The synthesis of natural products and technology in automobile production dates back to the early years of the auto industry. Vehicle interiors were largely made up of components derived from natural, renewable resources until the 1950s when synthetic substances were first adopted. However, since the beginning of the 1990s there has been a swing back to natural materials.

driving back to nature

DaimlerChrysler is one of the key players in this trend. In international projects, scientists at the company's Production Engineering research department have identified meaningful ways to use natural fibers. In Belém in Brazil, for example, (see **p. 53**) coconut fibers are being made into car seats, while in Ulm, Germany (see **p. 58**) engineers are already testing the use of natural-fiber-reinforced plastics in vehicle exteriors.

A coconut on a bed of fibers

A coconut cut open

Coconut husks, washed and dried, await processing

the coconut and latex lifeline

A successful and sustainable way to use renewable resources from the rainforests of Brazil

Bounded by the Atlantic Ocean and the mighty waters of the Amazon, the Rio Pará and the Rio Tocantin, the island of Marajó in the Brazilian state of Pará is the largest river island in the world. Here, just a few kilometers south of the Equator, a rich and varied collection of tropical plants and animals thrives in the hot and humid Amazonian climate.

While the western part of the island is covered with rainforest, the land to the east is poor. Faced with soil exhausted after years of monoculture farming, the region's small farmers resorted to a policy of slash-and-burn or left the island in order to try their luck in the cities – often in vain.

"We really didn't have much choice here. We mostly grew coconut palms – real monoculture farming – and we had poor soil conditions to contend with, too. The contaminated drinking water from our wells caused lots of illness, especially among the children. We didn't even have electricity and lived from the meager earnings we got from selling fruit and coconuts at the market in Belém," recalls Henrique Tavares Gouveia, chairman of the small farmers' association in the community of Praia Grande on the eastern coast of Marajó. "At the time, I couldn't see any future for the place and was already thinking of moving to the city." If he and his family are still on the island, it is all thanks to POEMA.

POEMA stands for "Programma Pobreza e Meio Ambiente na Amazônia" – the Poverty and Environment in Amazonia Research and Development Program. At the beginning of the 1990s, the University of Pará launched POEMA on the island of Marajó with the aim of combining measures to protect the ecosystem of Amazonia with initiatives to combat poverty. The university's venture was supported by DaimlerChrysler AG, the local government and initially by UNICEF, too.

The partners in the project had set themselves some ambitious objectives: cleared land was to be reforested in order to permit a continuous yield all year round. And as the harvests were to be processed on the spot, affordable and appropriate equipment had to be acquired. The products had to be economically viable and have a guaranteed market.

The project bore fruit – quite literally. The dreary monoculture plantations have given way to mixed tropical forest whose coconut palms, rubber, cacao, banana, Brazilian chestnut trees and many other plants have enriched the soil. "In the past, a coconut palm might have borne about 40 coconuts a season. Today, we regularly pick more than 90," says Henrique Tavares Gouveia.

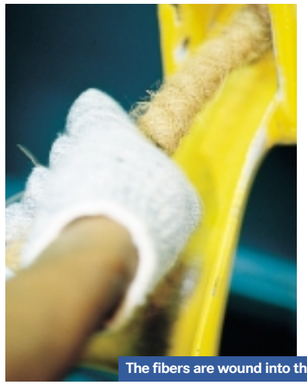
But there is more to POEMA's success than reforestation and greatly improved harvests. Research and the latest technology also play an essential role. For example, the "Production Technology" Department of DaimlerChrysler do Brasil works closely with DC teams from Ulm and Stuttgart to make valuable technical know-how available to POEMA. DaimlerChrysler also joined forces with the University of Pará to study renewable resources from the rainforest with a view to establishing their suitability for use in auto manufacturing or other sectors. The raw materials in question include fibers, plant oils, resins, dyes and rubber. In the case of Marajó, the researchers looked at the possibility of ...

