that we gained a new dimension in our knowledge about materials, surface chemistry. An area we were not so familiar with. That introduced completely new knowledge for Sandvik," says Gunnar Brandt. ●●●

CERAMIC INSERT GRADES for milling machines increase productivity in cast iron and hardened steel due to the potential for higher cutting speeds

NANOSIZED SILICON NITRIDE PARTICLES oxidize and form strong agglomeratets when exposed to air. This made production of silicon nitride parts very time-consuming. By increasing process temperature and pH, the surface forces on the particles were modified. This helped deagglomeration of the particles.

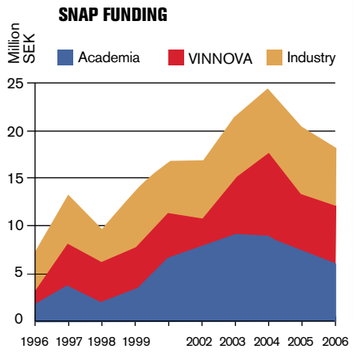


Green chemicals *and thickeners*

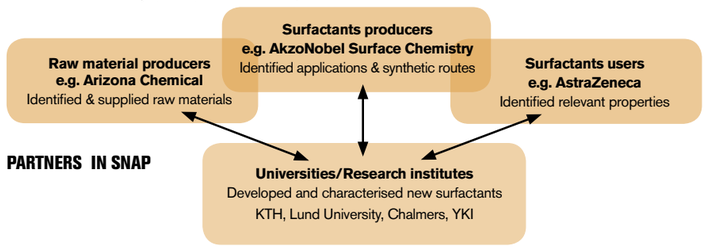
The AkzoNobel chemical group has been one of the companies that have set the pace in FYF and at YKI. Thanks to longstanding cooperation with YKI, not least through consortia, the group has increased its fundamental knowledge about several important chemicals.

EVA ÖSTERBERG, former R&D Director at AkzoNobel. She was also chairman of the research consortia SNAP, contributing to the then emerging field of green chemistry.

Surfactants are a group of substances that YKI and many of the companies that are members of FYF have been working with for many years. Surfactants play a very important role in many industrial applications. The traditional main raw material for tensides, as for many other chemicals, has been oil. But interest in producing 'green' chemicals from vegetable raw materials rose during the 1990s.



INDUSTRIAL PARTNERS IN COMPETENCE CENTRE SNAP included the supply chain as well as the end users of surfactants (illustration below). SNAP was jointly funded by Vinnova, academic institutions/research institutes and industry (above). Source: Mikael Kjelin, SP



"We had already done some research ourselves on sugar-based surfactants but we needed to supplement and probe more deeply. As we were members of FYF over the years we have been able to consult its experts and use YKI's skills. But we have also taken part in major research consortia," says Eva Österberg, formerly head of R&D in Akzo Nobel Surface Chemistry.

Between 1996 and 2006 AkzoNobel was involved in SNAP, the Centre for Surfactants Based on Natural Products, together with both YKI and other FYF members – a consortium supported by Vinnova. (The head of SNAP was moreover Professor Per Claesson, who is interviewed on pages 29–31 of this journal). The chemical features of the new sugar-based surfactants differ to some extent. The solubility of a sugar-based tenside is not, for example, the same as one made from oil.

"We needed to learn more about and determine the surface chemical features of the new surfactants. And SNAP was very good at that. We gained access to instruments and expertise that we did not have ourselves," says Eva Österberg.

In recent years AkzoNobel has continued to develop sugar-based surfactants, some of this work based on SNAP's findings. Today there are applications in the mining industry, for instance, and detergents for car-washes and consumer products. Today surfactants based on vegetable raw materials are used in plant protection products and asphalt production.

A few years later AkzoNobel also participated in CODIRECT, Controlled Delivery and Release Centre, another consortium in which YKI and members of FYF carried out research with support from Vinnova. Here too AkzoNobel increased its basic knowledge about a group of chemicals, those known as celluose derivatives. These are used as thickeners in everything from food products, paints and building materials such as tile cement and putty.

"Thanks to our involvement in CODIRECT we have greater understanding today of how to design these cellulose derivatives so that they have the desired features," says Leif Karlson at AkzoNobel Performance Additives, who was for some time chair of CODIRECT.

In addition to having some of its research funded by Vinnova, Leif Karlson can see benefits in taking part in consortia.

One major advantage is the great exchange of experiences. You learn from other companies. A broader academic group also means that input to discussions comes from different directions," says Leif Karlson.

RESEARCH as business development

CHRISTOFER OHLSSON (right), head of marketing at FYF member Gipeco collaborated with YKI/SP staff **MIKAEL KJELLIN** and **MARTIN ANDERSSON** (left) in a number of research projects

"One of the speakers was Mikael Kjellin from YKI and he had only been speaking for five minutes when I realised 'this, damn it, is the man I want to talk to'. In the break I went up and introduced myself and said that I wanted to improve our technological capacity in surface chemistry. After the seminar we had lunch together. And that's how it was."

