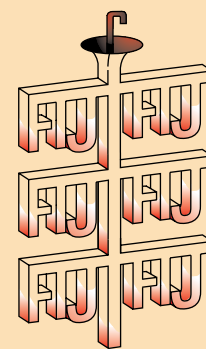


INVESTMENT CASTING

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RE-ORGANISED, RE-ENERGISED, RE-DEDICATED

A tour of the “New” Howmet Aluminum Casting

Alcoa’s Howmet Aluminum Casting group can claim with justification that it is a new organisation, doing business in a new way. Over the last four years, the aluminium group has been restructured and a new president, Gary Warness, is now at the helm. The group’s five facilities, one in France, two in Canada and two in the USA, all have new general managers. The group’s flagship plant, formerly clustered in a warren of WWII era factory buildings in North Montreal, has been relocated into a single new building in Laval, Quebec, Canada, making the new plant the most modern, as well as the largest, aluminium investment casting facility in the world.

On the technology front, Howmet has strengthened its team with a new technical director for the operation, Larry Zellman, formerly with Boeing, and a new corporate level director of product conversions, Audy Phillips, formerly with Vought Aircraft. In addition, new quality managers are in place at four of the five facilities. Two of the organisation’s plants, Laval and Hillsboro, Texas, USA, are the first two Howmet plants of any type to earn the recently introduced AS9100 accreditation, the aerospace industry’s most advanced quality certification programme. The Federal Aviation Administration of the US, aerospace original equipment manufacturers (OEMs) and leading suppliers plan to make AS9100 the standard quality system for the entire industry, and Howmet’s aluminium casting facilities have striven to be in the forefront of compliance with these new standards.

According to the group’s management team, many of whom were interviewed for this article, Howmet’s reorganised aluminium operation has placed itself in a position to respond effectively to the expectations of casting buyers.

Gary Warness, who has been president of Howmet Aluminum Casting for two years, has overseen many of the positive changes that have occurred. He says,

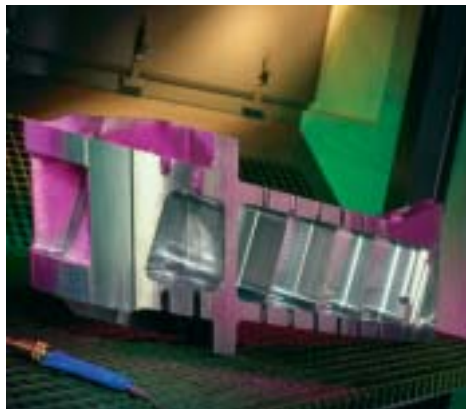
“My perception is that, as of a few years ago, the entire aluminium investment casting industry was coming up short in the eyes of important customers. Howmet Aluminum Casting was no exception at that time. However, since then, we have worked very hard to build a new team, introduce the highest quality standards, invest in and improve our casting process, create a culture of rock-solid business practices and demonstrate to customers that they can rely on us to meet all of their requirements.”

Warness directed the process of rationalising Howmet’s aluminium casting business. His objective was to manage a process of strategic renewal that eliminated marginal activities that were draining off resources from critical customers and products. The strategic renewal effort resulted in an entirely new management team, one plant closure, and a significantly reduced customer base. “We want to focus on those customers who represent the best future fit for our business, and we want them to know that we are committing the company to serve them better. We want to exit relationships where the fit is not good, so that we will not be distracted from our primary mission of serving the customers to whom we are making a long term commitment,” says Warness.

Howmet’s operations have built a reputation as casters of high property aluminium parts. The group’s various plants focus on aero-engine and airframe structural components, missile parts, electronic packaging, performance automotive and general industrial parts. “Our high property capabilities arise from the Sophia® process, which is able to impart advanced mechanical properties to aluminium components due to a proprietary method of investment casting. Components produced using the Sophia® process give our customers a way to make sure they can get in a reliable and affordable manner, the high mechanical properties they must have for their products,” Warness says.



