The Paperboard Product
Paper manufacturing has a very long tradition. Historical sources reveal that paper based on cellulose fibres from flax, cotton and other plants was first made in China around the year 105 AD.

Over the centuries since then, different raw materials have been used to produce paper. The Industrial Revolution transformed paper production from laborious manual operations, one sheet at a time, into a large-scale, computerised and efficient process.

The basic principles of paper and paperboard manufacture, however, are still the same today. Cellulose fibres are separated out from natural, renewable raw materials. The process still begins with a very dilute suspension of fibres in water. Most of the water is then removed by drainage and drying. A sheet of paper is still composed of a fine network of cellulose fibres.

It is no great step from paper to paperboard. There are two types of paperboard: single ply and multi-ply. For quality reasons paperboard is usually constructed in several layers, created by repeat applications of the dilute fibre suspension. This multi-layered material is widely used in packaging products and graphical applications.
Since the mid-19th century the primary source of cellulose fibre has been wood. The fibre is separated by either chemical or mechanical means from naturally occurring species. In the case of Iggesund these species are spruce, pine and birch from managed forests in Scandinavia and elsewhere in Europe. Such forests are maintained and expanded by the industries that rely on good access to timber. As a result of these efforts the stock of growing trees is increasing every year. In many areas growth now exceeds the amount of timber that is harvested.

This careful forest management ensures that even in the future the forests will form part of the sustainable cycle of nature and be a permanent source of raw materials.

The fibres in a tree trunk run parallel to its length. The fibres’ own length varies according to the tree species but in general the length is greater than the width. The relationship is indicated by the following table.

<table>
<thead>
<tr>
<th>Species</th>
<th>Fibre length mm</th>
<th>Fibre width μm</th>
<th>Shape</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spruce</td>
<td>3.1 – 3.5</td>
<td>19 – 50</td>
<td>Ribbon flat</td>
</tr>
<tr>
<td>Pine</td>
<td>2.0 – 3.0</td>
<td>22 – 50</td>
<td>Ribbon flat</td>
</tr>
<tr>
<td>Birch</td>
<td>0.9 – 1.2</td>
<td>20 – 35</td>
<td>Cylindrical with pointed</td>
</tr>
</tbody>
</table>

Spruce fibre – long and flat  
Birch fibre – short and cylindrical  
Pine fibre – long and flat  
Mixed fibres of spruce, pine and birch

Cellulose and the Laws of Nature

Carbon dioxide and water are converted into simple glucose-based sugars by the action of sunlight on the green chlorophyll-containing cells of the plant kingdom. This process is known as photosynthesis and is accompanied by the emission of oxygen. The natural sugars can be polymerised in plants to produce cellulose.
Cellulose has a high molecular weight and a straight-chained molecular structure. Plants use cellulose to grow by constructing cells – what we call fibres – and other structures which support the life of the plant. Each species has its own characteristic fibrous structure. Many tree species have been cultivated and developed over time into a renewable source of raw materials for the production of a wide range of paper and paperboard products. Careful forest management and the manufacture of paper products are therefore closely linked.

Cellulose constitutes around 44% of the composition of wood fibre. Pure cellulose fibres are soft, flexible and white. The other constituents are hemicelluloses, lignin and extractives. Hemicelluloses are a group of substances related to cellulose but have lower molecular weight and a more complicated chain structure. Lignin is a more complex polymer and very different from cellulose. It is hard and brittle. Both hemicelluloses and lignin occur in the fibre but the main concentration of lignin is between the fibres, giving adhesion and rigidity to the structure of wood.

The process of fibre separation, or pulping, takes advantage of the differences between lignin and cellulose.

More Laws of Nature

There are natural properties which all wood fibres have to a greater or lesser degree as well as specific properties associated with the fibres of particular tree species. Fibre characteristics are also influenced by the method of pulping that is used.

The general properties are:

- the ability of fibres to grip each other and bond into a strong, homogeneous structure
- flexibility, shape and dimensional properties which enable fibres to form a uniform interlaced network
- the capacity of the fibres to be favourably modified, mechanically or by using additives, during the production process.

Choices of Raw Material

Types of Fibre

Basically this choice is between long fibres (spruce/pine) and short fibres (birch). The board maker carefully selects and blends different fibres to achieve the appearance and functional properties desired for specific products.

