Graphite-Mold Casting Process Proves "Picture Perfect" for High-Tech Camera Housing

Capturing images at up to 60 frames per second, the new machine-vision SIMATIC HawkEye 1600T is no ordinary camera. With its sophisticated on-board computer, the compact HawkEye (only 4.5"x 2.5"x 1.25") can verify that products have been assembled, labeled, or packaged properly in a wide variety of production-line/quality-control applications.

During production of the HawkEye, Tom Driscoll, the hardware engineering manager at the Siemens Energy & Automation plant in Nashua, New Hampshire, was concerned when he realized the camera's optics and circuitry were going to be ready weeks before he could obtain the outer shells in which to enclose them. Cost was also an issue.

The Siemens SIMATIC HawkEye 1600T is a sophisticated, microprocessor-based machine-vision camera for in-process quality control and monitoring applications. Capable of capturing images at up to 60 frames per second, the HawkEye 1600T has a cast ZA-12 alloy housing produced by Graphicast using permanent graphite molds.

Finding a Cost-Effective and Timely Casting Method

"We had started down a path with a die-casting company, and we were running into some scheduling problems," recalls Driscoll. "It was going to take 14 weeks to get aluminum castings for the housing. After consulting several machine shops, we learned that machining the housings from scratch would cost in the vicinity of $250 for each half — $500 for each case! We quickly started looking for another solution."

Die casting was too slow. Machining was too expensive. Driscoll then discovered Graphicast, Inc. "They fit our budget, and they were quick," he says. Graphicast promised to have the first samples ready in 6 weeks, less than half the lead time for die-cast parts.

The two halves of the housing for the HawkEye 1600T camera (interior views shown here) are designed for dust- and water-tight assembly using only a single "O" ring. After casting, the halves are machined to mill precise features and to drill and tap threaded holes for the screws that will keep the halves together. At other points along the mating surfaces, Graphicast drills matching indentations, into which metal pins are inserted later to add stability to the assembled unit.

Graphicast's casting process is especially suited for low- to medium-volume production runs of 300 to 20,000 parts. The single-source contract manufacturer uses graphite molds to cast parts from ZA-12, a zinc-aluminum alloy that is harder, stronger, and more durable than aluminum, brass, bronze, or plastic. Graphicast offers in-house design, tooling, net shape casting, machining, and finishing.

Working Together

Driscoll knew the HawkEye's advanced circuitry would need a case capable of conducting and dispersing heat more effectively than an earlier model's extruded-aluminum housing. Furthermore, the new camera needed to be "industrially hardened," sealed tightly to withstand higher ambient temperatures, dusty or humid conditions, and even production-line washdowns. The Siemens design team came up with an ingenious design — wedge-shaped halves, sealed with a single "O" ring, that join along a line that does not transect the holes for the camera's lens, connector ports, or status indicators at the front, back and top of the housing.

Primarily electrical engineers, Driscoll and his colleagues needed some mechanical engineering advice from specialists at Graphicast to optimize the design for the casting process. "We were able to really leverage their design expertise," says Driscoll. Once the design was finalized, Graphicast guaranteed the graphite mold for the life of the part. The result of the collaboration is a case that seals out dust, withstands operating temperatures of 32°F to 122°F, and is certified watertight for submersions up to 30 minutes.