“Thanks to the technical and financial strength of our owner Alcoa, we have the resources to maintain our position as the technology leader in the area of aluminium investment castings,” says Gary Warness (centre), president, Howmet Aluminum Casting, Inc.



“Converting a 7055 hogout (left) to a D357 casting (right) improved stress carrying capability 30%, reduced weight 15% and cut costs by a full 80%,” says Peter Budkewitch, Laval’s product engineering manager.



Manufacturing Technology

“There are three broad areas where customers seek support from suppliers. Those areas are the development, production and component finishing phases,” says L Michael Senesac, director of business development for the five plant global enterprise. “The objectives in each phase are the same. First: faster, reliable delivery; and second, less cost. Howmet has invested to be able to respond to both these demands now and in the future.”

The new Laval plant is a case in point. The facility was laid out to handle both one piece flow and high volume production of a single part number. The plant layout, which is characterised by short travel distances between process steps, benefited from Howmet's decade long re-engineering experience in its 29 operating units around the world. This experience involved first hand learning of a variety of lean manufacturing techniques and mastery of integrated process management. To reduce variation and ensure repeatability, automated and microprocessor controlled investment casting equipment was installed - from wax injection, shell making, and furnaces, to heat treatment, finishing and inspection.

In addition, the plant layout was designed to speed throughput and to enable quick changes to accommodate market driven shifts, particularly in the highly cyclical aerospace market. “With our new plant configuration, the organisation knew it could support production in an expanding market, ramp up in response to handle the peaks of an up cycle in an expeditious manner, and make rapid adjustments when faced with a down cycle,” says Senesac.

“As a result of our plant layout,” says Sylvain Poissant, the Laval operation's general manager, “we are able to achieve a very high level of control over our manufacturing schedule, which in turn, gives us the ability to respond quickly and reliably to customers' needs.”

According to Peter Budkewitch, project engineering manager, customers typically send designs to Howmet electronically, using a variety of formats such as Catia, Pro-Engineer and Unigraphics. “This approach has multiple benefits,” he says. “First, it speeds up final design, material and process selection. Second, it reduces administrative, handling and verification costs. And third, it reduces the opportunity for human error. These factors enable

Howmet's casting engineers to quickly identify the optimal casting design and streamline development of the casting process.”

Senesac emphasises the importance of electronic data interchange. “Working this way, we are able to impact the three areas where customers say they want help,” says Senesac. “In the first phase of the process, concurrent engineering and design, combined with electronic data interchange and rapid prototyping, dramatically reduce developmental cycle time. The tooling supplier, also operating in a concurrent mode, can use the same data files as well. Then, in the production phase, our highly automated facilities, such as Laval, but including our other plants as well, can establish accelerated manufacturing schedules to get customers the parts they need quickly. We are aggressively trying to remove paper from critical development paths.”

Customers that want to continue compressing cycle time and cutting costs in the post casting phase can negotiate with Howmet for finish to print services that include a broad range of finishing options. “Taking advantage of our finish to print capabilities, customers can enjoy the reduced cost that is commonly associated with outsourcing. However, they can get additional benefits as well, such as reducing the number of suppliers they have to deal with, which can eliminate many non-value-added administrative tasks,” Senesac says.

Howmet has adopted the Alcoa Production System

The Alcoa Production System (APS) is a single, integrated manufacturing system. Alcoa designed the APS using the Toyota Production System as a model. In the process, Alcoa shaped Toyota's approach to automotive manufacturing into a system for making products at Alcoa business units. APS features 20 interdependent subsystems:

1. Stores
2. Buffers
3. Safety Stock
4. Bring the Arrow Down Once
5. Replenishment Signal
6. Best Practices
7. Multiskilled Workers
8. Operational Availability
9. Customer Use Rate
10. Levelling
11. Balancing Operations
12. Continuous Improvement
13. Changeover Improvement
14. Small Lot Size
15. Continuous Flow
16. Cleanliness
17. Management by Sight
18. Lead Time
19. Autonomation
20. Pull System

Stereolithography (SLA) offers customers a way to prove out their designs before investing in hard tooling. Increasingly, for low quantity production runs, customers bypass hard tooling entirely and rely on the 'soft' tooling SLA provides.



