



Figure 33: mountain activities and detachable chairlifts (Luw: 2005)

TECHNICAL RESOLUTION



Figure 34: Cobblestone pavement texture (Low: 2007)

MATERIALS

The selection of materials for a given project is influenced by physical properties relating to durability, sustainability and shape forming – the study of which is based in specialist areas of ergonomics – and is important to the aesthetic characteristics prescribed by the designer and end user.

Interesting material applications offer great shapes and tactile reference (inclusive design). Material selection is also key to creating mystery and ambiguity. It is not new materials that can offer a route to design innovation: traditional processes, crafted techniques, or old (even recycled) materials can be imbued with new life through previously unrelated applications.

ARBOFORM

Referred to as “liquid wood” (<http://www.ecolect.net/materials/view/arboform>), Arboform is a high-quality thermoplastic engineered material for applications that demand high technological standards. It combines the positive properties of natural wood with the processing capabilities of thermoplastic materials.

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Uses:

Like any synthetic thermoplastic material, Arboform can be formed into mouldings, plates or slabs using traditional plastics’ processing methods and machines. Cases for computers, televisions or cell phones can be made from this new “wood” material. By mixing lignin with natural fibres (flax, hemp or other fibre plants) and some natural additives, a fibre composite is produced. This composite can be processed and formed at raised temperatures to create parts.

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Manufacturing:

The raw material used to make these thermoplastic granules is lignin. Lignin is the most abundant natural polymer (the first is cellulose). Lignin is a by-product of the pulp industry. Worldwide, nearly 50 million tons of lignin is produced annually.

Arboform can be processed in an injection-moulding machine like any normal thermoplastic, and used to manufacture aesthetically pleasing products such as nativity figures, loudspeaker units, car instrument panels, chessmen for board games, or the stock of hunting rifles (<http://www.technaro.de>).

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Technical specifications

The disposal of Arboform is the same as naturally grown wood.

HUSQUE

Husque is a unique composite material comprising mostly of waste Australian Macadamia Nut Shell. The husque material can be machined, moulded, polished and combined with colour as with the image attached.

The Husque company was formed in 2003 by product designer Marc Harrison and architect Paul Fairweather to develop the Husque material and to apply it in the manufacture of designer and architectural products. Marc created this unique material of Australian macadamia shell milled and processed with a polymer to create a dense mouldable material.

Husque combines the iconic Australian macadamia nut, the principles of recycling and the ingenuity of Australian design to create elegant design objects. The range includes bowls, a tray and a vase each available in many colours (<http://www.husque.com/>)



Figure 35. contemporary PHMA three-dimensional systems (<http://www.gearnsponse.blogspot.com>)

PMMA (POLYMETHYLMETHACRYLATE)

Acrylic plastic refers to a family of synthetic, or man-made, plastic materials containing one or more derivatives of acrylic acid. The most common acrylic plastic is polymethyl methacrylate (PMMA). Also known as Lucite, Oroglass, Perspex and Plexiglas which vary according to the country you are in. The original PMMA was seen as a replacement for glass in a variety of applications and is currently used extensively in glazing applications. The material is one of the hardest polymers, rigid, glass-clear with glossy finish and good weather resistance. PMMA is a tough, highly transparent material with excellent resistance to ultraviolet radiation and weathering. It can be coloured, moulded, cut, drilled, and formed. It is also non-toxic and recyclable. These properties make it ideal for many applications including airplane windshields, skylights, automobile taillights, and outdoor signs. (Ashby, Johnson 2002: 193.)

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Physical properties:

PMMA is a glassy polymer with an amorphous structure. It has a density of 1.19 g/cm^3 and has very low water absorption. The refractive index ranges from 1.49 to 1.51 depending on the type. (Ashby, Johnson 2002: 193.)

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Mechanical properties:

Parts made of PMMA have high mechanical strength and good dimensional stability. Other properties include a high Young's modulus and good hardness with low elongation at break. PMMA does not shatter on rupture. PMMA is one of the hardest thermoplastics and is also highly scratch resistant. (Ashby, Johnson 2002: 193.)

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Thermal properties:

The thermal stability of standard PMMA is only 65°C . Heat-stabilised types can withstand temperatures of up to 100°C . PMMA can withstand temperatures as low as -70°C . Resistance to temperature changes is very good (Ashby, Johnson 2002: 193.)

