Automated Cutting & Stacking Cell for Dry Fiber Textile Reinforcements (GF/CF) in Automotive and Aerospace Applications

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technological approach
Cutting & Stacking Cell
Lightweight design with Fiber Reinforced Plastics (FRP)

- Necessity for lightweight design in the automobile industry
  - Reduction of CO2-emission until 2021
  - Trends: electric mobility, hybrid drives, etc.

- Lightweight strategy: Composite construction
  - High-strength steels, Aluminium, Magnesium alloys
  - Fiber reinforced plastics (CFRP, GFRP, ...)

- Premise: Availability of automated manufacturing processes
  - Conflict area: weight reduction ↔ arising costs

Source: VW AG

Big potential for weight reduction in transport industry

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Approach

Cutting
- Textiles
- Non Wovens
- Pre-Consolidated Layups
- Prepregs
- SMC

Stacking
- Taylored Fiber orientation
- Local Patches

Prefoming
- Binder activation
- Active wrinkle prevention

Resin Transfer Molding

Wet Compression Molding
Objective in Stacking

- The target is to cut and stack several layers of various materials quickly but precisely.
- The result is a multilayer and multiaxial stack.
Cutting Unit

- active blade wear measurement
- material position sensing
- material flow count
- unwinding slip compensation
- exchangeable cutting heads
- adaptive nesting algorhythm
- active belt guiding control
- automatic table calibration
- continuous material traceability
- material flow count
- active blade wear measurement
- material position sensing
- material flow count
- unwinding slip compensation
- exchangeable cutting heads
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Exchangeable Cutting Heads

Quick Exchange System

- Ultra Sonic vibrating blade
- undriven wheel blade
- driven rotary polygon blade
- robot calibration pin
- table calibration
Material Position Sensing

Sensors allow for fast and precise measurement relative to the cutter table of:

- materials position \((x, y)\)
- material angle \((\varphi)\)

![Diagram of sensor, cutter table, and material with coordinates \([x, y, \varphi]\)](image)

Bar chart showing accuracy in mm for different materials:

- GF woven
- CF +/-45
- CF 0/90
Stacking Unit

Flexible Gripper System

- Needle gripper
- Vacuum grippers
- Material detection
- Online size adjustment
Fixation of Stacks

- Automated fixation of the stacks by local Ultrasonic welding spots allow for handling operations and transport.
- Automated labeling of the stacks guarantees traceability of the parts.

US welding spot  
Label on CF-parts  
Welding and Labeling Table
Adaptive Nesting Algorithm

**Material definition**
material-related definition of cutting parameters

**Stacking definition**
Logical and easy data input to define each stack

**Nesting**
Optimized Nesting for perfect material usage of each cutter

**Production process improvement**
Automatic optimization of overall process including all cutters and robots
Adaptive Nesting Algorhythm

Automatic setting of parameters by the algorhythm for:

- cutters
- robots
- gripper
Layout of an Existing Aerospace Stacking Center

- 6 Cutting Units
- 1 Stacking Robot
- 1 Highly flexible Gripper
- 1 Welding and Labeling Table

Produced by Schmidt & Heinzmann
Central control unit manages all cutters directly for optimized process and includes nesting of each cutter.
Case Study: ROI based on Labor cost

<table>
<thead>
<tr>
<th>Production specification</th>
<th>Manuell</th>
<th>Automatic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amortization Period</td>
<td>a 6</td>
<td>6</td>
</tr>
<tr>
<td>Investment</td>
<td>US$ 600,000</td>
<td>1,400,000</td>
</tr>
<tr>
<td>Amount on shifts</td>
<td>- 3</td>
<td>3</td>
</tr>
<tr>
<td>Amount on hours per day</td>
<td>h/d 8</td>
<td>8</td>
</tr>
<tr>
<td>Hourly wages</td>
<td>US$/h 18</td>
<td>25</td>
</tr>
<tr>
<td>Number of cutting tables</td>
<td>- 6</td>
<td>6</td>
</tr>
<tr>
<td>Number of workers per table</td>
<td>- 1.5</td>
<td>0.33</td>
</tr>
<tr>
<td>Number of stacking/labelling</td>
<td>- 1</td>
<td>1</td>
</tr>
<tr>
<td>Number workers per table</td>
<td>- 3</td>
<td>1</td>
</tr>
<tr>
<td>Wages per day</td>
<td>US$ 5,184</td>
<td>1,788</td>
</tr>
<tr>
<td>Working days per year</td>
<td>- 235</td>
<td>235</td>
</tr>
<tr>
<td>Working days per month</td>
<td>- 19,58</td>
<td>19,58</td>
</tr>
<tr>
<td>Wages per year</td>
<td>US$ 101,520</td>
<td>35,015</td>
</tr>
</tbody>
</table>

**ROI after 15 month**

![Graph showing ROI](image)
Variety of Materials can be processed

- GF Fabric Rolls
- CF Fabric Rolls
- Foam
- Prepregs
- Honeycomb
- Metal Mash Sheets
Potential Application in Automotive Parts

- Roof Cover
- Hoods
- Underbody parts
Process Simulation

Features:
- Early stage cycle time calculation in the conceptional phase
- Parametric models helps to generate quick 3D Layout, which will be close to the final setup later
- Models can be modified in size and function very easy during the project phase

Advantages:
- Reachability of the robots
- Identification of the bottle neck process
- Complete visual process available
Virtual Start-up & Commissioning

Features:
- Virtual start-up & commissioning of the line
- PLC program operates the simulation model on the PC
- Virtual simulation can operate all actors/axes in order to check the correct function → virtual I/O check

Advantages:
- Debugging of the program before the line is installed
- Simultaneous engineering possible
- Complex processes can checked easily on misfunctions
Virtual Setup of the plant / line

Features:
- Virtual setup of the line
- Walking through the complete line in virtual reality
- Virtual plant after a cloud measurement

Advantages:
- Real dimension of the line in virtual reality
- Organizing the plant/line setup with a pick and place tool
- Reduce the pinch points
# Summary of Advantages

<table>
<thead>
<tr>
<th>Machine Features</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Each cutter only uses 1 material, no change!</td>
<td>Continuous production, stable and high availability</td>
</tr>
<tr>
<td>Universal gripper system with advanced needle/vacuum modules</td>
<td>Fast product change, during process needle modules on/off following different shapes</td>
</tr>
<tr>
<td>Sensors for:</td>
<td>Stabilized production process and self regulation for best quality</td>
</tr>
<tr>
<td>– Material edge detection</td>
<td></td>
</tr>
<tr>
<td>– n.io sign detection</td>
<td></td>
</tr>
<tr>
<td>– Material feeding supervision</td>
<td></td>
</tr>
<tr>
<td>– ...</td>
<td></td>
</tr>
<tr>
<td>One process one machine!</td>
<td>Standard system consisting of cutter, robots, gripper and software</td>
</tr>
<tr>
<td>Schmidt &amp; Heinzmann produces cutter, robotics, gripper and software</td>
<td></td>
</tr>
</tbody>
</table>
Thank you for your kind attention