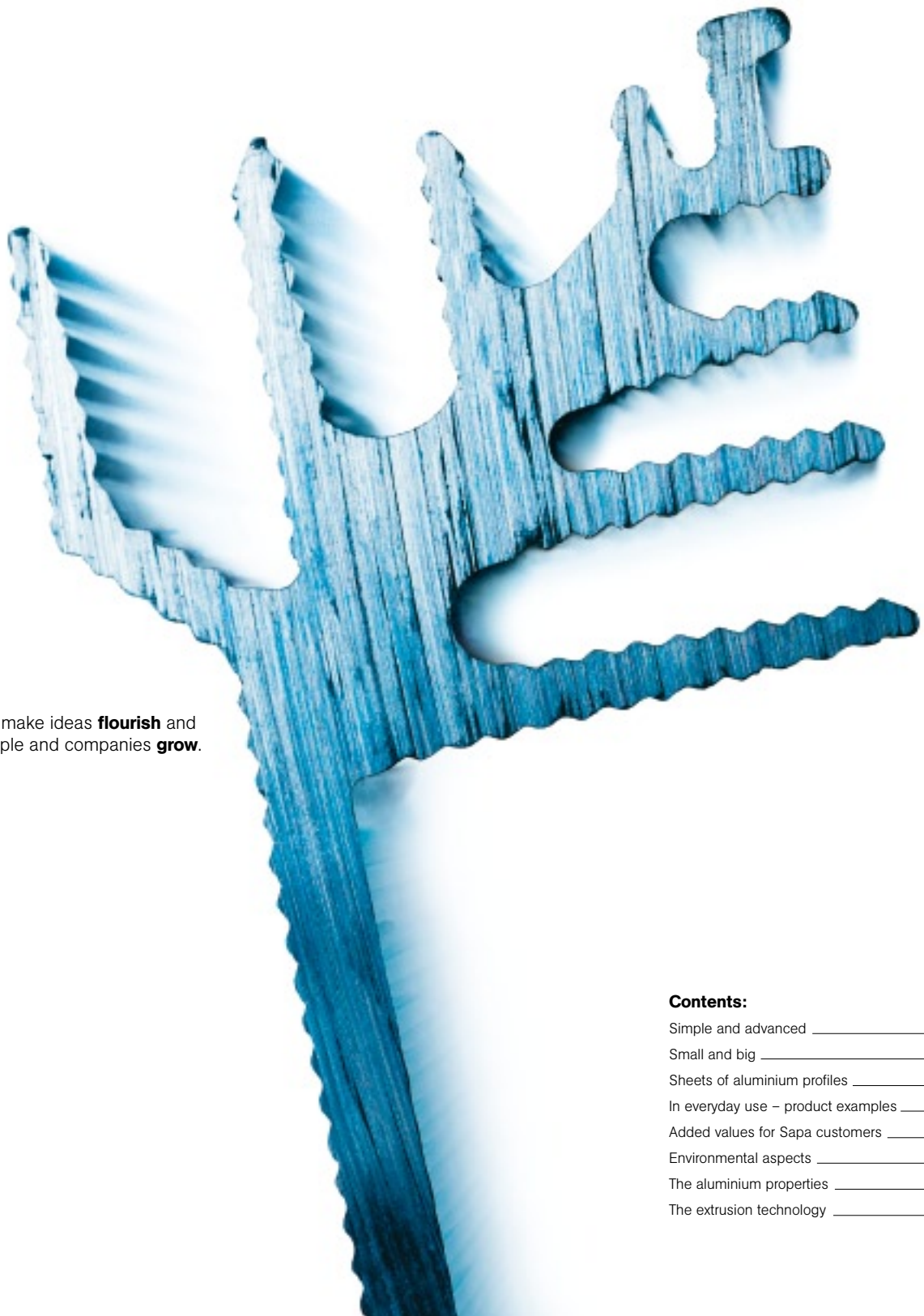


The image features a white background with several large, semi-transparent blue gear shapes. One gear is in the top left corner, another is in the bottom right corner, and a third is partially visible on the left side. The Sapa logo is in the top right corner.

**sapa:**

A **unique profile** will improve  
your prospects of success

Sapa Profiles: Our **combined  
resources** at your disposal



We make ideas **flourish** and  
people and companies **grow**.

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## **Aluminium profiles** do not recognise borders; neither does Sapa

What is the difference between a German and a French aluminium profile, between a Polish and a Swedish designer using aluminium profiles, between a profile-based product manufactured in for example Italy, Holland, Denmark or the UK?

Aluminium profiles do not recognise borders; neither does Sapa. This means that our **combined production resources** and **expertise** are available for **any customer** in **any country**.

With footprints in Europe, North and Central America and Asia we are the world's leading manufacturer of aluminium profiles and can serve customers on a worldwide basis.

We have production and sales in Belgium, China, Denmark, France, Germany, Hungary, Italy, Lithuania, Mexico, the Netherlands, Poland, Portugal, Romania, Slovakia, Spain, Sweden, the United Kingdom and the United States, as well as a sales presence in a number of additional countries.

