



***A THREAD
FROM SPACE
TO YOUR
BODY***

Technology Transfer Programme



Technology Transfer Programme

What do textiles, garments and satellites have in common? This brochure will help you find out, and tell you just how the European space industry is having an increasing impact on the textile industry in general. Several of the technologies used in the design and manufacture of modern garments come from materials and systems that were developed for applications in space. I hope this brochure will give you an insight into how advanced European space technologies are being applied to clothes, not only to improve their value and performance but also their comfort. Many innovative non-space products and services that will benefit society are now being introduced as a result of technological spin-offs from the space industry, and it is worth remembering that textile manufacturing is not the only sector to take advantage of the new technologies developed by European space companies. I hope this brochure will enable you to discover the new and unexpected ways in which space activities improve our daily lives.

Pierre Brisson
Head of the Technology Transfer and Promotion Office





Compact airbags derived from space applications allow safe parachute landings from low altitudes

SURVIVING SKYSCRAPERS

Safety Parachute for Skyscrapers

The tragic events at the World Trade Centre in New York have focused attention on a new safety aspect in high rise buildings; the need for a system which enables the occupants to abandon the building when there is no alternative but to use a device similar to a parachute. Current emergency parachutes only work properly if used at a certain altitude (50-100 m), and thus the problem remains of how to get out of buildings which are only 20 m or more high.

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The proposed solution is based on the know-how used in the emergency parachute combined with an inflating system so as to create a parachute which works from the very beginning of the jump. Karada, Becagli and Texteam together with SEVA-Technologies are developing an inflating system which works with the parachute and meets resistance specifications.

MADE TO MEASURE

Adjustable Damping Shoe

Walking is an important aspect of everyday life and footwear manufacturers have launched various products which enable the wearer to reduce the impact of rough ground or to improve transpiration from the feet. As far as the first point is concerned, the principal multinational manufacturers are concentrating their efforts on various R&D attempts to develop new solutions such as air bags in the sole of the shoe. So far, however, there is no system which permits the stiffness of the sole to be adjusted so that it can cope with different types of ground or operating circumstances. The creation of footwear with such a feature built into it would represent a major breakthrough both in terms of protection of the joints and in terms of safety as regards work shoes.



Space vibration - damping solutions allow for smart shock-absorbing soles



The solution proposed is based on know-how developed for applying magneto-rheological fluids to the damping of structures. By changing their viscosity, these fluids can be transformed from the liquid into the solid state in a matter of milliseconds through the application of a magnetic field.

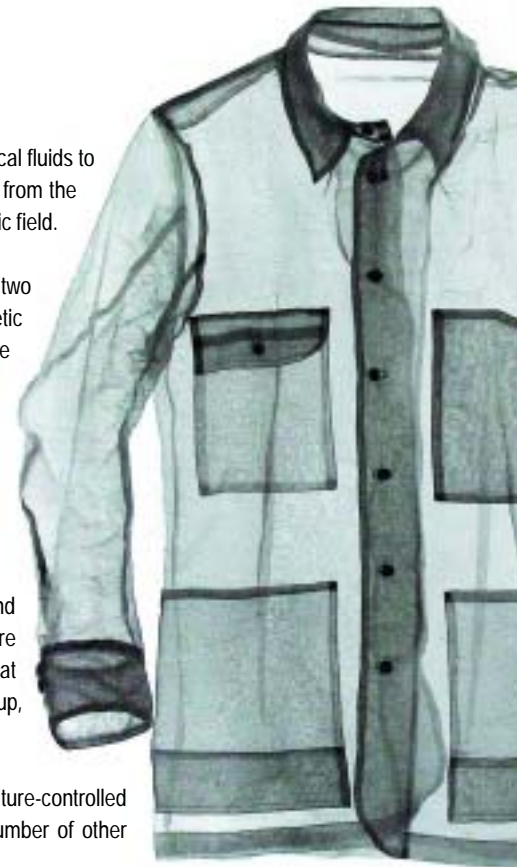
A prototype shoe has already been developed in which the fluid is contained in two intercommunicating compartments in the sole in conjunction with an adjustable magnetic field, so that the stiffness of the sole can be adjusted according to the roughness of the ground or to outdoor conditions.

