

SustainPack



SUSTAIN
PACK

SustainPack – The Journey

The aim

A project to push the boundaries of material science, combining scientific research and commercial applications to develop the sustainable packaging materials of the future

The objectives

The main objective of SustainPack is to ensure the future prominence and competitiveness of fibre based packaging using the exciting new opportunities in the field of nanotechnology, material coatings and communication technologies. Through research, development and application of nanotechnology SustainPack aims to reduce supply chain costs and add value by enhancing the functionality of fibre based packaging

The project team perspective

"By focusing on fibre based packaging and other renewable sources, sustainability is a major theme of this project. The impact of packaging in consumer's everyday life and its influence on ecology and the economy, makes packaging an important factor in our struggle to build a truly sustainable society. SustainPack is a unique opportunity for raw material producers, suppliers, converters, fillers, brand owners and retailers to define the future of packaging"

Kennert Johansson
SustainPack Co-coordinator
STFI Packforsk



"The project is a balance of technical solutions versus cost and viability. It has been justified by the dramatic increase in oil prices. At the start of the project in 2004 oil was \$25 a barrel, at the end of the project it is now \$115 a barrel."

Naceur Belgacem - EFC

SustainPack origins and the importance of fibre based packaging

SustainPack is the largest and most important research ever undertaken into sustainable packaging. It has been a four year research programme with a budget of 30m euros, 17m euros having been funded by the EU Sixth Framework Research Programme. This has been supported by a project consortium comprising of 35 partners from 13 countries. The project team is represented by packaging research associations, academia and industry partners.

The demands on packaging are continually changing, influenced by a variety of factors, ranging from increased functionality, more efficient and economical production methods that meet environmental and legislative standards. In an ever changing and expanding global market-place the potential for fibre based packaging is enormous, but in order to competitively capture this potential to the full, fibre based packaging materials need to:

- Have better barrier and performance characteristics while containing less fibres
- Provide active and interactive components
- Provide new structural design opportunities

The purpose of SustainPack is to establish fibre based packaging as the key player, being the most suitable and sustainable material of choice for packaging formats in the next decade. The main theme is to make totally renewable packaging, currently good barriers exist in fibre-based packaging but they are oil based and need to be replaced with bio-barriers. SustainPack aims to achieve this by applying nanotechnology solutions to deliver lean and added value fibre based packaging options for the benefit of users and consumers. The SustainPack project aims to extend the limits of fibre based packaging materials through applying nanotechnology; to put the European packaging industry at the forefront of global fibre based packaging technology. This will provide users and consumers with more added value packaging choices derived from sustainable resources. The SustainPack project has endeavoured to overcome the challenges of commercialisation by:

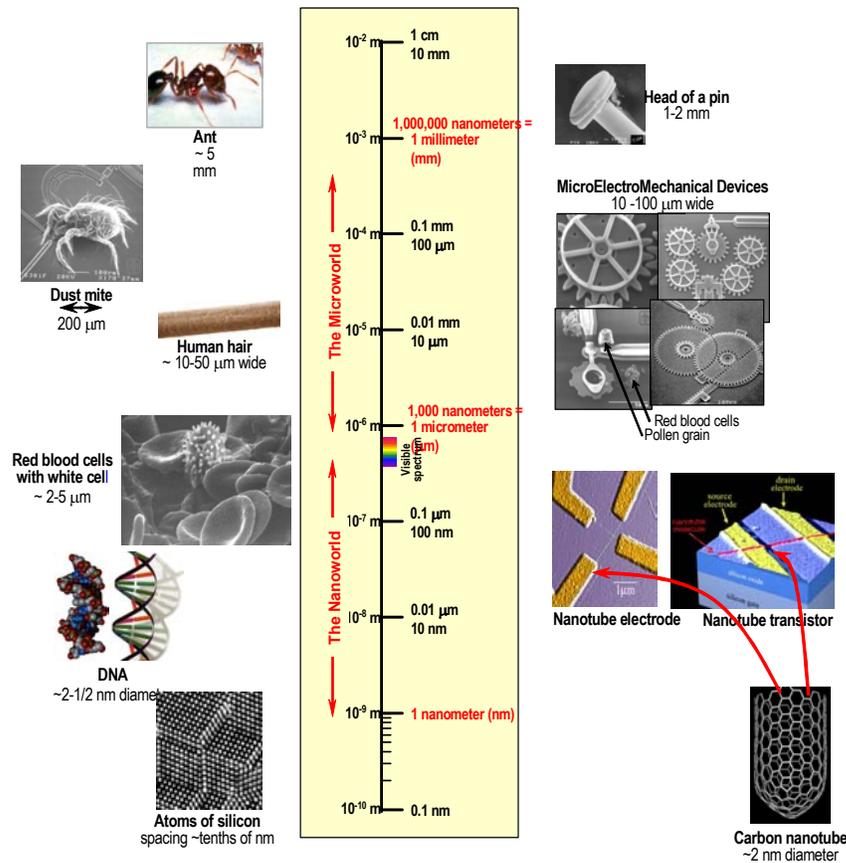
- Identifying what the market actually needs from fibre based packaging
- Conducting applied research directed at delivering fibre based packaging solutions that address the market needs
- Delivering packaging solutions that prove the technical and commercial viability of the new technologies

Fibre based packaging is made from fibres obtained from natural, sustainable raw materials, most commonly wood. The pulp and paper industry is on the front line, driving manufacturing efficiencies and promoting environmental responsibility. Fibre based packaging has a significant advantage over competing substrates because its basic raw material is renewable, recyclable and bio-degradable. Fibre based packaging has a variety of uses and applications providing an essential element throughout all supply chains. Corrugated and carton board contains and protects products during distribution, whilst other paper and board materials provide additional properties and product enhancements in the retailer and consumer environment. The typical EU consumer interacts with 10-20 pieces of packaging on a daily basis, a significant proportion of which are constructed from paper and board components. The fibres in paper and board provide strength and structure to packaging materials. Fibre additives combined with coating applications

provide the opportunity for high quality print, grease resistance and a variety of additional barrier properties that enhance the final package.

What is Nanotechnology?

Advancements in nanotechnology are some of the most important scientific developments achieved in recent years. Industry at large, but specifically the packaging industry is set to benefit from the opportunities and commercial applications that will be delivered. The SustainPack project seeks to identify and advance the application of nanotechnology to unlock these benefits. The definition of nanotechnology is "***the application of science and scientific knowledge, at the nanoscale, for industrial or commercial objectives***". In order to understand the size of material/matter involved at the nanoscale level, one needs to trace down the units of measurement. The nanoscale is far from the smallest measurement however, it is the smallest scale at which matter can be manipulated.



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There are two different manufacturing techniques for nanoscale materials, bottom up and top down. Top down refers to making nanostructures by machining and etching techniques, whereas bottom-up, or "molecular nanotechnology" applies to building organic and inorganic structures atom by atom, or molecule by molecule. When the technology reaches maturity the manufacture of products containing nanoscale materials will

significantly impact all industries and every level of society. The manufacturing techniques and manipulation tools used in nanotechnology have been employed for decades by chemists and physicists working in molecular medicine, biotechnology and advanced materials science. Recent developments in the tools used to characterise and observe nanoscale materials have led to an increased understanding of their behaviour and individual properties. These tools have been used to investigate the nanoclays and nanofibrils used in the SustainPack project.

Description		Applications
Nanoclay	~1nm thick sheet like minerals, which naturally form in stacks and can be split apart into the individual platelets	The split (exfoliated) stacks can be blended with renewable polymers to produce plastics with enhanced properties
Nanofibril	20-200nm diameter chains of cellulose molecules That form the cellulose fibres found in paper	The cellulose chains can be blended with other materials to give enhanced properties

Challenges for Nanotechnology

As with most developing technology, there will be actual and perceived risks as well as associated fears. SustainPack research has embraced the requirement to constructively and proactively debate these issues throughout the project lifecycle in order not to damage any further advances in the technology. Although there is increasing political support for nanotechnology it is necessary to avoid the scenario that developed around genetically modified food production in agriculture. Therefore thorough risk management and assessment of the advancements in nanotechnology are as important as the technology itself. It is envisaged that it will be important to assess whole lifecycles via life cycle analysis tools to quantify the net environmental benefits. These evaluations are critical to ensure there is no increased burden further down the supply chain for disposal and recycling of packaging. The technical challenges in achieving these aims should not be underestimated, they comprise of the following:

- Scaling up from laboratory pilots to industrial scale manufacture
- Fully understanding all the properties of nano materials and converting science into commercial application
- Regulating, standardising, classifying and risk managing nanotechnology developments

The challenges facing the evolution of nanotechnology in packaging materials is a combination of scientific research and commercial application which can be summed up as:

***" We now have the capability to produce sustainable organic packaging so it can be disposed of completely, meeting all the green and sustainable criteria...
But***

The spin off from sustainability has to be economic success"

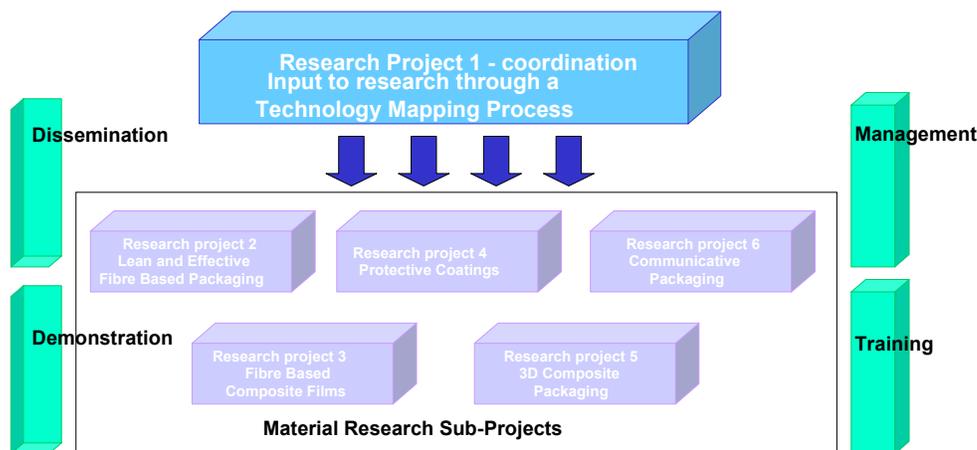
Paul Bartels of A&F

Technical Research Projects and Research Focus

An important characteristic of the SustainPack research programme is that it is a “pull driven” project. It focuses on the needs of customers and the downstream supply chain, thereby identifying research requirements and integrating associated key themes. A technology mapping approach provided the context and motivation for each of the five applied technical research projects, which focus on:

Technical Research projects

- 1 - Research coordination role
- 2 - Lean and effective fibre-based packaging
- 3 - Fibre-based composite films
- 4 - Protective coatings
- 5 - 3D composite packaging
- 6 - Communicative packaging



Research Project 1 –
is designed to determine and coordinate the market needs and provide direction for the Technical Research Projects.

