SMC BMC DESIGN AWARD 2022

“Sustainable Living”

SMC BMC - European Alliance

SMC BMC DRIVE COMPOSITE INNOVATION

Who are we?

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DRIVE COMPOSITE INNOVATION

Members:

astar SMC.BMC

AOC

Polynt Composites

Owens Corning

JM Johns Manville

ALTANA

menzolit Compounding Solutions

STS Group

Fraunhofer ICT

Beckers

IDI Composites International Europe

INEOS Composites

Agenda today

- Background SMC BMC and Composites
- Comparison with other Composites manufacturing technologies
- Design in SMC BMC
  - Do's and don'ts
  - Design case studies
- SMC BMC environmental
- SMC BMC costing
- SMC BMC Design Award 2022

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SMC and BMC are everywhere (without you noticing)

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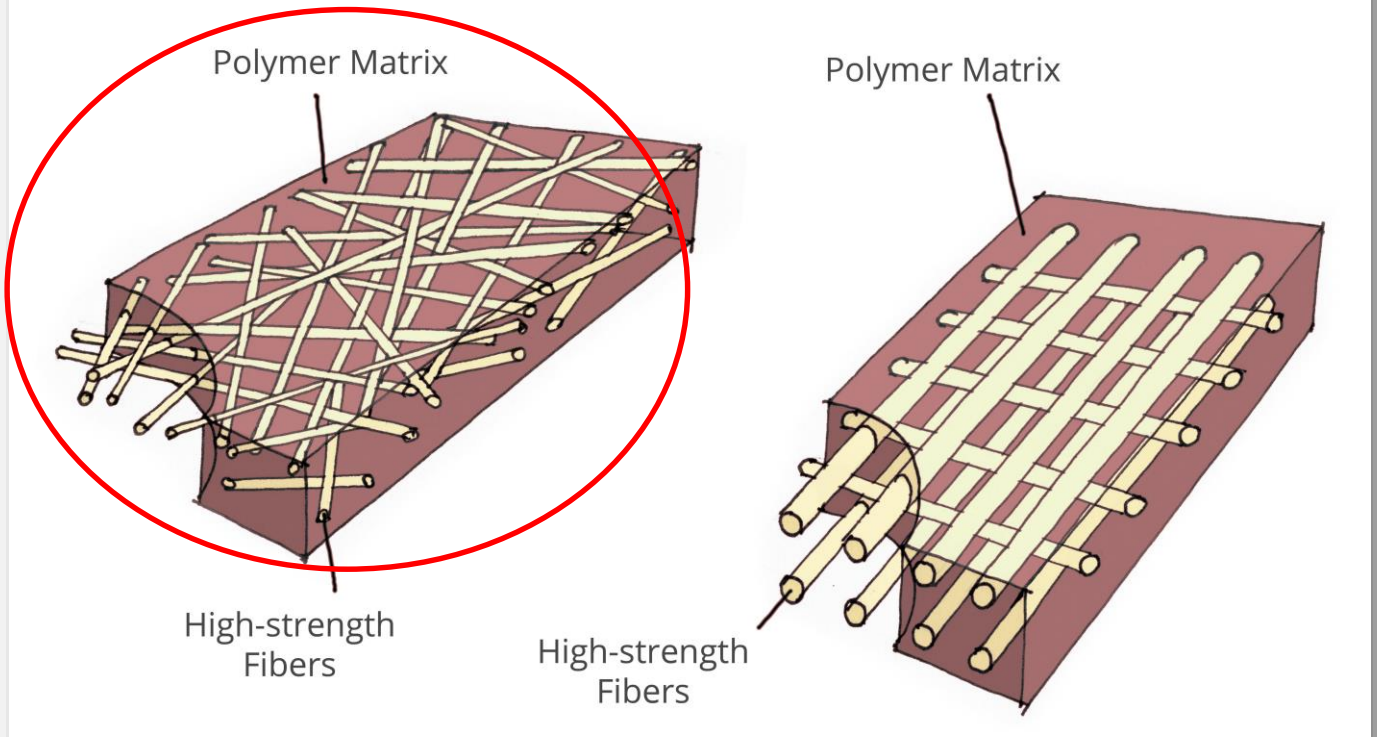
SMC and BMC are Composite Materials



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Mixtures of resin, fillers and reinforcement

Processed in heated mould to form a cured component

Sheet Moulding Compound

Sheets consisting of uncured resin, reinforced with glass fibres

Bulk Moulding Compound

Bulk mixture of uncured resin, reinforced with glass fibres

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Why use SMC and BMC?

- Flexibility to shape and create unique designs
- Light weight compared to steel, aluminum, stone
- Providing great strength, stiffness, mechanical integrity, better than what is possible with thermoplastics
- Resisting heat (insulating, dimensionally stable)
- In many cases cost-effective for medium to large production series (500-100,000 parts per year)

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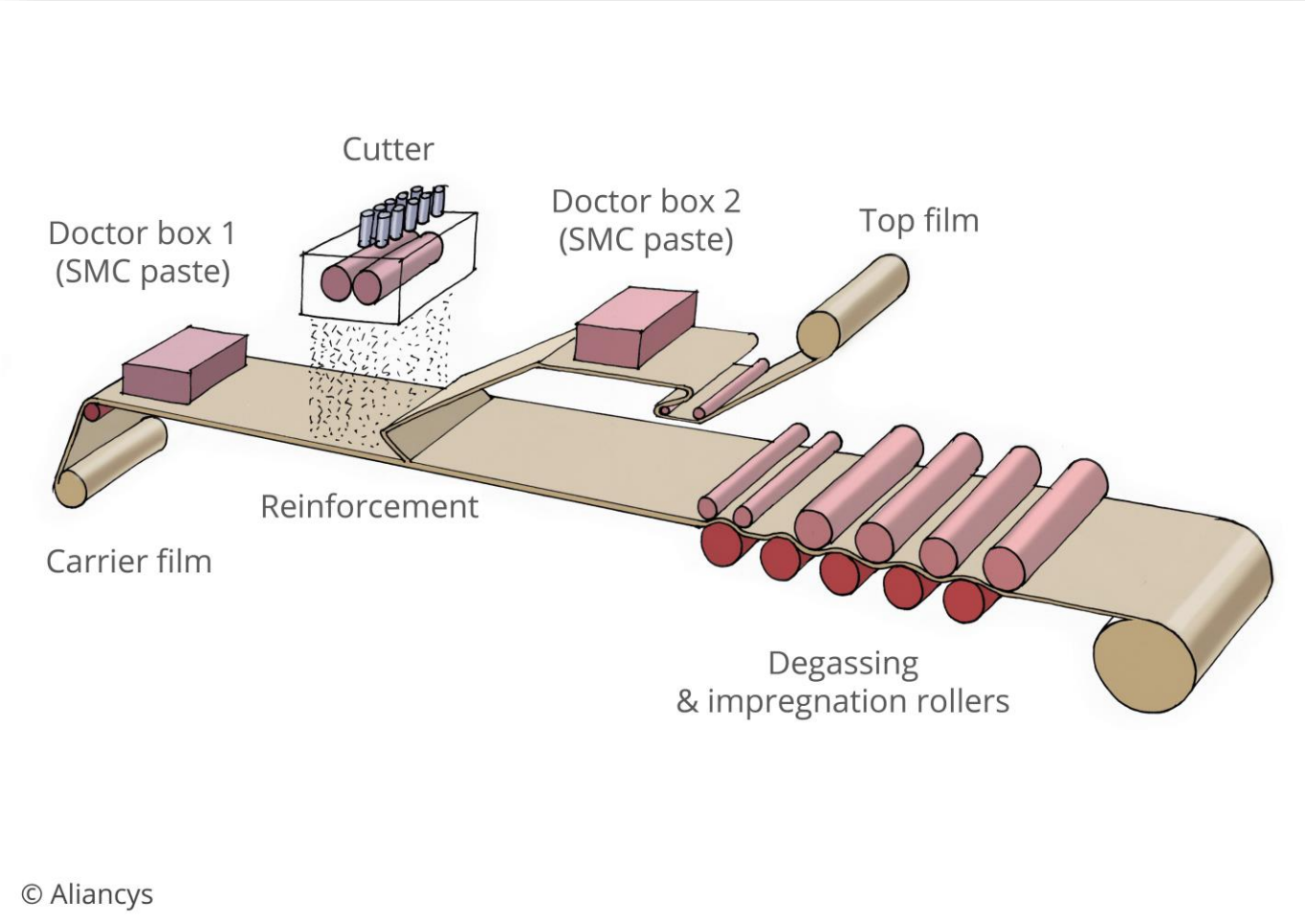
SMC production details