Sapa Profiles also includes separate key account organisations for the three business segments Sapa Automotive, Sapa Mass Transportation and Sapa TeleCom. These segments coordinate the Group's resources to optimally meet the requirements of customers in the automotive, rail, marine and telecom industries.

We see it as our task to find new applications for aluminium extrusions, and to develop and refine today's designs. We do so in close cooperation with people who like to see their ideas flourish and their market shares grow.

The ways and means we use are a massive bank of know-how and experience, technical resources and motivated staff.

Our aim is to create long-term business relations, with mutual profitability as the overall objective.

This is a language understood everywhere.

# We make them **simple**

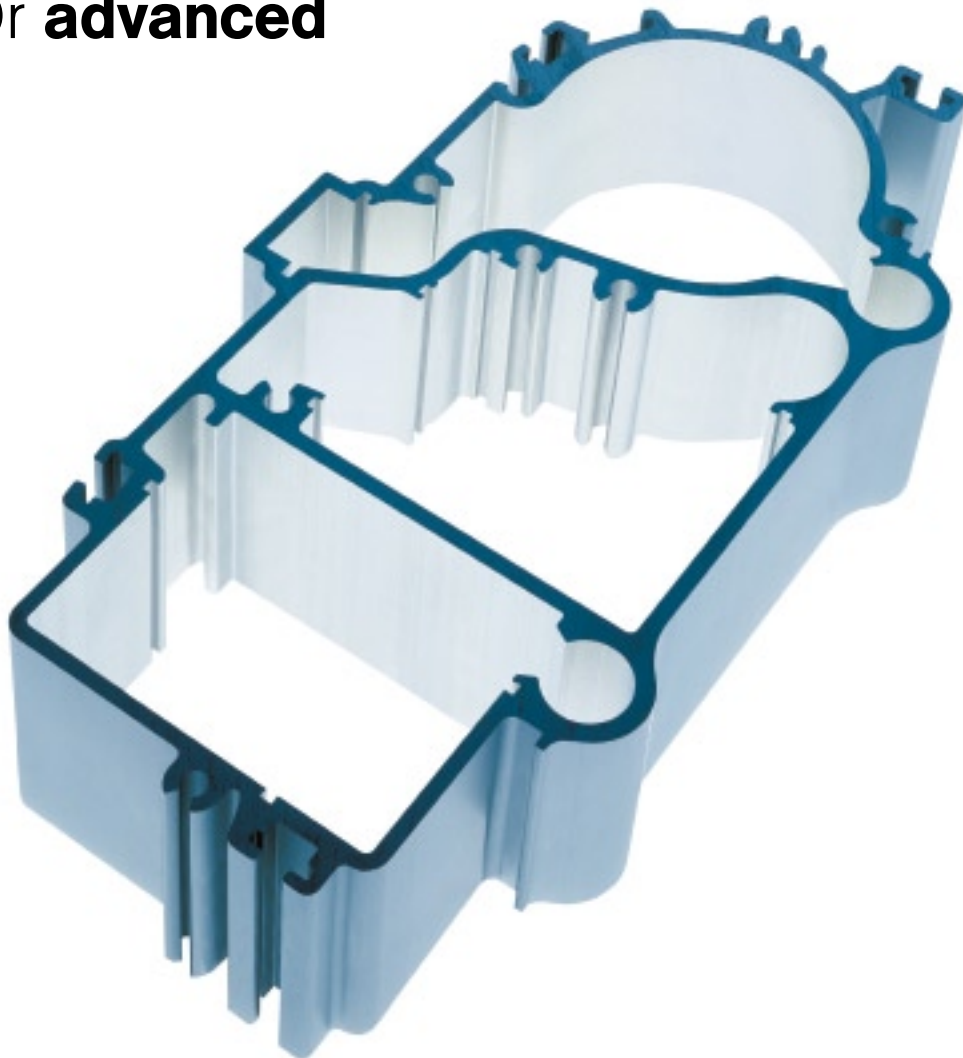


There is a simple solution to almost any design problem: aluminium profiles.

Sometimes a standard profile meets the demands. But there are always grounds for asking: What will the profile be used for? Can production be simplified? Can the end product be made more competitive? Can manufacturing costs be reduced?

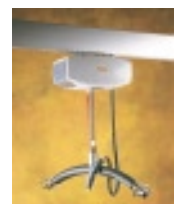
This is the kind of question we ask at Sapa. The answers are based on our unique experience. We extruded our first profile back in 1963.

Or **advanced**



The aluminium profile above is part of the GH2 ceiling-mounted lift produced by Guldman A/S in Denmark. The lift facilitates the safe handling of patients.

The profile is 284 mm wide and has three compartments for housing the lift motor and batteries. Once the profile has been extruded, the only machining required is cutting to length and the milling of holes.



A close look at a design will often reveal that a small aluminium profile is a vital part. More and more constructors and designers are realising the advantages of extrusion – the freedom it gives them to create precisely the shape that solves the problem, and achieve low tooling costs, easy machining, etc. It is all in your hands.