Christofer Ohlsson is head of marketing and one of the owners of Gipeco, a family-owned chemical company with just over 20 employees that makes cleaning supplies and products. The seminar held by the Swedish Chemicals Agency opened the door to the institute's research and eventually the company became a member of FYF. Since then Mikael Kjellin and his colleague Martin Andersson have taken part in a number of projects – first in YKI, then SP.

The first joint undertaking, funded partly by Vinnova, involved identifying and developing scientific evidence for some of Gipeco's most important products. One of the results was environmental certification of the products. Cooperation was launched with one of the world's largest manufacturers of flooring materials, Forbo Flooring.

One product had the unique feature of both cleaning and maintaining flooring and had been developed during the 1980s. Gipeco already knew that it worked. But the project helped to increase understanding of why it did so and also made it possible to use pictures to prove it.

"Just like the photographer Lennart Nilsson was taking close ups from inside the body, we were using a microscope to take pictures of the effects of our products and using them for cleaning. We tested several different flooring materials, plastic, linoleum, rubber and terrazzo."

Since then Gipeco has taken part in other projects, one for instance about how cleaning can help to reduce healthcare associated infections. In its most recent joint project Gipeco has been working with SP to develop green chemicals based on renewable raw materials.

Collaboration with YKI and SP has helped Gipeco in various ways. For instance, when the company's chemist retired Gipeco could use its research collaboration to appeal to applicants. "It's almost more difficult for us to recruit a capable chemist than to appoint a CEO. Thanks to our cooperation with YKI and SP we could attract several interesting candidates."

Longstanding collaboration with YKI's researchers has transformed Gipeco from the bottom up, to use the words of one of the partners, *Christofer Ohlsson*. The first contact was made during an environmental seminar.

Initially Christofer Ohlsson's suggestion that external researchers should be included in the company's own product development met with scepticism. One concern was that company secrets could be divulged. In order for the founder of the company, Christofer's father, and the rest of the board to accept cooperation an explicit confidentiality agreement was signed.

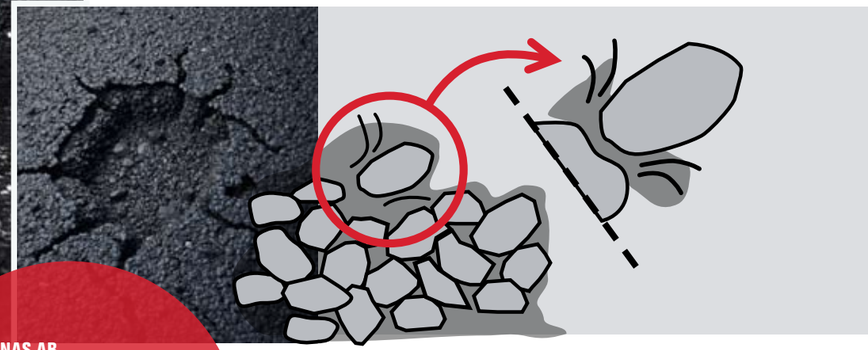
"But what was crucial for its success was enabling people from YKI and Gipeco to meet and get to know each other. If you can establish mutual trust then all relationships work."

Ten years after the seminar Gipeco has undergone fundamental changes. The close links with YKI/SP have helped to increase sales in Sweden and introduce new business models so that now an export drive is in the offing.

"All our employees now know that we cooperate with researchers. That's something that both I and they are proud of."

The oil company Nynas has worked with YKI for several decades. The long-standing relationship with the institute's researchers has equipped the company for the future, as the previous head of the Nynas group and CEO, Måns Collin, points out.

"We didn't cooperate with YKI primarily to earn money"



"I can confidently say that without a very active surface chemistry component Nynas would not have been able to take the lead in a number of niches. YKI was a strategic link for the company when it came to surface chemistry expertise."

Måns Collin has great experience of industrial R&D and different personal perspectives on the operations of both YKI and FYF. He began his career in Nynas as long ago as 1970 as a development engineer. He later became head of R&D and head of the group, and as Nynas's representative in FYF (and its predecessor SYF) he was for many years one of YKI's customers. After retiring a few years after 2000 he was for a few years a member for YKI's board and was even a research student at YKI for a short period.

"But I realised that I was too old to stand in a laboratory myself so now I coach a few other doctoral students instead at the Royal Institute of Technology."

Nynas is an oil company but it does not produce any fuel. Instead the company's refineries all over the world manufacture specialty oils, including bitumen (the black binding agent in asphalt) and insulating oils for transformers. Its head office is located, for historical reasons, in Sweden but more than 85 per cent of its market is in other countries.

The company was already in contact with YKI during the 1970s. After the oil crises, when the price of oil rocketed for a short time, Nynas and Måns Collin worked with YKI's then CEO, Stig Friberg, and others to develop replacement products, primarily for lead in petrol – a research project supported financially by what was then Sweden's Board for Technical Development. Since then this cooperation has continued. What significance have these long-standing contacts with FYF and YKI had for Nynas? In Måns Collin's opinion it is impossible to summarise the benefits in economic terms or new products.

