

## Modelling is the model

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# Meeting point on several levels

“Our task is to provide extended knowledge to all those throughout the value chains,” says Thomas Johannesson, the President of STFI-Packforsk.

The term, value chain, is our way of describing an activity where all those doing business together and creating additional value, are included. Our operations follow the chains of packaging, printed media as well as sustainable chemicals and energy.”

“Customers come to us together with their colleagues, either up or down the flow, for joint assignments or research. One clear example of this is the Liquid Packaging Cluster that TetraPak initiated and participates in, together with other companies in the chain.”

Thomas Johannesson often emphasises the role of his company as a meeting point for trade and industry as well as for the academic world. The latter has been much more apparent through joint initiatives with Karlstad University, the Mid Sweden University and the Royal Institute of

Technology Stockholm to bring together Swedish technical institutes and universities that have a connection to the forestry sector, in order to design a national business programme for the forest-based sector.

“Most companies have been forced to spread their research efforts over a huge area, which has made the structure run wild and become self centred. The future signifies that public research assignments are going to be in competition with other deployments on the international market. On a national level, we must therefore be in better agreement, so as to meet this competition.”

At the same time, activities are currently going on in national research financing, the industry in Sweden and among those involved in research to create competitive programmes and projects in concord with the strategic research agenda that FTP, The Forest-Based Sector Technology Platform, formulated for the EU 7th Framework Programme.●

## For technical developments and specialist know-how



PHOTO: TETRA PAK

“As Sweden’s biggest packaging company with considerable stakes in development in Sweden, it is essential to have excellent contacts with research institutes, universities and technical institutes.”

So says Göran Harrysson, the newly appointed CEO of AB Tetra Pak, the parent company of the Swedish Tetra Pak Group.

“It makes it possible for us to establish networks in the research world and have access to know-how and knowledge. Personally, I consider that Tetra Pak has a responsibility to participate and support institutes in their significant role as bridges between basic research and applied research.”

“As a partner and through membership in the The Private Owners’ Association Packforsk we are supporters of the STFI-Packforsk operations that specialise in our particular areas of operation. And, as active participants we take part in its research clusters, projects and assignment work.”

Tetra Pak, founded in 1951, is privately owned and still has a main base in Sweden. The focus is on process equipment and solutions to packaging for food-stuffs, with the main areas being process development and the packaging of milk and juice-based products.

Today, we are investing more and more money in the materials side of things, namely, paper, paper technology and polymer technology.▶

“The basis of a packaging system is materials and what interests us is materials development with a focus on costs. When it comes to packaging itself, we’re interested in projects with an emphasis on functions that are of concern to us. Take barrier problems, to give just one example.”

“Tetra Pak invests a lot in its own product development centred on Sweden and Italy, among others. In total, 3.5% of our turnover of approximately € 8bn is being invested in research. This may seem a small percent but, in money terms, it’s quite a substantial amount. External research is considered to be more long-term, aiming at technical development. One example of this is the Liquid Board Cluster, where the development of methods is the main focus.”

Tetra Pak turns to STFI-Packforsk for more short-term projects, where there is a lack of know-how in its own organisation. The assignments are a subset in a larger context, where results will lead to a finished product.

“Many of the assignments happen ad hoc and we utilise laboratory services in various areas. The new HPI Lab that specialises in usability is one interesting service that we have taken advantage of. And the STFI-Packforsk work with environmental profiles is another suitable area that companies need to invest in these days.

Furthermore, the results of research can be exploited for the building of knowledge in the company. The one that orders an assignment is responsible for spreading that knowledge and, as a result, raise the levels of technical expertise.”

Co-operation with STFI-Packforsk harks back 20 years, perhaps more, thinks Göran Harrysson, who remembers assignments that he ordered concerning resistance to transportation loads back in the 1980s. ●



**Som Sveriges största** förpackningsföretag är det viktigt för Tetra Pak att ha goda kontakter med forskningsinstitut, universitet och högskolor. Det ger möjlighet att etablera nätverk i forskningsvärlden och få tillgång till kunskap.