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SMC production equipment

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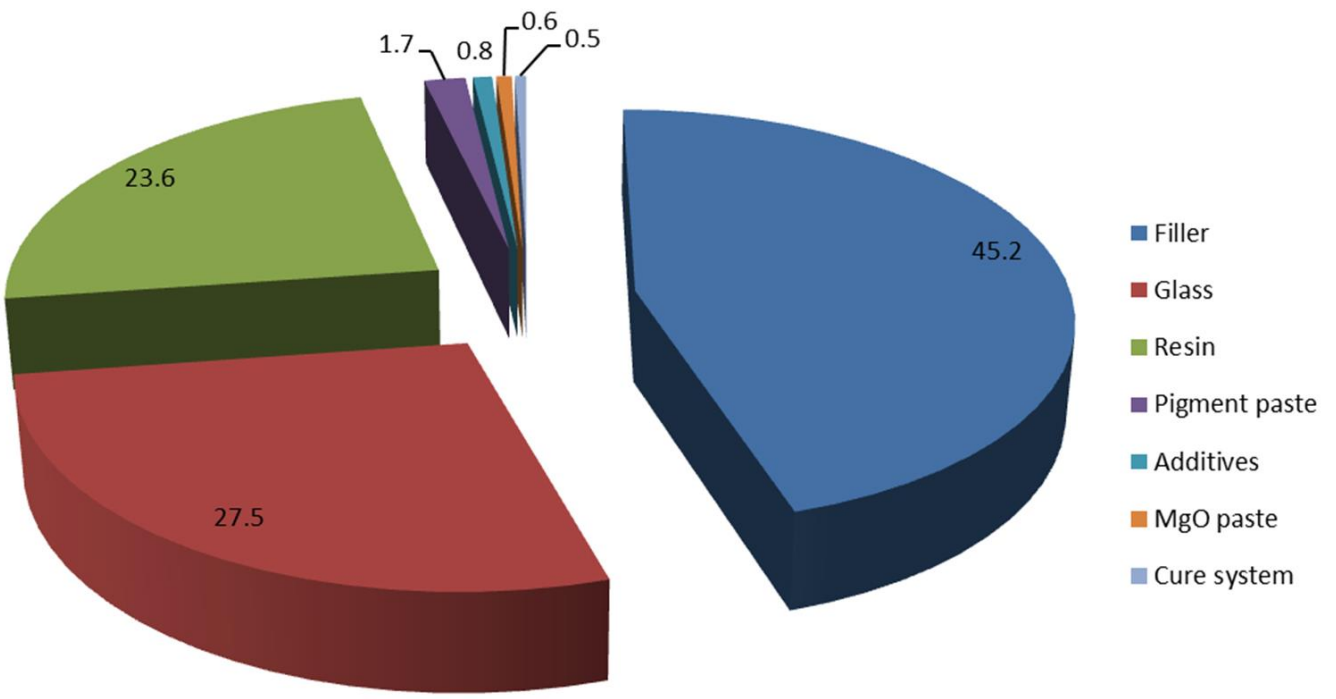
Typical SMC formulation



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Each component contributes to final performance

Component	Influences
Resin system	Mechanical properties Surface smoothness Shrinkage control
Additives	Wetting and dispersing Surface quality improvement Mould release
Cure system	Cure time Shelf life
Glass	Mechanical properties Dielectric properties Surface smoothness Colour
Filler	Shrinkage control Mechanical properties Surface smoothness Density
Pigment paste	Colour
MgO paste	Thickening: easier handling of intermediate

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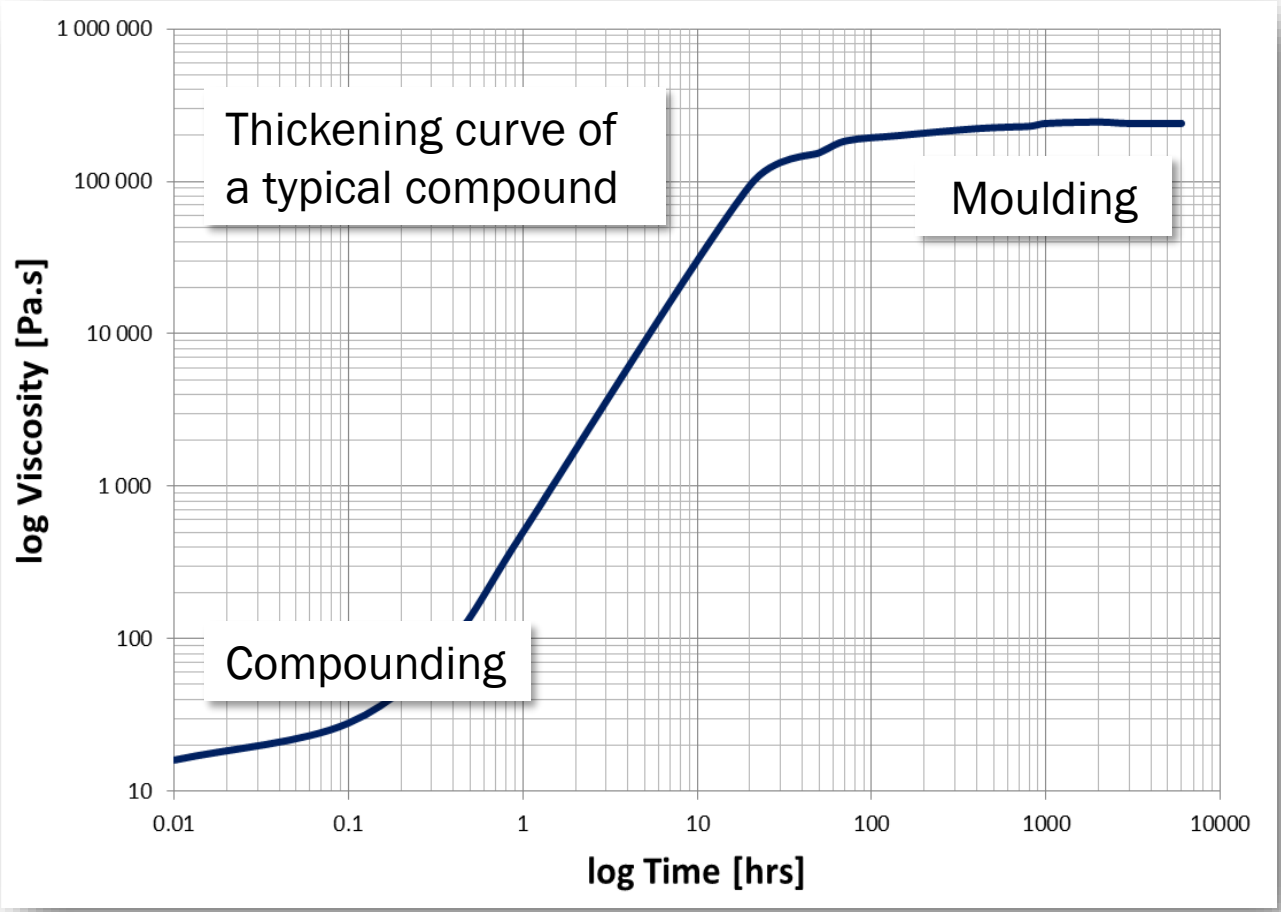
Resin thickening helps to better handle the SMC intermediate