We make them **small**



A hand is shown holding a large, complex aluminum extrusion profile. The profile is light gray and has a multi-chambered, triangular cross-section. The chambers are dark, and the profile has a textured surface. The hand is positioned on the right side, gripping the profile. The background is white.

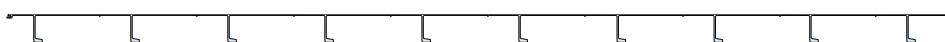
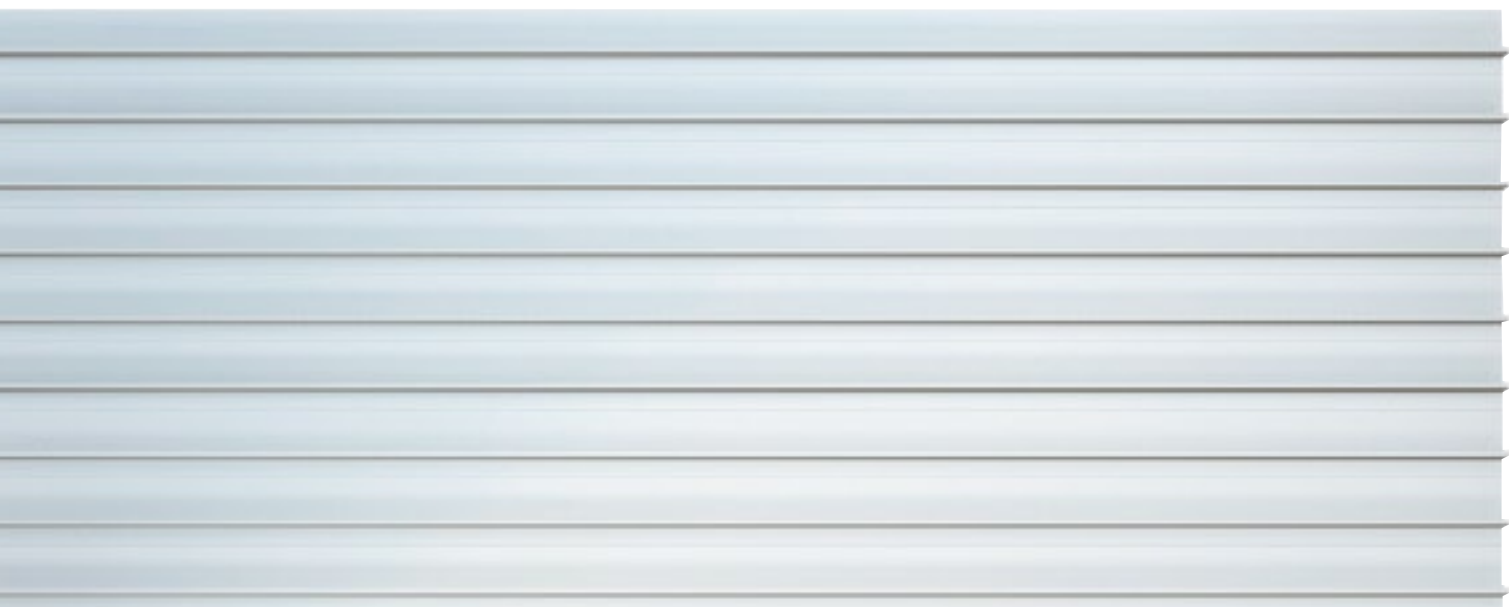
Or **big**

Size: 480 by 245 mm. Weight: 38 kg/m. This huge profile is used in all four- and six-car lightweight trains for the Dutch Railways (NS). For this project, a joint venture between **Siemens** and **Bombardier**, Sapa supplies nearly all the extrusions for the car body-structure, sidewalls, roofs, floors, crossbeams, crash boxes etc. This particular profile is one of the most heavily stressed profiles of the train, as it passes on all the loads from the car body to the wheel suspension.

And even **bigger**



Sapa can join extrusions to panels with a width of up to 3,000 mm in lengths as requested by the customers.



Prefabricated panels: We start with wide profiles. Using Friction Stir Welding rather than traditional fusion welding to join them together gives a number of benefits such as increased flatness and straightness. Strength is also increased. The FSW weld is homogenous and void-free with no oxide inclusions.

When Sapa supplies finished FSW panels the result is a reduction in costs. This is thanks to less welding in the customer's production, less materials handling, shorter throughput times and optimised dimensional tolerances. (Read more about FSW on page 17.)

Aluminium combines low weight and high tensile strength. In this cruise ship, built by **Fincantieri-Cantieri Navali Italiani**, the panels are used in the upper decks to lower the ship's centre of gravity.



## Aluminium

instead of steel, copper, plastics, wood, etc.

## Extrusion

instead of casting, injection moulding, etc.



Hatches for the toughest conditions and the most demanding customers. **Lewmar** makes use of the strength, formability and corrosion resistance of the aluminium profile.



You find pillars from **Tally Key** at camping grounds and marinas. They supply water and electricity, and light at the top. The profiles neatly hide and protect electronics and mechanical parts, and feature a number of integrated functions such as screw ports and channels.