Renewable resources: coconut fibers

Coconut fibers have been used in motor vehicles for more than sixty years – mainly in the interior trim and seat cushions. These strong fibers lend themselves to such applications as they are easy to produce and process and have an estimated service life of 90 years. Unlike plastic foam, they have good 'breathing' properties – a great advantage for vehicle seats in countries with hot climates like Brazil. Naturally resistant to mites and fungi, coconut fibers biodegrade with no adverse impact on the environment. Indeed, the remains of the fibers make an effective natural fertilizer.

In this hand-cranked sieve the useful fibers are separated from the fibrous waste which is used as fertilizer

Natural rubber is obtained by cutting into the bark of the giant "Samaumeira" trees



The fibers are wound into thick ropes in a spinning machine

Coconut fibers left to dry by a natural fiber supplier in Castanhal

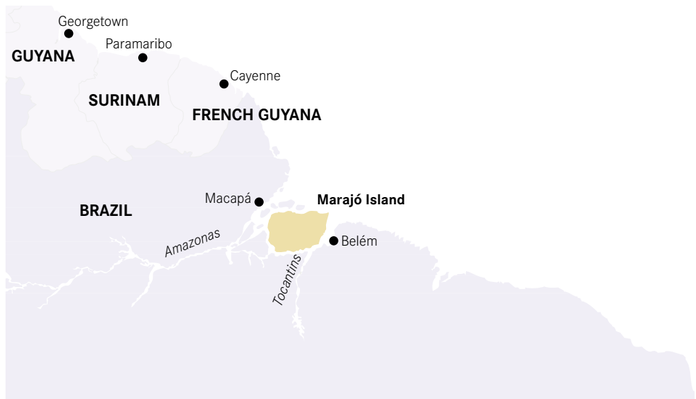
Processing the dry fibers

A bale of coconut fibers is pulled apart

Finished head restraints

Seats made of coconut fiber

The official opening of POEMAtec in Ananindeua, near Belém



Bounded by the Atlantic Ocean and the mighty waters of the Amazon, the Rio Pará and the Rio Tocantin, the island of Marajó in the Brazilian state of Pará is the largest river island in the world

... manufacturing auto accessories not only from coconut fibers but also from latex, another product indigenous to the island.

What began in Marajó in 1994 as a pilot project with a small, basic production facility, eight salaried employees, a workforce of 20 families and a monthly production capacity of 6,500 head restraints made from coconut fibers and latex, has now assumed completely different proportions: In the future, a modern factory equipped with the latest technology will produce a range of products from coconut fibers and latex.

March 7, 2001 saw the start of production at the "POEMAtec Fibras Naturais da Amazônia" (Amazonia natural fibers) company based in Ananindeua near Belém, the capital of the state of Pará. The organizations involved in setting up this new facility included the government of the state of Pará, the University of Pará and DaimlerChrysler. DaimlerChrysler made it possible for the company to purchase the latest production systems for processing natural fibers.

At present, 56 workers from Ananindeua produce seven tonnes of finished parts from natural fibers and latex every month. By the end of 2002, when POEMAtec expects to be working at full capacity, 150 workers will be producing 80 tonnes of natural products per month. In addition to seat cushions, backrests and head restraints for the automotive sector, the facility is also set to manufacture horticultural products as well as items for use in furniture production and the manual trades in the future.

During the start-up phase, DaimlerChrysler do Brasil, as POEMAtec's main customer, is taking up 60 percent of the company's initial production capacity. Inquiries have already been received from other potential customers.

Manfred Straub, purchasing manager at DaimlerChrysler do Brasil, has accompanied the POEMA project since the very start. **"The decisions we had to take weren't always easy. Mercedes-Benz is a brand which is synonymous with the highest quality – and that goes for the entire vehicle including the appointments. The communities on Marajó had to ensure that their products were up to our quality standards and delivered on time. Once the venture was up and running successfully, it was clear that the scale of production would have to be increased."**

Today, the "Pará Project" provides a regular income for some 5,200 people. It has played a decisive role in improving their living conditions and stands as an example of sustainable development: The targeted reforestation of areas which had been exhausted by a policy of slash-and-burn and monoculture farming has brought new life to deserted regions. The destruction of the rainforest has been halted and the people have been able to improve their standard of living by processing their region's products. DaimlerChrysler do Brasil and other companies are using natural materials which not only meet all their requirements but also biodegrade with no negative impact on the natural environment.

