COMPOSITE MATERIAL PARTS IN RENAULT CARS : THE PAST, THE PRESENT AND THE FUTURE

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In this presentation, I would like to present some applications for composite materials (thermoplastic and thermoset) in Renault cars, especially for large series vehicles.

My proposed outline is as follows:

- First of all, I would like to make some comments on **customer perception**, based on an ESTEL survey conducted of 400 new-car buyers and to give an overview of composite materials used in Renault cars.

- Then, I would like to spend some time explaining why composite materials have been used and where these materials have been used : that is to say the **past situation since over 30 years.**

- Next, I will give several examples of what Renault is using nowadays : **the present and current uses and developments going on.**

- Lastly, I will try to explain what will be **the future of composite materials** and what we need to increase new applications.

- **Customer perception** : During the ESTEL survey 4 main questions were asked to customers :

1. "What score, on a scale of 1 to 10, would you give to plastics for different characteristics ?" (safety, reliability, corrosion …).
2. The same question for the same characteristics, but comparing steel, aluminum and plastic.
3. "Did exterior materials influence your choice of model ?"
4. "In the future, which materials do you think will be increasingly used for car exteriors ?"

The answers show that the customer perception of different materials is quite reasonable, that materials are not the decisive factor to choose one car among another and that plastic is overwhelmingly seen as the material of the future, aluminum and especially steel are left far behind.

- **Overview of composite materials in Renault cars** : a breakdown of the different materials used in a car will give an idea of the weight ratio of ferrous, non ferrous, mineral and organic materials used in an average car.

- **Why composite materials have been used since 30 years ?**
  The main reasons are : weight saving to reduce gas emissions and fuel consumption, safety, cost reduction and customer's needs.

- **Where composite materials have been used since 30 years ?**
  Some examples of applications since 30 years will be described.

- **The present and current uses and developments going on.**
  A breakdown will show the main functions where composite materials are used today in a car and some examples will be outlined and explained.
  The current developments in composite materials will be discussed, especially the trend to go from current semi structural applications to structural applications : we need new composite materials, new composite manufacturing technologies and new composite design developments. An example of the development of a "high speed" RTM process will be given through the TECABS project.

- **The future of composite materials** : to increase the use of composite materials the part manufacturers will have to increase part quality, to have a better knowledge on composite material behavior, to improve manufacturing processes and to develop accurate calculation tools. On the other hand car manufacturers will have to work on how to introduce composite parts in the manufacturing car process and to develop joining technologies compatible with multi-material cars.
  Both we will have to work on recycling and waste management solutions.

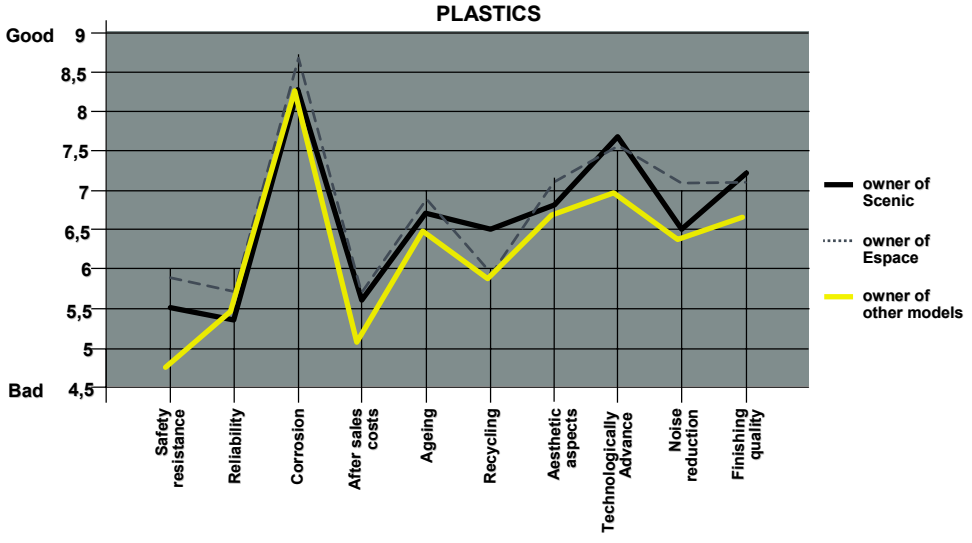
In the conclusion, I will outline that the use of composite materials has increased by 200 % over 30 years, a strong potential still exists for structural parts but metallic materials, aluminum and magnesium, are severe competitors and that we have to overcome two main drawbacks of composite parts : recycling and cost.

Summary

- Custumer perception of materials
- Overview of composite materials in Renault cars
- Why composite materials have been used since 30 years ?
- Where and how composite materials have been used since 30 years ?
- Main functions where composite materials are used today
- Current developments going on
- The future of composite materials : how to increase their use ?
- Conclusion

CUSTOMER PERCEPTION OF MATERIALS

Which mark would you give to plastics related to …?