Research Project 2 –
is involved the establishment of a nano facility for the production of cellulose and mineral based nanostructures for use in other research sub projects. It was also responsible for the surface modification of fibres and developing multi-layering and grafting technologies

Research Project 3 –
has developed renewable composite films, incorporating fibres and renewable plastics to compete with synthetic polymers

Research Project 4 –
is set to develop coating and printing technologies to enhance barriers and other functional properties

**Research Project 5 –
is developing fibre based 3-D composite packaging solutions**

**Research Project 6 –
is tasked with developing one and two way communicative packaging**

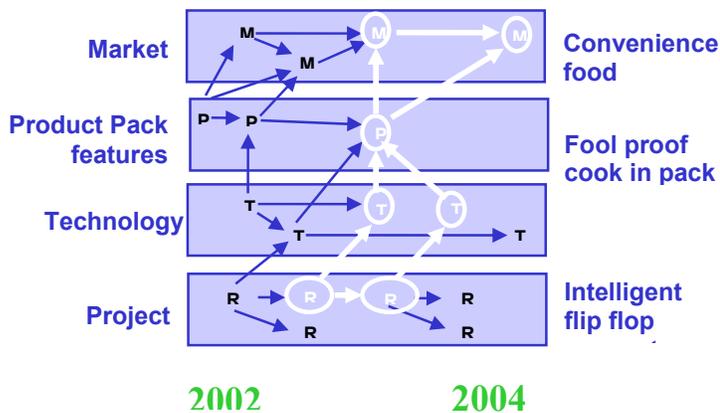
Technical research Project 1 - Technology Mapping and market needs

Technology mapping is a technique for identifying areas of technological promise and planning their future development and implementation. This is achieved by looking back from a designated point in the future, predicting the social and political landscape and determining what needs to be developed in order to get there. It is a process that provides structure and direction for defining and managing technology R&D. It has allowed the SustainPack partners to anticipate, monitor and manage the fundamental risks associated with the project.

The technology mapping process brought together the supply chain stakeholders to determine the trends and drivers influencing the packaging concepts of the future. From these trends and drivers, the packaging features of the future were identified. The technology developments and R&D required to deliver the packaging features were then plotted.

The final result was a detailed critical path for each of the Technical Research Projects in SustainPack. Six technology mapping workshops were held in the UK, France, Slovakia, Copenhagen, Spain and Sweden. A further five workshops were held (one per applied technical research project) concentrating on the technology requirements and R&D activities necessary to deliver the future packaging features.

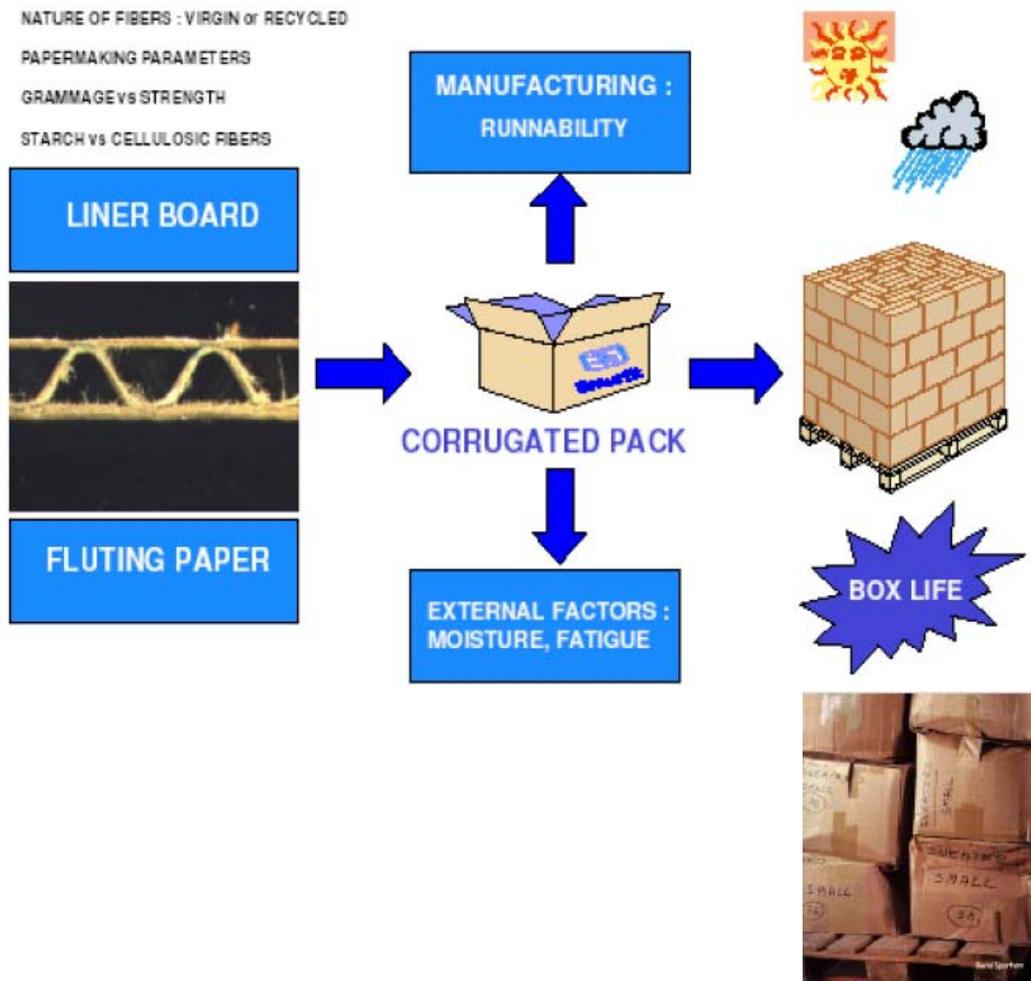
This process also helped the SustainPack consortium to identify and develop appropriate Packaging Solution Projects, by engaging with major brand owners and retailers, the main users of fibre based packaging. These Packaging Solutions Projects were aimed at “bringing to life” the outputs from the Technical Research Projects.



Technical Research Project 2 - Lean and Effective Fibre Based Packaging

The objective was to increase the dry, moist and wet strengths of fibre based materials to enable the design of more cost effective packaging that use less material. The target material reduction was 30%, even though this cannot be achieved through conventional technology developments. The target reduction would be achieved through using revolutionary and innovative nanotechnologies, utilising cellulose nanofibrils for reinforcing packaging materials. The technologies would then have to be implemented on an industrial scale for practical use in paper mill operations. It is essential that advances in other supporting technologies would need to be developed in parallel to achieve this.

The overall objective for paperboard development is to increase the bending stiffness of paper and board by 30% by using fibre engineering in conjunction with different nano structuring techniques. The strategy for achieving this objective is to increase the delaminating strength of paperboard. The project's Liner board developments address the collapse of boxes under moist conditions. The objective has been to increase the moist compression strength of linerboard by 30% while maintaining fracture resistance.



Project Feedback from Tom Lindstrom – Research Project 2 leader

What do you feel has been achieved from the key aims and aspirations of SustainPack over the last 4 years.

"We fulfilled all our goals in the laboratory for Research Project 2"

What do you consider to be the key breakthroughs?

"We succeeded in getting the nanofacilities up and running. From an intellectual point of view, we learnt what were the important parameters, for mechanosorptive creep and finally offered two solutions. The use of hardwood fibres and the new cooking method for softwood fibres to make them less kinked."

What have been the key barriers to overcome?

"When we started WP3, we knew very little about mechanosorptive creep. It was a huge barrier, but we learnt a lot!"

How have you overcome these barriers?

"We were lucky.....maybe hard work (transpiration) was most important."

If you had more time, what would you like to continue to build on?

"The use of nanoelements in papermaking.....we learnt something, but much more can be found out."

Technical Research Project 3 - Fibre –based Composite Films

The main goal of Sub-Project 3 is to develop composite films based on renewable polymers which can be used as a single layer in packaging applications, removing the need for lamination to other materials. The films have to exhibit good barrier and selective permeability properties, combined with thermal, mechanical and optical properties. This will make the composite films an attractive proposition to both industry and consumers.

In order to develop these innovative materials, combinations of several renewable polymers with different additives were studied by the project groups. There were 3 distinct approaches undertaken:

1. The development of combinations of mineral nanoparticles from clay (known as nanoclays) with blends of polymers.
2. New materials were developed by combining renewable polymers with nanofibres.
3. Nanofibres and nanoclays were combined with polymers.

The materials that have been developed are characterised by their barrier, optical, thermal and mechanical properties as well as their suitability as food contact materials. Seven different materials have been chosen:

- Polylactic acid (PLA)
- Polycaprolactone (PCL)
- Starch
- Gluten
- Polyhydroxybutyrate – polyhydroxyvalerate (PHB-PHV)
- Chitosan
- Gelatine

An important factor in this project is the focus on optimising commercial processing and scale up factors from laboratory to commercial application.