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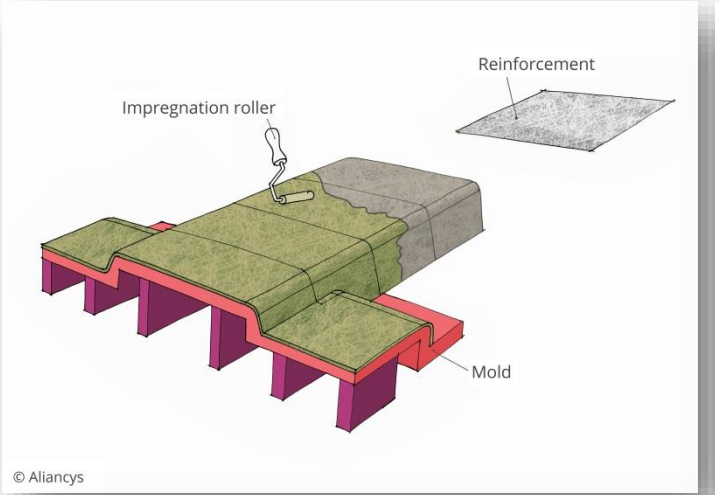
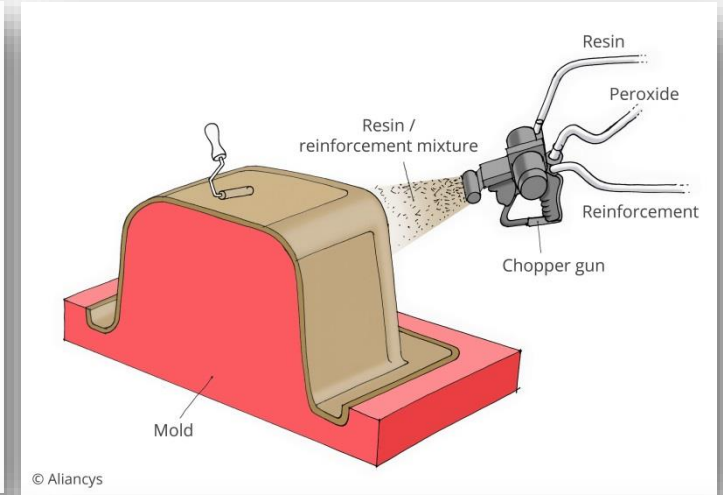
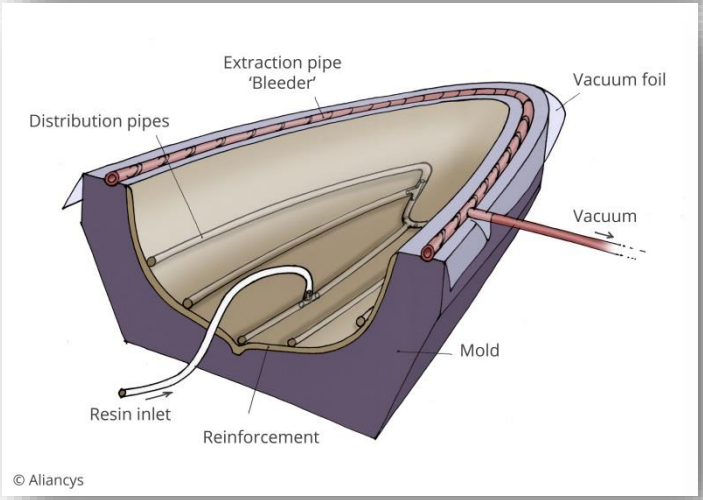
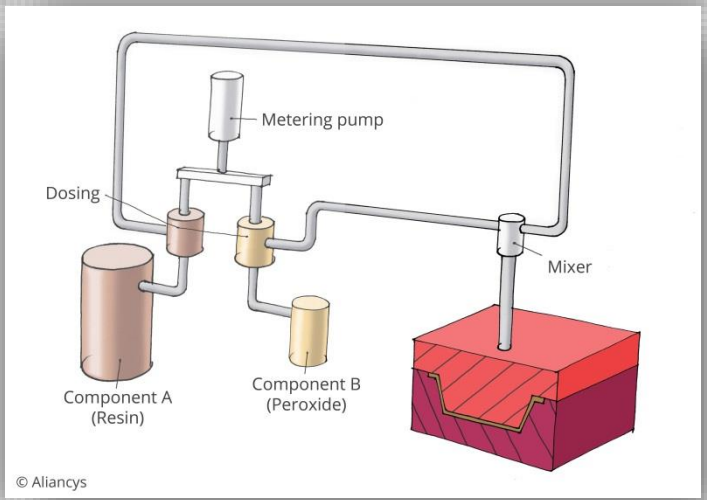
Other composite manufacturing technologies









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Technology comparison

Method	Production volumes	Tooling cost	Other features
Hand Lay-up	Low < 500-1,000 parts/yr.	Low to Moderate	Simple processing, design flexibility
Spray-up	Low < 500-1,000 parts/yr.	Low to Moderate	Simple processing, design flexibility
Vacuum infusion	Low < 500-1,500 parts/yr.	Low to Moderate	Suitable for complex shapes and large components (up to 100 m)
RTM	Low to Moderate 1,000-5,000 parts/yr.	Moderate	Faster production, low material cost, design flexibility, complex shapes possible, smooth surfaces
SMC BMC	High 500-100,000 parts/ yr.	High	Excellent part-to-part reproducibility, design flexibility, complex shapes possible, outstanding finished surfaces, minimal finishing cost
Metal	Very high > 100,000 parts/yr.	High	Excellent part-to-part reproducibility, moderate design flexibility, outstanding finished surfaces, cost competitive at larger production series

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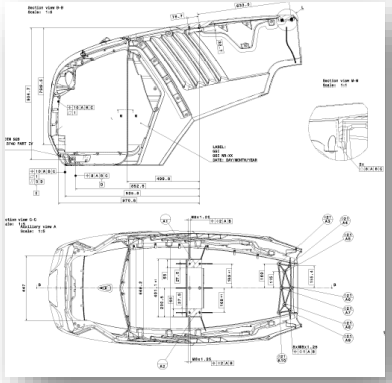
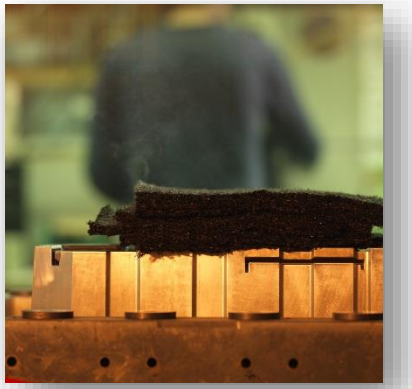
What do you need to make a part in SMC or BMC?