Tetra Pak stödjer verksamheten i STFI-Packforsk som partner och genom medlemskap i Packforsks Intressentförening samt deltar aktivt i forskningskluster, till exempel Liquid Board, i projekt och genom uppdrag.

Den externa forskningen ses som mer långsiktig och syftar till teknikutveckling. För mer kortsiktiga projekt där kunskap saknas i den egna organisationen lägger Tetra Pak uppdrag hos STFI-Packforsk. Labbtjänster inom olika områden utnyttjas också. Och arbete med miljöprofiler är ett annat aktuellt område där företaget idag måste satsa.



Maria Enroth, Åsa Moberg and Cathrine Löfgren have worked out sustainability indicators for the industry.

It is important to be able to measure sustainability. This is one of the pre-requisites for being able to arrive at improvements in the field of sustainable development.

With the aid of a case study in the value chain for liquid board packaging, STFI-Packforsk has produced a model for sustainability indicators. The result is a tool consisting of 29 sustainability indicators for liquid packaging board throughout the entire value chain.

“Together with industry representatives from the value chain for packaging with liquid board, we have worked out what the most important sustainability indicators are,” says Maria Enroth, the Project Manager. “The indicators reflect the significant financial, social and environmental aspects. The aim of the case study was to facilitate work in the industry by achieving sustainable growth.”

#### Working method for analysis

“By identifying the significant aspects and formulating indicators in each sub-area of the sustainability concept, viz. financial, social and environmental, we’ve produced a method that aids companies in measuring sustainability in the entire value chain,” continues Maria Enroth. “This working method provides a foundation for following-up, improving and communicating the sustainability work throughout the entire value chain for packaging with liquid board.”

The operations, included in the study of the value chain, were the collecting of the raw materials and the preparation of them, the production of board, plastic and aluminium, converting and printing the packages, together with any inter-

mediate transportation involved.

When identifying the significant aspects, consideration was given to the filling, distribution, utilisation of the package, recycling of the package and the waste disposal.

#### Tools for the industry

The benefit of producing tools for identifying sustainability indicators in the field of packaging is to give the industry the opportunity of developing, following-up and improving its sustainability work.

By producing a documented working method, the industry can more easily identify areas for improvement and find a means of communicating its sustainability work internally.

“In the long term, this may mean a model that makes it possible for companies to evaluate sustainability performance over a period of time and even to communicate their work externally,” adds Maria Enroth. ●

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#### Tillsammans med industri-

representanter har STFI-Packforsk tagit fram en modell för hållbarhetsindikatorer inom värdekedjan för förpackning av vätskekartong. Resultatet är ett verktyg bestående av 29 indikatorer som speglar de betydande ekonomiska, sociala och miljömässiga faktorerna. Modellen ger industrin underlag till att följa upp, förbättra och kommunicera hållbarhetsarbetet internt och externt.

De studerade aktiviteterna är råvaruuttag och -beredning, produktion av kartong, plast och aluminium, konvertering och tryckning av förpackning samt mellanliggande transporter.



# Modelling is the model

There are many advantages in being able to calculate theoretically what is happening with a product or a material, when it is subjected to various loading conditions. It minimises risks, it reduces costs and, not least, it raises levels of knowledge. In the Liquid Board research cluster, a model is being produced to simulate complex deformations in board.

In relation to other materials, it is difficult to model deformations and damages to paper and board in a proper way. The reason for this is that fibre structures in paper and board cause them to have increased stiffness in the in-plane direction than in the out-of-plane direction. It is therefore important to take into consideration the mechanisms of deformation, such as delaminating, when you model the development of damage in paper and board. The anisotropy (the various properties) that exists between the different

directions in paper is a factor that makes it difficult to build numerical models.

The paper-based industry has consequently been relatively conservative, when it comes to utilising numerical models in product development and research. A comparison could be made with the motor industry that, as a principal, models every component in a new car before it is constructed. For all that, the paper industry is ripe for the concept of modelling and simulations. That, at least, is what researchers in the Liquid Board Cluster are hoping for.

