# PAPER BEYOND 2000

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## Abstract

The pulp and paper industry has a fantastic potential to become the first and possibly the only truly "evergreen" industry. Our raw material is renewable, we apply sustainable forest operations, within the next decade our mills will be ecologically balanced, and our products are non-toxic and recyclable.

It is up to ourselves to "do-it-ourselves", to take charge and to find new solutions which will prepare us for a future full of trend-breaks.

The key is knowledge and competence. Our fundamental task is to build up the knowledge-base that will be necessary if we are to proceed and if we want success.

#### Is paper threatened?

Let me start by being provocative. Will we have paper beyond the year 2000?

Of course there will be paper, but my message is nevertheless a conditional "Yes, if we try harder". The future will be full of sweat and toil and tears. But we can make it! During the last two decades, we have seen paper being threatened. It started with the discussion of industrial pollution in general, and continued with pollution from the pulp and paper mills in particular. And then we had the discussion of product cleanliness and safety. And now we have become involved in a discussion regarding sustainable forestry.

We have also had the discussion about the paper-less office, which has not materialized so far. But I am convinced that most of us here today have the same problem. We handle too much paper. We need assistance in handling the information flow. The science fiction magazines envisage a chip operated into your brain through which you can get access to big outside data bases.

So far electronic aids have led to an increase in paper consumption, but the threats from the electronic media are still real and we must expect that there will be a less dramatic increase in paper consumption and that the growth rate for our industry may become smaller.

Nevertheless, there are many positive factors all adding up to a positive future, Figure 1. The old predictions about future capacities based on an increase in consumption of paper parallel to the increase in the standard of living are still valid. The vision of what the world of paper would be like "if the Chinese used as much paper per capita as the people in North America" opens up a potential which is still with us. At the same time we need to remember that the "use it and throw it away" mentality is definitely a thing of the past and that care with our resources is a long-range trend. Figure 1: World consumption of paper and paperboard 1970-2005 (source Jakko Pöyry)



Figure 2: Growth rate of paper and board consumption in the world 1990-2205 (source Jakko Pöyry)



The best market growth is predicted for high quality printing papers and packaging materials, where paper in a more unique way can offer high market satisfaction at a low price, Figure 2.

#### On our toes

But our industry's future will to a great extent depend on ourselves. We shall have to fight to find the different applications for paper and paperboard products.

Many of us know that the information included in a printed page is enormous, but it is not enough. And many of us know the advantages of packaging - for food protection, for transport, for storage and finally for display. But it is not enough.

Tomorrow's world will be a fight to find the applications where the advantages of a renewable and recyclable material are superior to the alternatives. The transition from "how do we use the raw material?" towards "what does the customer need?", which has taken place during recent years, will be further emphasised, and product development will take top priority.

We have seen paper sacks replaced by plastic sacks, and paper carrier bags replaced by plastic carrier bags, and we have resigned and accepted it all. "It is better, it is cheaper. We cannot fight it." And in the meantime we have converted our paper machines to the production of new paper products. We have been spoilt by a continuing market expansion allowing such conversions.

Today we see paper packets of biscuits with a good printing surface and a good barrier function. But the same biscuits are also being packed in a non-paper solution having a better printing surface and a better barrier function. Beyond 2000 the market expansion will not be self-generating. We shall be in a much more competitive environment and we shall have to fight harder to find new uses for paper-based products.

#### "Evergreen" industry

Let us instead look at all the advantages of paper as a material. Most important to me is the fantastic potential which the pulp and paper industry has to become the first and possibly the only truly "evergreen" industry – thanks to the facts that our raw material is renewable, that within the next decade our mills will be ecologically balanced, that our products are non-toxic and recyclable, and that natural polymers must gradually replace petroleum-based polymers.

Much effort is put into teaching small children to "save a tree". We all agree that we must have a sustainable forestry, that we must have good silvicultural practices, etc. There is, however, a tremendous difference between cutting down the rain forest and harvesting a modern forest plantation. And this is a message that we have to communicate to the public.