FORGET THE IRONING

Space Yarns for a Smart Shirt

Shape memory alloys (SMAs) are extraordinary materials; they can be stretched and deformed like an elastic band and will still return to their original shape. What is even more remarkable is that they can remember a shape that has been locked into them – so that if they are bent into a new shape, they will return to their original form when warmed up, often exerting considerable force in the process.

The European space programme developed SMAs for use as lightweight, temperature-controlled actuators. The unique features of SMAs have, however, shown great promise in a number of other fields.



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Through the ESA Technology Transfer Programme, D'Appolonia has transferred this knowledge to more traditional sectors. It is in this context that the Italian fashion company Corpo Nove, through their R&D spin-off Grado Zero Espace, has used this "material" as a particular feature in their collection by using shape memory metal fabric to manufacture a smart shirt.

The fabric of the sleeves can be programmed to shorten as soon as the room temperature rises by a few degrees – transforming a long-sleeved shirt into a short-sleeved one in a matter of moments! The fabric can also be screwed up into a tight ball, folded or creased, but will automatically return to its original shape if treated with a jet of hot air from a hairdryer. This alloy shirt is a real traveller's dream if you think that you can "iron" it with the hairdryer, even while you're wearing it.

The shirt has been listed among Time Magazine's Inventors of the Year, as well as in Popular Science magazine.

*Know-how on shape
memory materials
developed for
microgravity
experiments is now
being used for smart
shirts*





SPRING IN FORMULA ONE

Space Suit Technology at the Pit Stop

As part of ESA's Technology Transfer Programme, the Italian fashion manufacturer Karada and the designer Hugo Boss have produced an innovative type of overall for McLaren's mechanics. The challenge was to produce a thermally regulated garment which offered protection from fire while providing a comfortable working temperature for the whole team servicing the car, and maintaining the same safety standards which apply to the driver's overalls. The solution was 50 metres of plastic tubing, 2 mm in diameter, developed for astronauts' suits by the Canadian company Med-Eng, and installed by Karada in 55 overalls. The result was a miniaturised air conditioning system which offered maximum comfort even in extremely hot working conditions. The idea dates back to early 2001, when Karada's spin-off company "Grado Zero Espace" was formed to look into the applications of engineering, chemistry and mechanics in innovative garments. Led by Mauro Taliani, the designer for Hugo Boss, the team first developed a cooling jacket using plastic tubing to complete an internal cooling circuit controlled by a mini refrigerator. In late 2001 added impetus was provided by the technology broker D'Appolonia, a member of the TTP network, which pools the know-how of European space experts and identifies products that could benefit from



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such knowledge. The system was further developed and adapted to allow the Pescarolo team to keep cool while competing in the 2003 Paris-Dakar rally. The original jacket has been displayed at the Cooper-Hewitt National Design Museum in New York, part of the Smithsonian Institute.


Space Fashion is Cool

The Spanish company that helped to design the European spacesuit has now developed air-conditioned clothing for use on Earth. Clothing that can keep you cool in even the hottest environment could make a real difference to many different categories of workers; from firemen and motorcyclists in their heavy and hot protective clothing, to cooks and foundry workers in their hot workplaces.

Zodiac, the Spanish company which co-designed the European spacesuit, has collaborated with a Belgian university and two other partners to develop clothing that keeps the person wearing it cool.



Overalls containing space technologies are worn by the McLaren team



The system consists of a lightweight undergarment which blows cool air over the skin, thus taking advantage of the body's natural perspiration. This cooling mechanism, which contains few moving parts, is powered by rechargeable batteries, thus enabling full mobility. The undergarment can be worn on its own or under protective clothing. It is currently being considered by the London police force for use under bullet-proof vests.