“In order to go ahead with modelling and simulating, there are several obstacles that have to be overcome. Basic research during the last 10 years has made it so that there is a good starting point for utilising simulations to solve problems,” says Mikael Nygårds, the Project Manager. “Experimental methods have been produced that make it possible for us to measure the properties of materials in the out-of-plane direction. What’s more, numerical models have been developed for describing paper and board well.”

More can be learnt by utilising models and simulations. In research, the choice is often between experiments and simulations. Mikael Nygårds would like to point out that this is not an exclusive choice but that both of them should be used in order to learn as much as possible.



Mikael Nygårds and his colleagues in the Paper physics group would like to convey to their customers the understanding of the properties of the material and how it behaves under various stresses. “As consultants, we want to get them to start thinking the same way as we do,” he explains.

Instead of carrying out tests for each individual property, data from certain selected experiments are used to interpret and develop into general methods, so that these can then be used to predict a number of properties. This is all about a new way of thinking. With new models, such as modelling and simulating, the industry can gain increased understanding of what is happening and the effects a certain property or influence may have. With this knowledge, changes in processes and products can be made with greater precision and less risk-taking.

"The Forest Industry is, nevertheless, a traditional business," he says, implying that it is normal that it is preferable to proceed by trial and error rather than to trust in theoretical calculations that can predict how a paper or board is going to behave. He comments, "But a good model replaces costly laboratory trials and involves less risk-taking."

"When we develop models for describing paper and board, there are three important pieces to the puzzle in constructing the model," continues Mikael. "The first is to study reality with the aid of experiments, the second is to describe and formulate a mathematical model and, finally, the third is to implement and validate experiments and models against each other. This last piece of the puzzle is the most time consuming, yet also the most important. Without it, we don't know what a model can do or cope with. But, if instead we know how a model behaves in all situations, then we know we can dare to trust it when it is used for studying complicated instances of stress."

## Liquid Board Cluster

The Liquid Board research cluster aims at developing tools to be utilised for simulating complex stresses in board. To produce liquid board for packaging milk or juices, the board needs to be converted. Converting involves scoring operations that have the purpose of delaminating the board. A subsequent creasing operation then opens up the delaminated splits so as to provide the package with good and stable corners. There is a hard loading on the board during converting; as a result you can expect damages to develop. One of the aims of the Cluster is to simulate scoring and creasing in order to better understand these operations and also to identify the properties of the material in the board that are significant for optimising the scoring and the creasing.

According to Johan Tryding of Tetra Pak, the sponsors of a cluster play a vital role in discussions with the researchers, when defining measurable and realistic aims, together with the criteria for evaluating those aims.

"The packaging field and its goals must be based on an increased and enduring

packaging performance that reflects the wishes of our customers and consumers," he says and, furthermore, he thinks that this should be accomplished so that the total costs in the packaging chain become lower than today.

"In the Cluster, there is an agreement that STFI-Packforsk will be responsible for generating models and simulations and that TetraPak will be responsible for carrying out validating experiments in their pilot plant. With this way of working, we can generate a model that will more and more describe reality. Furthermore, we will continually become more aware of how the models correspond with each other, while, at the same time, we will find out what the industry thinks about our models," says Mikael Nygårds.

## Other applications

The Cluster has decided to simulate scoring and creasing. The numerical models previously developed may even be used for studying other mechanical loading in paper-based materials. This includes applications where delamination occurs, during printing, for example, but even applications where compression takes place, such as during embossing and calendering.

"I would be interesting to study special embossing, e.g. for Braille, with the modelling tools that we have already developed," concludes Mikael Nygårds. ●

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**Med nya verktyg** som modellering och simulering kan industrin få ökad förståelse för vad som händer och vilka effekter en viss egenskap eller påverkan har. Med den kunskapen kan förändringar i processer och produkter göras med större precision och mindre risktagande. I förhållande till andra material är det svårt att på ett korrekt sätt modellera deformationer och skador i papper och kartong, men grundforskning under de senaste tio åren har lett till ett bra utgångsläge för att använda simuleringar för att lösa problem.

Forskningklustret Liquid Board ska utveckla verktyg som kan användas för att simulera komplicerade belastningar av vätskekartong. Exempel på sådana belastningar är bignings- och vikningsoperationer för att ge bra och stabila hörn på förpackningen. Målet är att skapa bättre förståelse för dessa operationer och att identifiera vilka materialegenskaper i kartongen som är viktiga för att optimera bigning och viking.