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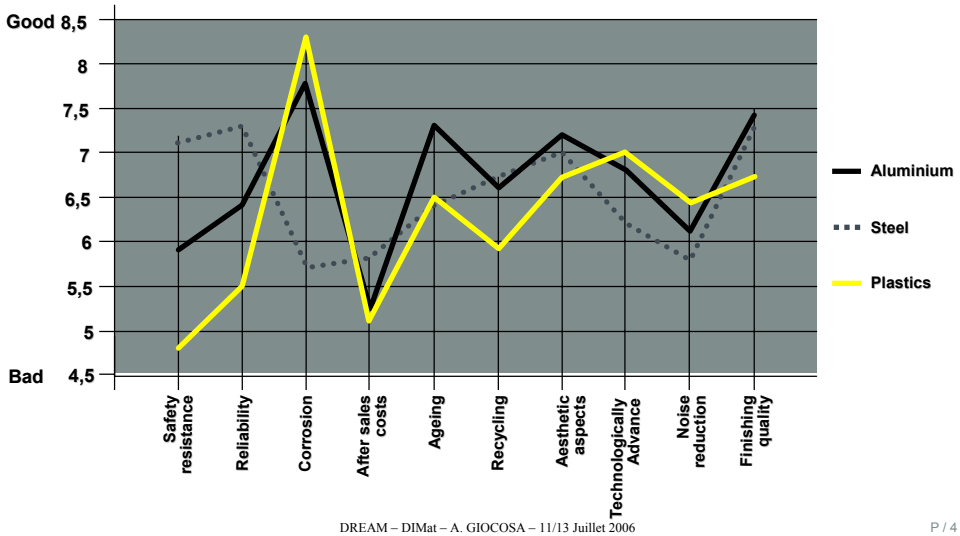
CUSTOMER PERCEPTION OF MATERIALS

Which mark would you give to steel, aluminium, plastics related to …?



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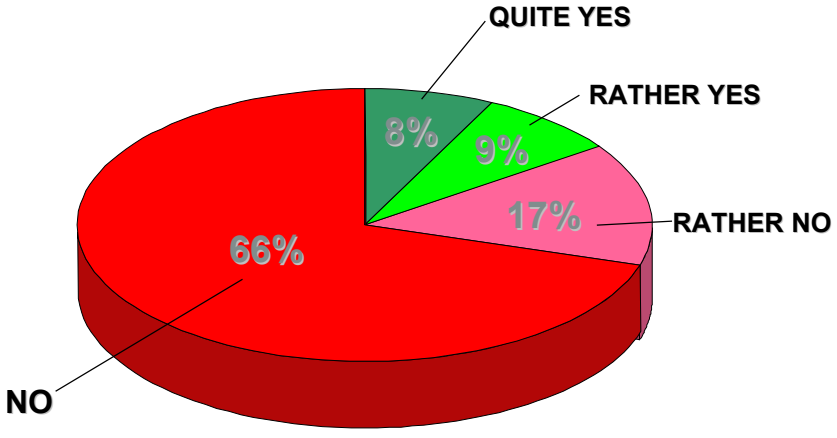
CUSTOMER PERCEPTION OF MATERIALS

DID EXTERIOR MATERIALS INFLUENCE YOUR CHOICE OF MODEL ?



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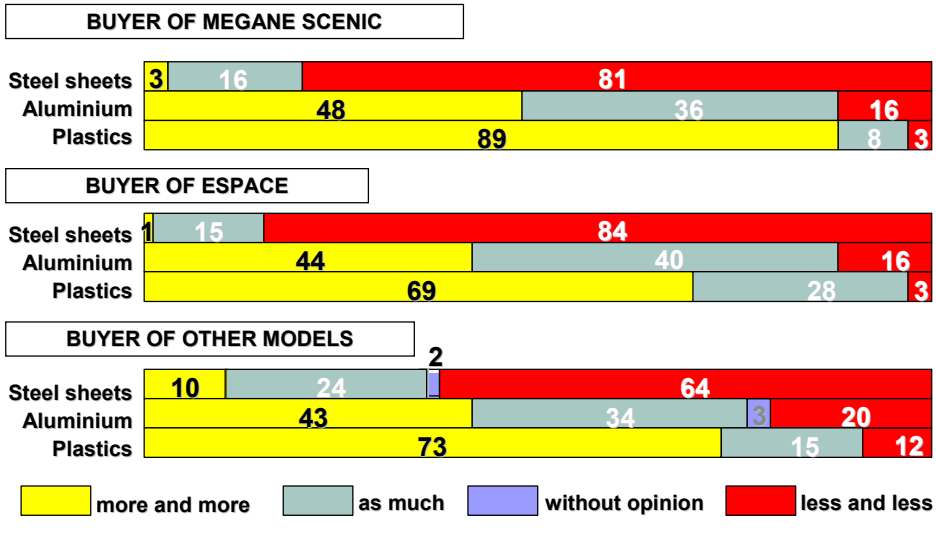
CUSTOMER PERCEPTION OF MATERIALS

IN THE FUTURE, WHICH MATERIALS DO YOU THINK WILL BE INCREASINGLY USED FOR CAR EXTERIORS ?