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Optical properties:

PMMA is naturally transparent and colourless. The transmission for visible light is 92%. The refractive index is 1.492 for PMMA. There are types that transmit UV rays, and types that absorb it almost completely, as a result of which sensitive dyes on painted surfaces behind are protected from fading.

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Natural colour:

PMMA is crystal clear and has a high surface gloss. It can be produced in all colours, transparent and muted.

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Advantages (Ashby, Johnson 2002: 193):

Material is very hard.

Material is clear and can be coloured in any colour from opaque to translucent.

Good weathering resistance.

Good optical properties.

High gloss.

Scratch resistant (but not as good as glass because it does scratch).

Variations of shatterproof are available.

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Limitations (Ashby, Johnson 2002: 193):

Difficult to mould thin walled products because of poor flow properties.



Figure 36: German Tiger Helicopter Equipped PMMA protective glazing (Moore: 2007)

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Manufacturing:

Reacting a monomer, such as methyl methacrylate, with a catalyst, forms acrylic plastic polymers. A typical catalyst would be an organic peroxide. The catalyst starts the reaction and enters into it to keep it going, but does not become part of the resulting polymer.

Acrylic plastics are available in three forms: flat sheets, elongated shapes (rods and tubes), and moulding powder. Moulding powders are sometimes made by a process known as suspension polymerization in which the reaction takes place between tiny droplets of the monomer suspended in a solution of water and catalyst. This results in grains of polymer with tightly controlled molecular weight suitable for moulding or extrusion. (Ashby, Johnson 2002: 240.)

Ashby explains that the (Ashby, Johnson 2002: 241) acrylic plastic sheets are formed by a process known as bulk polymerization. In this process, the monomer and catalyst are poured into a mould where the reaction takes place. Two methods of bulk polymerization may be used: batch cell or continuous. Batch cell is the most common because it is simple and is easily adapted for making acrylic sheets in thicknesses from 0.06 to 6.0 inches (0.16-15 cm) and widths from 3 feet (0.9 m) up to several hundred feet. The batch cell method may also be used to form rods and tubes. The continuous method is quicker and involves less labour. It is used to make sheets of thinner thicknesses and smaller widths than those produced by the batch cell method.

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Injection moulding:

Pre-drying is not necessary if a vented cylinder is used but if a normal cylinder is used then PMMA must be processed dry and it is advisable to pre-dry the granules for up to 8 hours at 70 to 100°C, depending on the type. Surface defects and blisters will form if damp granules are processed. Processing parameters: The mould temperature should be between 40 and 80°C, depending on the type. The material temperature should be between 200 and 250°C. As the temperature rises, molecular orientation and internal stresses decrease, but the risk of sink spots increases. As a general rule, high injection pressures are needed because of poor flow properties and it may be necessary to inject slowly to get the correct flow. This is particularly important for optical mouldings where visible weld lines will form if the correct parameters are not used. For thick mouldings a high follow-up pressure is needed for a long time (2 to 3 minutes).

Large gates are needed because of the poor flow but hot runners are possible. Reprocessing is possible if the material has been thoroughly dried and has an opaque colour. Optically good mouldings are not generally possible with regrind even if the regrind is glass clear.

Shrinkage is relatively low: 0.4 to 0.8% depending on the grade used. Avoid wall thicknesses of less than 1 mm (Ashby, Johnson 2002: 193).