Project Feedback from Susana Aucejo – Research Project 3 leader

What do you feel has been achieved from the key aims and aspirations of SustainPack over the last 4 years.

"A really memorable project, which included many personal experiences, overcoming cultural differences, creating networking opportunities with new partners that will carry forward into other projects"

What do you consider to be the key breakthroughs?

"Adding new nanoelements and using less plasticiser for processing at pilot level. Another key advancement was developing a methodology for characterisation of modified clays for food contact applications"

What have been the key barriers to overcome?

"the key barriers were in scaling for commercial applications , processing large quantities is not available yet and currently cost could be a barrier to this"

If you had more time, what would you like to continue to build on?

"Continue to improve the material properties, we can always continue the research by investigating lamination technologies"

Technical Research Project 4 - Protective Coatings

The aim of this project is to develop new coating and printing technologies for protective properties for mechanical and barrier resistance. The new technologies are based on biopolymers and nanocomposites. A key objective is to tailor materials in order to obtain a desired set of properties suitable for a given application that meets consumer needs and perceptions. The coating concepts investigated were:

- Enhanced performance by nano-sized materials
- Hybrid polymer/organosiloxane based functional coatings
- Microencapsulation
- Smart polymers with properties that can be easily triggered by ambient conditions

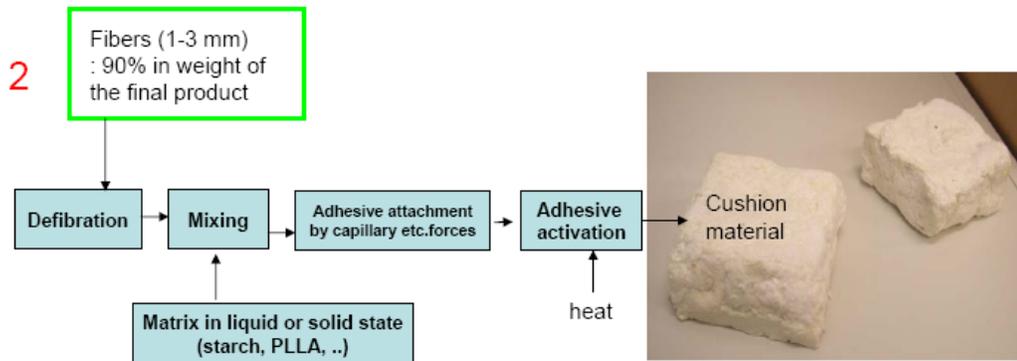
An important issue in the area of printing is the local reinforcement to minimize damage during the converting processes of folding, cutting and creasing. However, several of the coating material systems under development can be applied on a conventional printing press. The materials used must already have approval for food contact or have a high possibility of approval upon future application. Several types of coatings and microencapsulated agents for water protection have been developed at the laboratories of the participating organisations. These have been further optimised into coating and printing formulations. A screening formulation has been developed to check the properties of the packaging materials produced with the new innovative coatings. An overview has been created to provide a summary of the packaging products available on the market today. The properties required by the packaging products are described, as well as the existing tests to control the packaging characteristics. The screening protocol is based on this overview and has been continuously improved over the lifetime of the project. This will provide a useful tool for the European paper and packaging companies for product development and selection.

Technical Research Project 5 - 3D Composites

Apart from established segments such as egg cartons, there are very few fibre-based 3D packaging materials on the market. An aim of the SustainPack project is to create new 3D packaging through the development of 3D formable cellulose-based composites which can provide viable alternatives to petroleum-based cushioning and packaging applications.

There have been two approaches to meet this aim. The first is the development of nanostructured composites combining cellulose fibres or nano-components with a thermoplastic natural biodegradable polymer. The second is a controlled in depth modification of lignocellulosic fibres. This project consists of three technical activities:

1. Developing different methods for modification of cellulose fibres, suitable for the production of composites with less than 40% of matrix material. The investigated methods included:
 - Surface and in depth chemical modification
 - Mechanical modification and changes in properties due to moisture absorption and temperature change
 - Ways to produce cellulose fibres/inorganic nanoparticles hybrids
2. Processing of composites based on the fibres modified in phase 1 with the development of 3D formable cellulose based material for cushioning. After the selection of the polymers for the composites, different processing routes were investigated and tested.
3. The modified fibres and composites prepared previously were tested to assess their recycling or organic recovery properties, to evaluate them for food contact applications and to characterise their mechanical and hygro-mechanical properties.



Project Feedback from Christine Chirat – Research Project 5 leader

What do you feel has been achieved from the key aims and aspirations of SustainPack over the last 4 years.

"I will remember SustainPack as a project giving access to a high amount of partners in the field of packaging, and thus new potential collaborations in research and training. From a more personal point, I will remember this project as a project that has been led and coordinated very professionally and nicely."

What do you consider to be the key breakthroughs?

"Having proved that it was possible to prepare thermo pressed or thermo-moulded 3D composites from 30 to 50% of fibres and a renewable matrix (polymer), and that the fibre surface modification could improve some properties of the material "

What have been the key barriers to overcome?

"One key barrier to overcome has been to make people work together, and make people present their results in an understandable way by non specialists ! Technically, the main barrier has been the processing of these types of material."

If you had more time, what would you like to continue to build on?

"If the project had one more year to go I would have put the focus on the processing and its optimisation to get "industrially" possible products."

Technical Research Project 6 - Communicative Packaging

The main objective of packaging is to protect its contents from the factory all the way through the distribution chain up until the moment of use and even beyond. The communicative elements of packaging are of equal importance to protection and this

project is dedicated to developing and implementing communicative packaging through the following aspects:

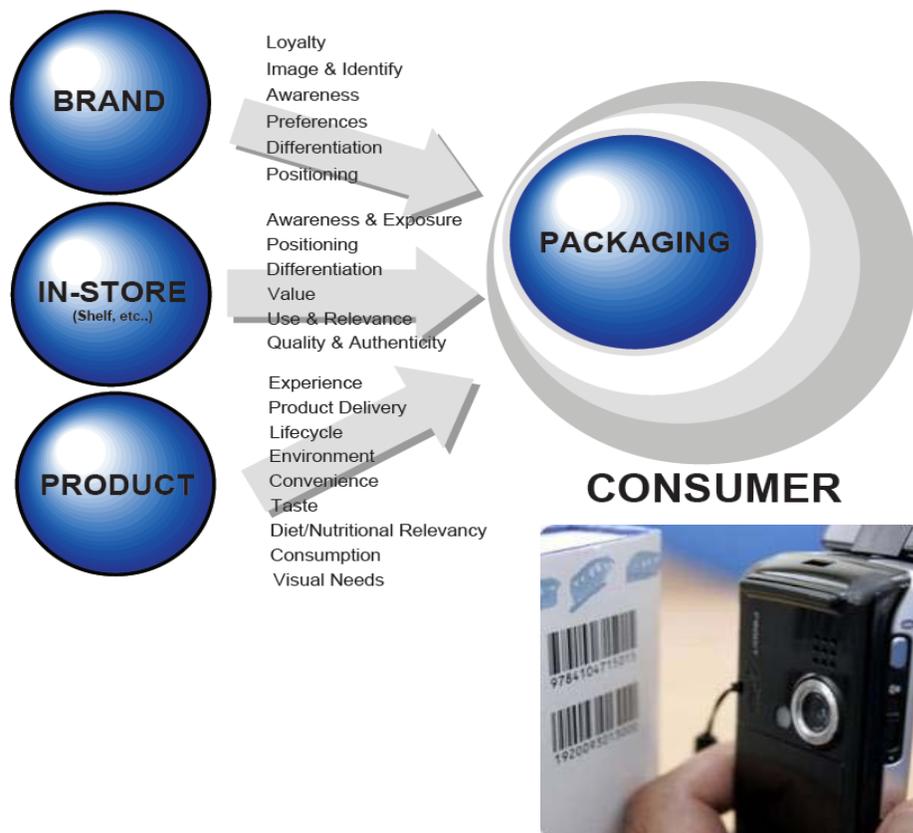
- Appeal and information
- Identification
- Anti-counterfeiting
- Quality indicators

Appeal and Information

Packaging has to convey a message in order to successfully promote and sell the product, especially if the package is not transparent and obscures the contents. The message goes far beyond just identifying the product which the package contains. To attract potential buyers, a package must communicate with the consumer more effectively than competing packages. In 70% of cases consumers decide which product to buy at the point of purchase in store. Development of an electrically switchable image printed on a cardboard box is a SustainPack activity that will give brand owners the opportunity to distinguish their products from the competition.

Legislation requires all ingredients and their origins to be displayed. Fitting all such information on the package has made fonts smaller causing difficulty for the elderly and people with impaired vision. A coded print, in the form of a 2-dimensional barcode that can be decoded with a mobile phone could provide a solution to this problem. This technology is being developed within this technical research project.

THE FIRST FIVE SECONDS



Identification

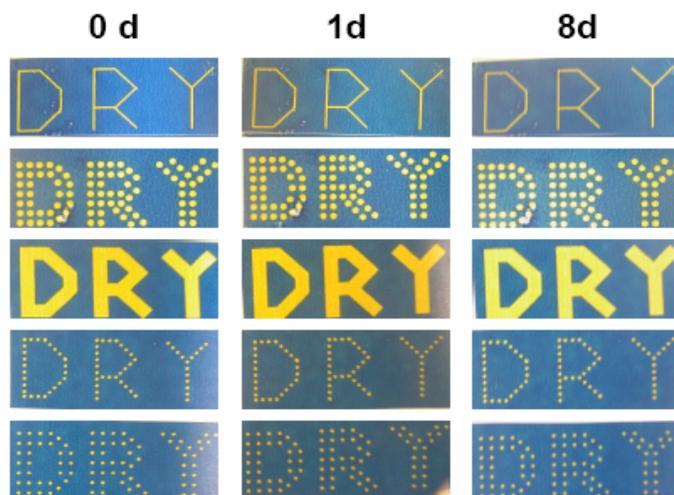
Tracking and tracing of products should be common place these days. The General Food Law, applicable from January 2005, dictates that all companies involved in food business operations must be able to identify the immediate supplier of a questionable product and the immediate subsequent recipient. In communicating the identity of a product, RFID is expected to compliment barcodes in the coming years. SustainPack is working on communication technologies like 2D barcodes which can be employed to provide additional information about product contents and usage.