The Banco Comercial Português resides in an intelligent building at **Tagus Park**, a science and technology park in the Lisbon metropolitan area. The sun breakers are a typical example of this intelligence. The aluminium profiles, developed by Sapa, save energy by regulating the indoor climate. The engine controlled aluminium blades also protect the facade against erosive rain, sun and wind.

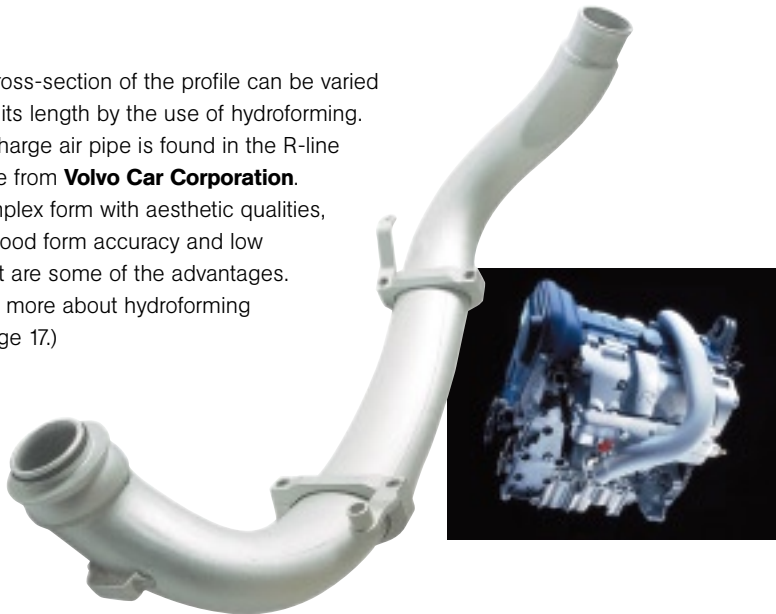
Corrosion resistance means **long** life and **low** maintenance costs.

You have chosen aluminium profiles for your design. **Why?**



**Mikael Ströberg**, technical designer at AudicomPendax: "Aluminium raises the status of the product, and extrusion technology gives me the ability to integrate smart solutions such as snap-fit joints and fastening slots. I have a close and rewarding relationship with Sapa's technicians. They bring valuable know-how to our company – and make us more competitive."

The cross-section of the profile can be varied along its length by the use of hydroforming. This charge air pipe is found in the R-line engine from **Volvo Car Corporation**. A complex form with aesthetic qualities, very good form accuracy and low weight are some of the advantages. (Read more about hydroforming on page 17.)



The London Tube system gets a more modern look. **Bombardier Transportation** is responsible for the Victoria Line Upgrade. Sapa is delivering complete body sides for 376 carriages. The sides consist of six profiles, each one about 350 mm wide, that are joined to create a seamless panel using Friction Stir Welding. (Read more about FSW on page 17.)

The tolerances are tight and the standard of surface finish is high. Sapa is managing all aspects of fabrication, including polishing of welded joints and drilling for windows and fittings.



The modern office often has walls of glass, or no walls at all. So how do you provide a good surface for projecting presentations? And what about storage space? Where do you keep the whiteboard? The solution from **AudicomPendax** was floor-to-ceiling pillars with a hollow core profile and semicircular "cover" profiles.



The Queen Mary cruise liner is powered by four engines with a total output of 157,000 horsepower. **Wärtsilä** builds complete drive systems for ships. Sapa supplies around 50 different profiles for diverse engine components, including a 160-kilogram beam – a single aluminium profile that is machined to create 200 holes.





In this design from **Seldén Mast** the headsail is furled around the forestay. The forestay profile (see picture) has a number of integrated functions. This demanding solution is made possible by the formability and strength of aluminium and the extrusion expertise of Sapa.

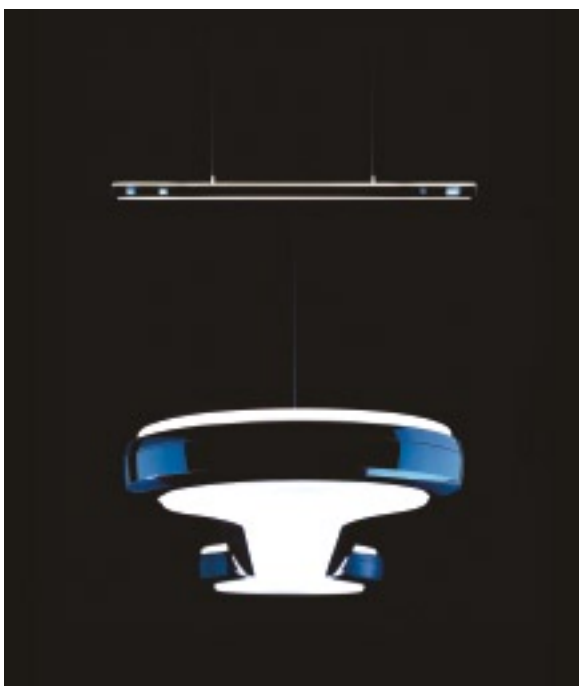
Cost **effective** production:  
Several functions can be integrated into a profile.