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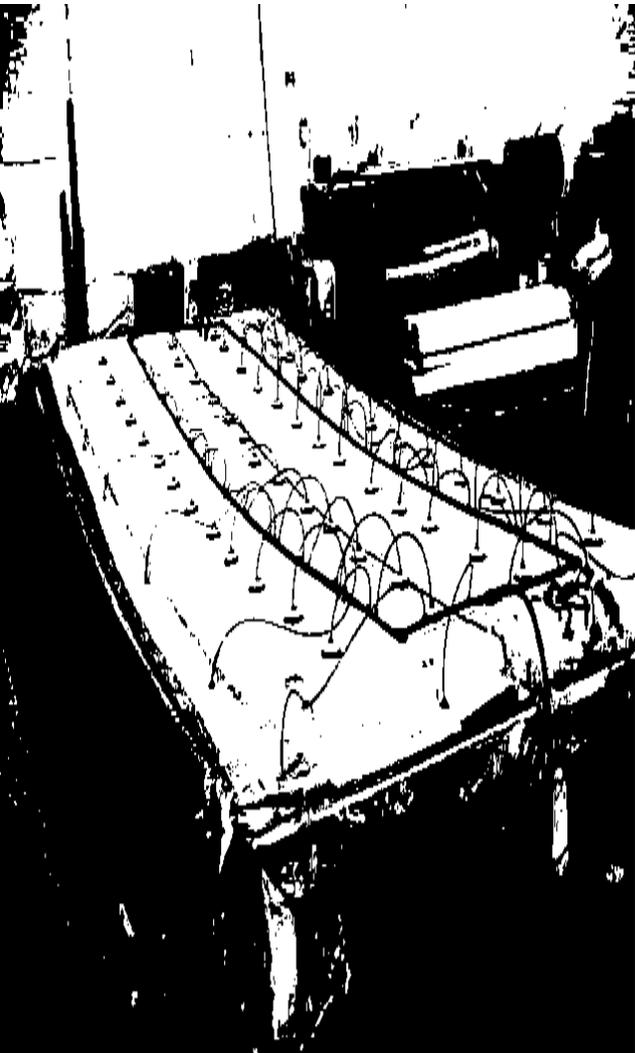
Extrusion:

Extrusion temperatures are between 180 and 250°C. Metering type screws with a compression ratio of 3:1 are generally recommended. Relatively high molecular weight formulations are used for the extrusion of sheets and profiles. A degassing screw with an L/D ratio of 20 to 30 is best.

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Bonding:

Solvents can cause stress cracks if internal stresses are present in the moulded part, so it is advisable to temper the part at 60 to 90°C before bonding. Methylene chloride, polymerisation, epoxy resin, contact and impact adhesives are suitable. Adhesion with solvent-based and polymerisation adhesives is better than with contact adhesives (Ashby, Johnson 2002).



GRP

Selected information in verbatim summarised from source (Moore, H., 2007. Composite Materials [information Sheet] (Personal communication, August 2007)

GRP stands for Glass Reinforced Polyester, outside the industry it is commonly referred to as fibreglass. Sheets of glass fibre matting are layered over a mould which is then coated with a special resin. The mixture is then left to set naturally or for quicker results is placed in an oven. The hardened polymer is then decorated and polished according to the customer's specified finish.

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Physical properties:

Glass Reinforced Plastic (GRP) is a light, durable and astonishingly tough constructional material which can be fabricated into all manner of products. It may be translucent, opaque or coloured, flat or shaped, thin or thick. GRP is a composite of a resilient durable resin with an immensely strong fibrous glass. The resin is the main component and is normally a polyester resin. Just as concrete may be reinforced with steel rods, so polyester resins may be reinforced with glass fibres to form GRP. This is the fabrication process, a single surface mould on which is impregnated layers of glass mat with liquid resin until the required thickness has been built up and the laminate is then extracted from the mould. Glass fibre is one of the strongest of all materials (Table 1). The ultimate tensile strength of a freshly drawn single glass filament (diameter 9-15 microns) is about 3.5 GPa. It is made from readily available materials, it is non-combustible and chemically resistant.

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MATERIALS	GLASS CONTENT		SPECIFIC GRAVITY	TENSILE STRENGTH	TENSILE MODULUS	SPECIFIC STRENGTH
				MPa	MPa	MPa
Polyester / glass roving	54	70	1.9	800*	30*	400*
Polyester / glass cloth	38	55	1.7	300	15	200
Polyester / glass mat	18	30	1.4	100	7	70
Mild steel (structural)			7.8	310	200	40
Duralumin			2.8	450	70	150
Douglas fir			0.5	75	13	150
Hickory			0.8	150	15	200
Portland cement			4	10	17	5

Table 2: material strength of GRP compared steel and cement (Composite Materials information sheet 2007)

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Mechanical properties:

A specific resistance, 2 to 4 times higher traditional materials, allows significant weight saving. According to applications, a GRP solution (i.e.: 70% fibres, 30 % resin) allows a weight save, for equal resistance, up to:

- 60 % in comparison to stainless steel,
- 65 % in comparison to aluminium, -
- 75 % in comparison to hot dip galvanised steel.