Anti-counterfeiting

Counterfeiting activities constitute a major global problem for retailers and consumers. EU Figures show that customs seized almost 85 million counterfeit or pirated articles at the e EU external border in 2002, the scale of the problem has escalated since then and is now estimated to be much as 7% of global trade. Anti-counterfeiting methods always need to be at the cutting edge of technology to stay ahead of the criminals. In this project anti-counterfeiting technologies are adapted and new concepts developed for use in or on cardboard packaging.

Quality Indicators

The quality of many food and pharmaceutical products depends on the temperature and relative humidity at which the products are stored. Sensors monitoring these conditions can communicate values indicative of the product quality. Though sensors for temperature and relative humidity have been available commercially for some time, SustainPack aims to develop low cost and reliable alternatives to enable large scale commercial application.



Colour change of humidity indicators in 20.9% relative humidity

Quality can be communicated to customers to emphasise quality standards, and among supply chain partners to optimise distribution chains and prevent product wastage and loss. The resulting savings can be considerable even in a highly developed country such as the Netherlands. Stock loss due to unacceptable quality is estimated to be 5%-10% of turnover.

Project Feedback from Paul Bartels – Research Project 6 leader

What do you feel has been achieved from the key aims and aspirations of SustainPack over the last 4 years.

"It has demonstrated that an enormous project can work collaboratively and compete at the edge of scientific research"

What do you consider to be the key breakthroughs?

"Creating better inks and increasing the possibilities of controlling humidity indicators and moving images"

What have been the key barriers to overcome?

"Sustainable fibre based packaging is still a relatively long way out but intelligent packaging features are almost there. Advancements in printed batteries will continue to accelerate commercial uptake after SustainPack. One of the central issues is how to increase interaction with retailers and consumers in order to educate the market"

If you had more time, what would you like to continue to build on?

"The use of communicative labels to optimise supply chains using data bars over RFID"

Packaging Solutions Projects

The SustainPack packaging solution projects are an essential part of SustainPack - after all, "seeing is believing". **The packaging solutions projects are aimed at using available knowledge to transform the elements developed in the technology research projects into a proven packaging end use application.**

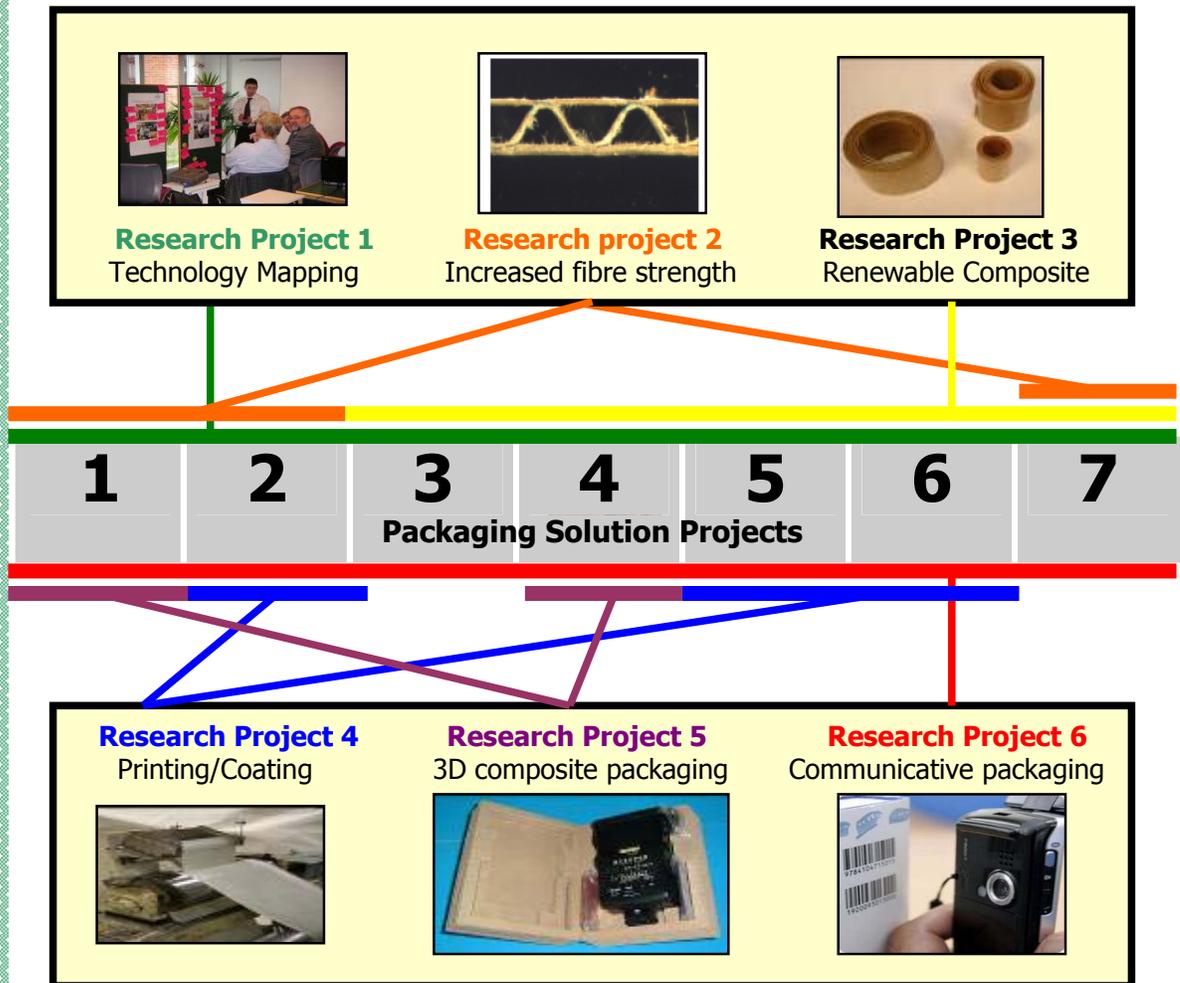
A key objective of SustainPack is to prove the technical viability of a new technology and demonstrate the potential economic advantages under real life conditions. New partners were introduced at appropriate points during the project to contribute new technical expertise and the physical resources necessary to deliver the packaging solutions projects.

To facilitate communication between all of the partners within the Technical Research and Packaging Solutions projects, there have been regular dissemination events and technical seminars supported by three strategic conferences and updated information on the Sustainpack web site.

Seven Packaging Solutions Projects were formed, as a result of the processes of technology mapping and identifying key market needs, which were completed at the outset of the Sustainpack project. The Packaging Solutions Projects are defined in the table below, along with their respective project managers.

Project	Description	Manager
1	A corrugated box offering equivalent performance with lighter weight material, incorporating fibre based cushioning, barrier coatings and an RH indicator/logger	STFI Sweden
2	A carton offering equivalent performance with lighter weight material incorporating barrier coatings and a 2D bar code	VTT Finland
3	A carton offering equivalent performance with lighter weight material, incorporating a laminated barrier film and a 2D bar code	VTT Finland
4	A barrier coated tray for chilled ready meals, sealed with a bio based nanocomposite film lid and incorporating a temperature logger	A&F Netherlands
5	A flexible packaging film for frozen food incorporating barrier coatings and a temperature logger	ITENE Spain
6	A flexible packaging film for snack products, incorporating barrier coatings and an RH indicator	Pira UK
7	A carton board or micro-flute box for luxury goods incorporating a biodegradable polymer window moving image and anti-counterfeiting technology	DTI Denmark STUBA Slovakia

The following diagram illustrates the interaction between the six Technical Research Projects and the seven Packaging Solutions Projects



Packaging Solutions Project 1A

To develop a stronger, sustainable packaging format for Fresh Produce.

Aims and aspirations –

To develop a stronger corrugated box for Fresh Produce combined with the following elements –

- Fibre-based cushioning materials
- Sustainable RH indicator or RH logger

Current situation



Each year damage of vegetables and fruits on the European market reaches Euros 9Bn, caused by insufficient packaging.

Heat damage

Compression damage

Final applications

To use Mangoes as a product example for building a suitable new sustainable packaging comprising a new corrugated box, new cushioning material and new RH / Time indicator.

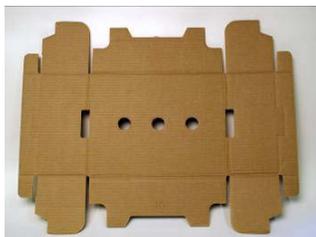
Top 4 Mango Producers - 2005

Country	hectares
India	1,600,000
China	433,600
Thailand	285,000
Indonesia	273,440
World Total	3,870,200



Key Sustainable Breakthroughs -

BOX – Technical research project 2
Kraftliner from Smurfit-Kappa



CUSHIONING – Technical research project 5
MaterBi



RH – TIME – Technical research project 6 –
Enzymatic RH / Time indicator

Indicator colour			
Storage condition	Product has been stored in far too dry conditions	Product has been stored in somewhat too dry conditions	Product has been stored in optimal RH conditions



Packaging Solution Project 1B

Aims and aspirations

To develop a stronger corrugated box combined with fibre-based cushioning material and RH indicator or RH logger.