"You don't enter into a long relationship with a research institute merely to solve specific problems or earn a certain amount of money. That's a bureaucratic way of thinking. It's a question of a company wanting a broader view of the world so that it can tackle questions that arise more easily or through greater diversification."

MÅNS COLLIN, former CEO of the oil company Nynas.

It is above all in two commercial areas that Nynas has cooperated with YKI: bitumen and insulating oils for transformers. One surface chemistry issue that recurred in several projects through the years was attempting to understand how bitumen binds with the stone aggregate that forms the bulk of asphalt. The binding agent usually works well, but when it fails to unexpectedly costs escalate and the question is "why". Different hypotheses were tested but no final answer emerged. If you turn to a research institute only to buy an answer to a specific problem, there is a great risk of disappointment in Måns Collin's view.

"The great benefit for us as a company was we never left them without having learnt something new. The researchers could describe the systems we were studying in a way that made it possible for us to find a solution ourselves.

"When you start a new research project there is often an over simple view of reality. After a time you realise that it was infinitely more complex than you believed. At that stage you might possibly launch the project again. You can do this in partnership with an institute, but just as often you have extended your own knowledge and can carry on alone."

The close and long-standing exchanges with YKI's researchers helped to make it possible for the company's own staff to discuss unexpected occurrences with customers intelligently.

"If you sell a product without any kind of theory about why it works, you are very vulnerable when things do not go as planned. And that threatens your commercial relationships – always, sooner or later. If you have the knowledge that allows the problem to be solved then you can win the customer back. And a customer that you nearly lost but can win over through an act that inspires confidence and is based on know-how is the best kind of customer by far."

In recent years Måns Collin has become involved in Swedish research policy, for instance as a member of the Swedish Academy of Engineering Sciences, IVA, and an advisor to major research funding agencies like SSF, Vinnova and Mistra. Måns Collin's feels that many research programmes yield good academic results but far too seldom have practical application for industry. He would like to see more research programmes that are directed by people with solid commercial and industrial experience. The model of collaboration between industry and YKI through membership of FYF could, he considers, serve as a source of inspiration in the future.

"I have seen no better model for how industry can cooperate effectively with academia than industrial research institutes. FYF plays an important role as a partner in YKI, mainly through its influence on the strategic focus of its operations. Sweden greatly needs more cooperation of the same kind as FYF and YKI," says Måns Collin. ●●●

> *"It's a question of a company wanting a broader view of the world so that it can tackle questions that arise more easily or through greater diversification.*

NYNAS AB

Produces specialty oils, for example for use in asphalt, transformers and as a raw material for glues and printing inks etc.

Head office: Stockholm, Sweden

Turnover: Circa SEK 20 billion

Employees: Circa 900

ASPHALT IS ROUGHLY MADE UP OF nine parts stone aggregate particles and one part binding bitumen. Durability of asphalt depends on the adherence of bitumen to the aggregates. Over the years, YKI and FYF member company Nynas worked in several joint projects to learn more about the surface chemistry involved in this adhesion.

Big pharma focusing on NANOSCALE INTERACTIONS

Finding solutions to the so called picking and sticking of tablets has been one of the reseach areas for the Swiss pharmaceutical and long-standing FYF member company Novartis in collaborations with YKI and SP.

Ranking as one of the largest pharmaceutical companies in terms of global sales figures, and with a staff exceeding 100 000 employees worldwide, Novartis is working with many research centers and universities in Europe, North America and Asia. In comparison, the researchers at YKI and later SP have always been well in tune with the interests of industry to implement results, according to Michael Schuleit.

– The analytical capabilities of YKI and SP, their conclusions and our mutual discussions have in many cases been helpful to make us understand our processes and/or material better. However, some of the results are a little too clever to share in public.

Basel-based Michael Schuleit, a long-time FYF representative and champion of YKI and SP, has been working together with the researchers in Stockholm for almost two decades. 'After so many years it has become important personal relations' he says. He has co-supervised PhD students, and has been engaged in numerous joint projects.

– I believe that the close relationship to industry has been of great benefit to YKI and now SP. FYF has provided a close link to real life and to the industrial environment. In that sense, the organisation of FYF was very fruitful.

Problem solving has been one area of interest to Novartis; analytical surface science another important theme for collaborations. One of the PhD students, supervised jointly by SP and Novartis, uses atomic force microscopy to study adhesion forces of particles including the surface of tablets. The ambition is to learn more why tablet sometimes disintegrate or sticks to the die during the tabletting process.