SUMMARY

High degree of design flexibility. The practical uses of GRP are virtually endless, limited only by your imagination. GRP opened many new avenues for creative designers. Its unique physical properties allow it to be easily tooled, moulded and manufactured to meet almost any specifications. Because there are few constraints on size, shape, colour or finish, the styling and appearance can take precedence.

The lightweight strength of GRP has always made it a popular choice for manufacturing. Gram for gram GRP can be stronger than steel and sheet metals. Highly resistant to environmental extremes. Glass reinforced plastic products provide better performance than plain non-reinforced plastic units. GRP offers distinct advantages in a wide range of products; its reduced weight and maintenance make it attractive on architectural projects. More and more industries are discovering the benefits of its versatility.

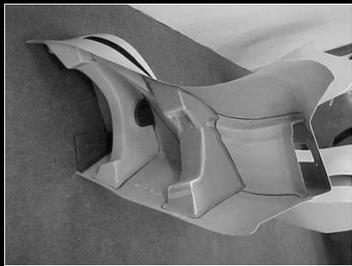


Figure 38: manufactured GRP component by MMS Technologies (Moore: 2007)

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Thermal / Electrical properties:

Excellent thermal insulation (1 000 times less heat conductor than aluminium),
Excellent electrical insulation (~ 6 KV / mm).

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Acoustic properties:

GRP provides superior acoustical properties when compared to plastic or metal. Various type of sound deadening materials can be laminated between high strength layers of GRP mat to achieve the preferred level of sound deadening.

Stability: GRP exhibits the least amount of expansion and/ or contraction when compared to plastic, wood, or metals. GRP parts have excellent dimensional stability and will hold their shapes under severe mechanical and environmental stresses.

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Aesthetic properties:

GRP parts are gel-coated in their moulds with a choice of flat, semi-gloss or high gloss colour eliminating the need for painting. In highly corrosive environments gel-coats are much more durable than most paints. GRP products can be manufactured in numerous finishes, textures and colours. GRP parts have sleek contours and a superior moulded appearance with high visibility colours.

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Other properties:

GRP is non-corrosive and has a much longer life expectancy when compared to a variety of construction materials. In highly corrosive environments GRP is the preferred choice over metal, wood, or plastic. A popular choice where exposure to harsh environments is a concern, GRP provides resistance to ultra violet light, extreme temperatures, salt air, and a variety of chemicals including most acids. Because fibreglass is chemically inert and corrosion-resistant, it offers an economical alternative to stainless steel.

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Advantages:

- The mould side of the product is left with a smooth aesthetically pleasing gelcoat finish, which never needs painting.
- GRP is cost effective in the long term, because it is corrosion resistant and maintenance free.
- Tooling costs are very low, in comparison with injection moulding and deep-draw steel tooling.
- Damaged products are repairable.
- GRP products have good chemical resistance.
- GRP products have good heat insulation.
- Mass production press tooling costs are very competitive compared to other options.
- GRP is versatile.
- GRP parts require very little maintenance - no rust, no painting, no wood rot. Reduces costly maintenance associated with repairing or replacing units.
- GRP is non-conductive, RF transparent, and helps to insulate against electromagnetic fields.