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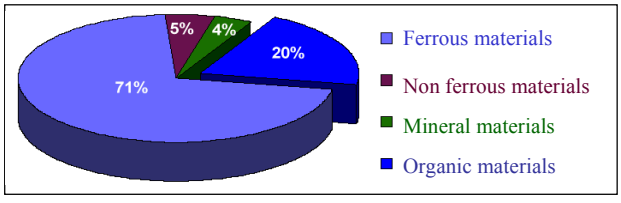
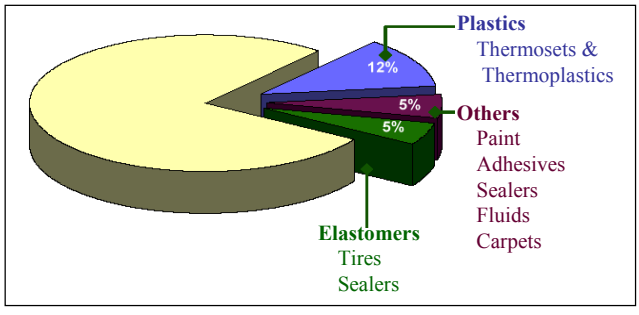
Overview of composite materials in Renault cars



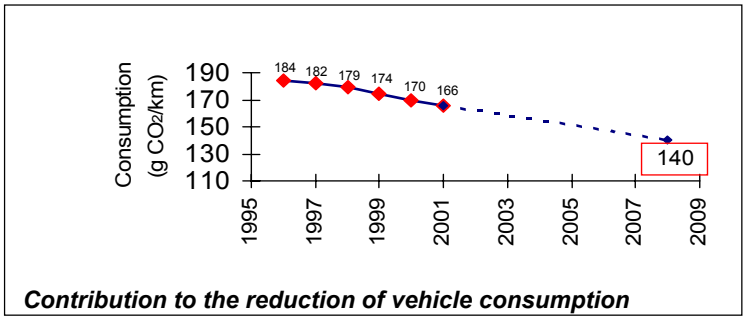
Weight ratio of materials in a car

Weight ratio of organic materials in a car



Why composite materials have been used since 30 years ?

- **Reduction of gaz emissions - Fuel consumption**
  - ***Reduction of CO_2 emissions (CAFE)***



Contribution to the reduction of vehicle consumption

Source ACEA

Gain of composite materials = Reduction of vehicle weight
100kg saved = Decrease of 0.4 l/100km (stabilized speed)

Why composite materials have been used since 30 years ?

◆**Vehicle safety**

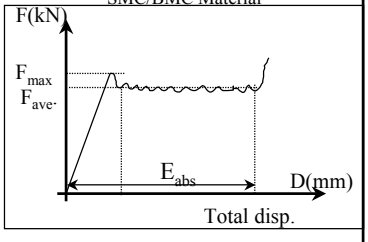
– ***No damage at low speed crash (4km/h)***

– ***New regulation concerning pedestrian impact***
Low pedestrian damage during crash

– ***Low repairing costs***

Removable crash area

Energy absorption curve of a SMC/BMC Material



Why composite materials have been used since 30 years ?

◆ **Cost Reductions**

– ***Increase of version number per vehicle model***

New Renault Megane : 5 different rear floor pans for 7 models

➡ *Reduction of the production volumes per model*

– ***Low tooling cost (for low to medium production volumes)***

– ***Simplification of manufacturing processes***
No machining processes
Multifunctionnal parts

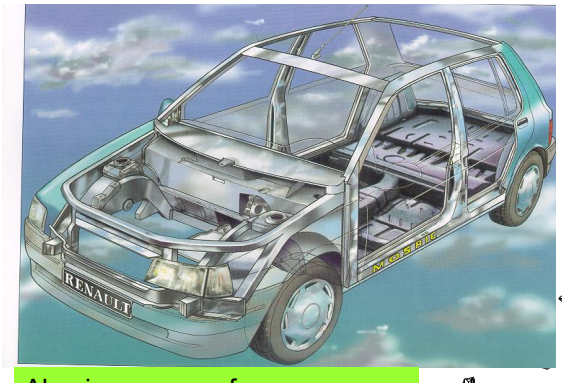
Why composite materials have been used since 30 years ?