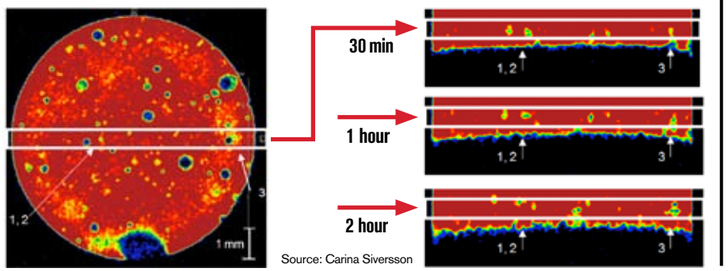
– We need to get a better understanding of the root causes responsible for the observation, and to develop predictive experiements upfront in order to minimize the risk of this very cost intensive phenomena.

Another PhD co-supervised by YKI and Michale Schuleit was Carina Siversson. Her research focused on characterisation of the polymer excipients containing the medication's active ingredient. While excipients, in order to be released in the body, must be water soluble, many active pharmaceutical ingredients are not. The solution is to produce a solid dispersion of the hydrophobic drug into a hydrophilic polymer.

– The PhD gave us better understanding on a molecular level of the solid dispersion. This gives us possibility to better design the polymers and to choose the right process to design the overall solid dsipersion properties needed for efficient in vivo-release.

For a long time Michale Schuleit worked in Technical Research and Development, He has switched position, and is now working in the Novartis Institute for BioMedical Research (NIBR). But he still keeps close ties with SP. In research areas like local drug delivery, e.g. in joints, there is collaborative work to be done, he concludes. ●●●

NMR IMAGES OF A SOLID DISPERSION TABLET, illustrating the rise of bubbles through the gel layer. The bubbles are labelled 1, 2 och 3 respectively. The white rectangle in the horizontal image (left) indicates the position of the three vertical slices (right). Each slice has a width of 0.5 mm.



Source: Carina Siversson

Carina Siversson is one of the doctoral students who has been trained at YKI in close collaboration with a member of FYF – Novartis.

What did your research focus on?

"I was using NMR (Nuclear Magnetic Resonance) imaging to study the interaction of the components of a pharmaceutical product. We were investigating how the composition of a pill can be optimised to provide the active substance with maximum effect."

What kind of contact did you have with Novartis?

"Michael Schuleit was my supervisor at Novartis. He was incredibly committed to my project even though he was in Basle and spent most of the time in Stockholm. He always took part in telephone conferences and we met several times each year."

While you were a doctoral student at YKI did you meet other members of FYF?

"Yes, above all through FYF Member Days, which gave me a chance to meet other industrial representatives from various fields every year. That taught me a lot about the values that prevail in industry and what they consider important in research collaboration."

Today you are employed as Research Manager at McNeil. What benefits have you had from your time as a doctoral student at YKI and cooperation with Novartis?

"For me it was the interaction with industry that was important. Being able to work at an early stage with an industrial partner gave me insight into the interplay between research and product development. The focus is on the customers and what the customers want." ●●●

ACADEMIC BIG SHOT WITH AN EYE FOR INDUSTRY

IN THE EARLY 1980s PER CLAESSON WAS A PIONEER in the field of measuring surface forces. Today he is a professor at the Royal Institute of Technology in Stockholm (KTH) and has contributed to the international reputation enjoyed by Swedish research into surface chemistry. For him industry is not merely a partner for cooperation but also an important source of inspiration.

Per Claesson's career proves that high-quality basic research is not the opposite of the more goal-oriented research and development that industry needs. Rather the contrary. His achievements span both academic and applied fields -- and he has been rewarded commensurately. In 2008 he was awarded the Arrhenius Plaque by the Swedish Chemical Society and five years later he received the AkzoNobel Science Award from the Swedish Academy of Engineering Sciences. He himself described what he does as "industrially inspired basic research".

"For me it's not a question of solving specific industrial problems. On the other hand I want to understand what fundamental knowledge is lacking that could solve a problem. And that's the gap I want to fill."

Per Claesson is one of the researchers who personifies the interdisciplinary activities that have been pursued for five decades now at the Institute for Surface Chemistry, (YKI). In principle, he has devoted his entire career to RIT. But even when he was studying for his PhD, Per Claesson spent most of his time at the YKI – a commitment that has continued in recent years at the SP Technical Research Institute of Sweden (SP). The close contacts and repeated exchanges with industrial companies have had a major impact on him and his career.

"If I had worked only at RIT I would probably have focused more on basic research and less on applications. But because I was being exposed all the time to complex industrial problems at ISC I had to come out of the ivory tower. I soon realised how much we did not understand."