Inom klustret har man beslutat sig för att simulera bigning och viking, men de numeriska modeller som har utvecklats tidigare kan även användas för att studera andra mekaniska belastningar som sker tex vid tryckning, präglning och kalandrering.



Mikael Nygårds

Mikael Nygårds has worked in the Paper Physics Group at STFI-Packforsk since 2003. This group is relatively small but it is very involved in cluster research as well as in consultancy work.

Mikael says, "Since there are not so many of us working with paper physics here, it makes it possible for us to work with different problems, due to the fact that the explanation to many of the problems has a basis in paper physics. As a result, the best thing about this work is the fact that you can work across the board with experimental and theoretical developments and, thereby, gain understanding."

In mills, paper physics often deals with emergencies, when it is necessary to find out what has been the cause of a problem with production or a fault with a product. Instead, Mikael's solution is to ponder a little deeper and produce a new experimental method in order to gain an understanding of what is going on and to be able to predict future problems.

This way of thinking is not unique to paper physics. Mikael started his career working with a completely different material. After studying Materials Engineering at Uppsala University, he did his doctorate in Solid Mechanics at the Royal Institute of Technology Stockholm. In this work, he developed numerical models for metals. Now he is working with paper and board. As manager of the Liquid Board Cluster (see the adjacent article), he thinks that it is fascinating to get more people involved in the approach to problems that he has been working with during recent years.

"Since there are more of us working with this, things are progressing faster and we can discover more about the problems we are looking at. It's exciting," says Mikael.

Mikael devotes most of his spare time to his children, 12 and 28 months old. ●

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# Efficient cooking of birch

In a joint effort with the pulp industry, STFI-Packforsk has recently concluded a successful project for a more efficient sulphate cooking of birch wood. Historically, research around the cooking of birch has been significantly less widespread than research on coniferous wood cooking. With the increase in costs for the raw material, a more efficient cooking is becoming more important for mills. This especially concerns sulphate cooking with the raw material of birch. An optimisation of process efficiency for this process is a matter of many thousands of euros.

“We had two aims for this Birch Project,” says Project Manager, Fredrik Lundqvist. “We have reached success with both of them.”

## More economical process

The main aim of the project was to improve the efficiency of the process. When it comes to the sulphate cooking of birch as a raw material, it is markedly more difficult than with softwood to control a cook with the aid of the kappa number.



Fredrik Lundqvist and Leelo Olm in the STFI-Packforsk cooking laboratory.

“We studied general aspects of the process using comprehensive laboratory studies,” relates Fredrik Lundqvist. “In addition, we worked jointly with individual mills to chart what the most important factors were, especially for them, and how the results of the project could be implemented in their own particular processes. The project comprised six Swedish mills and two Finnish ones, with each mill having its own particular process.”

“Some of the participating mills have continuous cooking, while others use the batch technology. Some use Swedish wood, others base their production on imported birch wood, mostly from the Baltic countries. Other parts of the processes differ in various details and, with the mills, we were able to produce those factors which were most important for each individual mill. Today, they all have the opportunity of improving their efficiency.”

## Carbonate an important factor

Carbonate is always present in industrial processes, but it has not yet been part of laboratory trials. It is quite usual not to have carbonate present in white liquor at universities and technical institutes with the laboratory production of sulphate birch pulp. Earlier laboratory trials have not been interpreted correctly and so it has not been possible to optimise the industrial processes.

Another difficulty with optimisation was that there was no correct continuous measuring of the kappa number in birch-based processes. The measuring of the kappa number is interfered with, when cooking birch with high doses of hexenuronic acid. The other aim of the Birch Project was, consequently, to develop a better technique for measuring the kappa number in the sulphate cooking of birch.

“It was therefore vital that the project

should have an involved, expert developer of measurement techniques. We had such a person from BTG, who has now developed a new measurement head for kappa number measuring that can cope with the conditions prevalent in birch cooking. This new technique, developed in the project, was tested in one of the mills, with a very positive outcome.”