- **Customer's needs**
  - ***Low cost in use***
  - ***Safety, Comfort, Reliability***
    Increase of constructor warranty (2 years --> 12 years)
    Fatigue properties increased with composite materials
  - ***Image and new services***

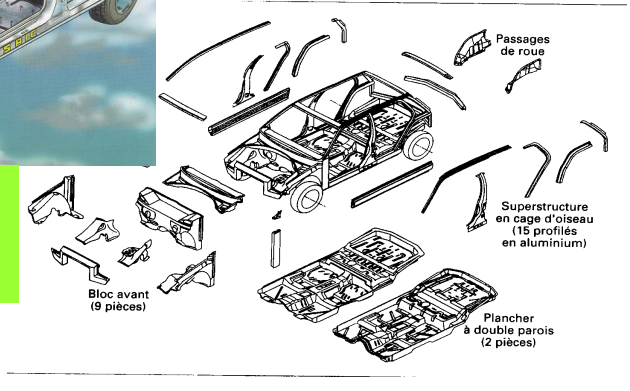
Vel Satis tailgate

Renault Kangoo : under roof boxes

Where and how composite materials have been used since 30 years ?



MOSAIC Project 1994



Aluminum space frame
Extrusion and cast node
Composites Integrated panels
Riveting + Adhesive bonding

Weight saving 20%
Overcost 20-40%

Where and how composite materials have been used since 30 years ?

◆ **SMC bumpers evolution**


R5, bumpers & trims


R15, bumper


R14, bumpers


Fuego, bumper


R25, bumpers & trims

Where and how composite materials have been used since 30 years ?

◆ **SMC body panels painted at low temperature**


Alpine A610


Espace 2


Espace 3 (except bonnet)


Avantime

Where and how composite materials have been used since 30 years ?

- **SMC/BMC components evolution**

1972 - Bumpers & trim unpainted part

1983 - SMC body panels Painted at low temperature

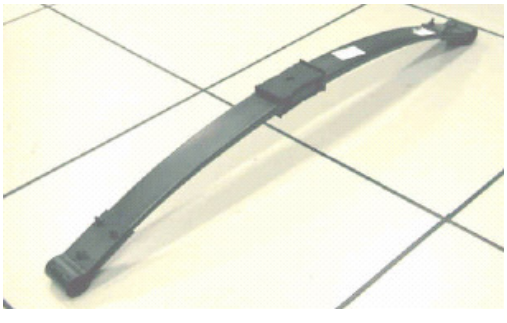
2000 - SMC tail gate Painted off line

2001 - SMC fenders Painted on line

Where and how composite materials have been used since 30 years ?

Trafic rear spring leaf :
- Weight saving : from 15 to 20 kg,
- Same cost / double steel spring leafs
- pre-preg epoxy glass LF (50/50 vol).

New transversal front suspension :
- epoxy – glass fabric,
- “High speed” RTM.



Main functions where composite materials are used today

◆ **Today's distribution of composite materials in a car**

• Interior accessories	50%
• External accessories	20%
• Under hood applications	15%
• External body panels	10 - 15%
• Structural applications	0 - 5%

Main functions where composite materials are used today

◆ **Composite materials for interior applications**

Clutch pedal
PA +GF

Roof panel
PP + Nat. Fib. or GF

Dash board structure
TP + fillers or GF

Door panel
TP + Wood

Main functions where composite materials are used today

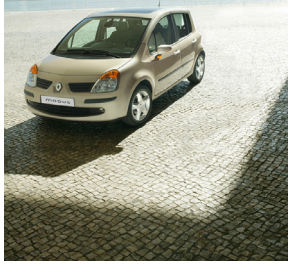
◆ **Composite materials for exterior applications : SMC and TP fenders**

SMC fenders
Medium production volume cars

ThermoPlastic fenders
High production volume cars

Main functions where composite materials are used today

◆ **Thermoplastic fenders across the range**



Main functions where composite materials are used today

◆ **Composite materials for exterior applications : SMC / BMC tailgates**

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Main functions where composite materials are used today

◆ **Composite materials for exterior applications : Scénic RX4 hybrid tailgate**

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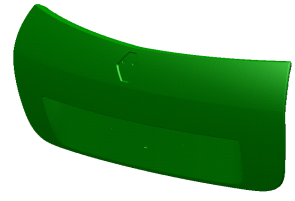
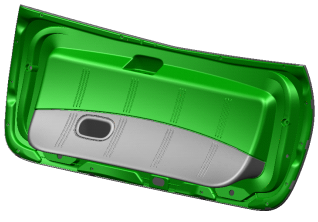
Main functions where composite materials are used today

◆ **Composite materials for exterior applications : Modus split tailgate**





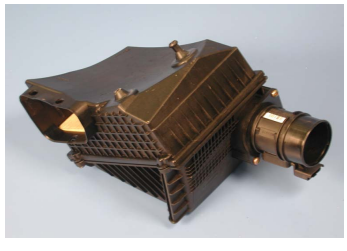
- **Skin panel painted Polypropylene (same as bumper)**
- **Inner panel GF reinforced PP – grained and bulk colored**
- **Additional element PP – grained and bulk colored (same as interior panels).**