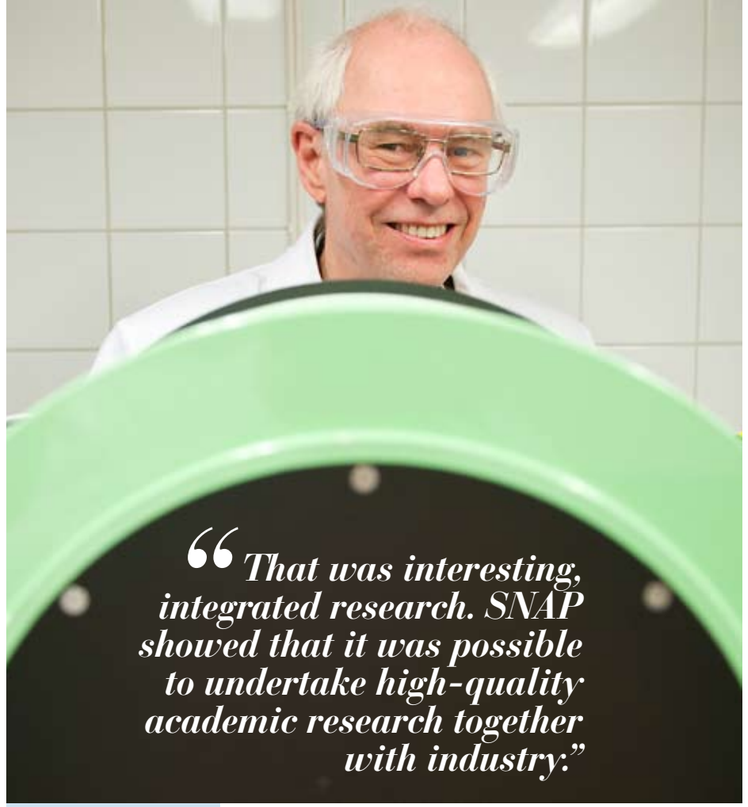
His research career started in Australia. After graduating with a Master's degree in engineering, Per Claesson spent the following year as a doctoral student in Canberra. At the time the staff of the Australian National University included Jacob Israelachvili -- the one person who more than any other has expanded the boundaries of knowledge in my field, Per Claesson tells us. Israelachvili had developed unique measurement equipment, a "surface forces apparatus". This equipment provided what were then totally new possibilities of studying the forces exerted when two surfaces are moving at very small distances -- at nanometre level – from each other.

When Per Claesson returned to Stockholm after one year of theoretical and practical work, a new laboratory was being set up. It was in this laboratory, a joint initiative by KTH and YKI, that the first surface forces apparatus in Sweden or the Nordic countries was installed.

"We created a world-class surface forces laboratory. We copied the instruments they used in Canberra but because ISC was working with industry our research was prompted by industrial problems."

A lot of the research in the laboratory focused on the interaction of tensides and solid surfaces in aqueous solutions. Tensides are surfactants that are used in everything from detergents and pharmaceuticals to papermaking and processing minerals in the mining industry. You have to know more about the surface forces generated by tensides to be able to develop tenside structures that provide the characteristics you want. This is knowledge that we developed together with industry," Per Claesson explains.

"We spent a long time looking at how tensides adhere to different surfaces and what forces were being exerted. I remember that it was great fun telling the companies that came to the YKI about what we were doing. A lot of our results provided totally new information for industry and for the academic world as well."



"That was interesting, integrated research. SNAP showed that it was possible to undertake high-quality academic research together with industry."

PERSONAL FACTS

Per Martin Claesson

Title Professor at the Royal Institute of Technology, 1981 onwards, with a 20-per-cent placement at YKI.

Date of birth 1957

Family Married, three children, one grandchild

Leisure interests
Preferably deep in the forests with his family – "I like being far from civilisation, that's when I'm happy."

Unexpected talent
Bird watcher. Up until now he has spotted 284 species, only 16 left before the magic 300. "It's the last few that are difficult, it's not exactly sparrows you have to look for."

Career

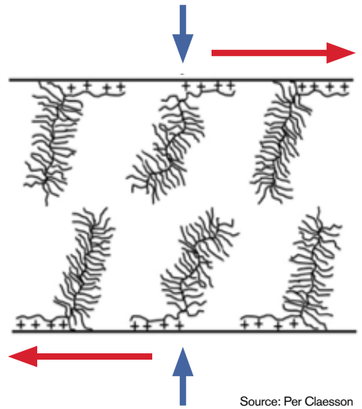
1977 Chemical engineering at KTH
1981 Doctoral student at KTH/YKI
1988 Head of Section, YKI
1989 Associate professor of physical chemistry, KTH
1989 Professor of physical chemistry , KTH
2008 Arrhenius Plaque
2013 AkzoNobel Science Award

As a young doctoral student Per Claesson had no great insight into the challenges facing industry. On the other hand the ISC's managing director, Per Stenius, did. He had very extensive knowledge of the challenges encountered in industry and the expertise in surface chemistry that was needed, Per Claesson points out. But as time passed his own understanding increased. Not least thanks to regular discussions with researchers in different companies. Membership of FYF included annual meetings with the YKI researchers and being able to ask for help with problems relating to production technology or other burning issues. And these discussions frequently provided the impetus for Per's own research.

"Sometimes certain problem areas arose again and again, and none of us at YKI could provide satisfactory answers. That's when I began to wonder how one could get to grips with a problem at a fundamental level.

"I could then base the wording of my applications for research funding on these reflections. They often became very good applications because they were based on genuine gaps in our knowledge."