Present package

			
Box Type = FEFCO 0201 Material: Double Wall Corrugated Fiberboard Size (mm): 490 x 450 x 275	Bag Type: Antistatic Material: Polyethylene Size (mm): 875 x 605 x 490	Cushion Type: Top and bottom Material: Dissipative EPP Density: 35 kg/m ³ Size (mm): 490 x 445 x 135	Product Type: CDU-G 19, electronic Size (mm): 410 x 315 x 140 Weight: 8, 75 kg

Final Applications

				
Box Technical Research Project 2 has reached Proof of Principle.	Bag Technical Research Project 3 has reached Proof of Principle.	Cushion Technical Research Project 5 has reached Prototype, with Mater-Bi TF01U-05	Cushion Technical Research Project 5 has reached Prototype, using dry Defibrated Cellulose.	RH Logger Technical Research Project 6 has reached Proof of Principle and a laboratory demonstration.

Packaging elements to be fulfilled –

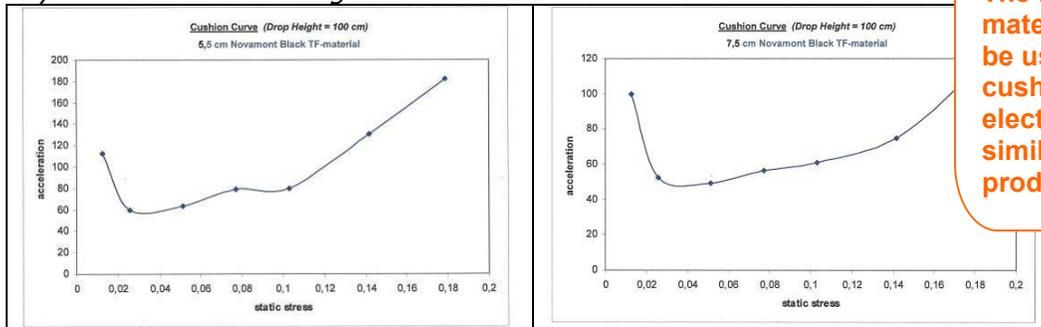
- A new corrugated box
- A new sustainable bag
- A new cushioning material –
In order to reach a sustainable and degradable solution, the aim is to replace the present oil based cushioning materials, e.g. expanded polystyrene, polyethylene and polypropylene, with a sustainable option.
- A sustainable RH logger

Key sustainable Breakthroughs

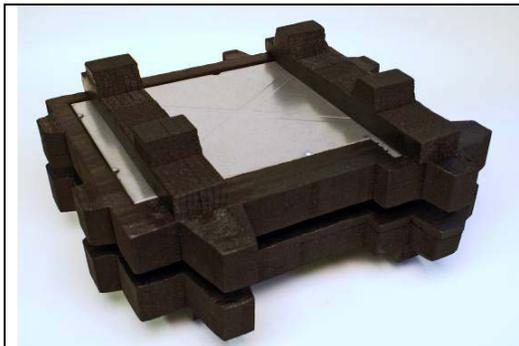
Tests carried out to assess new cushioning materials for suitability to the chosen end application –

Material	Type of test	Test method
OULU, Dry Defibrated Cellulose	Dynamic Shock Cushioning Characteristics	ASTM D 1596
Novamont S.p.A, Mater-Bi TF01U-05	Dynamic Shock Cushioning Characteristics	ASTM D 1596
Novamont S.p.A, Mater-Bi TF01U-05	Water absorption	ISO 535, Cobb 60s, Cobb 24h
Novamont S.p.A, Mater-Bi TF01U-05	Electrostatic properties	EN 61340-4-1, EN 61340-5-1
Novamont S.p.A, Mater-Bi TF01U-05	Free fall drop test	ETSI EN 300 019-2-2

Novamont .p.A, Mater-Bi TF01U-05, Dynamic Shock Cushioning Characteristics



From a variety of tests, it was concluded that -
- The Novamont material could be used as a cushion for electronic and similar products.



A biodegradable and recyclable top- and bottom cushion has been developed which fulfil the requirements for cushioning but not for ESD properties.



Principle for novel printed RH-logger demonstrated. Printed low-cost loggers feasible.

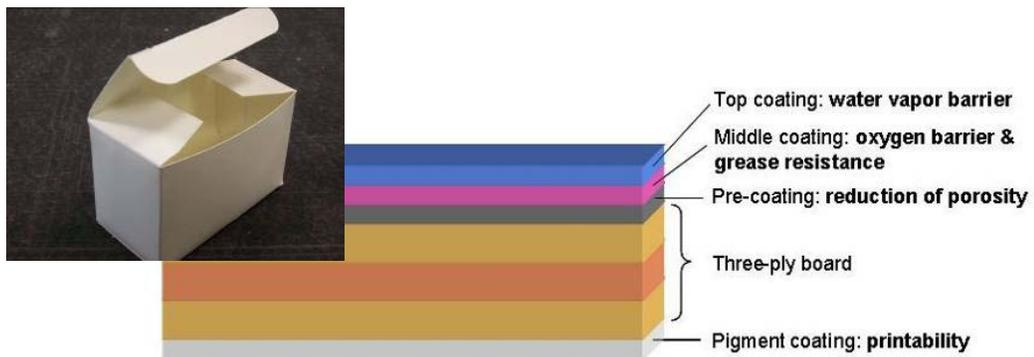
Packaging Solutions Projects 2 and 3

Advances in sustainable lightweight barrier coated and laminated board packaging.

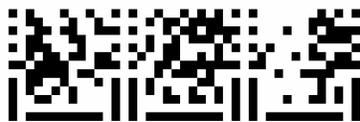
Aims and aspirations –

As these two Packaging Solutions Projects are very similar and have the same project manager, they will be considered together in this instance. The key aims and aspirations for both projects was to produce –

- A carton offering equivalent performance, with lighter weight material
- incorporating barrier coatings or laminations



- and a printed sustainable 2D barcode.



Key sustainable breakthroughs

- **Reduced material need with 20 % with constant delamination resistance and bending stiffness of the board**
- **Improved sustainable starch-based multilayer coating with superb oxygen barrier and fat resistance comparable to PE**
- **Added value and functionality in the supply chain: Demand driven and real-time delivery of audible and visual product information through 2D codes and mobile technology.**

Packaging Solutions Project 4

A renewable package for chilled ready-to-eat food

Aims and aspirations

The convenience food market is increasing rapidly in Europe and sustainable packaging is becoming high on everyone's agenda. Consumers like to buy high quality products, which means that new sustainable packaging must meet the protective requirements of the products through the supply chain.

Final applications - Cold filled ready meals with meat

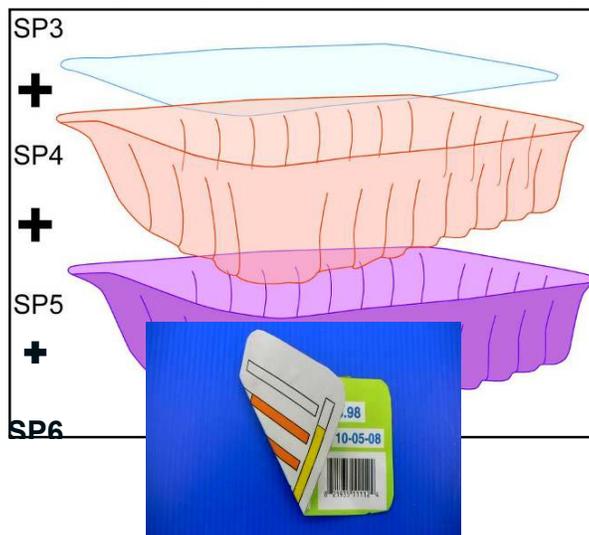
The new sustainable packaging must –

- Be renewable (green), with less material and be fully biodegradable.
- Have limited migration of water vapour, oxygen and carbon dioxide to keep the food fresh.
 - Must resist 4°C to 40°C with high relative humidity (100%) for a maximum of 10 days.
 - Must have low permeability to water vapour and water, between 4°C and 40°C.
 - Must have low a permeability to oxygen and carbon dioxide as possible.
- Incorporate communicative labelling, creating an optimal use of the supply chain with less waste.

Key sustainable breakthroughs

Samples of the following key packaging elements have been produced to varying stages of development, from concept through to proto-type -

- A tray lidding material of Mater-Bi or PLA with nano-clays from Technical research project 3 (SP3).
- A coated thermoformable tray material from the integration of Technical Research Projects 4 and 5 (SP4 and SP5.)
The tray is of Mater-Bi with softwood fibers.
The coating is gelatine and wax.
- A printed electronic temperature logger from ACREO and Technical Research Project 6 (SP6.) The logger is based on quality decay, determined by the meat.