The project also had the advantage of having an extremely knowledgeable researcher on cooking who was a member of the management group in the project, viz. Leelo Olm from STFI-Packforsk.

Fredrik Lundqvist adds, “We had a very involved and highly qualified steering group in the project as well.”

Participating in the project were Holmen/Iggesund, Korsnäs, M-Real, Smurfit/Kappa, Stora Enso, Södra Cell and BTG.●

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**STFI-Packforsk har** tillsammans med massaindustrin nyligen avslutat ett framgångsrikt projekt för effektivare sulfatkokning av björkved. En optimering av processeffektiviteten för denna process är en fråga om många miljoner kronor. Man har arbetat tillsammans med enskilda bruk för att kartlägga vilka faktorer som är viktigast för just dem och hur projektresultaten skall kunna implementeras. Karbonat finns alltid med i de industriella processerna, men har hittills inte funnits med vid laboratorieförsök. Tidigare försök har inte tolkats rätt, och de industriella processerna har därför inte kunnat optimeras. En annan svårighet med optimeringen har varit att man inte haft någon helt korrekt kontinuerlig mätning av kappatalet i björkbaserade processer. Ett mål var därför att utveckla en bättre teknik för mätning av kappatal vid sulfatkokning av björk. Den nya tekniken som utvecklats i projektet har också testats i en av fabrikerna med positiva resultat.



## EU Office supporting the industry

Catharina Ottestam, Manager of the new EU Office, says, "During the course of the past years, when we have participated in the different EU Framework Programmes, we have amassed a great deal of expertise. Our role is to exchange all this knowledge in order to succeed in obtaining EU funds from the 7th Framework Programme. A lot of our work will be directed at the "Forest Based Sector", a technological platform that was established on a European level. By succeeding in the EU Programme, we will be able to support our industry to a very good degree."

Two people are currently working in the EU Office. They are Catharina Ottestam and Barbro Nabb-Gustafsson, who work with providing services and regulation support for applications, how to establish a syndicate, etc. Its aim is to offer its services to all the value chains in

the industry, from pulp, paper, packaging and graphics products to timber, wood products and forestry concerns.

"We have observed that each Framework Programme tends to become bigger and bigger," says Catharina Ottestam. "This time, the "Forest Based Sector" technical platform is going to be 50% bigger than the previous Framework Programme."

This means that there is a need for experience and know-how to participate in these large applications, with participation from many countries.

"The first advertising is expected to be in December and the work with finding partners and ideas for projects before the first call has already started," adds Catharina Ottestam. ●

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### COMING EVENTS

#### AUGUST

28-1/9 5<sup>th</sup> Plant Biomechanics Conference

#### SEPTEMBER

19 Research Seminar for STFI-Packforsk Partner Customers

#### OCTOBER

2-5 Packaging Diploma Course, session I

5 Course on Packaging and the environment

11 ECOTARGET open workshop, Munich

For further information on coming events, see [www.stfi-packforsk.se](http://www.stfi-packforsk.se)

**Beyond will be back in September. We wish you a very pleasant summer.**

## Conferences aiming at future research

The competition for EU research project grants is tough. Before the forthcoming 7th Framework Programme, the forest-based sector in Europe has consequently combined forces in a Strategic Research Agenda within the framework of a joint European Forest-Based Sector Technology Platform. In addition to this, a national industry research programme is being prepared in Sweden. The aim of this is to strengthen the position and competitiveness of the Swedish forestry sector and to actively facilitate the opportunity for Swedish involvement in the EU Framework Programme for research and development.

In order to prepare those involved in research for the coming programme, STFI-Packforsk, together with the Royal Institute of Technology Stockholm, Karlstad University and the Mid Sweden University, initiated a couple of conferences during the winter of 2006. The following have been invited to the conferences, namely universities, technical colleges and institutes, researchers throughout the value chains from woodchips to consumers of packaging as well as the graphics media.



"As participants in research, we felt that something had to be done to guarantee future applications for research grants. Response to the invitation was enormous and this pointed to the fact that there was a need for co-operation on the part of many," says Lisa Tiliander who is responsible for the conferences.