For environments requiring it, a full suit can be supplied in which air cooling is supplemented by a liquid refrigerant pumped through the network of tubes inside the suit. By using its spacesuit know-how, Zodiac can also incorporate breathing apparatus into the suit, to enable its use with full protective equipment. The wearer can still move around freely and with complete independence thanks to the battery-pack power supply.

SUPPORTING THEIR FIRST STEPS

Monitoring Astronauts for Untroubled Baby Sleep

A new type of baby pyjamas, developed by the Belgian company Verhaert Design and Development and the University of Brussels (ULB), could help in preventing Sudden Infant Death Syndrome (SIDS), commonly known as cot death. SIDS is the sudden and unexpected death of a baby for no obvious reason. In the United Kingdom, cot deaths affect around four out of every 10 000 healthy babies, 86% of whom are less than six months old, while in the United States more than 2500 babies die each year within the first 12 months of life from symptoms attributable to SIDS.

From Space to Babies

The Mamagoose pyjamas draw on technology used in two space applications: the analogue bio-mechanical recorder experiment and the respiratory inductive plethysmograph suit. This transfer to a civil application of technology designed for space is part of the ESA Technology Transfer Programme. The Mamagoose project is also partially financed by the German Space Agency and IWT, the Belgian institute.⁵³



The Mamagoose pyjamas have five special sensors positioned over the chest and stomach: three to monitor the infant's heart beat and two to monitor breathing. This double sensor system ensures a high level of measuring precision. The special sensors are sewn into the cloth and do not come into direct contact with the skin, thus preventing discomfort for the baby. Mamagoose pyjamas are made from two layers: the first, which comes into direct contact with the baby's skin, can be machine-washed and the second, which contains the sensor system, can be washed by hand. The pyjamas come in three sizes, are made from non-allergic material and have been specially designed so that the sensors stay in place during use.

The control unit with the alarm system is connected to the pyjamas and continuously monitors and processes the signals it receives from the five sensors. It is programmed with an algorithm which scans the baby's breathing pattern to detect unexpected and potentially dangerous situations, whereupon it activates an alarm system. Moreover, the selective memory records data for a certain period of time before and after the alarm goes off to assist physicians in making a diagnosis.

Mamagoose prototypes have been tested on many babies in different hospitals and in varying environments and conditions, including babies of various weights and sizes, when they are in different 'moods' such as calm, irritable or upset, and when they are sleeping in different positions. So far, the results have been extremely promising, with a commercial product known as "Babyguard" soon becoming available.

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A SHIELD FOR CITY LIFE

Depositing Metals in Lightweight fabrics

POLYMET is an innovative, high-tech, woven/non-woven material (with an endless three-dimensional polymer structure) originally developed in space research programmes and which has special, micro-porous metal structures that can be adapted in size as required. Both the material it is used on and the shape can be varied to produce composite materials with characteristics such as resistance to tearing, high temperatures and chemicals, and it is therefore particularly suitable for producing innovative new products.



With POLYMET it is possible to create completely new surfaces by metallising high-tech fabrics using galvanic-technical procedures. Such fabrics are thereby provided with highly stable, specific, geometric micro-porous metal structures which can be programmed up to micrometre dimensions. This new compound can be used in micro-chemical systems.

Compared to the standard technology available on the market, POLYMET has significant technical advantages in economic as well as ecological terms. Given the adjustable nature of its microstructure, POLYMET is a versatile new compound with completely new functional properties. Other features of POLYMET are its elevated recycling potential, as well as its being pollutant free and resistant to most chemicals.

Complex textile structures developed for space programmes are adapted on Earth for fashion and technical textile applications

BECAUSE SAFETY IS NOT ENOUGH

Screening Out Vandals

Belgian Spacelink partners have put a French textile manufacturer in touch with a consortium that is trying to combat road and rail transport theft across Europe. Thefts from lorries and haulage containers are a growing problem all over Europe and vehicles with tarpaulin coverings are particularly vulnerable to attack. Freight containers are often left unattended for long periods of time in loading or storage depots, and while such covers are light and convenient to use they offer little protection against vandals or thieves.