THE ILLUSTRATION SHOWS brush polymer layers that are pushed together and rubbed against each other to determine surface forces (blue arrows) and friction forces (ref arrows). These are biomimetic molecules similar in architecture to some of the lubricating molecules found in e.g. human joints.



Source: Per Claesson

Over the years Per Claesson has led a number of major research initiatives. He was, for instance, the head of the SNAP Centre for Surfactants based on Natural Products, one of Vinnova's competence centres, in the early 2000s. This centre included ten or so companies and six academic participants, among them both KTH and YKI.

"That was interesting, integrated research. SNAP showed that it was possible to undertake high-quality academic research together with industry."

The centre's aim was to increase the use of renewable raw materials for the production of tensides. Per does not know, however, to what extent this research led to new products. This is often the case with collaborative projects and is not something that he has any real regrets about.

"In industry they would dearly like to learn what we know. Then they don't want to tell us more than they have to so that we can do the right kind of research. Those are the rules of the game.

"But I see sometimes when I buy different detergents that some of the tensides based on sugar we studied at the competence centre are included in the declarations of contents."

The good results also helped to create an even more positive attitude to cooperating with industry at KTH. As a technological institute KTH has always has close contacts with industry, Per Claesson points out, but for a long time both individual researchers and professors were not totally convinced of its value.

"That lack of conviction has been more or less totally eradicated today. SNAP and the other competence centres that worked so well were one of the reasons for this change of heart. Nobody can say that they gave rise to poor academic research."

Where Per Claesson once studied the forces between surfaces that move towards and away from each other, attraction and repulsion, in recent years his focus has shifted towards the forces exerted when two surfaces rub against each other, in other words friction. What he and his colleagues are particularly interested in today is how the body minimises friction by lubricating joints like elbows and knees, 'biolubrication'.

"We can bend our elbows backwards and forwards with hardly any resistance. And we can go on doing so until the age of 100 if we're lucky. But that's a little odd because our joints are mainly composed of bone, cartilage and water."

The water in our joints contains small amounts of lubricants, including polar lipids. By learning more about the frictional forces in lipids, which have a similar chemical structure to the tensides that Per Claesson has been studying earlier, he hopes to be able to develop new lubricantsthat function in water. In the long term these could be able to replace today's oil-based lubrication systems – at least when the pressures and the temperatures are not too high.

"We are trying construct synthetic molecules which lubricate in the way lipids and other biopolymeric lubricants do. So far we have identified a number of completely natural and biomimetic molecules that enable very low friction on model surfaces."

He still sees possibilities in continued development of partnerships between the academic world, research institutes and industry. In 2015 KTH nominated a handful of professors to be ambassadors for cooperation with the surrounding community. Per Claesson was the one chosen for this task for the School of Chemical Science and Engineering. He describes with enthusiasm the School's plans to build a new laboratory with first-class instruments that will be able to undertake surface science research.

"My vision is that the laboratory should be available for both academia, research institutes like SP and for researchers in industry. I'm convinced that would be really valuable for all concerned." ●●●

Research assistant who became an IT ENTREPRENEUR

Help for the paper industry to study particle precipitation – and what's more, John Elvesjö came up with the idea of eye-tracking technology that helps disabled people all over the world. The IT company Tobii is both a successful and unexpected outcome of collaboration between industrial members of FYF and researchers at YKI.

"Bengt saw an unruly young mind that dared to question everything, that loved screwing things apart and modifying devices, but which at the same time possessed a theoretical understanding."

JOHN ELVESJÖ CO-FOUNDED TOBII, a world leading company in eye tracking. The technology originated at YKI in a research consortia for the paper industry.

John Elvesjö had only been studying for a year at KTH when he met Bengt Kronberg, professor and head of a section at YKI. Instead of continuing his studies in Engineering Physics he took a post as a research assistant at YKI, where one of his jobs was sorting glass bottles. But YKI and the companies that were members of FYF had also gained access to a fountainhead of creative ideas, a talented mathematician who was good with his hands. It was not long before he began to improve the analytical equipment.

"A couple of things got broken while I was doing it, but in the end I had rebuilt four of the measuring instruments. A lot of people had already had similar ideas. But it had been more difficult to implement them. I wasn't scared."

After a few years he became a member of a research consortium and was given the task of developing an optical sensor that could measure the surfactant content of a solution continuously. This work was so successful that the technology was later commercialised in a company – one that was supported financially by YKI and the industrial consortium.

John Elvesjö was soon involved in another research consortium on the development of a sensor, this time to measure how particles in paper pulp precipitate in a liquid. Late one night he was sitting in the lab turning the equipment this way and that when he set some coins rolling along his desk and managed to programme the sensor to decide what kind they were and which direction they were taking.

"At one moment the sensor found my eyes instead. The sensor announced 'there are two coins, they're pointing this way, they are crowns'. That was an 'aha' experience. If the sensor could see where my eyes were pointing, I should be able to construct a tiny one and put in a pair of glasses or a computer … . It started me thinking."

