ALUMINUM ALLOY DEVELOPMENT
FOR THE AIRBUS A380 — PART 1

Airbus-Alcan integrated product teams were set up very early during the aircraft definition process to manage the most challenging airframe development effort ever. This article outlines how the teams worked together to support the A380 program by developing new alloys and investing in new equipment. A second article to be published next month will show how this teamwork led to the development, qualification, and production of a complete set of new aluminum alloys for wing and fuselage structures.

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On April 27th 2005, the giant Airbus A380 took off from Toulouse airport for a successful maiden flight. Seven years earlier, in April 1998, discussions had started between Alcan Aerospace (at that time Pechiney Aerospace) and Airbus for the development of advanced alloys and innovative solutions for the A3xx, as it was then designated. Seven years were needed to develop, qualify, and produce a full set of new alloys for wing and fuselage structures, as well as the equipment to fabricate such large structures.

This article outlines the work done by various Alcan Aerospace business units in collaboration with Airbus to develop alloys and production methods that led to more than a 50% market share of the aluminum structures on this aircraft.

Integrated product teams

When the first meetings were held with Airbus in April 1998, participants agreed to form integrated product teams (IPT) who would select and develop appropriate alloys and fabrication methods for the various structures of the giant aircraft. Two main objectives were assigned to these IPT teams:

- **Structures**: The objective for Alcan was to provide all the A380 metallic parts. This goal required investing in equipment that could fabricate large structures compatible with the large dimensions of the aircraft, particularly for the wings. The objective for Airbus was to define maximum part dimensions as a function of what Alcan was able to propose.

- **Alloys**: The objective for Alcan was to follow as closely as possible the need for new alloys (and thus launch or complete the associated development and qualification activities) as well as the need to extend availability of existing alloys (particularly in the high gauge ranges). The objective for Airbus was to follow the alloy development activities, and adapt when needed their design allowables to Alcan capabilities.

More than 40 such IPT meetings were organized with the various Airbus entities in France, the United Kingdom, Germany, and Spain from the start of the project to completion of final structural definitions. Considering the large size and dedicated alloys of the A380 wings, many of the discussions were held with the Airbus-U.K. wing teams. Airbus primary subcontractors with design responsibilities were also regularly visited, including Sabca, Alenia, EADS Germany, Latecoère, and others.

The success of these activities is shown by the fact that close to 100% of the aluminum structure tonnage is capable of being fabricated in Alcan Aerospace plants.

Dimensional issues

It became obvious early on that the large dimensions of the various wing parts, such as wing panels, spars, and ribs, would require significant investments in new equipment. Two main wing dimensional issues versus the available fabrication possibilities of Alcan were seen:

- **Wing panel length**: Maximum achievable length would have to be 36 meters, compared with the maximum length capability of about 23 meters at the Issoire plant (Fig. 1). The 36-meter length was needed because the wing would have a separate outer wing of a few meters in length.

- **Inboard spars and ribs**: A related issue was that no stretcher, including the world’s largest in the Ravenswood plant (acquired by Alcan in 1999), was able to process such enormous parts, which Airbus wanted as integrally machined plates. The available wing stringer length of about 24
meters was not an issue, since additional joints did not penalize wing weight. No major investments were thus needed for these parts.

Investment plans were thus proposed and accepted for extended plate production in the two major Alcan sites of Issoire, France; and Ravenswood, W.Va.

Dedicated investments

Most of the work in the Issoire plant was dedicated to extending the maximum length to the required 36 meters. This included the following, along with the processing route:

- Developing hardware and knowhow to cast very large ingots in advanced alloys needed for the volume of metal related to the upper and lower inner wing panels, as well as to the upper integrally machined outer wing panel (Fig. 2).
- Installing or upgrading the cast-house handling equipment, because larger ingots meant heavier weights.
- Lengthening all necessary equipment in the plate department. The hot-mill table, heat-solution furnaces, the stretcher, the U.S. inspection tank, and the contouring machine are examples of major equipment that was upgraded (Fig. 3).
- Installing or upgrading the plate handling equipment. Safe handling of 36-meter plates required other means than those previously available for shorter lengths. This included dedicated turn-over equipment for skimming both sides of the wing panels.

As a result of these investments, ingots of up to 20 tons were successfully produced in advanced 2xxx and 7xxx alloys. Also, long 36-meter wing panels were processed very rapidly through the plate department, after optimization of the plate flow through the plant.

Heavy-gauge parts

Most of the work at the plant in Ravenswood, W. Va., was dedicated to producing heavy gauge, high-volume parts, such as inboard spars and ribs. This included the following, along the processing route:

- Developing hardware and knowhow to cast very large ingots in advanced alloys for the biggest spars and ribs.
- Installing or upgrading the foundry handling equipment, to enable manipulating larger and heavier ingots.
- Improving the world’s largest stretcher (30 Mlb /13600 tonnes) at the Ravenswood plant. Improvements allowed the stretcher to reliably stretch heavy gauge plates at maximum power.
- Installing or upgrading the plate handling equipment, such as lay-off crane, forks, and similar equipment.

To supply aluminum for the large spars, a significantly larger ingot had to be cast in Ravenswood. In the late 1990s, the largest production-scale 7xxx alloy cast ingot weighed 22,000 lb. Over the next several years, with the combined resources of the Ravenswood cast house and the R&D Casting Research Team located in France,
ingots weighing over 37,000 lb were successfully produced. Further process improvements led to excellent recovery and reliability in casting such a challenging geometry in an advanced 7xxx alloy.

As a result of these investments, very large ingot sections and lengths were successfully produced in advanced 7xxx alloys. Also, new plate equipment quickly proved its efficiency in the processing of long and wide wing spars and ribs. The table shows the new combined plate capabilities of the two Alcan sites of Issoire and Ravenswood.

**Increased capability**

As can be seen, most if not all of the increase in dimensional capability was driven by the wing part sizes. Some of these improvements were also necessary for various fuselage parts. The most significant fuselage applications needing large metal volumes were integrally machined main frames (mostly located each side of the doors), cockpit window frames, wing rib one, and some of the gear bay walls. All have super-size plate dimensions and are produced in the Ravenswood plant. The main frame attached to the rear pressure bulkhead was one of the very first fuselage parts to be machined, from a 7040-T7451 plate produced from the U.S. plant.

In addition to the multi-million dollar investments in larger (mostly plate) dimensional capabilities, Alcan had also to invest in increased production capacity, to be able to meet anticipated A380 production rates of about four aircraft per month. A380 total delivered metallic parts were in fact estimated to be about ten times those of an A320, at about 1000 tons per aircraft, thus needing extra production capacity which has been installed progressively over the last few years.

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### Combined plate fabrication capabilities of the two Issoire and Ravenswood plants

<table>
<thead>
<tr>
<th>Application</th>
<th>Main feature</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wing Panels</td>
<td>Up to 36 m long</td>
<td>Width up to 3.8 m available, with shorter length</td>
</tr>
<tr>
<td></td>
<td>Up to 3 m wide</td>
<td></td>
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<tr>
<td>Spars, ribs, frames etc.</td>
<td>Cross-sections of up to about 425 000 mm²</td>
<td>Examples: 150 x 2800 mm; 200 x 2050 mm</td>
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</tbody>
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