By 1996 this problem had become so overwhelming that three companies – a French firm constructing haulage containers, a Belgian plastics and composites firm, and an important Belgian railroad forwarder decided to join forces with CRIF, the Belgian industrial research centre, to develop a new system for

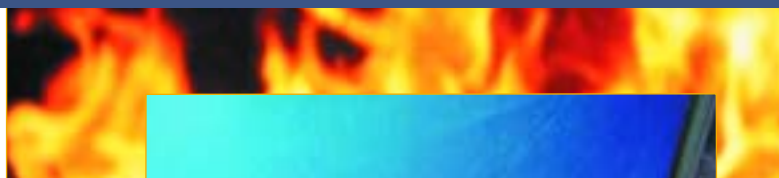


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protecting containers. The work was sponsored as part of the EC CRAFT scheme and initial studies showed that it might be best to concentrate efforts on producing a stronger, more resistant covering which still maintained the advantages of being lightweight, flexible and easy to clean. But where were they to find such a material?


As part of its work for ESA, the Spacelink network looks at non-space companies to find out what type of technology they might need. It was this procedure which led to the Belgian partner Creaction announcing that it was interested in finding a vandal resistant textile. Luckily, after the success of its flameproof textiles used on the Ariane rockets, the French company Société Ariégeoise de Bonneterie had modified its knitting techniques to produce a flexible, wire fabric which was extremely difficult to cut through and therefore well-suited to the task.

By December 2000, research had been completed and large scale testing was under way. Parcour, a consortium of eight European companies including a Dutch multinational manufacturer of vehicle tarpaulins and a French SME specialised in building coaches and repair kit systems, is now developing a vandal resistant alternative to the standard tarpaulins currently in use. In a market that accounts for about 120 000 units a year worldwide, potential sales of this new material are estimated at about 7000 units a year.



Special knitted fabrics designed to create effective shields against infrared radiation have been further developed for cut-resistant tarpaulins, as well as for protection against high temperatures in many working environments



A large background image of an astronaut floating in space, with the Earth's horizon and clouds visible. The astronaut is wearing a white spacesuit and is positioned on the left side of the frame. On the right side, there are mechanical structures, possibly part of a space station or shuttle, with various cables and equipment. The overall scene is set against the bright blue and white of the Earth's atmosphere.

Rocket Textile Takes the Heat of Industry

A flameproof textile initially developed for use on the Ariane rocket has been welcomed by industry for its applications in fire prevention and protection from heat. Certainly, a woven fabric that resists flames and protects from extreme heat probably isn't the first thing you'd think of as coming from space technology, but these are actually the primary features that rocket-motor inventors look for to defend sensitive equipment from the engine's flames.

In 1990, Aérospatiale and SEP (Société Européenne de Propulsion) contacted a family-run textile company in Montferrier, France to ask them to help develop new flameproof materials for use on rockets. The company, SAB (Société Ariégeoise de Bonneterie) used all of its know-how acquired over forty years in knitting and coating textiles to produce Flamebrake, a new type of textile which will stop flames from advancing and repel heat.

A special knitting technique is used to combine Kevlar and Preox fibres into an optical fibre which can block out 90% of infrared radiation over a considerable range of temperatures. By forming the material into layers, heat transfer can be almost entirely eliminated, another innovation developed for the Ariane rocket. Flamebrake can be impregnated with an aerospace silicon coating to produce a laminated material with a high level of flame resistance.

Flamebrake's remarkable properties can be best seen in its application at CEA (Commissariat à l'Energie Atomiques) in France. In the high temperatures reached in the cooling system of a nuclear reactor core, Flamebrake was seen to protect workers both from heat (temperatures from 2100 to 2500°C) and from dripping molten metal, while transparent screens made from Flamebrake meant that researchers could observe the results of their tests close up.

In an area where there are few competitors, there are many commercial applications for Flamebrake. Firms in the metal and glass working sectors such as Pechiney SA and St. Gobain SA have been using the insulating properties of Flamebrake to good effect to shield their production workers, while the excellent fire retardant properties of Flamebrake have been taken full advantage of by incorporating them into the upholstery of seats for public transport and public buildings like the Toronto Skydome.