Design



Mould



SMC sheets or BMC compound

Press

Operator or robots for handling parts

Assembly

Painting

Logistics

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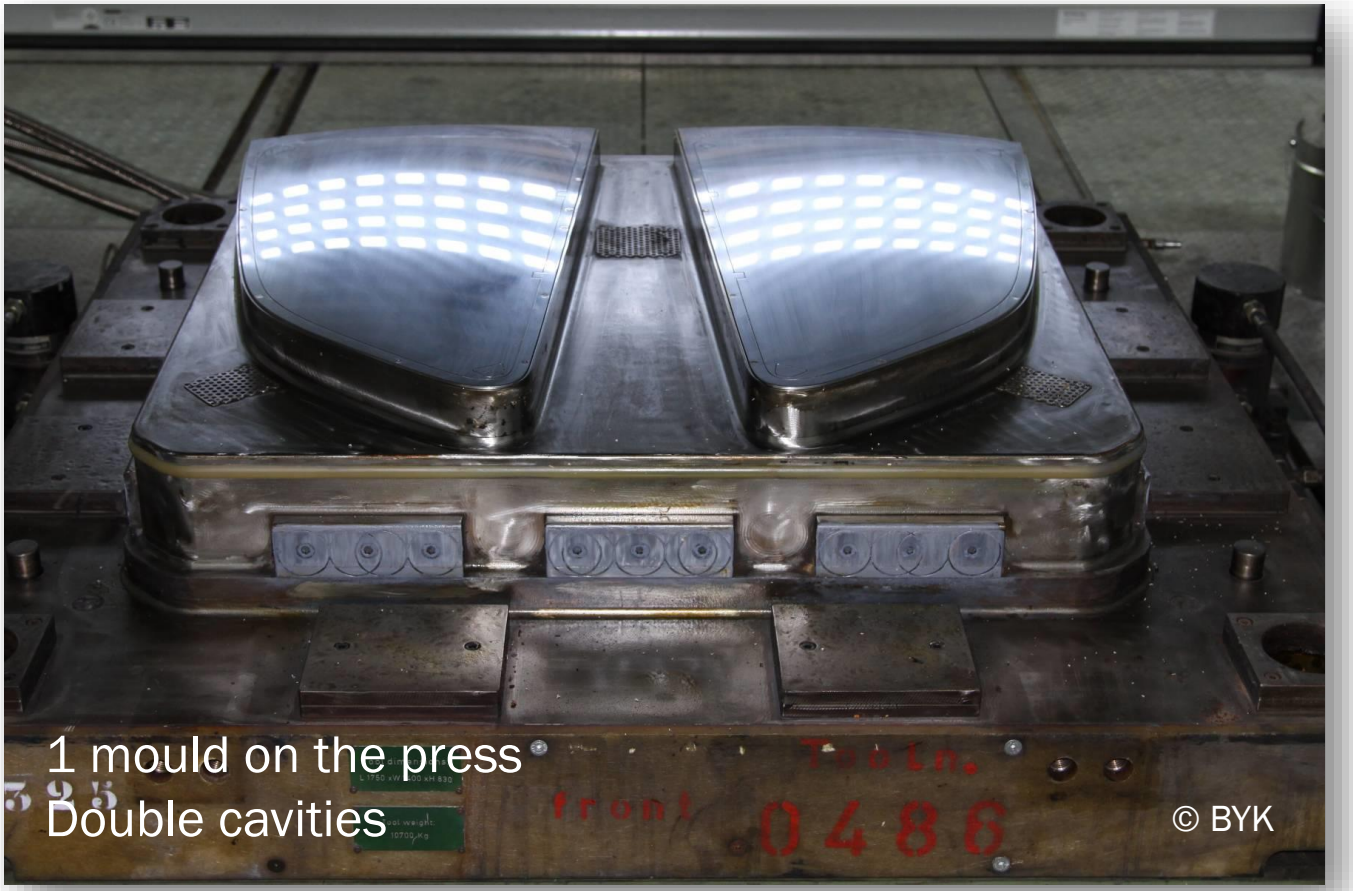
Mould example



1 mould on the press
Double cavities

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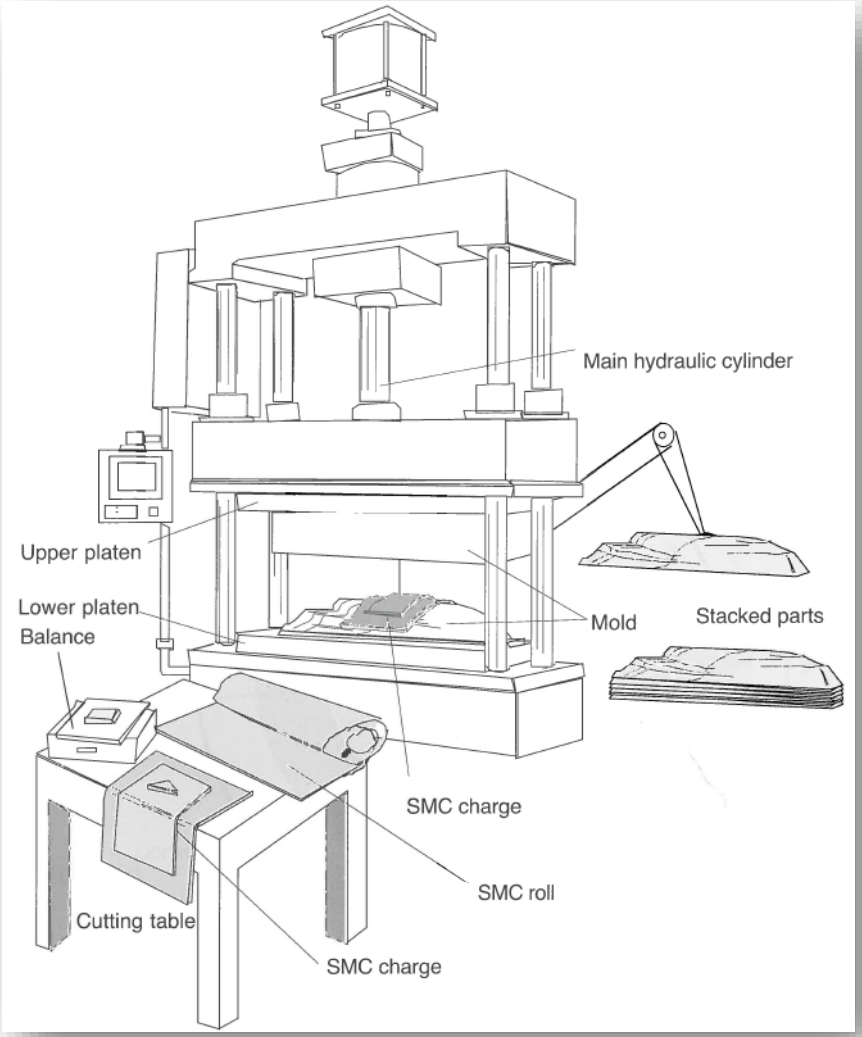
SMC moulding cycle



Picture ex: Compression Molding
Davis / Gramann / Osswald / Rios
Hanser Verlag 2003

1. Place SMC charge in mould (manual or robot)
2. Closing of the mould
3. Moulding (flow of SMC + cure)
4. If applicable: injection of IMC (in-mould coating)
5. Cure of IMC*
6. Opening of the mould
7. Remove moulded part (manual or robot)

Design in SMC BMC

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SMC BMC bring Design Freedom

Feature	Detail
Elevated strength and stiffness	Excellent mechanical properties even at very high and very low temperatures,
Solutions for weight reduction	Inherently low density materials, weight reduction through part consolidation and functional integration.
Precision and predictability of dimensions	High part stiffness and heat stability enables close tolerances to be achieved.
Resisting elevated temperatures	Inherent heat resistance, CTE (coefficient of thermal expansion) close to CTE of metal
Part safety through great fire resistance	Elevated resistance to fire and low smoke generation, even at low wall thicknesses
Electrical insulating performance	Great dielectric strength, low water absorption, low surface resistivity
Great Class A surface	Ability to obtain excellent surfaces for offline and online painting processes
Low emissions	Low emissions from moulded components for interior applications

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SMC and BMC are different

SMC

- Longer fibre length
- Higher fibre content
- Greater flexural strength and tensile strength
- Larger flat parts
- More structural requirements
- Good cosmetics
- Body panels, building facade panels, deck lids, electrical cabinetry

BMC

- Shorter fibre length
- Lower fibre content
- Injection moulding capability
- Finer cavities and thinner parts
- Higher filler content for smoother surface
- Headlamp reflectors, appliances (iron heat shield, coffee machine parts, fuse switch, oven handles, auto engine throttle body)