She relates that the first conference, held in January, had the main aim of informing those participating about ongoing and planned activities among those involved and the providers of finance. During the second conference held in March, participants took part in various

workshops with the aim of choosing those themes in the strategic research agenda, where the needs for research efforts are greatest.

"The ideas that emerged in the workshops are valuable contributions from those involved in research as an input to the national research agenda. In the work with creating a strong position through co-ordination among researchers, we are now well armed with an excellent network, prior to the EU 7th Framework Programme," concludes Lisa Tiliander. ●

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# B



# ! New energy-supplying technology in a new company

In collaboration with Chalmers, STFI-Packforsk has developed a new, cost efficient process named LignoBoost, which makes it possible for pulp mills to free themselves of being dependent on oil while, at the same time, LignoBoost is offering the market a superior new bio-fuel. This new technology is being taken one step further from research stage to veritable production, with the start of LignoBoost, an STFI-Packforsk subsidiary.



The many energy-saving possibilities with LignoBoost attracted quite a number of media representatives. In the foreground is Per Tomani, one of the researchers behind the new method, being interviewed after the press conference.

“What society needs today are innovations. LignoBoost is a good example of what we at STFI-Packforsk mean by ‘Turning Science into Reality’, where explorative research carried out in co-operation with universities and technical institutes is further developed, then tested and implemented in industry,” said Thomas Johannesson, President of STFI-Packforsk, when he greeted the media and other interested parties at a press conference on 29 May.

### New cost efficient technology

Black liquor is a by-product that come from pulp production. It is already being utilised as a source of energy in recovery boilers at pulp mills. However, lignin is in black liquor; it is the binding agent in wood and it offers many more fields of use. With the new technology of LignoBoost, high qualitative lignin can be extracted from black liquor in the sulphate process, a lignin, if dried, which possesses about the same energy value as coal.

“The extracting of lignin has been done before but, compared to earlier known processes, LignoBoost requires less investment capital and involves lower variable costs. At the same time, lignin is drier and

cleaner,” comments Per Tomani, one of the researchers behind this patented method.

He continues, “But the processes don’t only provide a new source of energy in the form of lignin. The extraction itself means, furthermore, that pulp mills with limited capacity soda recovery boilers will now be able to increase their pulp production at substantially lower investment costs than before.”

### Demonstration plant

LignoBoost is the result of 7 years’ research that was part of KAM (The Ecocyclic Pulp Mill) and FRAM (The Future Resource-Adapted Pulp Mill), research programmes financed jointly by the industry with Mistra and The Swedish Energy Agency. LignoBoost AB will be demonstrating this technology in a plant at Bäckhammar Mill.

This demonstration unit will produce approx. 4,000 tonnes of lignin a year. This is equivalent to supplying electricity and heating to 1,300 houses. The lignin will be transported by rail to Fortum, a power company in Stockholm, and it will constitute fuel for producing electricity and heating for Stockholm’s district heating network.

A full scale plant is expected to utilise more than ten times the amount of lignin that the demonstration plant can use. A market study shows that there is a potential for full-scale plants in about 100 pulp mills around the world. ●

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**En ny kostnadseffektiv** process, kallad LignoBoost har utvecklats av STFI-Packforsk i samarbete med Chalmers. Tekniken innebär att lignin kan utvinna ur svartlut, en biprodukt vid massaframställning, och bli till högvärdigt bränsle med ett energivärde jämförbart med kol. Processen innebär dessutom för massabruk med kapacitetsbegränsande sodapanor en möjlighet att öka massaproduktionen till väsentligt lägre investeringskostnad än tidigare. Resultaten från närmare tio års forskning kommersialiseras nu i och med dotterbolaget LignoBoost AB som ska demonstrera tekniken i en anläggning vid Bäckhammars bruk, där ca 4000 ton lignin per år ska produceras som bl a ska ge elektricitet och värme till Stockholms fjärrvärmnät.



Beyond is published by STFI-Packforsk AB  
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Translations: Kevin Austin, BizTech English AB  
ISSN: I 652-6503  
Print: SIB-Tryck, Norsborg

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