Laval at a glance

At 14,000m² Howmet Laval Casting is the largest aluminium investment casting plant in the world. Built new from the ground up, it is also the world's most modern aluminium investment casting plant.



The Laval Casting facility

Casting capacity:
Number of processes:

US\$70 million/year
Conventional
Medium properties
High properties



Sylvain Poissant (left), general manager of Laval Casting, inspects a large, structural casting for dimensional accuracy. Laval specialises in large, high-property aerospace castings.



Quality

According to Warness, nowhere has the aluminium casting organisation's dedication to improvement expressed itself more than in the area of quality. "For example, four years ago many of our plants had no quality accreditations. Neither did most of our competitors. Nonetheless, we set out to change that. Today, in addition to the recently earned AS9100 accreditation, our operations have also earned a long list of industry and customer accreditations (see box story). We have come a long way in demonstrating to our customers that we are serious about adhering to the strictest quality standards, as well as living up to their highest expectations. We view ourselves as setting the standard for the industry," says Warness.

Quality improvement played a role in Howmet's strategy to dedicate itself to the aluminium casting business, set industry standards and earn the respect - and business - of casting buyers. In Canada, the planned relocation from an old facility to a new one provided a platform for codifying the quality standards and best practices of the entire group. Renald Robert, Laval's plant quality manager, reports: "We wanted the new facility to start out using only documented best practices. So we set as our objective to document thoroughly each production process, to have the entire process totally

In Laval, a 20 person quality improvement team assembled from experts throughout Howmet's superalloy, titanium and aluminium casting operations, went to work. Over a three year period, they uncovered the root causes of quality problems and devised systemic solutions to correct them. In practice, the team fixed problems before authorising a process to move from the old North Montreal plant to the new facility in Laval. When processes met base line quality standards, they were allowed to move to Laval.

Next, quality leaders performed a plant wide gap analysis, documenting the difference between the 'as-is' and 'to-be' scenarios. They examined engineering, the wax room, shell making, investment casting and inspection. In each area, they reviewed the entire process from start to finish. After mapping the process and the gaps, the team installed best practices, measured performance and closed gaps by standardising procedures at every stage of the process. "Tribal knowledge was no longer permitted to guide decision making," says Robert. "Only decisions that are arrived at within the framework of our best practices are permitted."

The efforts of Robert and his colleagues in the Laval operation have produced results. For example, performance in the area of quality yield was 75% in 2001; year to date 2002 performance has been 94%. "We have made quality improvement a disciplined and high priority activity in Laval and in our other plants. It is the key to continuous improvement and being able to meet customer expectations," says Robert.

Quality certifications

- AS9100 Certification
- ISO9002 Certification
- Boeing D1-9000 Certification
- NADCAP Accreditation in:
 - Heat Treatment
 - Welding
 - Materials Testing
 - Etch
 - NDT (Nondestructive Test)

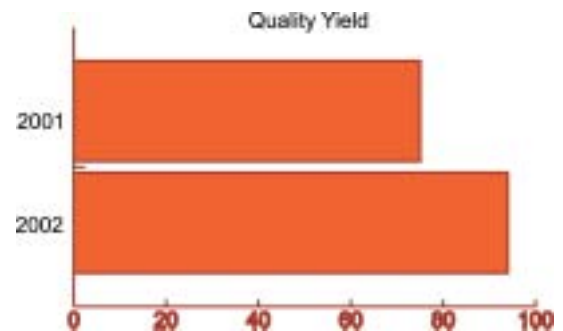
In addition, Howmet combines an internal peer audit system with an external, third party auditor to monitor quality assurance.



L. Michael Senesac (left), director of business development for the aluminium operations, discusses the latest version of the quality manual with an employee. The manual codifies requirements for the performance of all quality related tasks.

understood by the people working in the new plant, before moving it to Laval."