How do we see ourselves beyond the year 2000?

In a recent letter to Dr Bo Berggren, Chairman and CEO of STORA. Mrs Caroline Palmstierna of a design center called Swedish Form wrote "It must be time to stop using nonrenewable plastic materials. Instead, renewable materials that can be incinerated should be used. It ought to be possible to make knives and forks of specially form-pressed carton board, milk bottles of cellophane and paper shopping bags with an inner lining of renewable polymer in order to stop wetting research through. ls anvone pursuing and product development in these areas ?"

It is stimulating to receive this kind of letter, but at the same time one asks "Why do we not pursue such ideas ahead of time before being pushed by the public?"

It is up to ourselves to "do-it-ourselves", to take charge and to find new solutions which will prepare us for the future - a future that we know will be full of trend-breaks. We have to prepare ourselves to be able to handle and take advantage of these trend-breaks, and not to be surprised or overwhelmed when they occur.

We have a fundamental task to build up the knowledge-base that will be necessary if we are to proceed and if we want success.

#### Our frames of reference

The pulp and paper industry is becoming more and more international. At the same time we have to avoid simplifications and uniformity of thinking. Packaging materials may contribute to overfilled landfills in the industrialized world, but they are absolutely necessary in other parts of the world to protect food on its way to the end user.

One of our problems is that to the general public "paper is just paper", whereas there have been, as you know, incredible improvements over the years. Consider that we are able to produce a 40 g/m<sup>2</sup> newsprint at a speed of 1500 m/min that can be printed without the reader having to read both sides simultaneously, or the multilayer carton boards that can efficiently use different types of fibers in different layers. Tomorrow's paper will not be today's paper. Of that we can be certain, but the public may never realize that there has been a real shift.

By identifying paper as a material I believe we could extend our networks and, at least from the scientific community, more often get stimulating inputs.

## Tomorrow's paper

What are the functionality requirements of tomorrow's paper.

- Print quality I have already touched upon. Do not ever let the competition beat you on this.
- Stiffness is one of my favourites. There is hardly any paper, except tissue, which does not need stiffness.
- Fracture toughness is another favourite especially for all packaging materials.
- And the challenge to get the "living" cellulose fiber to stay alive for some properties and to play "dead" for others.

- Recyclability will be reinforced, probably in such a way that it will be an important parameter to consider when buying virgin fiber.

The only thing we know about the future is that we shall see changes, trend-breaks, discontinuities, paradigm shifts or whatever you want to call them.

We have seen growth progress in Brazil and Chile in short fiber Eucalyptus and long fiber Pinus Radiata respectively - to many of us a real threat.

But the real trend-break is of a later date when the availability of raw material per hectare per annum was found to be higher in New York and London. It will take beyond the year 2000 before the recycled fiber reaches a balanced market value.

During this period all of us as taxpayers will be called upon to subsidise the reclaim of fiber, and the green wave will continue to carry the surfers who like a so-called "live sheet" more than a clean one, and printers will even make it look recycled by printing "stains".

At the same time, we in this industry must be careful to ensure that we do not fall into the trap of producing materials with poor printability, so that, from a quality point of view, paper becomes less attractive than other media.

To many of us the conversion to the totally chlorine free (TCF) pulp is dramatic. The reasons behind its advance are numerous; all the way from the green movements to

wholesalers and others fighting for market shares in the frame of environmental image, attempts to save the dying sulphite industry and nationalistic industrial politics. Whatever the reason, TCF pulps are here and so are the huge investments that accompany them.

#### **Ecologically balanced process**

I have always seen the dioxin and TCF issues in a larger perspective. How can we handle the chlorine issue in an environmentally balanced situation? That doesn't sound very market oriented. But, yes, it is market oriented. There are a few basic issues that we have to deal with and a few basic messages that we have to bring to the attention of the public.

