



Opening the door to long term success

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The Apeer range of composite doors is manufactured by Apeer Doors in Ballymena, Northern Ireland. The project has been a great example of how manufacturing success hinges around planning and detailed practical experimentation.

The original remit from Apeer Doors was to develop a composite door with a quality of finish and intricacy of moulded detail far beyond their competitors' products which mostly use imported 'skins' manufactured in SMC. This was to be combined with the capability to manufacture doors in a wide range of sizes and in very significant production volumes from the outset. The company had very limited experience in composites manufacturing and so finding the right partners would be key to success. Early in-house experiments with hand laminated door skins were frustrating. It soon became obvious that poor quality, high cost and slow production rates all combined to make this route impractical. Even if the quality issues could be resolved, the number of moulds required, the size of production area (with the inherent fume extraction requirements) and the number of skilled laminators needed would all be major issues. It was decided at this stage that a correctly specified 'closed mould' RTM process could provide a viable route to production.

Having searched for potential partners Apeer Doors contacted Composite Integration in 2003 and met to discuss the project at the JEC exhibition in Paris. Apeer Doors had been frustrated by the somewhat contradictory advice that they had received from various suppliers in the composites industry and it became increasingly obvious that there was no 'off the shelf' solution available. Recognising that success would depend on detailed planning, the opportunity was taken to break the project down into distinct practical stages. It was agreed that a body of work would be needed in order to specify and validate the key elements of a robust and viable system. The technical and commercial challenges in each stage were clearly identified and this would allow proper

evaluation, both technically and commercially, before committing to the next stage.

The key stages identified were:

- **Tooling:**
 - Tooling design.
 - Specification of tooling materials.
 - Identification of suitable suppliers.
- **Tooling surface treatment:**
 - To provide detailed wood-grain texture.
 - To achieve optimum durability.
- **Materials:**
 - Resin system to achieve excellent surface stability combined with rapid cycle times.
 - Fibre to provide required structural properties combined with excellent surface finish.
 - Release agent system to enable rapid cycle times with minimal build-up and no transfer to the moulded product.
- **Materials handling**
 - Systems to handle bulk materials within the production environment including resin, filler, catalyst, fibre, etc.
- **Processing equipment**
 - Injection equipment.
 - Mould clamping system.
 - Mould heating system.
 - Integration of entire system and development of the operator control system.
- **Installation and commissioning**
 - All equipment and tooling to be delivered and commissioned within a timescale linked to the building of a completely new manufacturing facility.
- **Training**
 - Operators and maintenance engineers to be fully trained.

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• Ongoing technical support

- Reliability and technical support would be vital elements if productivity was to achieve planned levels.

Apeer Doors set some fundamental parameters which would influence the technical route taken:

- Minimal cycle time (<10 min)
- Surface finish (not reliant on using a gelcoat and suitable for painting)
- Minimal wastage
- Minimal labour
- Maximum automation but with simple and robust technology.

Having agreed the outline project costings, Composite Integration started work on the fundamental mould design. In order to achieve the proposed cycle time of less than 10 min it was obvious that durability was going to be a key factor. Tooling grade aluminium was chosen as the most suitable material and a hard-anodised surface was specified to provide excellent durability and abrasion resistance. To achieve rapid and consistent cycle times, temperature control would also be a vital consideration. Before commissioning the first production tooling a small scale test mould was machined to enable the production of indicative test panels. This stage proved vital in the assessment of the finished products both cosmetically and structurally and gave real confidence in the performance of the full scale process. Various resin systems, reinforcement types and release agents were tested and the results enabled the team to identify the most effective combination.

Scott Baders urethane acrylate system, Crestapol 1210, was eventually chosen due to its toughness, low viscosity and rapid cure times. Used in conjunction with a continuous-filament glass mat this provided excellent structural and cosmetic performance whilst allowing very rapid cycle times. Injection and vent port positioning and sealing details could all be proven by these practical trials. Heating and cooling requirements were also tested at this stage and it was found that, despite the relatively thin laminate, removing the excess exothermic heat generated during cure was going to be necessary. The test laminates produced not only provided an exact representation of the final 'grained' surface with the intricate moulded panel details but also enabled simulation of the complete moulding process, so allowing the final cycle time to be accurately predicted.