Two chairs from **Blå Station**: Gecco (above), which uses two profiles – for the seat and footrest. And Sting (below), which uses two profiles for the seat and back. Both are joined without screws or welding. Sapa cuts, polishes, anodises or paints and assembles the parts.

Sting is exhibited in the Swedish National Museum and has received the Red Dot Design Award for "Best of the Best".

Designers: Fredrik Mattson and Stefan Borselius.



Orosso from **Fagerhult**. Straight and round fluorescent tubes in a single light fitting create a new, organic form. The straight sections are profiles with details that make assembly easier, such as screw ports and channels. The profiles also house transformers and other components.





**Heat sink profile** for a base radio station. Profiles have found many applications in the telecom industry. One of the reasons is that aluminium has excellent thermal conductivity, and the addition of flanges to a profile greatly increases the cooling area.



FrontLine service poles from **Thorsman**. A new concept to create the flexible office. The pole supplies each workplace with connections for electricity and communication.

You have chosen aluminium profiles for your design. **Why?**



**Johan Lindau**, Blå Station: "Products like Sting and Gecco wouldn't be possible without a producer who shares the designers' vision. We choose to support young and innovative designers. They are attracted by the unique possibilities of extrusion technology and the aesthetic values that the metal offers."

The formability, ease of machining, and jointing techniques always give major **economic benefits** in production.

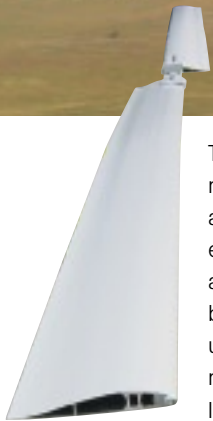


Headquarters of **OCMW Brugge**, in Brygge, Belgium. Architect: Archinovo. Aluminium profiles from Sapa used by Sapa Building System.

Aluminium profiles  
combine  
low weight  
with high  
strength.



Aluminium profiles give engineers and designers great opportunities to experiment with shape and expression. Tooling costs are reasonable and there are few technical limitations. Sapa supplies anodised aluminium profiles that are ready to fit to **Nespresso** espresso makers.



Taking off with an MT-03 autogyro. The gyrocopter, manufactured by **AutoGyro** in Hildesheim, Germany, is a rotating-wing aircraft. It is something like a helicopter, except that its rotor is not driven by a motor but by the airstream itself. The challenges of designing the rotor blade and its attachment point are many: the 1.1 mm ultra-thin wall and its acutely asymmetric cross-section must remain as straight as possible for their entire length and resist even the smallest degree of torsion. The rotor is 8 metres in diameter and each individual profile is 4 metres long.



**The Louvre Pyramid** is a modern structure in historic surroundings. Architect Ieoh Ming Pei: "That space must have volume, it must have light." He chose the pyramid form and based its proportions on the classic Egyptian pyramid at Giza. The glazing system with aluminium profiles ensures that the pyramid is preserved for future generations.



The door beam on Volvo's new C70 sports cabriolet was too heavy and did not meet safety requirements. Time was short when **Volvo** contacted Sapa. A hydroformed aluminium beam had to be designed, tested and manufactured in just over six months. An intense period of collaboration followed. The deadline was met, and so were quality and safety requirements.

Read more about hydroforming on page 17.



You have chosen aluminium profiles for your design. **Why?**



**Jacco Zwart**, Armada Outdoor: "Two main reasons: You can achieve ingenious solutions with aluminium profiles particularly as regards jointing. Aluminium is well suited for outdoor projects, where high strength and corrosion resistance are essential. And the anti graffiti coating contributes to a long aesthetic lifetime."

**Salomon** is a major supplier to the alpine world elite. In their most advanced skis there is a Sapa aluminium profile as an intermediary between the ski and the binding. The profile helps to absorb forces between the foot and the ski.



Wooden décor is frequently in demand for use on board ships. The disadvantages are the flammability of wood and the problems of cracking and rot. On the luxury cruise ship **Carnival Legend**, **Merima Oy** has used curved frame aluminium profiles with the look of solid wood and the properties of aluminium. Method: Decoral, a development of powder coating that gives patterned surfaces. (Read more about Decoral on page 17.)

Holland is a cycling nation. In order to reach more passengers, the Dutch Railways started a project to improve the bicycle parking facilities around the railway stations. **Armada Outdoor** made the winning concept – a new type of bicycle shelter. Sapa took an active part in the development and engineering phase of the project and is now a logistic partner in the material flow and stock management on a daily basis.



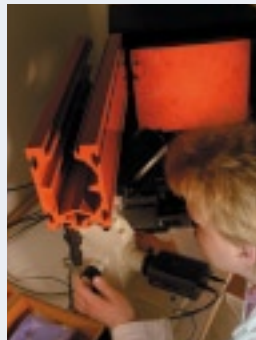
# Added values



## Cutting to length and tumbling

The cutting speeds attainable with aluminium are far higher than those with steel. Saws especially designed for cutting aluminium can cut the work piece so neatly that, for most purposes, there is no need for further processing of the cut.