One of these is that no pulp or paper mill can ever be fully closed.

Around 1970 there was a vision that some time in the future we would be able fully to close a mill, but we bring wood raw material including eg different minerals into the mill.

These compounds will not be a part of the product. They can be recovered from within the process and they can then be returned to the forest. - A true ecological system but not a closed mill, Figure 3.

### Figure 3: Ecologically balanced mill



**Ecologically balanced process** 

#### **Tomorrow's research**

Some of you are perhaps expecting me to serve to you the areas and topics of research on which you should be concentrating from now on. That would be marvellous, wouldn't it?

This is not how I see the research field. It is up to all of us to try to envisage the future and put our efforts into new research areas that each of us believes to be useful.

At the same time, this industry has so many issues to solve simultaneously and quickly that it is wise for us to try not to overlap too much. Here in Europe, for example the large companies, operating in several countries, will not in the future accept that their branches in the United Kingdom, France, Italy, Germany, Finland, Norway and Sweden etc each pay for similar research being performed in the respective countries. This again presents an opportunity, because none of us is in a position to do everything in our own house; not at UMIST nor at IPST, not at Paprican and not at STFI.

To prepare ourselves for the future, STFI will have a new organisation from the first of July next year. In order to create a better environment for basic research and at the same time get closer to the "customer" in our applied research, we shall divide STFI into two parts with significantly different principles of organisation – one part to be headed by senior researchers of professorial status and the other by research "entrepreneurs" who can create research ideas of more immediate industrial relevance, assemble the necessary funds and run a project.

It is also quite clear that we must concentrate on fewer issues where we can be best, and learn to get help from others in those fields where they are best and in which we do not concentrate. If we all in the research community would dedicate ourselves to "assisting each other" in such networks, we can speed up the research process considerably. – The lag time from idea to final product MUST be reduced by half!

#### Challenges

In preparing this presentation I did ask a few distinguished people around the world to assist me. I thank everyone for

your dedicated efforts in instantly responding to my telefax. Your contribution can be summarized in these challenges:

- Better printing surface
- · Barrier properties with renewable raw materials
- Fiber composites
- The right fiber for the right product
- Lean paper production
- Mechanical pulp with less energy
- Lean and clean chemical pulp

And additionally in line with many of my statements - what is not on the list.

Let us look at the paper sheet beyond the year 2000. With your help, all you qualified researchers and innovators, not only the traditional board products but also many printing paper grades will be stratified in order to optimize the position in the sheet of the different raw materials.

A sheet of carton board, Figure 4, is often presented in a wellknown diagram with the bulky middle for stiffness, the plies on both sides for tensile strength and the outside coating for good printability.

# Microporosity Smoothness Tensile stiffness Bulk Tensile stiffness Tensile stiffness

#### Figure 4: Diagram of mutlilayer carton board

# STFI

Let us use the stratified sheet as a background to discuss the route towards which the research is heading, Figure 5. A real challenge!

Figure 5: Tomorrow's printing paper



STFI

The basic knowledge in our field of business is slowly becoming advanced enough to allow more and more of our research to be treated by mathematical models. We can forget experimental research and use mathematical models, until the time comes to verify and validate the models by real data.

It all starts with the raw material - the right fiber for each product. A lot of effort is going on to achieve this from the virgin fiber side, but at the moment the recycled fibers are making the situation more complicated.

My vision is nevertheless that it will soon again be evident that it is vitally important to be able to control the raw material mix, whether we talk about virgin fibers, new ways of classifying recycled fibers including energy recovery or uniform and/or structured pigments. This is a large R&D field to which we must devote much of our research resources.

Paper chemistry is a long-time favourite of mine. When the KM7 board machine at the Skoghall mill was speeded up from 18 to 36 tonnes per hour, almost half of that increase was achieved through chemistry, and I still see an enormous potential in the further application of paper chemistry.