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Great in Lightweight

Property	Steel	Aluminium	SMC	Carbon SMC
Density (g/cm^3)	7.8	2.7	1.8	1.4
Tensile strength (MPa)	365	483	80	200
Tensile modulus (GPa)	200	70	13	30
Specific tensile strength (MPa)	4.6	17.8	4.5	14.3
Specific tensile modulus (GPa)	2.6	2.6	0.7	2.1

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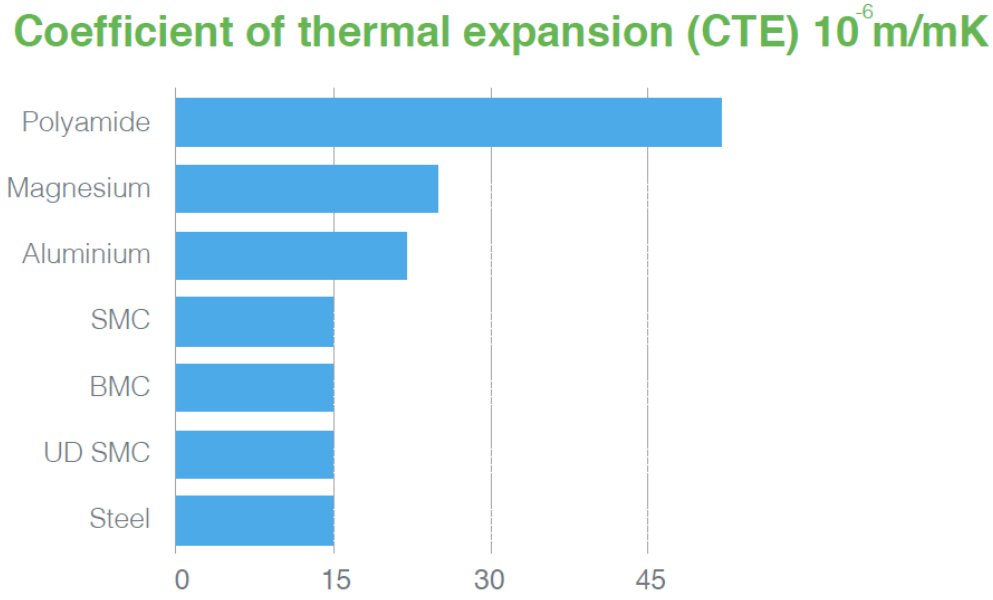
CTE SMC BMC similar to steel: beneficial for inclusion in larger assembly



Gaps between trunk lid and fender remain the same in winter as well as in summer

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Design process in SMC BMC

- Review design objectives
- Select development and production partner(s)
  - Minimising design loops and optimising design efficiency
- Validate design for structural, appearance and cost
- Review SMC BMC product specifications
  - Class A, low weight, high stiffness/ strength
- Review design for manufacture-ability
  - Undercuts, draw direction, narrow sections, shear edges
- Preliminary structural evaluation

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Toolbox for the Designer

- Customized shape
- Light weight
  - 1.8 g/cm^3 for standard SMC, 1.2 g/cm^3 for low density
- Local stiffening
  - Use of ribs and bosses
- Use Glass fibre vs. Carbon fibre reinforcement
  - Carbon fibres superior stiffness but very high cost
- Surface textures and grains, surface smoothness
- Electrical permeability
- Metal integration (stiffeners, inserts)
- Bonding to metal, wood

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Basis design considerations for SMC BMC components

- Maintain uniform wall thickness for uniform flow, uniform curing and the minimization of warpage and distortion
- Best use contoured surfaces
  - Pay attention to minimise potential items that reduce flow thin wall sections, corrugations or ribs
- If panels are too thick this will further increase non-linear curing times
  - Recommended for aesthetic/ exterior panels: 2.0-3.0 mm thickness
  - Recommended for structural panels: 2.0-3.5 mm thickness
  - Core of part thicker, edges may be thinner
  - Typical curing times: 20-30 seconds per mm thickness
- This also minimizes read-through where there are thickness changes (non-Class A design)

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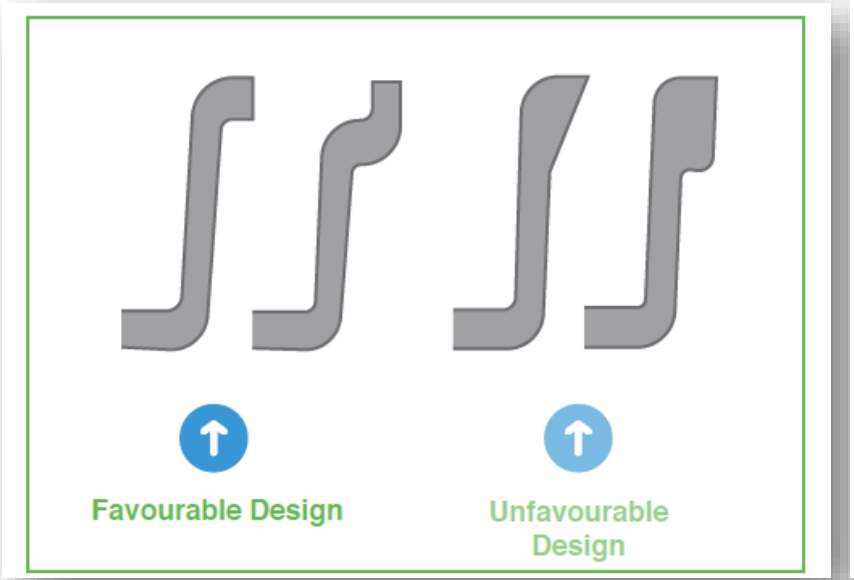
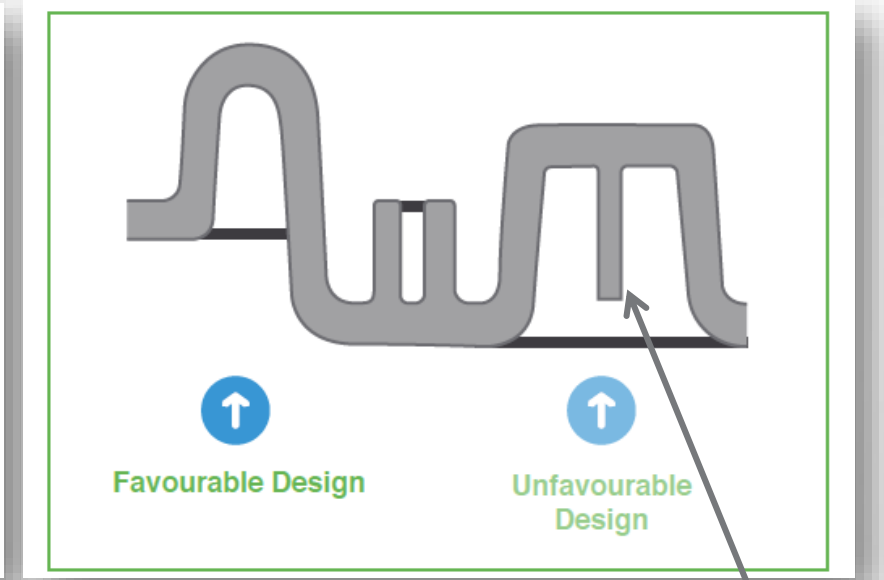
Constant wall thickness

- Avoiding thin to thick sections along material flow path and at end of the flow
- Best for surface quality and isotropic properties





This rib is much thinner than main flowline: SMC will flow first horizontally without filling the rib. When mould will be filled and pressure will increase, SMC will fill the rib with significant sink marks. This is to be avoided.