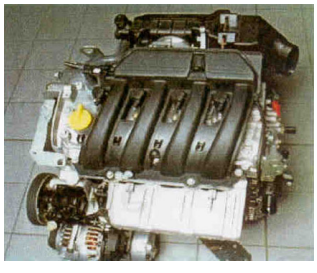
Main functions where composite materials are used today

◆ **Composite materials for under the hood parts**

Under engine protection
PP + GF

Air filter
PA+GF





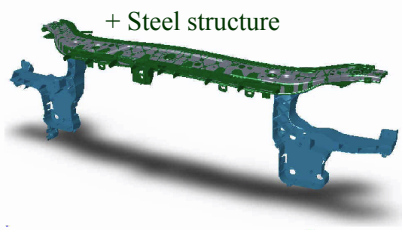
Intake manifold
PA + GF
Cost reduction : 30%
Weight reduction : 30%

Main functions where composite materials are used today

◆ **Composite materials for structural parts**

Rear floor pan (Mégane 2)
Low density SMC

Technical front end (Mégane 2)
PA+GF
+ Steel structure



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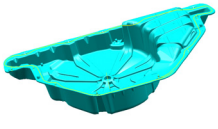
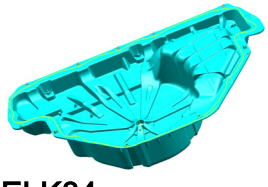
Main functions where composite materials are used today