The production facility on Marajó, where everything began, has now stepped up its capacity thanks to an initiative by its own associates. But POEMAtec is not regarded as a competitor by the people of Marajó. Sales of head restraints and sun visors produced in Marajó have been secured in the long term thanks to a contract with DaimlerChrysler do Brasil. And, as Henrique Tavares Gouveia proudly adds: "Thanks to the support and wages we get from POEMA, we now have clean water which we pump to the surface with a windmill before it goes on to be filtered and purified using solar energy." When asked if he still sometimes thinks about leaving Marajó, he smiles contentedly and answers a heartfelt "no!"

Renewable resources: flax and hemp

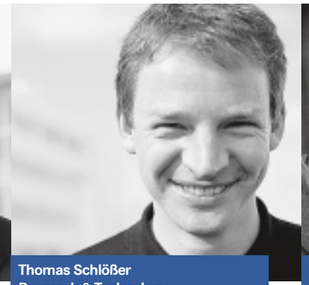
Cultivated for over 5,000 years, flax has long been used in the clothing and textile industries in the form of linen while flax fibers are also used as insulation material.
The cultivation of hemp has been authorized in Germany since 1996. The varieties concerned have a THC (tetrahydrocannabinol = cannabis) content of less than three percent and therefore have no narcotic effect.
Both plants are renewable resources and thus form part of a natural materials cycle. The high tensile strength of their fibers makes them ideal for reinforcing plastics. These indigenous fiber-plants also have a huge logistical advantage: as they are able to grow in central Europe, there is no need to transport them over long distances – a factor which helps the environment and also permits additional cost savings.

natural fibers replace glass fibers

It was a long uphill struggle but it was worth it: Natural fibers are now proving their worth at DaimlerChrysler in exterior vehicle components.


Diether Claus
Designer


Kolja Rebstock
Head of Production Engineering


Thomas Schlößer
Research & Technology


Hans Germar
Compenent supplier


Jürgen Knothe
Research & Technology


Underfloor protection for
EvoBus vehicles

Ecological materials are expensive and rarely satisfy high technical standards – a widespread prejudice which the team at DaimlerChrysler's Research and Production Technology Department in Ulm, Germany, is busy disproving. Their aim is to increase the proportion of ecologically compatible resources and easily recyclable materials derived from natural substances used in automaking while satisfying the industry's demanding technical and economic standards.

Since 1992, researchers Thomas Schlößer and Jürgen Knothe have been working with their colleagues on testing a compound of natural fibers and plastic (polyester resin) for use in exterior automotive components. **"When we're conducting research into a new material, our principal consideration is always its usability – and that's a factor which depends just as much on it having the appropriate technical properties and its financial viability as on its ecological compatibility,"** explains Jürgen Knothe. The members of the Ulm team see it as their mission to achieve a balance between the three all-important factors of technology, economy and ecology as this is the key to the successful implementation of the results of their research and development activities.

"As our aim is to increase the proportion of natural-fiber materials used in cars, we started looking at the exterior of the vehicle," says Thomas Schlösser, referring to a project which was to take the Ulm researchers into completely unknown territory.

It was a question of developing a natural-fiber reinforced material which would function not only as a protective cover, but would above all be able to resist aggressive external factors such as the effects of the weather or damage from stone chips. The team decided to start with a part of the vehicle exterior where fiber-reinforced materials were already being used and chose the underbody paneling.