> **The GRP advantages in comparison to galvanised steel:**

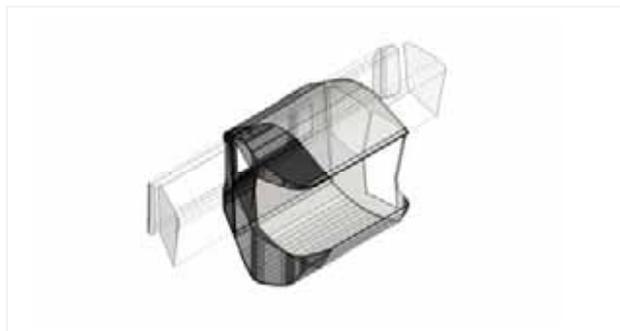
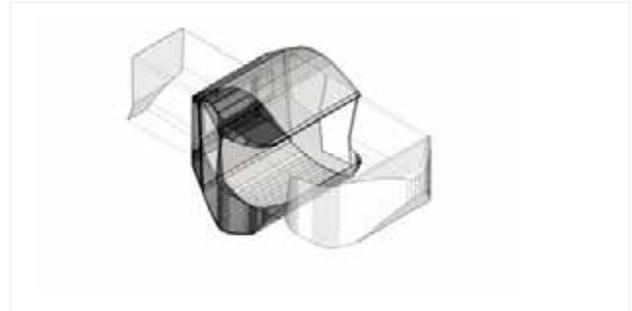
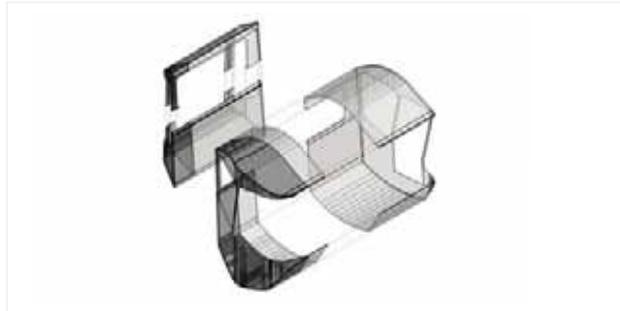
- Corrosion resistance is not related to the zinc coating quality as on the steel.
- No risk of injury.
- Resistant to salt water, to sulphur, chlorine or basic environments.

> **The GRP advantages in comparison to aluminium:**

- No electrolytic corrosion due to contact of two metals in humid environment.
- Much higher life span in basic, chlorine or halogen atmosphere.

> **The GRP advantages in comparison to stainless steel:**

- Absence of corrosion under tension (mechanical).
- Absence of hollow corrosion.
- Recommended in chlorine.



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VEHICLE ASSEMBLY AND FASTENING

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The vehicle will comprise of three major components:

- > 01 A left frontal lobe
- > 02 A right frontal lobe
- > 03 And a posterior lobe (

The left and right lobes will be joined by top and bottom structural components made out of CRP (carbon reinforced plastic) and pop riveted to the major components. A urethane seal will be responsible for a tight and secure grip between the components and assure that there will be no future leakage at the various joints. These structural components and joints will be covered by removable ceiling and floor systems which will also be riveted to these structural components as well as to the outer GRP skin of the vehicle.. These extruded profiles will thus perform dual functions as mentioned and are critical in the assembly of the vehicle as a whole (similar strength and function as known I-beams).

The posterior lobe will then be joined to the assembled frontal lobe. The posterior lobe (storage compartment) will further strengthen the whole assembly in that it will retain the two frontal lobes.

The windows are made from PMMA with UV-filters. All the PMMA glazing will be fixed to the GRP skin of the vehicle by means of a poly-urethane sealant and seals attached to GRP skin. The back window will be hinged at the top (similar to the mechanism used for Jeep Cherokee canopies) and will have a hydraulic mechanism which will assist in the opening and closing of the back window. The door opening/closing mechanism should be inserted in a compact, removable box and combines the door closing and locking functions.

INTERIOR COMPONENT ASSEMBLY AND FASTENING

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STANDING (STANDARD) UNIT

- control box is fixed to the skin of the vehicle with self tapered screws (all electrical wiring for LED display etc. are hidden inside the control box and can easily be reached by unscrewing and removing the inside panel (see drawing)
- the waste bin is not be fixed but is removable
- the sound unit are also fixed to the skin of the vehicle, but easy to disassemble should it be repaired
- a ski holder are slide into a fixed u-component on outer GRP-skin of the cable car
- an all-purpose bicycle rack consist of two legs that are bolted onto a fixed mechanism on outer GRP-skin of the cable car

SEATER UNIT

- the seating unit consists of a bottom component which clip into the control box and its support, the back component alternatively slide into a fixed u-component (screwed into GRP skin).there are also a slide-in additional support for the bottom seating component as well as a slide-in footrest.

PIC-NIC UNIT

- The “pic-nic” unit are also clipped (some mechanism as seating component) into the other clip permanently attached to the anterior skin of the vehicle. The control box provides support for the entire one side of the unit. The unit can be finger hinged “up and down” so that passengers can sit down as they enter the vehicle.

The entire detachable component range makes use of a specific designed clip-in, slide-in and bolted mechanisms which makes assembly and disassembly of the components effective and easy. All mechanisms are fixed which minimise loss and theft of these mechanisms usually needed in assembly. By designing compact units one makes adds comfort to storage and transportation components.