Tumbling: Used mainly for deburring. Produces different surfaces depending on the time and tumbling medium.



## High-speed machining

Sapa is well equipped in this field with a number of CNC machining centres. The dynamics of the machines have been significantly improved and they have considerably more efficient control systems than conventional machines.

Cutting speeds of 3,500 m per minute and above allow feed speeds to be increased. As a result, machining times are reduced. The high speed also reduces burr formation and increase tool service life.



## Bending

From simple to advanced bending and from short to long production runs. Methods: pull bending, roll bending, stretch bending and press bending.



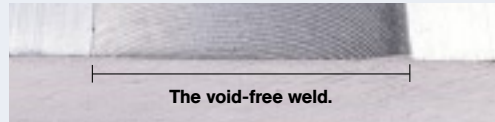
## Fusion welding

Aluminium is eminently suitable for welding. MIG and TIG are the dominant methods. FSW (see next page), bonding and taping are other thoroughly proven methods of jointing.



## Turnkey solutions

Sapa can accept responsibility for the entire production chain. As in the case of this customer, the work done by Sapa can include anything from extrusion to the purchasing of additional materials, assembly, packaging and distribution to dealers.



## Friction Stir Welding

The process: A rotating tool is pressed into the metal and moved along the line of the joint. No filler metals or shielding gases are used.

FSW exploits aluminium's ability to withstand extreme plastic deformation at temperatures that are high, but not above the melting point. In FSW, the clean metal surfaces of the profiles that are to be joined are heated by friction generated by a rotating tool and pressed together at very high pressures. This forms a new, homogeneous structure.

Compared with fusion welding, FSW gives:

- Increased strength.
- Increased leakproofness – entirely void-free, impermeable joints of a higher strength than fusion welded joints.
- Joints that are, in principle, flush with the surface.
- Reduced thermal deformation – only low thermal stress in the material, hence the flat surfaces.
- Increased repeatability – production has few variables and these are easily controlled; the result is tight tolerances.

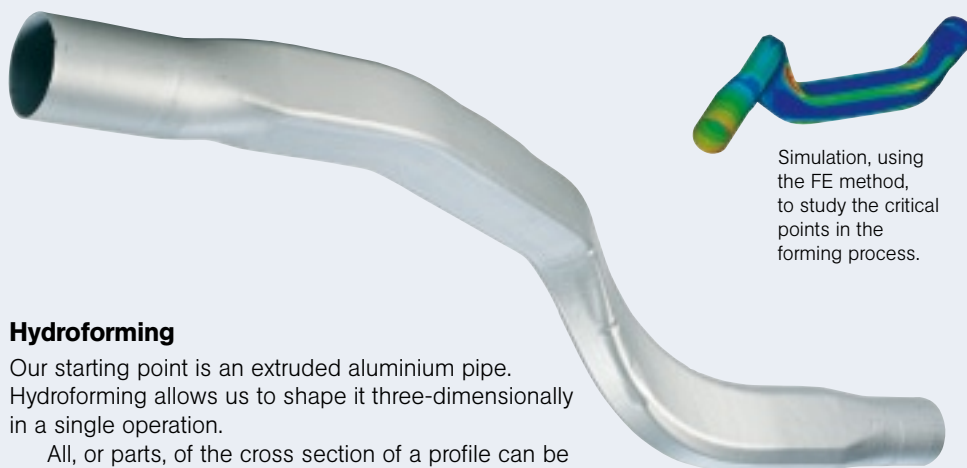
FSW is an established technology. Sapa started series production using FSW in 1996.

**How** can an in-depth partnership with Sapa increase a company's competitiveness?



**Jari Anttila**, Manager Hull Design and Manufacture, Kvaerner Masa-Yards, Turku Shipyard, about FSW:

"The most important gain for us is the fact that the panels are considerably more level and straighter than fusion welded profiles, and that the tolerances are closer. This means we get a more efficient production."



Simulation, using the FE method, to study the critical points in the forming process.

## Hydroforming

Our starting point is an extruded aluminium pipe. Hydroforming allows us to shape it three-dimensionally in a single operation.

All, or parts, of the cross section of a profile can be tailored using hydroforming. In a single operation, complex parts can be created with very good dimensional accuracy. It is also possible to make local changes such as domes or holes. By eliminating several machining operations, lead times can be shortened.

The principle: The profile is placed in a die that has an inner geometry exactly replicating the shape of the finished component. The die is locked securely in position and hydrostatic pressure is then set up in the pipe (profile). As the profile is pressed against the die, it takes up the shape of the die.

In the autumn of 2001, Sapa began series deliveries to Volvo. Today, Sapa has world-leading and unique expertise and experience in the hydroforming of long aluminium beams.

The shaped component. Note the cross-sectional changes throughout its length.

# Added: surfaces

## Anodising

Anodising is used to (amongst other things):

- maintain a product's "as-new" appearance.
- enhance corrosion resistance.
- create a dirt repellent surface that satisfies stringent hygiene requirements.
- create a decorative surface with durable colour and gloss.
- create a "touch-friendly" surface.
- create abrasion-resistant surfaces.
- give surfaces an electrically insulating coating.