◆ **Rear floor pan modularity (Mégane 2)**



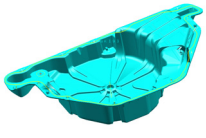
BC84

Rear overhang : 742mm



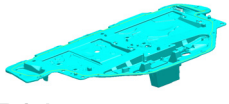
ELK84

Rear overhang : 970 to 991mm



J84

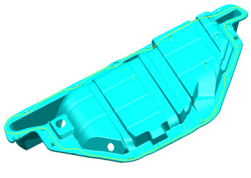
Rear overhang : 723mm



R84

Rear overhang : 906mm

Steel reinforced



B84 LPG

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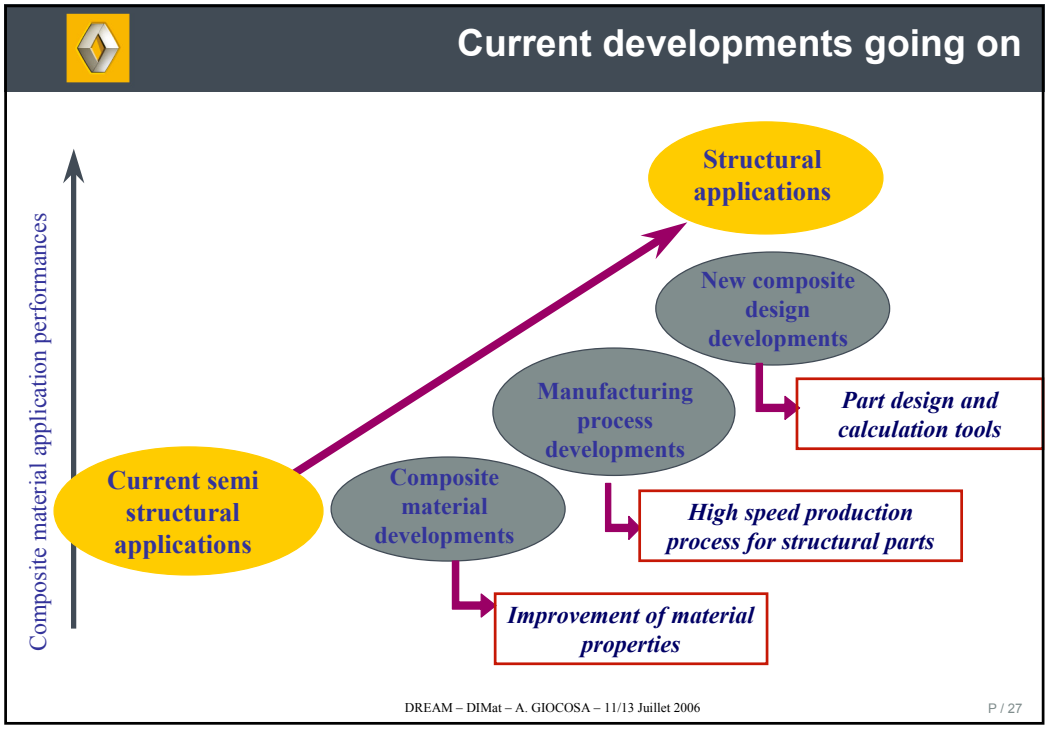
Current developments going on
Composite material application performances
Structural applications
New composite design developments
Manufacturing process developments
Part design and calculation tools
Current semi structural applications
Composite material developments
High speed production process for structural parts
Improvement of material properties
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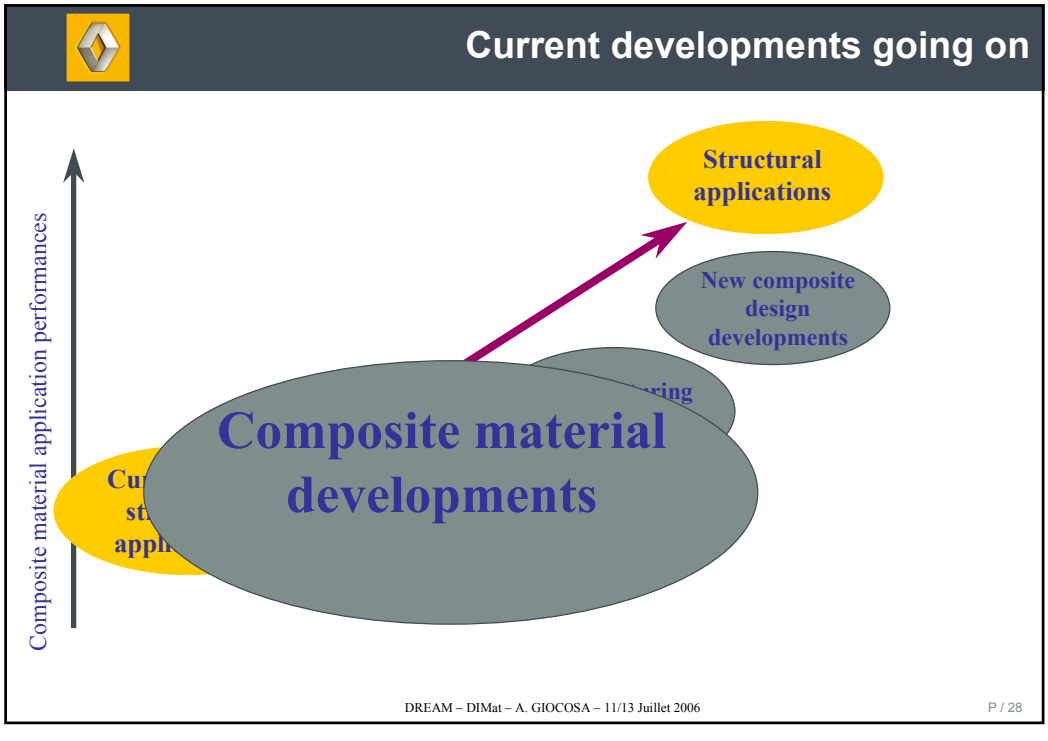
Current developments going on
Composite material application performances
Structural applications
New composite design developments
Composite material developments
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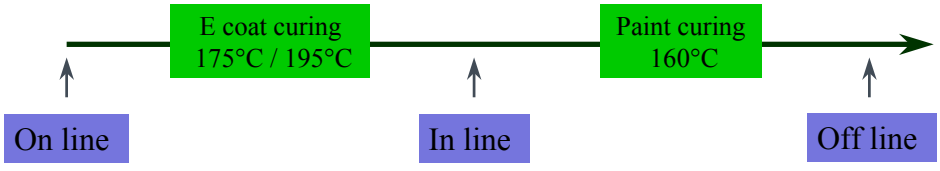
Current developments going on

◆ **New composite materials : Targets**

- ***Costs effective parts***
- ***Improvement of composite part properties***
- ***Introduction of composite parts in the car manufacturing process***