The company Tobii was founded in 2001 and since then it has grown constantly. In 2014 its turnover was approximately USD 100 million and it employed over 600. Its customers come from online commerce and the games industry, but behavioural researchers are also interested in its technology. The company is also working with SP to develop technology for the vehicle industry. But the major application area is for the tens of thousands of disabled people who can use Tobii's technology to control computers only through eye movements.

The business idea is still based on the developments made by John Elvesjö while he was at YKI: programming optical sensors to detect the position of the eye and which direction it is moving in. John Elvesjö is enormously grateful for the creative environment that prevailed at YKI and points out that today his company provides jobs for many people.

"Tobii is the outcome of the funding that was provided by both the state and the member companies. I think we should blow our own trumpets for our joint contribution to a successful industrial company."

NEW SOLUTIONS TO FIGHT ANTIMICROBIAL RESISTANCE THROUGH INTERDISCIPLINARY COLLABORATION

Resistance to traditional antibiotics is a rapidly increasing problem that in the future could make infections impossible to treat and thereby bring the state of medical care back to the pre-antibiotic era from the beginning of the last century. The development of new, efficient solutions to prevent and treat infectious diseases is therefore a key priority and in focus within SPs initiative Infection Management.

SP has with its broad technical expertise and strong industrial and academic network a great potential to facilitate and accelerate innovations that aim to prevent, treat and monitor resistant bacteria and infectious diseases. SP is presently a key partner in national and international projects worth over 200 MSEK aiming to:

- develop new antimicrobial products with new mechanism of action and administration forms
- decrease hospital-acquired infections by innovative hygiene and cleaning routines as well as development of new materials
- develop innovative analytical techniques for risk and quality monitoring within the food industry
- improve animal welfare and health

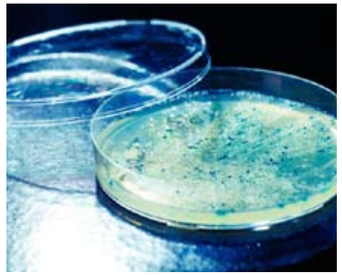
The Infection Management area within SP is expected to grow in the near future by coordination of strategic activities and competence development within the area.

– I am convinced that we need strong, interdisciplinary collaboration in order to make significant progress within the Infection Management area, says Helena Bysell, project Manager within SP Life Science.

FORMAMP-Innovative nanoformulation of antimicrobial peptides to treat bacterial infectious diseases

Antimicrobial peptides have a great potential as new therapeutics against infectious diseases as they are less prone to induce bacterial resistance due to mechanism of action. However, peptides display challenges related to stability that need to be addressed in order to become functional therapeutics. The aim of FORMAMP is to explore a number of innovative formulation strategies based on nanotechnology in order to improve the efficiency and stability of antimicrobial peptidess in clinical development. Functional products that can be applied directly on the infected site are developed for treatment of infections in skin and lungs.

The results of this large collaborative, interdisciplinary project will generate efficient treatment strategies combatting one of the largest threats to our global health, reducing healthcare costs and expanding the growth of European enterprises within the field of pharmaceutics and nanomaterials.



CONTACT:
Project coordinator: Helena.Bysell@sp.se
Budget 10 M Eur (2013-2017)
16 partners from 5 European countries
www.formampproject.com

FORMAMP is funded by FP7/2007-2013 under grant agreement no 604182

I-TEX – INTELLIGENT use of innovative textiles

I-tex is a collaborative, interdisciplinary project within the VINNOVA program Challenge Driven Innovation. The project aims to decrease healthcare-associated infections through modifying textile materials with sustainable bacterial inhibition technologies and innovative probiotic systems. As textiles represent about 90% of the contact area in close vicinity of a patient, the cleanliness of these surfaces plays an important role for patient recovery. One of the key questions for I-tex is therefore to investigate the possibility to reduce the spread of infection and bacterial burden, by applying innovative textiles.

– We believe that a broader approach, including both development of innovative materials and behavioral knowledge, is what is needed, says Jesper Hedin, project manager within Life Science at SP and coordinator for the I-tex project.

The project team involves material scientists, chemists, clinicians and hospital personnel, cleaning experts, behavioral scientists as well as representatives from the Medtech industry. The project will develop innovative textile materials that, combined with knowledge about infection routes, cleaning protocols and system- and behavior knowledge about the healthcare environments, will make the local patient environment at hospitals healthier.

CONTACT:
Project coordinator: Jesper.Hedin@sp.se
Budget 2 M Eur (2014-2016),
13 partners from Sweden and Norway
Funded by VINNOVA • www.i-tex.se

Without the Royal Swedish Academy of Engineering Sciences (IVA) neither FYF nor YKI would have existed. The Academy's current president Björn O. Nilsson looks back on how it all began and also looks ahead. He sees a changed attitude to industrial research and believes in new forms of cooperation.