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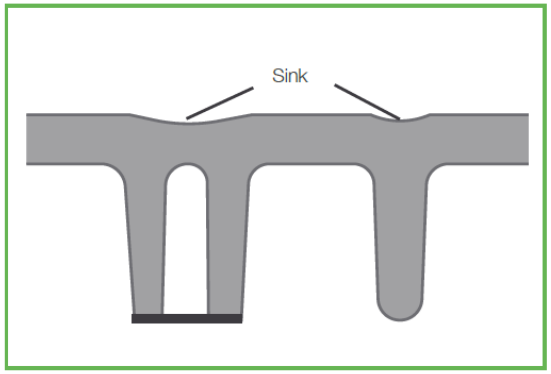
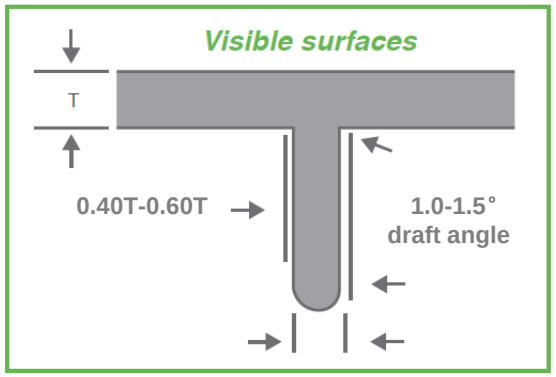
Ribs and radii

- Ribs used for stiffening
- Risk of sink marks
- Use optimised design





- Recommended radius minimum 2 mm for inside corner
- 1.5 mm minimum for outside corner

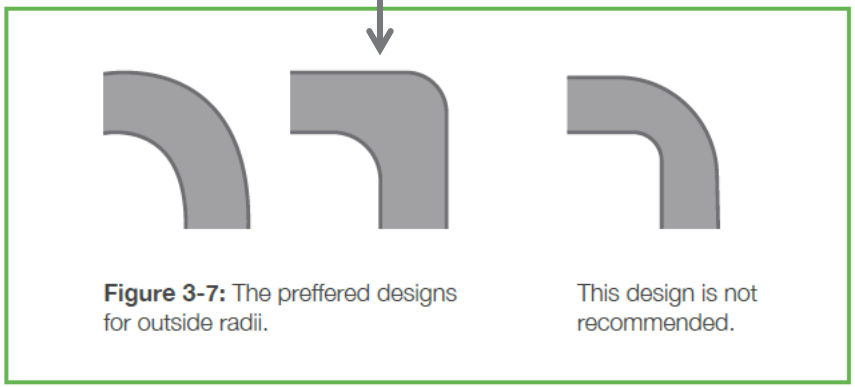


Figure 3-7: The preffered designs for outside radii.

This design is not recommended.

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Truck body panels

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Car body panels

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Body panels

Design requirements

- Unique and attractive shape
- Available in multiple colours
- Light weight (impact on driving)
- Solid feel: sense of quality
- Durability for use and handling during many years (incl. salt spray, UV resistance)
- Passenger safety: meet EU safety testing standards in crash test
- Easy assembly
- Easy repair after car accident
- Easy cleaning

Solution

- Low density SMC with Class A+ capability
- In-mould coating for painting primer layer
- Offline painting
- Production 100-800 parts/yr

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Agricultural vehicle

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Agricultural vehicle

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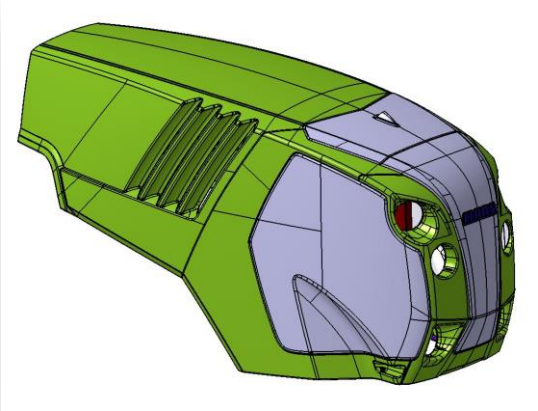
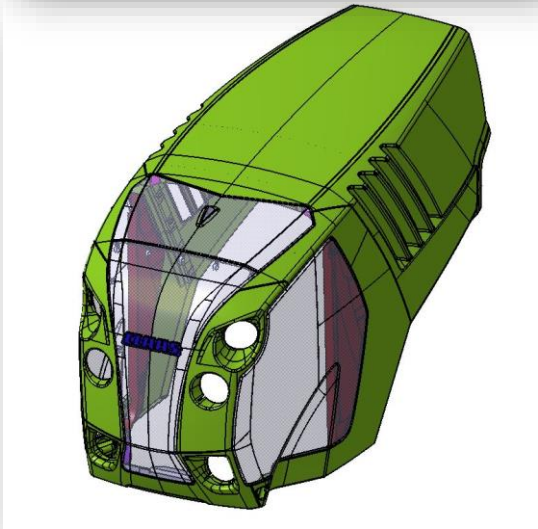
Now in SMC: unique shape





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Engine hood interior view: top and side component combined

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Agricultural vehicle

Design requirements

- Unique and attractive shape
- Colour customer standard
- Solid feel: sense of quality
- Durability for use and handling during many years (incl. salt spray, UV resistance)
- Easy assembly
- Easy repair after eventual tractor accident
- Easy cleaning

Solution

- Low density SMC with Class A+ capability
- In-mould coating for painting primer layer
- Offline painting

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Electrical charging unit

© Johns Manvlile

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Electrical charging unit

Design requirements

- Customized shape
- Colour customer standard without painting
- Solid feel: sense of quality
- Durability for use and handling during many years
- Vandal proof
- Easy assembly
- Easy cleaning

Solution

- Low density SMC
- Mass-colored (no painting)

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Headlamp reflector in BMC

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Headlamp reflector

Design requirements

- Customised shape (fit in car design, precision of reflection)
- Dimensional stability at high temperature, surface smoothness (precision of reflection)
- Retention of strength and stiffness during full car life
- No fogging (volatiles on lens)
- Lowest possible water absorption
- Easy assembly

Solution

- BMC with high filler loading and Class A+ capability
- Vacuum tools
- Cold runner gates
- Offline metallisation

Chair in SMC

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Chair in SMC

Design requirements

- Unique and attractive shape
- Available in multiple colours
- Stacking capability
- Solid feel: sense of quality
- Sufficient strength and stiffness to accommodate rough handling, heavy persons
- Durability for use and handling during many years
- Easy cleaning

Solution

- Standard SMC with Class A capability
- Combination of in-coloured versions and painted versions

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SMC BMC Environmental

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Composites are sustainable materials

- Lightweight during installation and use
- Saving CO_2 and energy
- Typical working life 10-100 years
- Minimal maintenance
- Can be mass-colored for exterior parts, eliminating painting steps
- Recycling demonstrated
- Typically lower Eco footprint than comparable solutions in steel, concrete, wood

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Insight through Life Cycle Assessment (LCA)

- Identifies the material, energy and waste flows associated with a product over its entire life cycle
- Understand Eco-efficiency of products and solutions
- Quantify environmental impact of composite solutions vs. alternative solutions
- Use to steer product/ process development in the most sustainable direction

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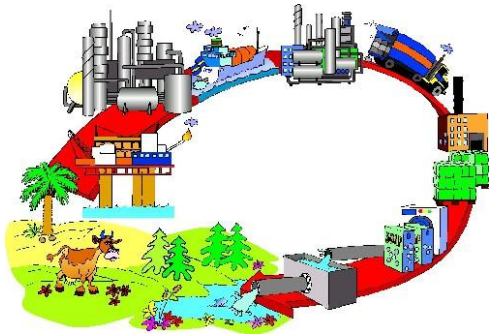
Life Cycle Assessment (LCA) vs. Carbon Footprint

LCA: Sum of all environmental impacts over total life cycle



CO_2 footprint: one part of the LCA. Easy to compare, but provides no insight into other environmental effects (e.g. toxicity, waste, resource consumption, land use)