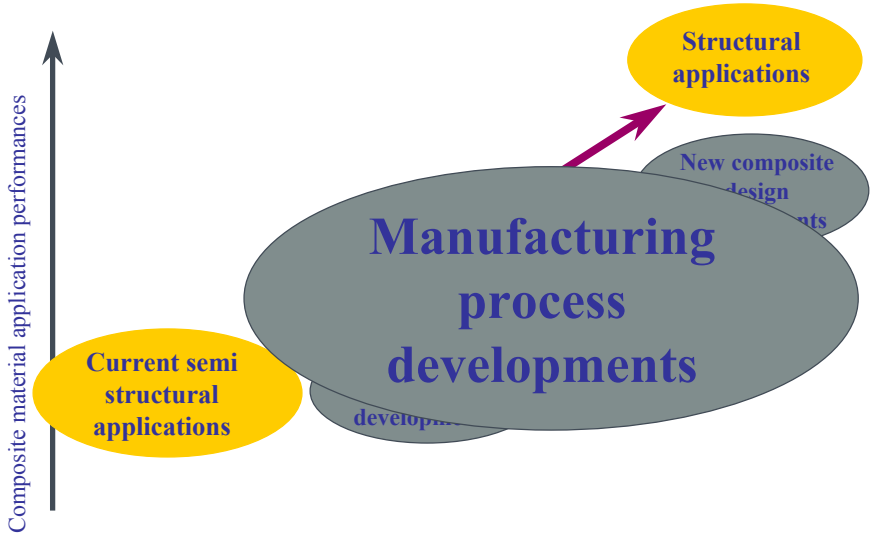


Current developments going on

◆ **New composite materials : Some examples**

- ***Composite materials reinforced with nano fillers***
  Introduction of mineral nano fillers or carbon nano tubes in TP matrix
  Semi structural applications (body panels, under the hood parts)
- ***Composite materials reinforced with natural fibers***
  Introduction of natural fibres (Hemp, flax ...) in TP and thermoset matrix
  Semi structural applications (Interior applications)
- ***Composite materials reinforced with carbon fibers***
  Introduction of short carbon fibres, or carbon fibre fabrics
  Structural parts (floor pans, cross beams, Body In White parts …)
  Semi structural parts (openings)

Current developments going on



Current developments going on

- **New composite manufacturing technologies : Targets**
  - ***Cost effective process***
    Integration of functions
    Waste reduction
  - ***Production of structural composite parts***
    Use of long fibre reinforcements and fabrics
  - ***At least medium production volumes (100 - 700 parts / day)***
  - ***Production of high quality composite parts***

Current developments going on

- **New composite manufacturing technologies : Research area**
  - ***Manufacturing process***
    New manufacturing tools
    Improvement of process parameters
  - ***Process calculation tools***
    Selection of the best manufacturing strategy
    Reduction of development duration
    Reduction of prototyping step
  - ***Improvement of material processability***
    Resin reactivity
    Fabric drapability

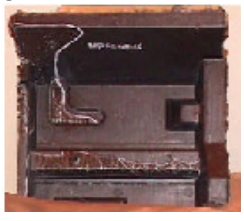
Current developments going on

- **New composite manufacturing technologies : Development of a «High Speed» RTM process**
  - ***High fibre ratio (up to 50%)***
  - ***Use of carbon fibre reinforcements***
  - ***Complex shape : part with hollow cores***
  - ***Improvement of injection step***
  - ***Improvement of resin curing***
  - ***Production time < 10 min***

Part developed in the TECABS project

Current developments going on

- **New composite manufacturing technologies : Process calculation tools**
  - ***Material behavior description***
    Definition of local material properties
  - ***Strong impact of part structure***
    Geometrical singularities
    Structural singularities (sandwich structures ...)
  - ***Influence of material properties evolutions***
    Viscosity,
    Fibres / matrix segregation (SMC)



From TECABS project

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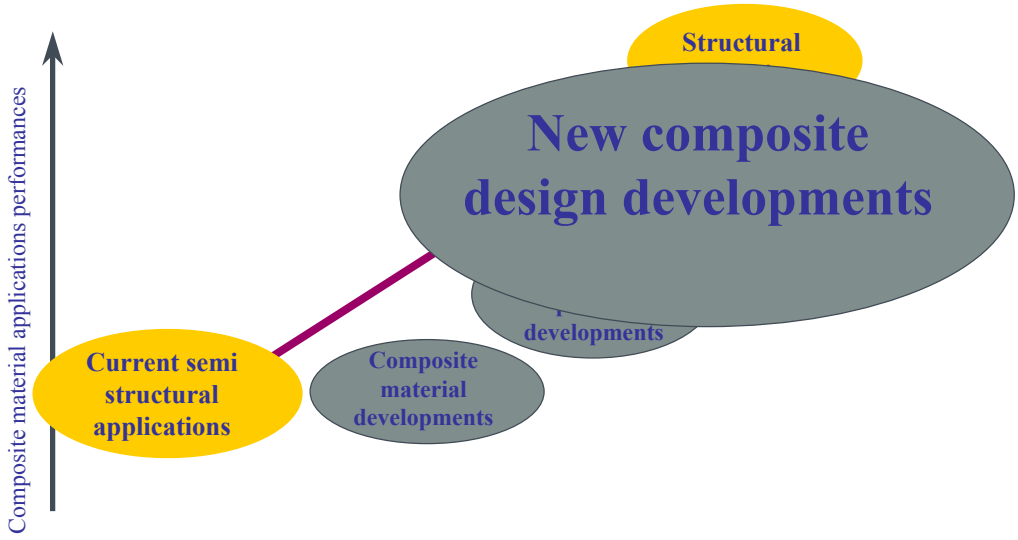
Current developments going on



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Current developments going on

◆ **New composite design developments : Targets**

- *Lightweight innovative composite parts*
- *Increase performance part versus metallic solution*
- *Improvement of calculation tools for designing composite parts*