AN INFALLIBLE GLANCE

An Eye for Colour

Textile manufacturers can now look forward to a more reliable system for checking on-line the colours of fabrics thanks to Earth-observation technology. This system can supply significantly improved colour resolution compared to a conventional camera and gets close to the precision of the human eye. Given that it's the fabric which moves, it does not require complicated scanning mechanics and reduces measurement times. This is the original application conceived by D'Appolonia within the framework of the ESA Technology Transfer Programme.

In December 2000 a preliminary prototype was presented to a group of textile manufacturers in Como, by the Italian Textile and Silk Associations, for in depth assessment and research. Based on a successful trial phase, a preproduction prototype has been further developed by a group of companies led by IRIS in Italy with the support of the European Commission's CRAFT Programme.



Optoelectronics developed for space missions are applied to objectively identify and evaluate faults both on grey and coloured fabrics

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Smart Camera for Finding Fault

High-speed smart-vision sensors used on satellites are now taking over the tedious chore of checking for defects on factory production lines. Quality control is an extremely important part of manufacturing, but is not as easy to automate as the other stages of a production process since it often requires a visual appraisal, which is slow and unreliable as well as being expensive. There is now a chance, however, that the need for human intervention in the inspection process could be reduced by the use of smart cameras originally developed to position satellites accurately.

Satellites used for communication need to be accurately positioned in relation to the Earth so as to be able to transmit signals perfectly. To do this, onboard equipment needs to be able to make very precise measurements, as well as being compact, lightweight and requiring little power. Celsius Tech Electronics of Sweden and ESA found that the smart optical sensing system produced by Integrated Vision Products, also in Sweden, did the job. It works by comparing the view of Earth that one has in space with a pre-programmed image using prominent landmarks like the Cape of Good Hope to keep the satellite and its antennas correctly positioned. Another advantage is that the whole system, including its sensors, processors and memory fits on a chip the size of a fingernail. The incredible speed and processing power of the system, which can capture more than 4000 images per second and conduct a range of image processing directly on the chip, has made it suitable for a number of industrial applications.





The Italian technology company D'Appolonia has suggested taking advantage of the speed and precision of the smart camera to control the production process itself. Recent R&D projects led by the Italian company IRIS have presented a prototype which performs automatic inspection of the fabric while still on the loom. By incorporating smart cameras into production machinery, faults can be detected and repaired as they occur, which would greatly improve efficiency in many manufacturing industries. Within the framework of the ESA Technology Transfer Programme a partnership between IRIS and Panoptes, a leader in inspection systems, has been established to follow up commercially the initial space technology transfer.



Benefits for our daily lives: The ESA Technology Transfer Programme

Over the past 35 years, the European space industry has gained considerable expertise in building, launching, controlling and communicating with satellites. From this long experience of how to overcome the hazards and problems created by such a hostile environment, many valuable new technologies, products and procedures have been developed. Today, this expertise is improving our daily lives by providing many innovative solutions for products and services on Earth.

Groundbreaking European space technologies are becoming increasingly more available for development and licensing to the non-space industry through the process of technology transfer. The ESA Technology Transfer Programme has already achieved over 150 successful transfers or spin-offs from space to non-space sectors.

This success is reflected by the fact that since 1991 technology transfer has generated more than 20 million Euros in turnover for European space companies and 250 million Euros for the non-space industries involved. Already 2,500 jobs and 25 new companies have been created.

The ESA Technology Transfer Programme is carried out by a network of technology brokers across Europe and Canada. Their job is to identify technologies with potential for non-space applications on one side, and on the other side to detect the non-space technology needs. Subsequently, they market the technology and provide assistance in the transfer process.

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or visit the ESA Technology Transfer Website:

<http://www.esa.int/ttp>

or the ESA-supported technology market places:

<http://www.technology-forum.com>

and

<http://www.t4tech.com>

or look for textile-related examples at

<http://www.gzespace.com>

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