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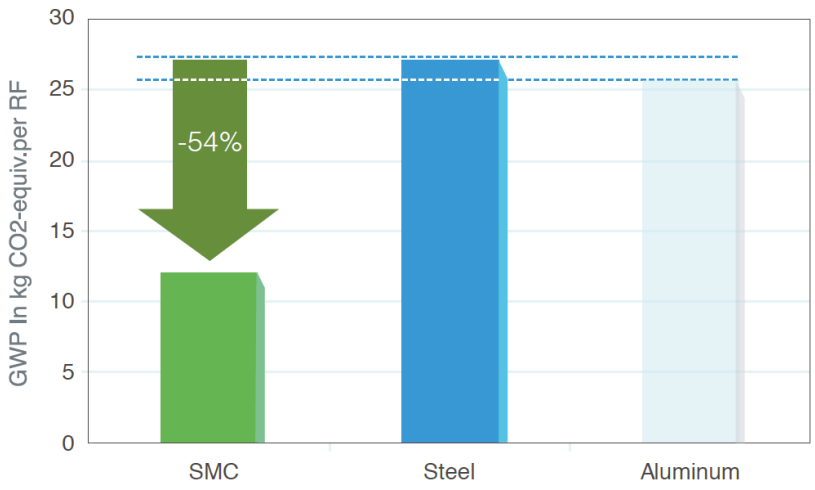
Example: stationary box in SMC



Significantly lower Eco footprint than metal equivalent

- Total SMC of 10.6 kg
- 2,45m2 SMC functionality (=reference Flow)
- White and Grey

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Composites Recycling in important

- End-of-life solutions integral to product design
- Efficient use of resources offered by Mother Nature
- Reducing Eco-footprint
- Minimized lifetime cost
- Proud about the products you make
- Affordable waste management solutions for part fabricators

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Co-processing viable route for recycling glass reinforced composites

Use of regrind fiber and filler in new formulations	Solvolysis into original raw materials	Co-processing in cement kilns
Difficult to manage powders and fibers (Ercom experience)	Difficult to manage powders and fibers	Easy to manage regrind, also in scale up
Only possible to re-use as small percentage in new formulations	Requires costly separation of liquid fractions	Re-use of valuable raw materials plus energy recovery
Requires major investment (Ercom experience)	Requires major investment	Reduction of CO_2 footprint
Demonstrated at full industrial scale	Demonstrated in small scale equipment only	Demonstrated at industrial scale, but so far only suitable for glass reinforced composites

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Composites Recycling through Co-Processing is Reality Today

- Neocomp (D) and Geocycle/ Holcim (D) are processing ~15,000 MT/yr of regrind
- Composite parts collected from SMC, BMC, wind energy, others
- Converted into regrind
- EU: recognition: composites recycling through co-processing is fully compliant with WFD (Waste Framework Directive

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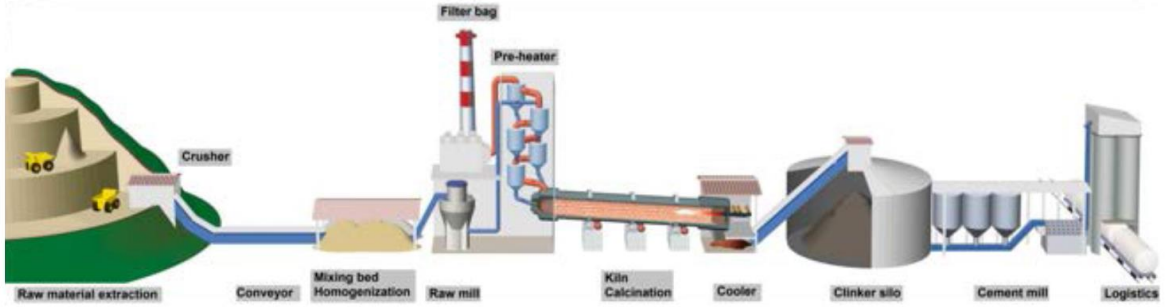
Enabling reduction carbon footprint cement manufacturing

- Composite recycling through co-processing in cement clinker manufacturing
- Partially replacing coal and raw materials by glass-reinforced composites
- Significant emission reduction
  - 0.9 kg CO_2-eq/kg composite
  - 1.8 kg CO_2-eq/kg resin



Typical cement manufacturing process (Courtesy: Holcim)

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SMC BMC Costing

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Costing of parts in SMC BMC

Fixed cost

- Depreciation over entire lifetime of the part (2-7 years)
- Development cost (design, engineering, prototype testing)
- Mould (~50-150 k€/unit)
- Robots (~50 k€/unit)
- Assembly (~10-100 k€)
- Painting line (250-300 k€, 10 year lifetime)
- Press usage 500 k€ (10 year lifetime)
- Cost of capital: ~5 % per year
- Buildings and infrastructure

Variable cost

- SMC or BMC compound cost (2.00-2.50 €/kg, carbon 30 €/kg)
- Waste (1-2 %)
- Labour (40-50 €/hr)
- Energy (typically 2-5 % of total variable cost)

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Simple Excel tool available: costing unpainted parts

Assumptions	
Number of of parts per year	10,000
Part life time (yrs)	7
Production cycle time (min)	2
Effective production time (days/yr)	300
Working hours per day (hrs)	8
Time required for production (days)	42
Effective usage of SMC BMC Press (%)	14
Part weight (kg)	2.00
Fixed cost	
Engineering, Design, Prototyping, Testing	50,000 €
Tool investment	100,000 €
Robots	100,000 €
Cutting SMC	5,000 €
SMC BMC Press	500,000 €
SMC BMC Press, corrected for effective usage	69,444 €
Total investment	303,611.11 €
Cost of capital (%)	5
Depreciation per year	**45,542 €**
Depreciation per part	**4.55 €**

Variable cost	
SMC BMC Compound unit cost (€/kg)	2
SMC BMC Compound per part	4.00 €
Number of operators at SMC BMC press	1
Number of operators at assembly, painting	1
Operator hourly rate incl. benefits (€/kg)	50 €
Number of operator hours (hrs)	333
Effective operator hours (hrs)	667
Labour cost	33,333 €
Labour cost per part	3.33 €
Cost of energy, utilities	0.22 €
Variable cost per part	**7.55 €**
Total part cost	**12.11 €**
Total part cost (incl. 30 % overhead, margin, risk, etc.	**15.74 €**

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2022

“Sustainable Living”

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SMC BMC Design Award

- Create ideas for new SMC BMC applications
  - Growing outside traditional applications of Transportation and Electrical
  - Better promotion of sustainability and recycling
- Increase awareness of designers about SMC BMC (and composites in general)
- Build stronger collaboration and professionalism in the supply chain
- Award criteria:
  - Creativity
  - End user functionality - Marketability
  - Feasibility in SMC BMC
  - Sustainability
- Two editions so far (2017 and 2019), new one in 2022

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Design Award 2019 was a Success

- Theme: Sustainable Mobility
- Participation of leading design schools
  - Netherlands, Belgium, Portugal, Finland, Spain, France, Germany
- Well-balanced Jury with designers and SMC experts
  - Joan Montobbio (Menzolit, Chairman)
  - Hubertus Rehermann (SMC at Daimler)
  - Andrea Ratti (Composites Design at Milano Politechnico)
  - Joachim Froment (Independent Designer)
- Great award ceremony in Stuttgart
  - Quality presentations
  - Presence composite industry
  - Finalists happy about event and award prize structure
- Good follow up with winner potentially leading to commercial success