Packaging Solutions Project 5

To develop a new generation of sustainable food packaging for low temperature applications

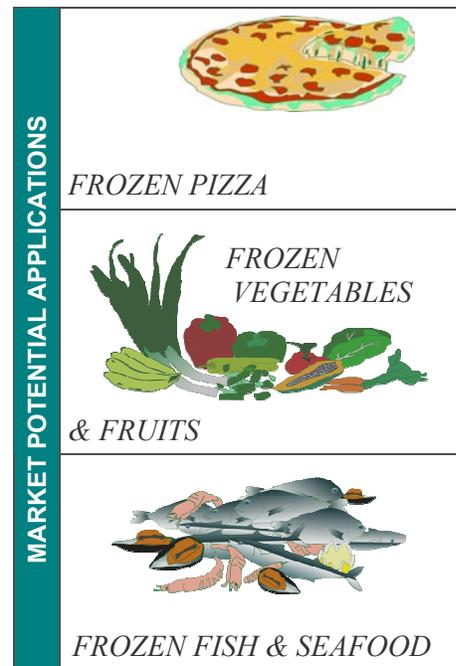
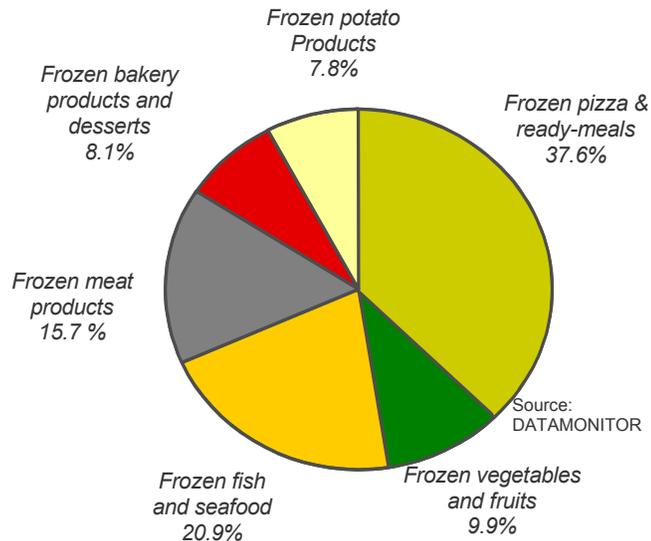
Aims & aspirations



DEVELOPMENT OF A SUSTAINABLE PACKAGING CONSISTING ON A FLEXIBLE PACKAGING FILM FOR FROZEN FOOD, INCORPORATING BARRIER COATINGS AND A TEMPERATURE LOGGER

Final applications

EUROPE FROZEN FOOD MARKET SEGMENTATION



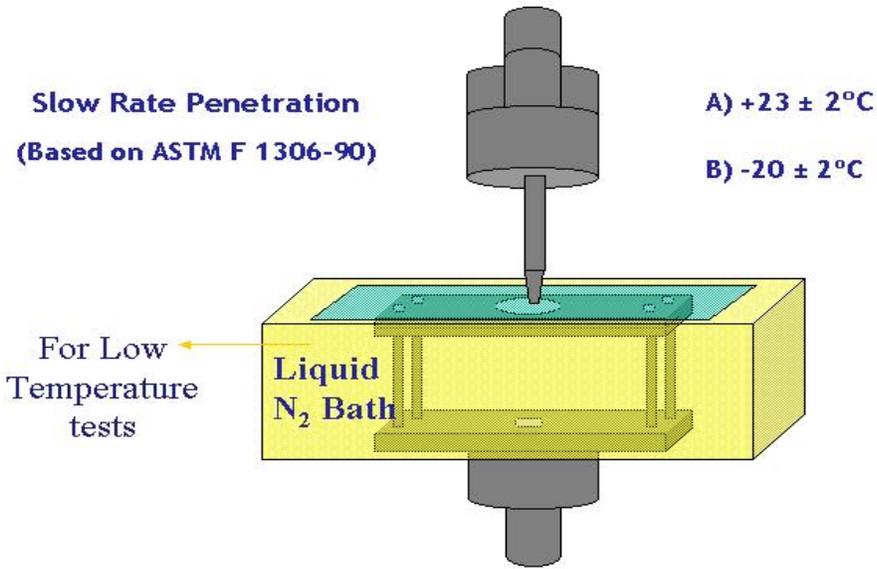
Key sustainable breakthroughs

(1) Biopolymer film - Technical Research Project 3

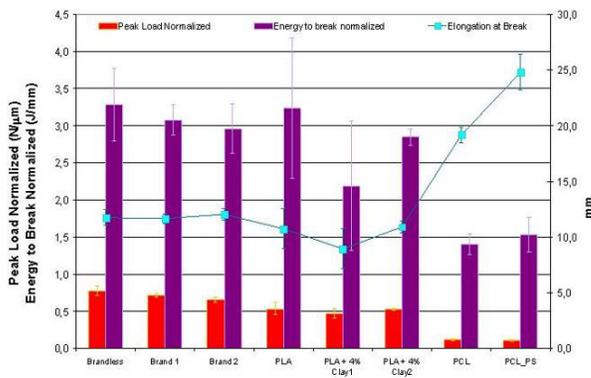
Materials selected were PLA and PCL.

Properties tested were (a) mechanical and (b) barrier, the results of which were then compared to commercially available films.

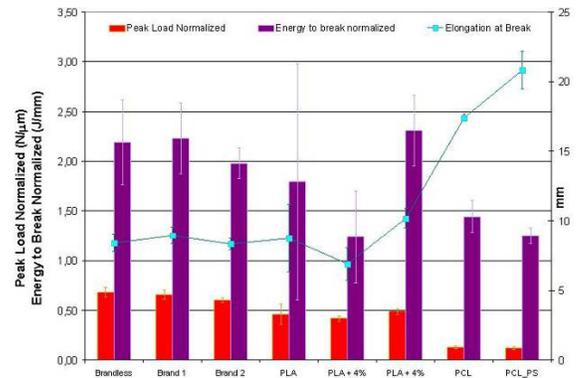
(a) Mechanical properties -



A) $+23 \pm 2^\circ\text{C}$



B) $-20 \pm 2^\circ\text{C}$



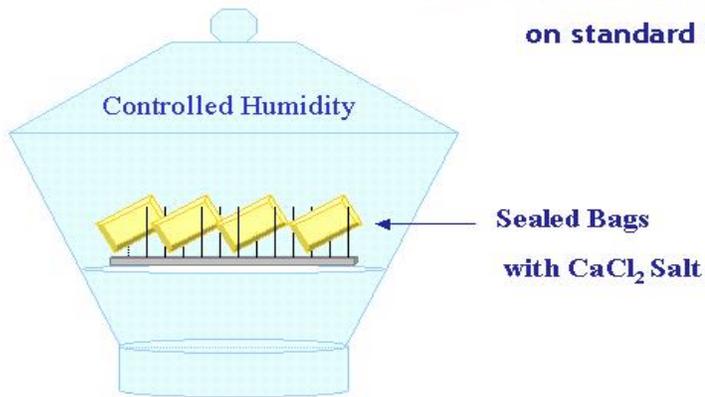
Decrease in WVTR when adding clays on PLA

(b) Barrier properties -



IMPORTANCE OF WVTR IN FROZEN FOOD PACKAGING:
STUCK OF COMPONENTS IN READY MEALS (condensation of water over the product)

Water Vapour Transmission Rate (Based on standard D 3079-94)



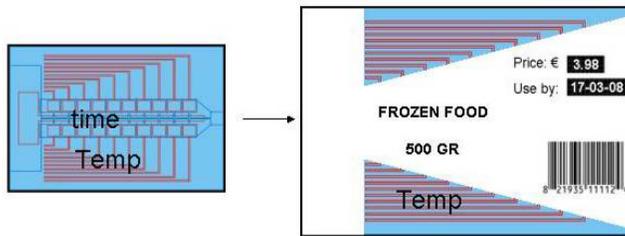
(2) Temperature logger – Technical Research project 6

Could only detect abuse events –

- Ideal temperature less than -18°C at 5 to 10 minutes time intervals.

3 levels:

- Below ideal
- Abuse above -18°C (24 hours – 1 time interval)
- Abuse above -2°C (1 to 24 hours)



85 x 55 MM (CREDIT CARD SIZE) OR SMALLER

(3) Barrier Coating – Technical Research Project 4

A study of barrier coating on PLA has not proved fully successful and further work is required.

A study of the printability of PLA is currently being carried out by XAAR.



Packaging Solutions Project 6

Sustainable packaging for ambient snacks

Aims & aspirations

To develop a sustainable flexible packaging film incorporating barrier coatings and a relative humidity indicator.

Final applications – highlighted in yellow



	Chocolate bar	Full fat Potato Chips (snacks)	Low fat Potato Chips (snacks)	Biscuits	Cakes
WVTR (g/m ² /day) @ 38°C, 90% rh	5	0.2	1-5	5	2-5
OTR (cc/m ² /day) @ 23°C, 60% rh	1	1	50-100	500	500
Moisture content (%)	6-30	2-8	2-8	2-8	6-30
Heat seal range (°C)	cold seal	30-300	30-300	30-300	30-300
Migration allowed (Yes / No)	no	no	no	no	no
Taint allowed (Yes / No)	no	no	no	no	no
Grease Resistance (High / Medium / Low)	High	High	Medium	High	High
Converting / filling equipment required	HFSS	VFFS / MAP	VFFS / MAP	HFSS, FW pleats	HFSS / VFFS
Shelf life (mths)	5-8	5-6	5-6	6-8	1-5

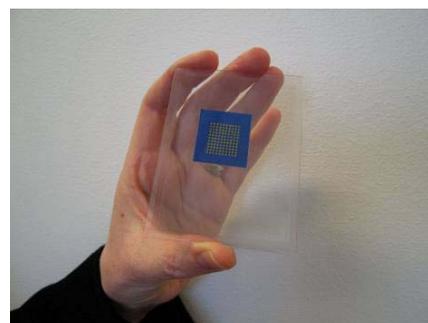
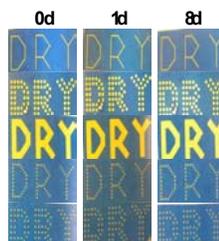
Key Sustainable Breakthroughs -

Concept coated papers from Technical Research Project 4 –
High water vapour and oxygen barriers are still being developed.



Printed relative humidity indicators from Technical Research Project 6 –

These would ideally be incorporated inside the packaging, but visible from the outside through a clear window. Colour and text changes indicate changes in humidity.