Continued developments must be made to achieve further closure of our systems and to cope with the handling of the "dirtier" systems by the proper choice of chemical additives under dynamic conditions which call for advanced on-line control. But, as I see it, the big advantage of paper chemistry will be in product development. In the future, the contribution to new product functions will be extremely important and we shall see a rapid development towards:

- Functional, environmentally friendly wet-end chemicals
- Functional surface applications
  - uniform absorption
  - surface energy
  - barrier properties
- Polymers from renewable raw materials
- Enzymatic methods

A lot of fundamental knowledge is needed to assure this development.

# **Barrier properties**

Referring again to the biscuit packages I showed to you earlier, one most interesting challenge is dealing with the barrier properties of renewable raw materials in order to make our products more competitive in a truly "evergreen" situation. Barrier properties applied directly in the paper machine giving a good printing surface

The whole field of liquid packaging, for example, is an area where there is a need for fundamental new knowledge in different fields from polymer technology to the transport of fluids.and gases, and the science of adhesion.

## New forming techniques

The last fifteen years have seen rapid developments in new technology for papermaking. Twin-wire forming has meant that paper can be produced at a much higher speed with acceptable formation. Twin-wire forming has also undergone a development from roll forming to blade forming.

New types of formers are now on the way, formers that combine the two techniques, starting with roll forming and continuing with blade forming in order to obtain a better combination of formation and retention. One of the first rollblade units built was the STFI former, Figure 6, in which the wrap-around roll angle as well as the blade positions are adjustable. It is part of the STFI Pilot Paper Machine, called FEX, which is an important research tool for the future with a maximum speed of 2,500 m/min, including stratified headboxes.

Figure 6: The STFI-former is part of the STFI Pilot Paper Machine FEX



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Coming back to the internationalisation question, FEX might in the future be used not only for Sweden but might possibly also be the Euro-FEX.

## **Coating and calendering**

In the future, strong economic restrictions will mean that offline coating will more or less disappear. All paper will be coated on-line, and we shall probably see a lot more of the new types of coaters where the coating colour is applied as a film by means of rolls, for instance the BTG-Källe-Inventing HSM-coater.

Supercalendering is another cost-consuming technique that will surely disappear to a great extent. Instead we shall see a greater use of on-line soft calendering in one or several nips where the paper is carried through nips of soft and hard roles at high temperatures.

#### Lean paper production

Paper chemistry, barrier functions, coating and calendering are examples of fundamental features of the concept of lean paper production which involves:

- High machine speed
- Multilayer sheet build up
- New dewatering, pressing and drying techniques
- · New techniques for surface treatment
- Fast product changes
- Uniform product quality

All this requires an expansion of our basic knowledge in these fields:

- Fluid mechanics (fiber suspensions, coating colour)
- Polymer adsorption, flocculation
- Transport of heat and water
- Rheology
- Optical properties
- Information technology

# Efficiency

One topic that is close to the heart of most business managers today is efficiency. And most of us have been successful in building highly efficient processes that produce more or less bulk products at a rapid rate.

Very soon we shall have to convert these huge monsters like a modern 300.000 tonne per year fine paper machine into something entirely new. Like a lion-tamer at the circus, we have to take the whip, snap it once or twice and "abracadabra" the machine will make a greater range of grades, change grades in seconds and supply the customers just-in-time without using big warehouses.....Figure 7

Figure 7: Flexible production



.....and at the same time making the processes less capital intensive. What a challenge!!!

#### Supplier participation

More and more, the process development is being carried out by qualified suppliers to the pulp and paper industry.

Here we touch another of the principal questions on our way to the year 2000. Who is responsible for what research? Can we rely on the suppliers only in the development of new equipment?

This is a perfect example of this industry's multi-skilled dependence. The pulp and paper industry has to participate and push the suppliers to understand what the need is and that there is a need for joint research.

This all adds up to the need for an enormous range of new skills and shows that pulp and papermaking are truly multiskilled disciplines needing assistance from numerous specialist fields.

