INNOVATIVE TEXTILE TECHNOLOGIES FOR THERMOPLASTIC COMPOSITE MATERIAL
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\textsuperscript{6} ALSTOM Transport, 48 r Albert Dhahene, F-93400 Saint Ouen, France
MAPICCC Project

- **Objective**: One-shot Manufacturing on large scale of 3D up graded panels and stiffeners for lightweight thermoplastic textile composite structures

- **Total costs** (€): 9,013,875.80
- **Duration**: 48 months  Period : December 2011 – December 2015
- **Partners**: ENSAIT, COEXPAIR, MECACORP, POLIMI, TUD, ARMINES, ESI GROUP, TTF, STEIGER, ALSTOM, RTU, REDEN, FINERIS, VOLVO, ESI-GMBH, TENCATE, GSD.

- **WP1**: Project management – financial and administrative
- **WP2**: Specifications for the development of demonstrators and specifications for raw materials
- **WP3**: Development of 3D shape preforms in one step for panels and stiffeners at pilot scale
- **WP4**: Enhancement of simulation tools to model processes and predict mechanical characteristics
- **WP5**: Development of automated systems and quality system to produce up graded preforms
- **WP6**: Implementation of 2 demonstrators, integration of automatic equipment systems, and modelling tools
- **WP7**: Demonstration of automated production process to manufacture: panels and stiffeners
- **WP8**: Dissemination, IPR, exploitation plans
## MAPICC Solutions (WP3) pilot scale development

<table>
<thead>
<tr>
<th>End Users</th>
<th>MAPICC solutions (pilot scale)</th>
<th>Industrial Partner</th>
</tr>
</thead>
<tbody>
<tr>
<td>AUTO-MAPICC</td>
<td><img src="image1.png" alt="Image" /></td>
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<td>TRUCK-MAPICC</td>
<td><img src="image2.png" alt="Image" /></td>
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<tr>
<td>RAIL-MAPICC</td>
<td><img src="image3.png" alt="Image" /></td>
<td>ALSTOM</td>
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</tbody>
</table>

Same initial raw material: commingled E-glass/PP or E-glass/PA
AUTO-MAPICCC. Development of new thermoplastic composite oil pan to obtain lightweight and thermo-resistant solution

3D Thermoplastic (E-glass and polypropylene) textile fabric

IR heating system

Final oil pan part made with thermo-formed 3D warp interlock fabric and over-moulded with polyamide resin to obtain external ribs.
AUTO-MAPICC. Simulation tools to model textile process and predict mechanical characteristics

Modelling of the oil pan final part has been optimized in weight with respect to the mechanical stress distribution and final volume.

Simulation results helps to predict the fabric behaviour during the thermo-forming step.

Modelling of the 3D warp interlock weave diagram (left picture) can be done by simulation of the weaving process to obtain a more accurate 3D woven structure (middle picture). Thermoplastic yarn has been modelled at a micro scale by integration of 30 filaments (right pictures).
AUTO-MAPICCC. Development of 3D shape preform of oil pan using 3D warp interlock weaving technology

A 3D warp interlock fabric with thermoplastic yarns (E-glass and polypropylene) has been produced and optimized at a pilot scale.
AUTO MAPICC. Development of 3D shape preform of oil pan using 3D warp interlock weaving technology

Different dry preform shapes (hemispherical and gusset) have been done in one step production.

Monitoring of dry preforming step has been achieved with sensor yarns inserted in the 3D warp interlock fabric.
## AUTO-MAPICC: Technical data sheet and engine hood industrial stamping

<table>
<thead>
<tr>
<th>Numbers of prototypes</th>
<th>Warp /Weft density (yarns/cm)</th>
<th>Surface weight (g/m²)</th>
<th>Thickness (mm)</th>
<th>Number of layers</th>
<th>Number of frames necessary</th>
<th>Yarn used</th>
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</thead>
<tbody>
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<td>4014</td>
<td>4.3</td>
<td>4</td>
<td>24</td>
<td>Twintex 1100 dTex</td>
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</tbody>
</table>
TRUCK MAPICC. Development of new thermoplastic composite seat frame to replace existing metallic part and obtain lightweight and crash resistant solution

Thickness optimisation based on composite (PP/GF) knitted behaviour
TRUCK MAPICC. Development of 3D shape preform of seat reinforcement using 3D warp interlock weaving technology

Dedicated patterns of 3D warp interlock fabric (right) with thermoplastic yarns (E-glass and polypropylene) have been dry-formed in one step of production and consolidated by thermo-forming process.
TRUCK MAPICC. Development of 3D shape preform of seat reinforcement using 3D warp interlock weaving technology

Dedicated patterns of 3D knitted structure (left) with thermoplastic yarns (E-glass and polypropylene) have been dry-formed in one step of production and consolidated by thermo-forming process.
# TRUCK MAPICCC. Technical data (WP3)

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<th>Yarn used</th>
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</thead>
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<tr>
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<td>Depending of the area</td>
<td>1187</td>
<td>2,8</td>
<td>Depending of the area</td>
<td>24</td>
<td>E-Glass / polypropylene 842 Tex hybrid yarns</td>
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</tbody>
</table>
RAIL MAPICC Solution tubular cross made with commingled yarns

One piece woven in 3D warp interlock fabric

Forming process
**RAIL MAPICC. Technical data (WP3)**

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<td>2</td>
<td>3</td>
<td>24</td>
<td>Twintex 1100 dTex</td>
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<tr>
<td>7 (dry)</td>
<td>12/9</td>
<td>1613</td>
<td>2 (dry)</td>
<td>3</td>
<td>24</td>
<td>E-Glass / polypropylene 842 Tex hybrid yarns</td>
</tr>
</tbody>
</table>
RAIL MAPICC _ Modification of the design
RAIL MAPICC. Cross stiffener produced by over braiding

- Step one: production of braided stiffener
- Step two: assembly stiffeners
RAIL MAPICC. Mandrel over-braiding for cross stiffener

- **Water soluble mandrel:**
  - PVA based glue: 17 wt% PVA into water,
  - Sand/PVA mix: 3 wt% of glue,
  - Dried at 85°C for 8 hours.

- **4 layers overbraiding with constant take-up speed:**
  - Take-up speed: 7mm/s
  - Rotational speed: 2 tr/min
RAIL MAPICC. Thermo-consolidated cross stiffeners
## MAPICC Solutions. TRL level estimation

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<th>TRL estimation</th>
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<td>TRL 4 – 5</td>
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<tr>
<td>TRUCK-MAPICC</td>
<td>![Image]</td>
<td>TRL 3 – 4</td>
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<tr>
<td>RAIL-MAPICC</td>
<td>![Image]</td>
<td>TRL 3 - 4</td>
<td>![Image]</td>
<td>TRL 5 - 6</td>
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Acknowledgments

• This study has received the support from the European Commission through the large-scale integrating collaborative project MAPPIC 3D - number 263159-1 - and entitled: One-shot Manufacturing on large scale of 3D up graded panels and stiffeners for lightweight thermoplastic textile composite structures.

• Thank you for your attention