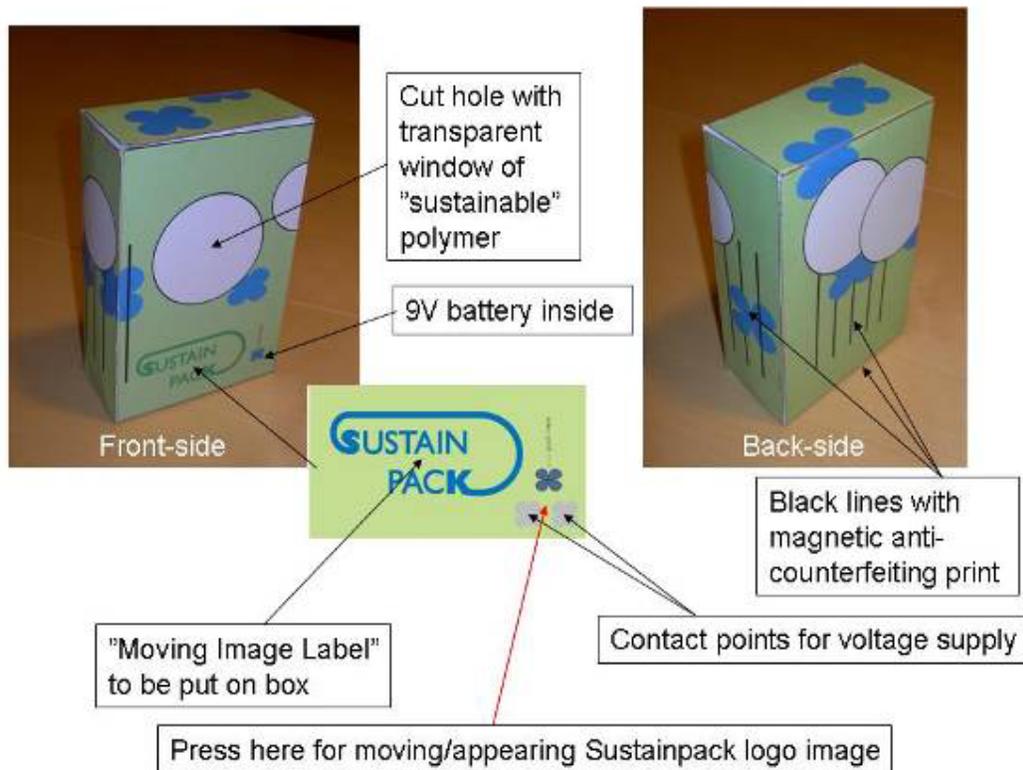
Packaging Solutions Project 7

A carton board or microflute box for luxury goods, incorporating a biodegradable polymer window and sustainable communicative technology.

Aims and aspirations

To develop a package made of the following key elements -

- A carton board / microflute box from Technical research project 2
- A sustainable, biopolymer window from Technical Research Project 3.
- A sustainable and printable electronic moving image and a sustainable and printable anti-counterfeit image from Technical Research Project 6.



Final applications – Luxury goods -

For example –
Gift confectionery



Gift wine in a presentation box

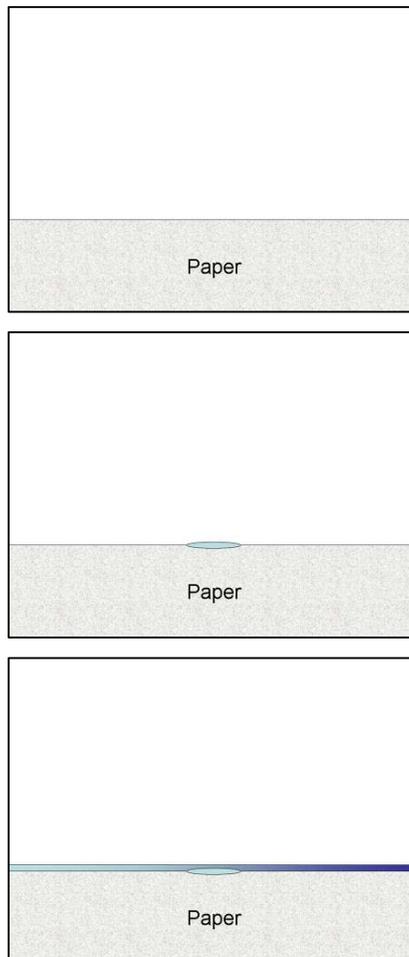


Key sustainable breakthroughs

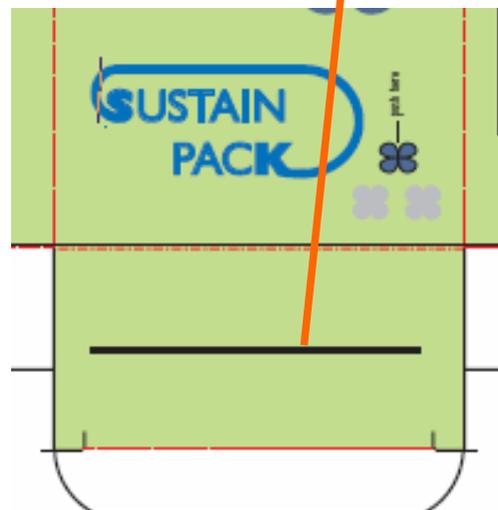
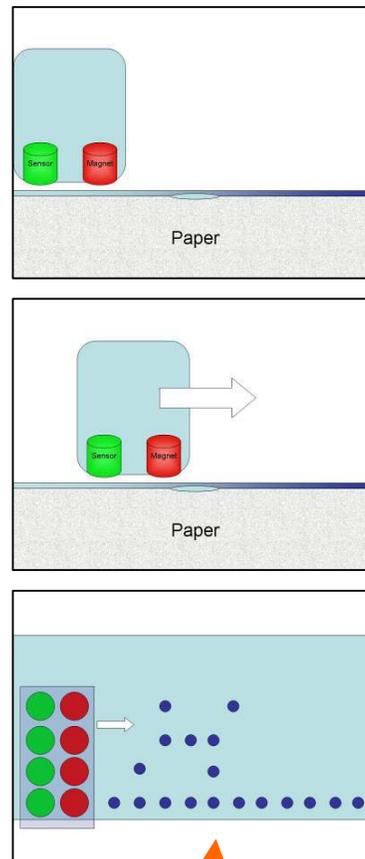
Key breakthroughs lie within the development of communicative packaging elements from Technical Research Project 6 –

(1) Printed anti-counterfeit technology –

Printing



Scanning



(2) Printed electronics – creating a moving image



ACTIVATED



**PARTIALLY
ACTIVATED**



**BEFORE
ACTIVATION**

Summary & Breakthroughs

There are important development areas where the SustainPack project has made significant advances without producing a final packaging solution. For instance, its work on printing active elements directly onto packaging has laid the groundwork for a process that could ultimately make tagging of individual items more affordable, particularly if the research is linked to the development of RFID technologies.

The Teams working on communicative packaging have made great strides in the use of visual signals through moving images. They have been successful in making bar codes, humidity and temperature monitors as part of the fibre-based packaging design.

The project partners have realised that paper packaging is more restrictive than plastics in respect of design and hence the focus on the 3 dimensional elements of packaging. Though there is not yet a product prototype, the team has gone a long way towards developing the materials research necessary to progress the use of nanofibres in a wider range of shapes for packaging.

Future Opportunities

Market research was conducted in 2004 to determine demand projections until 2008. This was based on interviews with senior managers from more than 100 technology providers, brand owners and packaging converters. Results revealed that pack converters viewed track and trace, anti-theft, food quality and anti-counterfeiting as important/very important. Brand owners were less bullish than converters, rating track and trace as important/very important and tamper evidence, anti-counterfeiting, anti-theft and food quality/safety as fairly important. Winning technologies for converters included freshness indicators, doneness indicators, time temperature indicators, printed electronics and smart inks.

Winning technologies for retailers were freshness indicators, chip radio frequency identification (RFID), electronic article surveillance (EAS), time temperature indicators and printed electronics. Rapid growth in freshness indicators was expected due to changing consumer lifestyles, growth in modified atmosphere/controlled atmosphere technologies and consumer preference for foods with indicators. The most rapid expansion of intelligent packaging was forecast in pharmaceuticals and food. Although the main smart application is currently anti-theft, by 2008, it will be brand enhancement. RFID is expected to overtake EAS in sales, although it is still presently hampered by costs, improved functionality of barcodes, technical drawbacks and the lack of standards

Key drivers for current and future growth in intelligent packaging include:

- Falling cost of RFID technologies - including smart active labels (SAL) and electromagnetic ID (EMID);
- Full commercialisation of non-electronic diagnostics;
- Improved retailer confidence through pilot-scale evaluations;
- Consumer demand for diagnostic packaging, notably freshness indicators;
- Legislation on traceability of food;
- Legislation on cold chain management;

- Retailer differentiation increasingly on service and quality and not on price;
- Growth in anti-counterfeiting measures, especially in pharmaceuticals;
- Enhanced functionality (speech on product displays etc.) providing for higher levels of product information, promoting and packaging novelty.

Intelligent retail packaging is defined as packaging with the ability to:

- Monitor and indicate the condition of the pack contents;
- Remotely signal information such as product identity;
- Store and provide information on product history and origins;
- Assist in the use of the product;
- Indicate evidence of tampering or product diversion;
- Provide promotional and marketing aids on the pack;
- Interface with other intelligent technologies to ensure optimal product use and conversion;
- Assist in reducing costs and increasing product sales through improved stock and supply chain management.

The current awakening of environmental consciousness amongst consumers is an important **trend**, not just a fashion. Consumers remain confused (or in denial) as to what they should do and buy to make their actions comply with their environmental conscience. It will be several years before there is a widespread and significant enlightened consumer group making genuine, educated environmental choices.

Packaging waste recycling targets in Europe will not increase in the future (these are already capped until 2014, with the EU in no mood to re-open the packaging & packaging waste directive) It is envisaged that the packaging focus will instead shift to minimisation and reducing the carbon footprint (driven by the commitments and activities of retailers in Europe and the US)

Carbon footprint, packaging minimisation drivers and legislation will provide opportunities for the expansion of online farmers markets and the creation of new business models for major retailers sourcing local produce. Carbon footprint labelling is likely to become the norm within 5 years, which will increase the focus on renewable and biodegradable packaging materials. Biodegradable and biopolymer packaging consumption will grow rapidly from a relatively small base. Although penetration will still be low by 2011, exponential growth after this will see biopolymers established as a mainstream packaging material within 20 years.