In the past, underfloor encapsulation had always been made of plastic which was reinforced with glass-fiber mats to increase the strength and resistance of the material. Technically speaking, this combination represents an optimum solution – but in ecological terms, it is something of a problem. The residue produced when glass-fiber reinforced plastic is burnt is made up of large numbers of glass filaments which cannot be broken down using ecologically compatible methods. Furthermore, many physicians believe that the glass dust generated when processing the material causes allergies and irritates the skin.

Plastics reinforced with natural fibers, on the other hand, are harmless from both ecological and occupational health angles. When the natural fibers are burnt they release only the amount of carbon dioxide which the plant absorbed when it was growing. The result is a neutral CO_2 balance-sheet.

As the type of plastic used – polyester resin – leaves no environmentally harmful residues either, the combination of natural fibers and polyester resin is an outstanding solution from an ecological point of view – an opinion confirmed by Horst Wilde, Professor of Organic Chemistry at Leipzig University: "Natural-fiber reinforced polyester resin is the ideal choice for the automotive sector. Not only does it have the advantage of being ecologically harmless when disposed of – polyester resin releases only water and carbon dioxide when burnt – but it is also lighter than the other materials which could be used. This means that fuel consumption is reduced. And when the material is disposed of by incineration, the thermal energy released can be put to good use."

No problems with ecological compatibility here. The next challenge facing the DaimlerChrysler developers was to find the right compound of polyester resin and natural fibers which would satisfy two sets of requirements: the in-house delivery instructions and the DIN standards for tensile strength and impact resistance; no easy task, especially as the excellent durability and resilience of glass fibers make them a tough act to follow.

The compound of natural fibers and polyester resin had to be able to hold its own when compared with the mechanical characteristics of glass-fiber reinforced plastic with regard to factors such as elongation at tear, tensile strength, elasticity, combustion behavior and water absorption. After testing a large number of plants in order to determine the strength and general quality of their fibers, it was established that green flax and hemp were the best choices.

In a process similar to that used for glass fibers, the flax or hemp fibers are processed to form fiber mats. **A comparison of the Life-Cycle Assessments conducted for natural-fiber mats and glass-fiber mats shows that, from the production of the seeds/procurement of the raw materials to the production of the finished mat, the natural-fiber mats require roughly 83 percent less energy.** Furthermore, mats made from flax and hemp fibers can be as much as 40 percent cheaper to produce than their glass-fiber counterparts.

DaimlerChrysler suppliers take the finished natural-fiber mats and transform them into the required components. "Switching over from glass fibers to natural fibers caused no problems at all with the production equipment. We can use the same tools and machines and there are no additional costs involved," explains Hans Germar, whose company supplies DaimlerChrysler with the finished components.

Before being adopted for series production, the ecological underbody paneling was subjected to a number of functional tests which were often very time-consuming. It was only when they had passed these tests not once, not twice, but three times, that the components were deemed to be up to the job.

The natural-fiber reinforced underbody panels have been used in series production since the beginning of 2000. Diether Claus, a design engineer in the MultiClass Bus and Touring Coach department at DC subsidiary EvoBus, was involved in the development and testing of the natural-fiber reinforced encapsulation panels and was therefore able to see for himself just how well-suited they are to their purpose. "We succeeded in making three different underfloor encapsulation panels from natural-fiber reinforced plastic. Even though there are slight variations between vehicle models, the panels are still versatile enough to provide reliable protection for the engine, transmission and radiator," he says.

All new EvoBus model series which enter production from June 2001 will be equipped with protective encapsulation made from the environment-friendly compound of flax fibers and polyester resin. Some 10,000 of these new ecological components will be used each year.

Thus, the researchers in Ulm have taken another step towards a successful and harmonious combination of environmental, natural and technical factors. Projects of this kind require time, money and the will to make a lasting impact, but they demonstrate that, far from being incompatible, advanced technology and a regard for the natural world can form a meaningful synthesis which also makes sound financial sense.

"When we're conducting research into a new material, our principal consideration is always its usability – and that's a factor which depends just as much on it having the appropriate technical properties and its financial viability as on its ecological compatibility"

A bale of flax