To accomplish this objective, management developed a comprehensive approach to upgrading quality throughout the aluminium plants. First, Howmet established internal quality audit teams to define base line processes, identify what needed to be improved and establish training and reorganisation targets. "Also, we were committed to creating a culture of openness for interacting with customers," says Robert, "and to do that, we had to have complete confidence that our quality system was the best in the industry."



Xavier Dumant, general manager of Howmet's aluminium casting plant in Evron, France, checks a complex wax pattern. The Howmet high property Sophia® process was developed in Evron.



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Many markets capitalise on castings

According to Director of Business Development Senesac, "There are a number of areas where the cost reduction capabilities of the investment casting process will create opportunities for growth. One market where cost reductions can be especially dramatic is aerospace - and the aluminium operation has taken many steps to upgrade its services to this segment.

"Investments in our new Laval plant, advanced casting technologies, and aggressive and systematic improvements to our quality system were, in large part, designed to communicate to our aerospace customers our commitment to the business. Our aerospace customers represent approximately 75% of our total business, underscoring the importance of these investments. In fact, we serve every major airframe and gas turbine manufacturer, as well as a host of leading system and component suppliers. Thanks to these relationships, we find opportunities to get into more and more areas of the aircraft because of the process's ability to deliver major savings. It is typical for a customer to get a savings from 20 to 50% by converting expensive fabricated assemblies to more affordable single piece castings," says Senesac.

Defence, high performance auto racing and medical represent additional markets served.

"We have a percentage of our capacity not currently being utilised, so we are eager to expand the benefits of castings to new markets and are aggressively pursuing business in a variety of non-aerospace segments," says Senesac.

Audy Phillips, formerly with Vought and now director of product conversions for Howmet Aluminum Casting, says "One of the promising trends we are observing is the willingness of customers to work with us earlier in the design process. Customers recognise that if they design a casting without the involvement of the casting supplier, they often miss opportunities to increase the castability of their designs at the start of the process. A design that lacks castability necessarily involves time, effort and money to develop. These are precious commodities and are conserved by

employing a concurrent engineering approach right from the beginning."

Phillips says that aerospace designers sometimes don't understand the degree of design freedom available with the casting process. An awareness of that design flexibility often alters their appreciation for what the process can do. "There are many areas of casting capability that affect design options and it really takes a lot of experience to know

how to take full advantage of them."

According to Phillips, there are five areas of aluminium investment casting that are of interest to design engineers:

- Properties. Aluminium investment castings can be produced with extremely high properties. This gives designers the ability to use a relatively low cost lightweight material that can take on a variety of structural applications.
- Shapes. Aluminium castings can be produced in large, complex, asymmetrical shapes. Today castings of more than two meters in length are routinely produced.
- Cost Savings. Castings can be produced in near net shapes, which can significantly reduce raw material and machining requirements.
- Simplification. Castings can consolidate dozens, sometimes scores, of detail parts, simplifying administrative tasks and streamlining assembly, paperwork and supplier management chores.
- Design flexibility. Engineers can design components with thin and thick walled sections in the same piece, as well as intricate passageways for the flow of liquids or gases or to accommodate wires, cables or piping. In addition they can design sculpted surfaces and datum pads to speed finish machining.

"All of these capabilities of the investment casting process help dismantle design barriers, enhance product performance and cut cycle time and cost," says Phillips.



Large, complex, asymmetrical castings consolidate multiple details in a single piece and can cut costs at every step from initial design through production and inspection.



Customers seeking a cost effective approach to producing complex parts that require advanced physical properties and dimensional consistency are converting to the investment casting process in increasing numbers.

Investment casting process benefits at a glance

Cost reductions of 20-50% are typical compared other processes:

- | | |
|------------------------|---------------------------------|
| - Near net shapes: | Lessen raw material cost |
| - Cast in features: | Require less machining |
| - Parts consolidation: | Reduce assembly |
| - Cored passageways: | Improve product performance |
| - Complex shapes: | Enhance design options |
| - Large shapes: | Reduce welding and fabrication |
| - As cast surfaces: | Improve aesthetics |
| - Asymmetrical shapes: | Increase pool of castable parts |



Kevan Todd, general manager of the plant in Hillsboro, Texas, USA, reviews quality performance metrics with the operation's quality supervisor.