Current developments going on

◆ **New composite design developments :**

- **Tailgate with carbon fibre reinforced materials**

	Weight saving (%)
Steel version	Ref
SMC reinforced GF version	15%
SMC reinforced CF version	25%

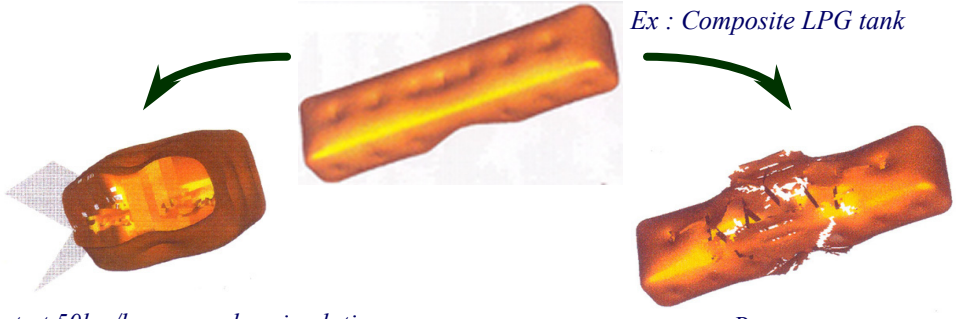
- **Structural rear floor pan**

	Weight saving (%)	Cost
Steel version	Ref	1
Metal / composite version	15%	1
Composite reinforced GF version	38%	1.2
Composite reinforced CF version	47%	2.2

Current developments going on

- **New composite design developments : calculation tools**
  - ***Virtual validation of composite part behavior***
    Static behavior
    Dynamic behavior

Ex : Composite LPG tank



Impact at 50km/h on an edge simulation

Burst test

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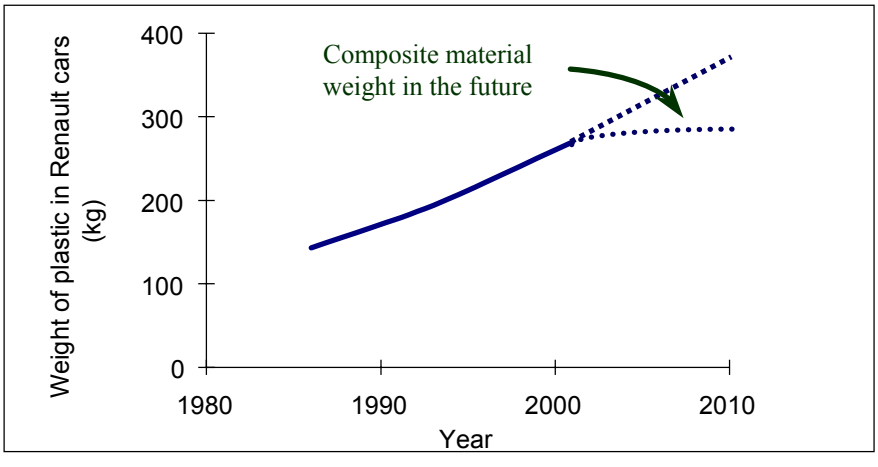
The future of composite materials

- **Trend of composite materials evolution in the automotives**



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The future of composite materials

◆ **How to increase the use of composite materials ?**

- **Improvement of part quality**
  Improvement of surface aspect for body panels applications
  (SMC parts)
- **Better knowledge on composite material behavior**
  Dynamic behavior
  Durability
- **Manufacturing processes**
  Reliable manufacturing process
  Good part quality
- **Accurate calculation tools**
  Overall trend : increase of virtual prototypes

The future of composite materials

◆ **How to increase the use of composite materials ?**

- **Introduction of composite part in the manufacturing car process**
  No influence on the manufacturing car process
- **Development of multi-material joining**
  Strong joining for structural applications
  Removable assembling techniques (After Market ...)
- **Reduction of material costs**
  Case of High Tow Carbon Fibres
  Today : 12 - 17 Euros / kg
  Future : 8 - 10 Euros / kg ??

The future of composite materials

◆ **How to increase the use of composite materials ?**

- **Recycling Aspects**
  - ***End of Life Vehicle (ELV) European directive for 2015***
    - 95% of the vehicle by weight should be re-used or recovered
    - 5% of vehicle by weight could go to landfill
    - 10% of vehicle by weight could be incinerated
  - ***Development of recycling and waste management solutions***
    Cost effective recycled materials
    Cost effective waste treatments

Conclusion

- **The use of composite materials has increased by 200% over 30 years.**
- **A strong potential still exists for structural parts but the introduction of composite materials is difficult.**
- **The introduction of composite materials in a new vehicle project is long : complete development needs 10 years.**
- **Steel, Aluminum, Magnesium, are severe competitors of composites.**
- **The choice of a car manufacturer takes into account the part requirements and costs and NOT the material.**