Total global consumption of biodegradable polymers is just 36,000t, or 0.3% of the consumption of rigid and flexible plastic packaging in Europe alone. Expansion of the sector may be rapid: "*BASF forecasts that the world market for biodegradable plastics to grow by more than 20 per cent per year.*"¹ However, even with rapid expansion, supply of biopolymers over the coming years is likely to remain small scale in comparison to the wider packaging industry, and this could limit uptake: "*Large converters like Alcoa need assurance of steady supply at significant volumes - the industry is not quite there yet!*"; Cameron Koeppel and Jeff Pristera, Alcoa, USA²

Future production volumes may not only be limited by processing capacity. Production of raw materials for biopolymers will require the dedication of significant areas of agricultural

¹ Source: Confectionery news.com

² Source: Biodegradable plastics in packaging applications, Chicago, 12-13 September 2006

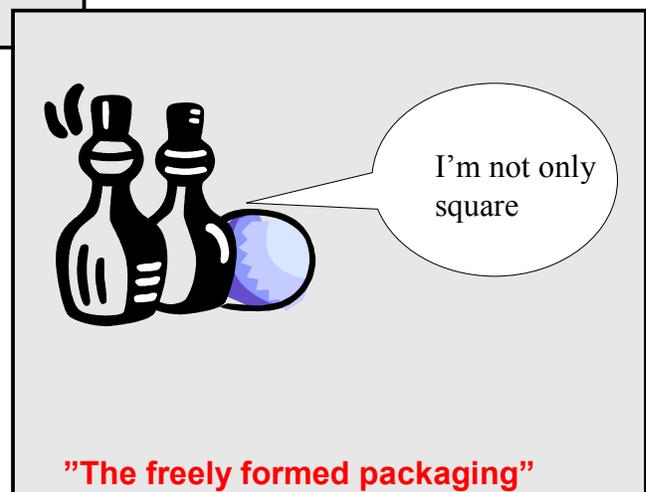
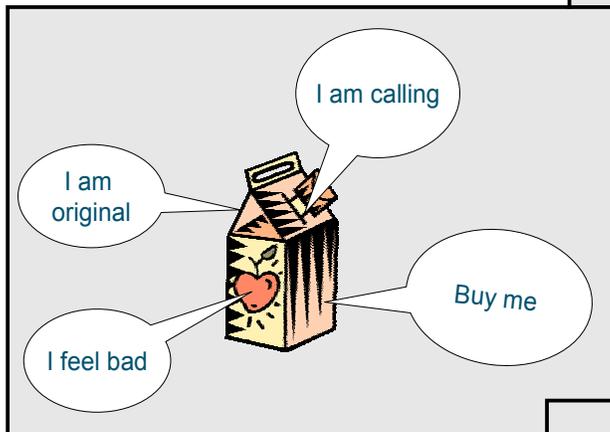
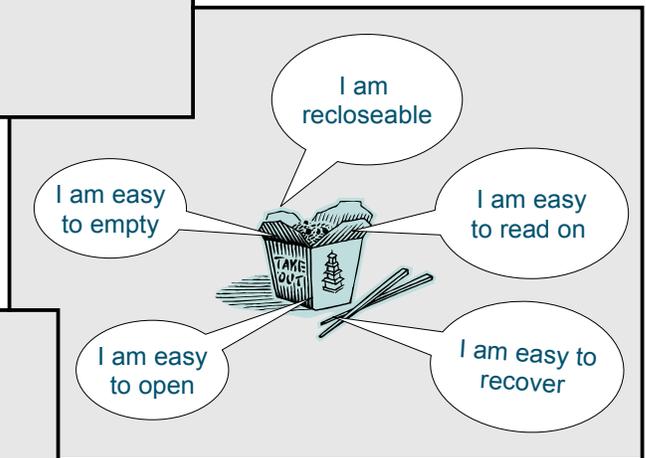
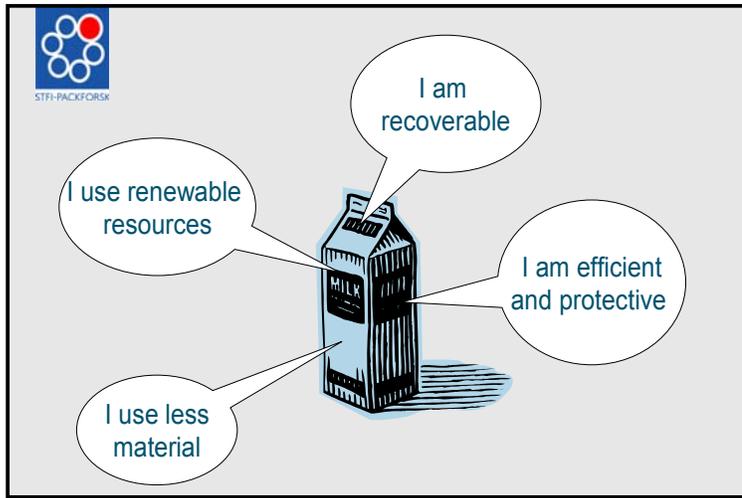
land. For producing biopolymers this will require in the region of 1.74 ha per tonne of biopolymer³. To put this into context, an optimal size PLA plant producing 140,000 tonnes/year would require an estimated 350,000 tonnes of maize⁴. In land area, this would be around 243,000 hectares – nearly 500,000 football fields, or the equivalent of around 1.1% of total UK agricultural land. To produce the UK's entire plastic packaging requirement from biopolymers would therefore require the conversion of nearly 10% of UK farmland to biopolymer product.

In addition, land area will also be needed for producing the raw materials for bio-based fuels. Competition for materials between biopolymers for packaging, non-packaging applications and bio-fuels could be a significant issue in the future.

The development of sustainable fibre-based packaging is to create a value chain from the wood yard through the papermaking and converting processes to end use applications. The packaging product can then be recycled by direct entry into the waste paper stream for reuse in papermaking applications. This is not currently possible with the extensive use of petro-chemical based additives and plastics.

The SustainPack project has started the process of developing a new generation of packaging solutions using renewable and fully recyclable materials that also respond to the growing packaging communications market. The future for fibre-based packaging will require the re-engineering of the packaging value chain to deliver increased, capital efficiency, product innovation and more competitive packaging materials. The materials will require improved barrier properties to prolong shelf life and carry consumer information and brand protection using new communication technologies and active ingredients. In the future, the ability to completely recycle a package will become a prerequisite of the design itself. Improved collection systems will exploit the potential to characterise and increase the quantity and quality of fibre recovery in the recycling process.

The fibre-based packaging of the future will have to incorporate all of the following elements to produce a truly sustainable, recyclable and competitive proposition to oil based packaging materials.



SustainPack Partners



Research organisations

- Acreo AB, **S**
- Agrotechnology & Food Innovations, **NL**
- Centre Technique de Papier, **F**
- Consejo Superior de Investigaciones Cientifica, **E**
- Danish Technology Institute, **DK**
- Fraunhofer Gesellschaft, **D**
- Institute for Surface Chemistry, **S**
- Oy Keskuslaboratorio - Centrallaboratorium Ab, **FIN**
- Packaging, Transport & Logistics Institute (ITENE), **E**
- Papiertechnische Stiftung, **D**
- Pira International, **UK**
- Risø National Laboratory, **DK**
- Stazione Sperimentale Carta, Cartoni e Pasta per Carta, **I**
- STFI Packforsk, **S (Co-ordinator)**
- Technical Research Centre (VTT), **FIN**
- University of Oulu, **FIN**

Universities

- Alma Mater Studiorum, Universita di Bologna, I
- Ecole Française de Papetiere et des Industries Graphiques, F
- Helsinki University of Technology, FIN
- Karlstad University, S
- Royal Institute of Technology, S
- Sheffield Hallam University, UK
- Slovak University of Technology, SLO
- University of Agriculture of Szczecin, PL
- University of Aveiro, P
- University Bordeaux 1 (LCSV) , F
- Universitat de Girona, E

Industrial partners

- Ahlstrom Research and Services, F
- Cartonajes Levante, E
- Kappa Packaging Development Ltd, NL
- Sainsburys Supermarkets Ltd, UK
- Smurfit WW Research, Europe, F
- Stora Enso Skoghall AB, S
- Walki Wisa Oy, FIN
- XAAR Jet AB, S

What the partners had to say about the SustainPack experience

"A very rich experience and a very efficient way of spending European funding"

Naceur Belgacem

"A lot of energy put in.....I'm really happy with the results, both personally and professionally"

Susanna Aucejo

"We have established a network of scientists which needs to be preserved and continued in future projects"

Paul Bartels

"It has been really interesting and useful to manage a technical project from a market perspective"

Dorotea Slimani

"The most challenging project I have ever participated in"

Dugan Bakos

The project opened up possibilities for European wide research co-operation in a smaller scale and in more efficient way.

Panu Lahtinen

"The aims were rather general in the beginning of the project and they have since that focused considerably. The main objective, development of printed visual indicators has been obtained."

Maira Smolander

"A very positive experience, to be involved in so many emerging technologies at the same time."

Søren Østergaard

"This project laid the foundation for future projects aiming to replace fossil-based packaging materials with renewable materials. And it was a most interesting social experience."

Tom Lindström

So what could be done differently, what have been the barriers?

"Communication and distance"

"Scaling and price barriers"

"The production and availability of nanofibres, they are still very expensive"

"I have spent a lot of time administering and co-ordinating rather than on science"

"New technical challenges kept appearing as the work progressed. Some of the partners change of personnel during the project has caused some delays in the progress of the work."

"I have been really surprised that many researchers are working on goals made up by them selves with out a real interaction to the industry."

"The idea is 1%, making the idea reality is 10% and commercialisation is 89%, we still have a long way to go"

Closing Statement from Kennert Johansson – SustainPack Co-ordinator

"It is good that we decided to involve the whole value chain in this project, as it has taken the research forward more rapidly. As well as new and interesting technology developments the project has enabled more academic researchers to realise that packaging is a very important business"