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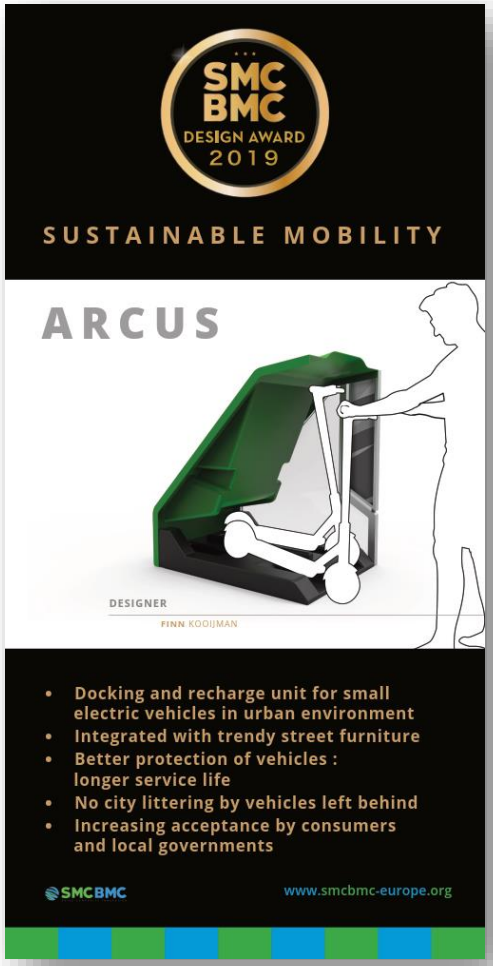
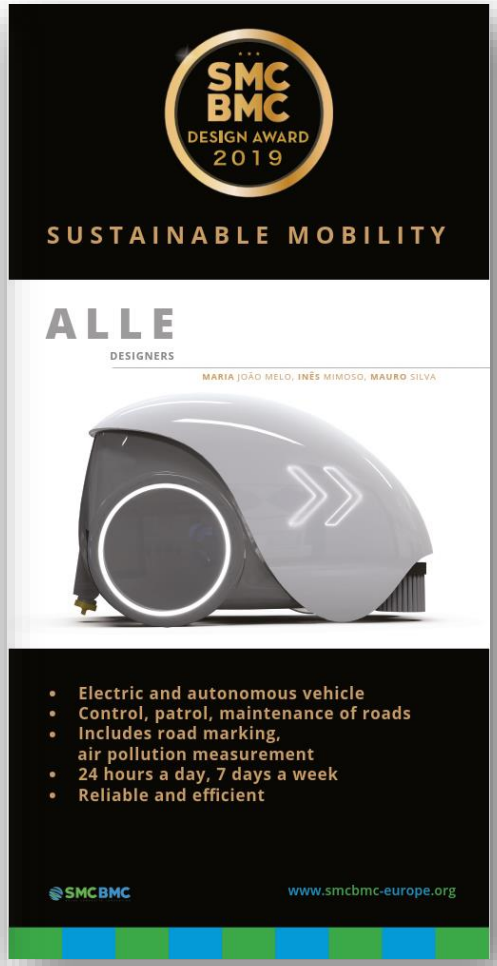
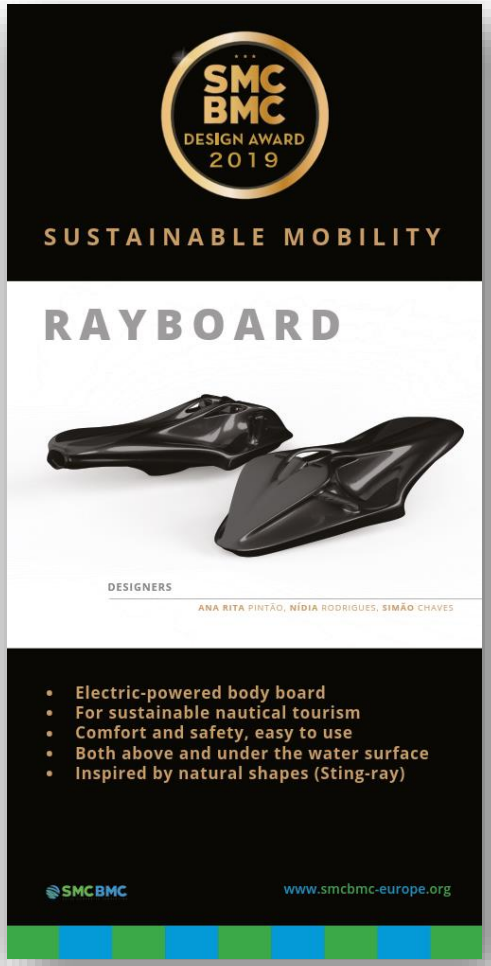
Great Projects with Potential







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Now Launching 2022 Edition

- Launch in January 2021
- Involve design schools/ universities:
  - Trainings, seminars at design schools by EA members
  - Involve molders and partners for student visits
- Project submission closure Dec 15, 2021
- Jury meeting Jan 2022
- Award ceremony likely in Mar 2022

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Solutions for Sustainable Living

- How to improve quality of life?
  - Population is growing, increased average age, longer working life, increased cultural diversity
- How do we live together after Corona?
  - More people in less space, promotion 15-minute towns, smart city solutions for better health
- How to significantly reduce environmental footprint?
  - Low cost to implement, solutions for mass vs. solutions for happy few, long lasting, requiring only limited space

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Expectations for Participants of the SMC BMC Design Award

- Define full list of key drivers and functional requirements, which you use as starting point
- Translate into part design: solution in SMC or BMC
- Explain the benefits of your design
- Demonstrate manufacturing-ability
- Convince us on market-ability and commercial viability
- Optional: structural analysis, costing

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What do we ask you to deliver?

- Power Point Presentation to explain your proposed design
  - Requirements, key choices made, benefits offered, manufacturing capability, commercial viability
  - Demonstrate that you meet the design criteria
  - In English language only
- One page word document accompanying the prototype
- One high resolution picture of your design (300 dpi min)
- If possible, send us a prototype of your design

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Award Criteria

Criteria	Description	Weight (%)
Creativity	Includes unique shape, aesthetics, functional integration	30
End user functionality - Marketability	Includes positive impact on consumer life, major improvement in functional performance, ability to market and demonstrate added value	30
Sustainability	Reduction of environmental footprint, low cost to implement, long lasting, solutions available for many people (not for happy few)	20
Feasibility in SMC BMC	Manufacturing ability, production feasibility in large production series, using at least 4 of the most important functional performance benefits of SMC BMC • Elevated strength and stiffness • Solutions for weight reduction • Precision and predictability of dimensions • Great Class A surface • Resisting elevated temperatures • Part safety through great Fire resistance • Electrical insulating performance • Low emissions from the parts after moulding	20

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And the prize …

- Gold award: 7,500 € in cash/ 7,500 € in coaching
- Silver award: 1,500 €
- Bronze award: 1,000 €
- Participation in award ceremony
  - Tickets paid for 2 members per finalist team
- Exposure to Composites trade press
- Advice on product commercialization
  - Follow-up workshops with Finalists: Marketing, Design, Manufacturing, Business opportunities

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Training sessions available for you

(at our premises or at your place depending on nr. of participants)

- Examples of part designs in SMC and BMC
- Some of the design details important for these materials ("do's and don'ts")
- Typical requirements and end-customer expectations
- Overview of the design process: how does it work in real life?
- Simple costing model
- Manufacturing and scale-up considerations

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Coaching for the winner team

- To provide to the Gold Winner advice on their design pertaining to improving their design, engineering and marketing the product.

Design	Material expertise	Business Development	Marketing	Finance	Manufacturing
Feasibility	Compound	Attractiveness	Presentations	Cost Model	Cost effective
Industrial expertise	Norms	Market assessment	Promotion	Business Model	Lean operational model
Simulation	Quality	Positioning	Communication	Structure	Industrial expertise

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Your contacts for local follow-up

Country	Contact	Email
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More information

- Please check out our web site for details
  www.smcbmc-europe.org
- Registration for the award on
  http://smcbmc-europe.org/award.php
- SMC BMC Design information can be found in our Design Manual, available through
  www.smcbmc-europe.org/publications.php

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How Will You Use SMC BMC?

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Thank You for Participating in the SMC BMC Design Award 2022