To measure is to know. This old truth is a key to the future. It is no longer sufficient to find a measuring technique to meet your problem. It is necessary to find the measuring technique that gives you not only confirmation of the parameter you intended to measure but also a head start towards your next research project. Just as in modelling this means that the integration between different skills becomes most important. I have here tried to summarize the new STFI contributions within the measurement technology field that are of interest to a fundamental research group like the one we have here today, and I came up with this list.

STFI'S CONTRIBUTIONS

- Fracture toughness
- Long term creep behaviour in compression
- Friction
- Image analysis techniques
- Rapid measurement of fiber characteristics

The newest contribution on this list is the STFI FiberMaster. Using the STFI FiberMaster, the fiber shape can be very quickly evaluated on a large and representative number of fibers, Figure 8.

Figure 8: Data from STFI FiberMaster



#### To foresee trend-breaks

Some trend-breaks we can foresee. Multilayer structures are appearing for some new qualities, impulse drying will soon have its first application and the new super-thin surface treatments are already on the market. Encouraging results have been obtained with two-sided dewatering using a stratified headbox.

And already today we can also see the growing importance of new disciplines such as logistics and information technology.

The multi-skill way of working is a real challenge. And I am also quite hopeful that the modern researcher into fundamental paper properties is open-minded enough to accept and adopt new approaches, e g to handle the statistics of on-line experiments.

# **Opportunities**

My message is easy to summarize.

Most important to me is the fantastic potential which the pulp and paper industry has to become the first and possibly the only truly "evergreen" industry – thanks to the facts that our raw material is renewable, that we apply sustainable forest operations, that within the next decade our mills will be ecologically balanced, that our products are non-toxic and recyclable and that natural polymers must gradually replace petroleum-based polymers.

It is up to ourselves to "do-it-ourselves", to take charge and to find new solutions which will prepare us for the future -a

future that we know will be full of trend-breaks. We have to prepare ourselves to be able to handle and take advantage of these trend-breaks, and not to be surprised or overwhelmed when they occur.

The key will be knowledge and competence. We have a fundamental task to build up the knowledge-base that will be necessary if we are to proceed and if we want success.

I have also found it important to stress:

- The need to cut the time from basic research to a new product on the market
- The multi-skill dependence of the modern pulp and paper industry
- The need for specialization and closer networking
- The need to understand different frames of reference in the international society
- The need to use our creativity in all possible ways (including finding out what is already known or what someone else is doing)

And remember, we researchers often know the fundamentals better, and we must use this knowledge to explain these to the public in a carefully planned educational manner.

Our evergreen situation leaves us with numerous opportunities. It is up to us to show that we are not bound by the huge investment capital as a millstone around our necks. Let us show that we have progressed from being the best evolutionists in the world into creative, revolutionary thinking market-oriented engineers and scientists.

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Let us do our best to ensure that it will not take10-20 years before we have been able fully to integrate our new opportunities like renewable polymers, enzymatic surface treatments, built-in barrier functions, etc. and at the same time have the best competitive printing image. And similarly in the packaging sector.

In doing so, we must not forget the need to attract the next generation . And, of course, the best of the next generation. We need to be attractive enough to get the best and most creative brains to our R&D. But we must also be attractive to the young engineers and technicians who will be running our complex capital intensive units and get every cent of the investments – taming our monstrous machines to the flexible, just-in-time situation and still increase efficiency.

Again, do not forget. We must always compete with quality. The best images, whether they be printed on paper or plastic or by electronic means, will win.

I hope that I have been provocative enough to release some extra adrenaline. We have a job to do. Our industry depends on us. Unless we researchers can participate at the new speed necessary and supply new knowledge and participate in converting this knowledge into new products, there will be a future only for low cost, efficient production and we will continue gradually to give in to new solutions using alternative materials. But, and I am the true optimist, our thinking – even among researchers – has by now turned away from "how can I convert this raw material?" to "What does the market need?".