Customer satisfaction

“The standards for customer satisfaction keep changing,” says Warness, “which makes customer satisfaction a moving target. What meets expectations today may not measure up tomorrow.”

Warness says that constant change drives the aluminium casting operation to focus on three objectives internally. Pursuit of these objectives helps the organisation stay abreast of change and makes sure workers have the training and tools to respond to customer expectations. Warness says the three objectives are customer focus, continuous improvement and employee development.

According to Warness, focusing on customers demonstrates Howmet’s commitment to the aluminium casting business and maintains good lines of communication. This initiative has become easier

for the organisation now that the process of rationalising its customer base is well under way. By the time the process is finished, Howmet expects to have 50% fewer customers. Moreover, the remaining customers will have a powerful strategic fit between the company’s capabilities and the customers’ long term needs.

Howmet has joined the ranks of other companies that seek to make continuous improvement a

way of life. To that end, the organisation has developed an expertise with a range of lean manufacturing and quality assurance techniques, an effort now showing up in the company’s performance measurements such as quality, on time delivery, productivity and safety.

“Also, we are investing in hiring experienced and talented people and making additional investments in training them further when they are on board,” Warness says. “Without a disciplined pursuit of these three objectives, we run the risk of losing ground in the global arena.

“We have established a number of services for customers who want to save time and money by outsourcing activities they used to perform internally or used to outsource to multiple vendors. They’re finding that it is much more efficient to outsource to one supplier that has the capability to manage everything and deliver fully inspected, ready to assemble components or subassemblies, to the point of use, just in time,” he says.

Senesac says that the reward for investments in quality and establishing closer working relationships with fewer customers is now materialising. “We have an increasing number of customers who have authorised Howmet to self-certify the quality of parts. Their confidence in our recently upgraded quality system is such that they can take the quality of a Howmet component as a given. The next step will be the elimination of Material Review Boards, or MRBs, at customer locations. MRBs were set up to pass judgment on acceptability for use of parts that were out of spec in some slight way. However, as our highly automated systems continuously reduce variation and

improve repeatability, there will soon be no need for MRBs, because they will have no way to add value,” Senesac says.

Aluminium investment castings trim costs and cycle time by eliminating sub-assembly and secondary machining requirements, while reducing raw material and administrative requirements



Howmet can deliver complex components and subassemblies that are ready to install as delivered, allowing OEMs to outsource the entire manufacturing process, conserve capital, manage assets better, and focus on what they do best.



Bill Rossi (left), general manager of the Bethlehem, Pennsylvania, USA, plant, reviews performance metrics with employees to show the correlation between improved safety and on-time delivery.

Howmet’s customer satisfaction strategies

Make to use

- What customer wants
- When customer wants
- In quantity customer wants

Eliminate waste

- Time
- Scrap and rework
- Non-value-added activities

Everyone solves problems

- Immediately
- At the source
- As a team

Plant capabilities

A key element in the group’s strategy for renewal was the alignment of each site with target markets. The objective was to leverage the unique strengths and capabilities of each plant. “With such a strategy, we would be able to fulfil our vision of customer focus by making sure the casting plant that serves each customer offers the best fit between the capabilities of the individual plant and the unique production requirements for each part. Under this scenario, each plant’s part size and process expertise are precisely matched to customer requirements. The result is improved utilisation of our resources and more effective customer service,” says Warness.

“Our focus is large, complex parts with medium to high properties,” says Sylvain Poissant, general manager of the Laval Casting operation.

“Consequently, we serve a lot of aerospace customers with parts for engine and airframe structures, missile structures and large electronic boxes. Following the Alcoa Business System’s guidelines, we are integrating concurrent engineering, finish to print and assembly capabilities to our services. This approach helps us add value and enhance our competitiveness in the eye’s of customers.”