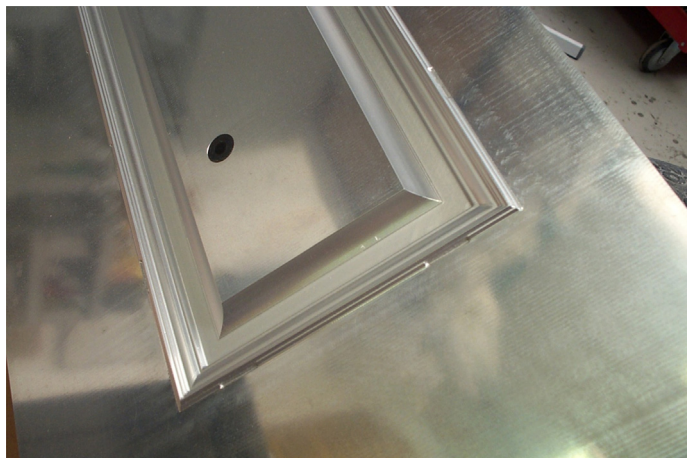
Having established the fundamental moulding parameters (injection pressure, temperature, etc) the mould clamping system could be specified. In order to achieve the required cycle time a relatively high injection pressure was required (up to 20 bar) and so a hydraulic clamping press was specified with a closing force of 400 tonnes. The up-stroking press was designed with a sliding lower platen to allow access to the 'A' surface for fibre loading and product demoulding. The tool surfaces were mounted onto water-heated platens and included a simple location and attachment system to enable rapid tool changes. The injection machine were connected to the mould using the Composite Integration Automatic Injection Valve which enables the complete injection and flushing process to be carried out without any manual intervention.

UK company Autorim were chosen to manufacture the press due to their experience in thermoset moulding processes and their willingness to work collaboratively with the Composite Integration development team. The PLC control of the press, injection machine and heating/cooling system were integrated to provide a high level of automation but with a very simple operator interface. Whilst the production equipment was being manufactured consideration was given to the handling of raw materials and the moulded components. The Crestapol resin system requires the addition of mineral filler and accelerators and so a bulk mixing system was specified to allow 2 ton batches to be mixed and continuously agitated before being supplied to the injection machine. A fibre preparation and cutting area was designed and fibre roll widths specified to minimise wastage.

Mobile racks for the moulded skins were built to provide ease of movement within the factory as well as support whilst continuing to cure. The Composite Integration team installed and commissioned the complete system and were producing production quality skins within the first few days whilst also achieving cycle times below the original target. The original system has continued to work reliably over the last ten years with a minimal amount of intervention. As sales volumes have grown two further complete systems have been installed at Apeer Doors to keep up with demand with need for a fourth system expected within the next year. Composite Integration visit to service the equipment annually and provide any technical support that is needed to keep



Fine grain feature of finished door surface.



Door panel mould surface.



A moulded door panel fresh off the press.

production running smoothly. Over this time several sets of new tooling has been supplied to manufacture new designs.

The excellent technical collaboration developed over the years allows ongoing development to happen efficiently with new designs and materials regularly being investigated. Confidence in this robust and scalable manufacturing facility has allowed Apeer Doors to expand consistently and they are currently actively seeking partners in other European countries to further develop their market. The project has proven that high volume composite manufacturing is achievable and certainly is not confined to the high tech automotive and aerospace industries. "With Composite Integration's assistance, we have come a long way in the last 12 years! Our initial attempts to produce our doors with hand lay techniques quickly showed us that we would require some help to realise our vision of manufacturing the Rolls Royce of glass fibre doors. We met with Composite Integration at JEC in 2003 and their unique expertise and insight quickly directed us towards RTM as the possible solution to our production problem. After a lot



Mr Asa McGillian of Apeer Doors (right) and Mr Richard Bland of Composite Integration Ltd (left).

of detailed planning and experimentation we arrived at the right combination of manufacturing process and material selection. The current operation now runs for 24 hours a day, 5 days a week, using heated RTM presses and Ciject injection machines. The original injection machines are now over ten years old and still provide reliable performance producing over 400 doors per week, with a target to reach 500 per week by the end of this year – cycle times are under ten minutes per door. This year turnover is set to exceed £12 million and will see the company produce its 100,000th door! Composite Integration's expertise and assistance has been absolutely invaluable to the project. They are a great team that combine high levels of professionalism and expertise with great customer focus—they have certainly opened the door to success for us!"