Types of Pulp

There are three different fibre separation processes, which all produce different kinds of pulp: mechanical, chemical, and recycled fibre.
The Paperboard Product

Mechanical
This process gives a very high yield of fibre from the timber. The presence of lignin in the pulp makes the fibres hard and rigid. This produces a paperboard with high stiffness, limited strength, low density and lower resilience. Mechanically separated virgin fibre pulp containing lignin reacts more strongly to changes in external environment, humidity and temperature, something that can have a negative effect on flatness and dimensional stability.

As a result, paperboard made solely from mechanical pulp is relatively weak. The paperboard retains the yellowish colour of the wood used and it is pure because it is made solely of natural and known raw materials.

Chemical
This process preserves the length of the virgin fibre. The pure cellulose extracted has a high degree of consolidation. Both of these features produce a very strong paperboard sheet.

The fibre is flexible and soft, giving good creasing, embossing, and die-cutting properties and low dust generation. Bleached cellulose pulp has high whiteness, brightness and light stability. Paperboard made of virgin fibre pulp has the highest possible purity and provides packaged products with the best odour and taste protection.

Recycled
This separation and recycling process utilises a wide variety of waste paper and board. Each time a fibre is recycled it is contaminated and shortened and its capacity for consolidation is reduced. This means that virgin fibre must be added to maintain the quality of recycled pulp. Recycled pulp is carefully cleaned and screened during stock preparation. Mixed waste paper is not usually de-inked for paperboard manufacture and hence the pulp may retain traces of inks, adhesives and other residues which together give this kind of paperboard a grey colouration.

The resulting product has less predictable composition and poorer functional properties than virgin fibre-based boards. Read more about recycled fibre pulp in the Paperboard Manual.

Paperboard Manufacture
In addition to the types of fibres and pulp, the construction and coating of the paperboard sheet also affects the paperboard’s final properties. By selecting and combining types of fibres, the pulp preparation process, sheet construction and coating, the paperboard gains the final properties needed to meet a wide variety of market demands.

Coating
Top ply
Centre ply
Bottom ply

Foldability comparison between single ply and multi-ply paperboard
Multi-ply Paperboards

By creating several layers of pulp in the wet state the paperboard manufacturer can combine the advantages of different types of pulp in a single kind of paperboard. Even if the same kind of pulp is used in each layer, the separate layers are treated and shaped individually so as to achieve the best possible quality. Multi-ply construction offers benefits, e.g. in creasing and folding performance.

Coating

White-pigmented coatings, usually based on china clay or calcium carbonate, are applied in one, two or even three layers to either the top or both sides of the paperboard to improve whiteness, smoothness and gloss. This achieves the desired printing and varnishing properties.

Types of Paperboard

This section describes the most common types of paperboard.

Solid Bleached Board (SBB, GZ)

Solid Bleached Board (SBB) is made exclusively from bleached chemical pulp. The term SBS (Solid Bleached Sulphate) is sometimes used to describe this product. It usually has a coated top surface and some grades are also coated on the reverse side. This is a medium density board with printing properties that meet the high requirements of graphical and packaging products. SBB can be die cut, creased, hot foil stamped and embossed with ease. It therefore gives wide scope for advanced structural and surface designs. It is pure and hygienic and is therefore suitable for the packaging of aroma and flavour sensitive products.

Folding Box Board (FBB, GC1, GC2)

Folding Box Board (FBB) comprises middle layers of bleached or unbleached mechanical pulp sandwiched between layers of chemical pulp. The top layer of chemical pulp is bleached and pigment coated. The reverse side of the board may be cream in colour. This is because the reverse side layer of bleached chemical pulp is translucent allowing the colour of the middle layers to be apparent. The reverse side layer may, however, be white because a thicker layer of chemical pulp was used or the layer is clay coated – this product is known as White Back Folding Box Board. The combination of inner layers of mechanical pulp with outer layers of chemical pulp creates a strong and stiff sheet, taking advantage of the well known I-beam phenomenon in physics.

This is a low density material with high stiffness. Fully coated grades give excellent printing and visual impact. This is a virgin fibre paperboard with consistent purity for product safety.