"THE IDEA OF **AN INDUSTRIAL RESEARCH INSTITUTE** HAS NEVER BEEN MORE MODERN THAN TODAY

"YKI's first CEO, Per Ekwall, played a major role in establishing the centre. Then Stig Friberg took over the post and helped bring cooperation with industry up to speed," says Björn O. Nilsson.

1963 saw the foundation of something that a few years later was given the new name of Ytkemiska institutet, YKI. The initiative came from the Royal Academy of Engineering Sciences and from the very start the Academy's extensive network of contacts with engineers in Swedish industry was an important factor in the establishment of the institute's cooperation with companies. In 1968 SYF was founded, the predecessor of the organisation that later became FYF. That was when the platform was laid for this cooperation model in which industrial members were partners in YKI and could influence its operations.

"The establishment of YKI was the result of inspiration from the German research institutes. Today we highlight this as an important era in the Academy's history," says Björn O. Nilsson.

A few years have elapsed but the model for cooperation between industry and institutes is just as valid as ever in the opinion of Björn O. Nilsson, whose own background is in pharmaceuticals, both research and commercial operations. Björn O. Nilsson feels that he can see a change of attitude where the idea behind YKI and FYF and the other industrial research institutions is gaining more and more ground – in the university world as well.

"The idea of an industrial research institute has never been more modern than today. People sometimes talk about the Grand Canyon, with industry on one side not understanding the basic research that is needed and the academic institutions on the other with no idea of how industry works. I believe, and hope, that that is a thing of the past."

Today's major social challenges, such as new energy systems and materials science to take just a couple of examples, increasingly require cross-disciplinary cooperation. This is true in the area of surface chemistry as well, or nanotechnology, which is what much of the field is now called. But to succeed in interdisciplinary research projects each scientific discipline has to dig deep into its specific fields, Björn O. Nilsson tells us.

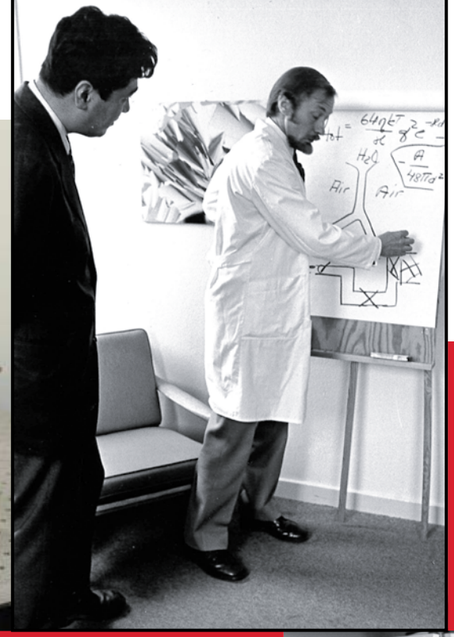
There is less and less talk about the division between basic and applied research. Now it's either good or bad science. Most good science can be applied but that depends on profound understanding within the discipline itself."

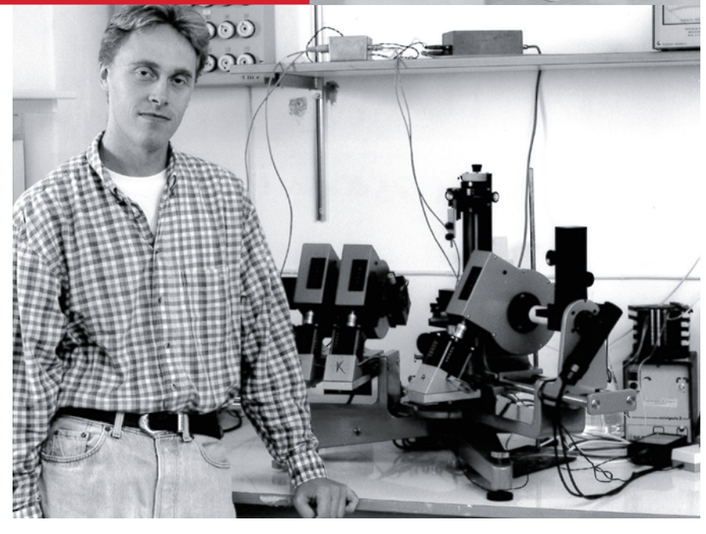
So how will future cooperation between industry and research be organised? Björn O. Nilsson points out that the FYF/FKI type of co-operative model has been successful but believes that we will see a broader palette in the future.

"I'm quite convinced that in the next two decades we are going to see new methods of collaboration between industry and the research world develop. We can see, for instance, that today our technological universities are working with impact issues. The commercial sector will also launch new innovative initiatives. ● ● ●

What would those who founded YKI and contributed to the establishment of FYF say if they could look back today on the results of what they created?

"That, of course, is difficult to know, much of the development in YKI has been influenced by the people working there. But I believe they would be very happy about many of the things that YKI and FYF achieved."





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LEARNINGS FROM AN INDUSTRY-ACADEMY PARTNERSHIP

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