According to Xavier Dumant, general manager of Evron Casting, “Evron pioneered the development of the controlled solidification process known as Sophia® back in 1987. This process allows the foundry to



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produce castings with the very fine solidification structure demanded for aerospace and Formula 1 racing applications. This process helped our plant increase sales 30%.”

Kevan Todd, general manager of Hillsboro Casting, says his plant primarily manufactures electronic packaging, electro-optical devices, high property structural parts, missile components and castings for medical applications. “We pour A356, A357, A201, A206, D357 and C355 and keep our seven 1,200lb (545kg) furnaces busy responding to customer demand for increasingly short manufacturing cycle times,” he says.

William Rossi, general manager of the Bethlehem Casting facility, says, “Our castings are primarily used for electronic packaging, electro-optical devices and missile components. Our continuous improvement effort involves frequent kaizen events, typically focused on process improvement. To date our efforts have improved productivity performance 45% compared to performance levels two years ago.”

“We specialise in small castings at Howmet Georgetown Casting,” says Andreas Hack, plant manager of the Georgetown, Ontario, facility. “All our production fits within a twelve inch (30cm) cube. We pour both aluminium and copper base alloys and have customers in medical and commercial markets, as well as in aerospace.”

TWO PRIORITIES: SAFETY AND DELIVERY

Howmet reports that ensuring employee safety is a top priority at all Alcoa business units. The Bethlehem Casting operation, for example, hired Buck Johnson in 2001 as environmental safety manager. He reports, “Our plant, which has been through an Alcoa safety audit, has set up a safety committee and a new plant wide alarm system. In addition, we’ve put air handling systems in the wax and metal removal areas, installed an advanced overhead hoist system in the wax area and thoroughly trained every employee in safety procedures. We hold safety meetings in my office first thing every morning to keep momentum going for our continuous effort to improve safety.”

The results of this safety effort have been good across the entire aluminium casting operations, according to Warness. “Taking the Bethlehem plant as an example, there has not been a lost time accident in over a year, the plant Total Recordable Rate (TRR) has plummeted 72% from 13.68 to 3.2 as of June 2002. (Latest figures available at press time.) Although we have had very gratifying results from our safety effort to date, we still plan to intensify our effort. In the days ahead, our newly formed ergonomics task force will identify and implement even safer work practices,” he says.

Warness adds that internal safety and external customer satisfaction metrics are two sides of the same coin. “As safety improvement has been our top internal effort, on time deliveries to customer expectations has been our top external focus. A workforce that knows how to maximise safety is a workforce that is also in the best position to maximise productivity, a key factor in being able to satisfy customers. Using Bethlehem as an example, as their safety improved significantly, so has their on time delivery, which has averaged 97% over the last year,” says Warness.

“Howmet’s Aluminium Casting operation has done an enormous amount of hard work over the last four years to redefine quality and customer service

standards in the aluminium investment casting segment of the industry. That hard work is now bearing fruit in the enterprise wide performance metrics we track. As a result of the hard work of all of our employees over the last few years, we feel we have reengineered the aluminium casting operation to the point where it can now measure up in the eyes of the world’s casting buyers.”



With 1,000 employees worldwide and five plants in three countries, Howmet Aluminium Casting is the largest aluminium investment casting enterprise in the world.

Plant overview

Laval, Quebec

Plant size: 14,000m²
Part Sizes: Medium and large
Properties: Medium to high

Evron, France

Plant size: 8,000m²
Part Sizes: Medium and large
Properties: Medium to high

Hillsboro, Texas

Plant size: 6,300m²
Part Sizes: Medium and large
Properties: Conventional to medium

Bethlehem, Pennsylvania

Plant size: 4,450m²
Part Sizes: Small to medium
Properties: Conventional

Georgetown, Ontario

Plant size: 3,345m²
Part Sizes: Small to medium
Properties: Conventional



Andreas Hack (left), plant manager of the facility in Georgetown, Ontario, Canada, discusses the castability of a part with co-workers. Georgetown specialises in small aluminium and copper castings.

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Phone: 610.266.0270

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