The most frequent type of anodising is natural anodising. Sapa also supplies profiles with coloured oxide layers. This includes pigments and techniques that provide very good lightfastness, suitable for outdoor use.



Vertical anodising line.

## Painting

Broadly speaking, there are absolutely no limits to the choice of colour. Besides the RAL and NCS S colour systems, we also work to customers' own colour definitions.

**Powder coating** is the dominant method of painting aluminium extrusions. The prime qualities of powder coating and powder coats are:

- No risk of running or blistering.
- High repeatability.
- Powder coatings withstand knocks and abrasion far better than wet paint coatings.
- Good formability (e.g. can be formed after coating).
- Suitable for outdoor use (good resistance to UV and corrosion).

**Wet painting:** Sapa uses many different types of paint and can, of course, offer water-based paints.

Sapa has a number of anodising and powder coating plants, each of them specialising in different products. The pictures show vertical lines – profiles up to 7 metres long are suspended vertically rather than horizontally, thereby giving a manifold increase in capacity.



Vertical powder coating line.

**How** can an in-depth partnership with Sapa increase a company's competitiveness?

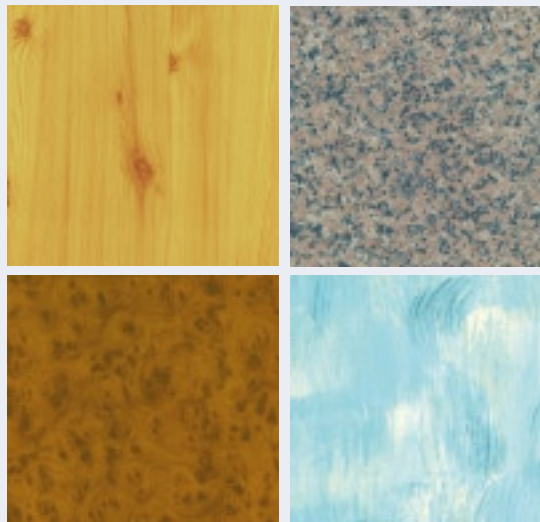
### Decoral

Decoral is a development of powder coating that gives patterned surfaces.

The technique: A special composition powder coating is first applied. The pattern is then transferred to the profile. The original pattern, most usually a photographic image of wood or stone, is copied onto a film that holds the pigments forming the decorative design.

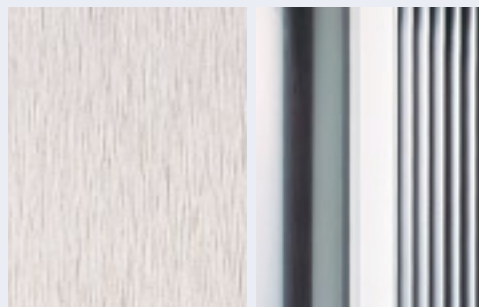
The depth of penetration is crucial for the results – a shallow pattern is subject to comparatively large stresses. The Decoral technique ensures deep penetration. The result is a surface with all the properties of a traditional powder coating.

Without being any thicker than normal powder coatings, Decoral can add the look of solid wood to a profile's durability, "create" marble with the same density as aluminium... When it comes to patterns and colours, there are no limitations.



Example patterns – choose from a wide range, or create your own.

### Improving surface quality



Grinding is one of the methods. The resultant surface can be "very fine", "medium" or "coarse".

Polishing smooths the surface. To achieve a high-gloss finish, polishing is followed by bright anodising.



**Lennart Lindeberg**, Proton Caretec, about the company's bed for home care, E-bed: "Sapa supplies a product ready for assembly. We can streamline our organisation, increase our flexibility and production resources, and gain access to unique know-how."



### Sapa HM White

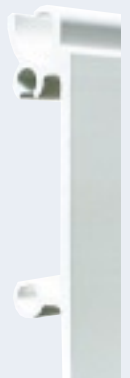
Sapa HM-white is produced by electrophoresis (Honnystone Method). Using direct current, the paint is applied on the surface and in the anodising layer.

This method offers a UV-resistant white with a range of advantages, including:

- Very good gloss retention,
- resistance to chemicals,
- corrosion resistance and
- adhesion.

The values for hardness, impact and abrasion resistance are almost identical to those for powder coatings.

No build-up of coating at the edges. This is perfect for structural profiles that have to be mated with each other and for snap-fit and telescopic designs.





All life on Earth is adapted to its presence – aluminium has always been a natural part of the environment. An ordinary brick wall contains 10-20 kg of aluminium per square metre. One square metre of ordinary aluminium sheet for wall cladding weighs around 2 kg.

# A better world from an **environmental** point of view

## **Aluminium – the “green” metal**

Around 8 % of the Earth’s crust consists of aluminium in the form of different minerals. So aluminium is one of the few metals for which the availability of raw materials is literally unlimited.

The material properties of aluminium (see next page) contribute to low environmental loading – in our production, in your production, and at the end user.

Recycling: Aluminium can be reused for the same purposes over and over again. Unlike many other materials, aluminium does not lose its unique properties. Furthermore, recycling requires only 5 % of the original energy input.

## **Profiles – for “green” design**

The extrusion technique has few limitations. You can incorporate a number of functions into the section – to make the extrusion simpler to machine and simpler to install. You can save metal by placing most of it where it is needed most, and thus reduce the weight of the structure.

The tool cost is reasonable. So you can easily and quickly produce prototypes in which your design features can be tested and refined.

## **Sapa – for “green” cooperation**

Cooperation with Sapa offers great scope for reducing the impact on our environment. This is achieved by the properties of aluminium, by the opportunities that extrusions have to offer, and by environment conservation work at Sapa.

In addition, Sapa can carry out all further processing. This offers substantial logistics benefits and reduced environmental loading.

We will naturally be glad to provide detailed information on our production and the environmental measures we have taken. You are welcome to contact us to gain a deeper insight into the way aluminium, extrusions and Sapa work in harmony to benefit the environment.



# The **properties** of aluminium

## **Weight**

With a density of 2.7 g/cm<sup>3</sup>, aluminium is approximately one third as dense as steel.

## **Strength**

Aluminium alloys commonly have tensile strengths of between 70 and 700 MPa. The range for alloys used in extrusion is 150 – 300 MPa.

Unlike most steel grades, aluminium does not become brittle at low temperatures. Instead, its strength increases.

At high temperatures, aluminium's strength decreases. At temperatures continuously above 100°C, strength is affected to the extent that the weakening must be taken into account.

## **Linear expansion**

Compared with other metals, aluminium has a relatively large coefficient of linear expansion. This has to be taken into account in some designs.

## **Malleability**

Aluminium's superior malleability is essential for extrusion. With the metal either hot or cold, this property is also exploited in the rolling of strips and foils, as well as in bending and other forming operations.

## **Machining**

Aluminium is easily worked using most machining methods – milling, drilling, cutting, punching, bending, etc. Furthermore, the energy input during machining is low.

## **Joining**

Features facilitating easy joining are often incorporated into profile design. Fusion welding, Friction Stir Welding, bonding and taping are also used for joining.

## **Conductivity**

Aluminium is an excellent conductor of heat and electricity. An aluminium conductor weighs approximately half as much as a copper conductor having the same conductivity.

## **Reflectivity**

Aluminium is a good reflector of both visible light and radiated heat.

## **Screening – EMC**

Tight aluminium boxes can effectively exclude or screen off electromagnetic radiation. The better the conductivity of a material, the better the shielding qualities.

## **Corrosion resistance**

Aluminium reacts with the oxygen in the air to form an extremely thin layer of oxide. Though it is only some hundredths of a µm thick (1 µm is one thousandth of a millimetre), this layer is dense and provides excellent corrosion protection. The layer is self-repairing if damaged.

Anodising increases the thickness of the oxide layer and thus improves the strength of the natural corrosion protection. Where aluminium is used outdoors, thicknesses of between 15 and 25 µm (depending on wear and risk of corrosion) are common.

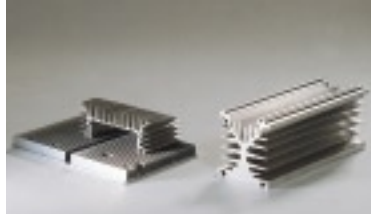
Aluminium is extremely durable in neutral and slightly acid environments. In environments characterised by high acidity or high basicity, corrosion is rapid.

## **Non-magnetic material**

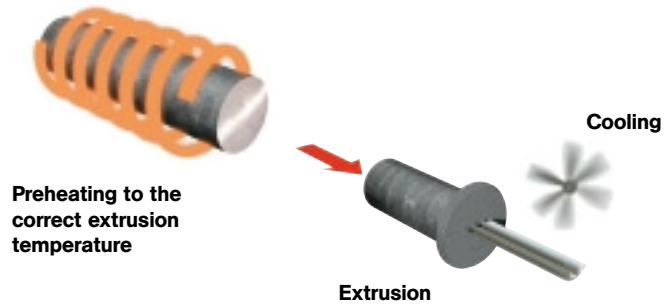
Aluminium is a non-magnetic (actually paramagnetic) material. To avoid interference of magnetic fields aluminium is often used in magnet X-ray devices.

## **Zero toxicity**

After oxygen and silicon, aluminium is the most common element in the Earth's crust. Aluminium compounds also occur naturally in our food.



# The **extrusion** technology



**Extrusion:** A preheated aluminium billet is forced through a die, the profile emerging rather like toothpaste from a tube. The shape of the profile is determined by the shape of the hole in the die.  
The profile's length is normally between 25 and 45 metres. Cooling in air or water commences immediately the profile leaves the die.



**After cooling**, the profile is stretched. This is both to relieve any stress and to give the profile the desired straightness. At the same time, all functionally important dimensions and surface quality are checked. The profile is then cut to a suitable length or to the exact length requested by the customer.

The final strength of the material is controlled through natural or artificial ageing.