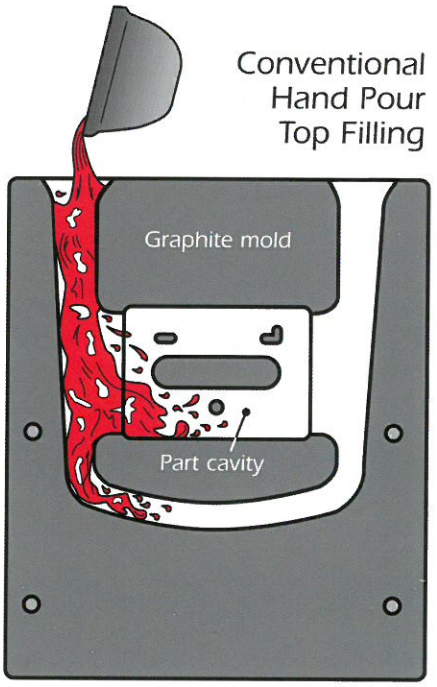
An Economical Alternative

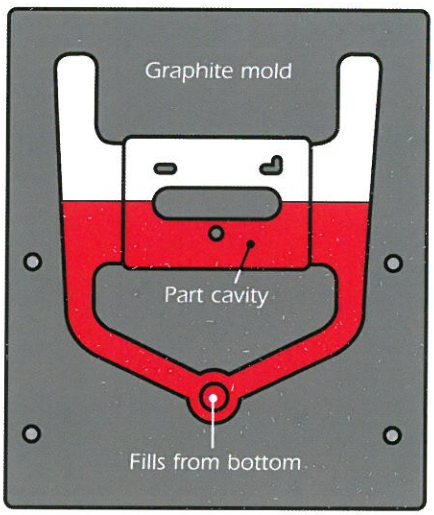
Tooling costs for the graphite mold/ZA-12 process are much lower than those for die casting or injection molding. The properties of graphite, a form of carbon, make it ideal for moldmaking. Because a graphite mold will not warp or corrode, it is reusable, with a virtually infinite shelf life. Graphite costs much less than tool steel, it requires no heat treating, and its exceptional machinability dramatically shortens the moldmaking phase.

Graphicast obtains the best possible casting results by using proprietary automated machines that fill each mold from the bottom up. This minimizes the turbulence of the molten metal, thereby greatly reducing porosity. Using a process controller to simultaneously control fill rate, cycle time, and temperature, these machines yield parts of exceptional quality and repeatability at a relatively low cost per part.

Equally important to the process are the attributes of the ZA-12 alloy, which has excellent castability at a relatively low temperature. Because ZA-12 is spark-proof, it can be used in hazardous environments, and since it cannot be magnetized, it is ideal for electronic shielding. Castings have a density approximately the same as cast iron and can include contours, variations in surface elevations, holes, and other precise features.

ZA-12 parts require no heat treating, and their typical surface finishes of 63 microinches or less are better than





Graphicast uses specially designed equipment such as Low Turbulence Automatic™ casting machines, shown above. Because they fill molds from the bottom up, these machines minimize turbulence in the molten metal and produce parts of exceptional quality and repeatability. Machines control fill rate, cycle time, and temperature simultaneously.

Outer surfaces of the housing halves for the HawkEye 1600T camera are chromated and painted after casting and machining. Wedge-shaped, the halves join along a line that does not transect the holes for the camera's lens, connector ports, or status indicators at the front, back, and top of the assembled housing. After painting, the housing half that forms the top and back of the camera is screen-printed with "reference designators" — symbols that tell the installer which connector cables go into which sockets (right). The half that forms the bottom and front of the unit has a large opening for the camera's lens.

finishes from other casting processes. For non-castable features, ZA-12 is machined as easily as brass or bronze and more easily than cast iron or aluminum. In many cases, ZA-12 parts require little or no secondary machining.

Although ZA-12 castings have a bright, corrosion-resistant finish that requires no coating or other preparation, they can be chromated, plated, painted, powder-coated, or finished with electro-coated acrylic or epoxy.

The graphite/ZA-12 process is an ideal hedge against uncertainty. Because a graphite mold can be modified quickly and economically, it provides manufacturers with much more flexibility in debugging or improving products while still controlling costs — a major advantage over traditional casting methods.

Accelerated Time-to-Market

For Siemens' production runs of 1,000 HawkEye housings per year, Graphicast's non-recurring tooling costs were roughly one-fourth the cost of tooling for traditional die-cast aluminum parts. The cost per housing was only a tenth that of machining the parts from stock.

After machining, which included drilling holes for LED status indicators on the top of the HawkEye, Graphicast technicians measured the critical dimensions of every part and inspected a sampling of the parts more thoroughly with a coordinate measuring machine (CMM).

Driscoll's team had their first-article samples plus 50 more pre-production parts only 4 weeks after issuing the purchase order. The housing halves were machined and chromated. They were then painted, except for some masked areas where wires would enter the unit. After painting, "reference designators" — symbols that tell the installer which connector cables go into which sockets — were screen-printed onto each casting. These additional steps took 10 more days, and the samples were complete — just shy of the 6 weeks Graphicast had promised.

Many ZA-12 parts are used in precision applications. Graphicast has high-speed CNC machining capabilities and can quickly and economically perform milling, boring, drilling, or tapping operations.

"We've been very happy with the quality of the housings," says Driscoll. "Graphicast really helped us meet our production schedule and budget. They listened carefully to our needs and were very responsive every step of the way. I guess our experience validates their key selling point — accelerated time-to-market."

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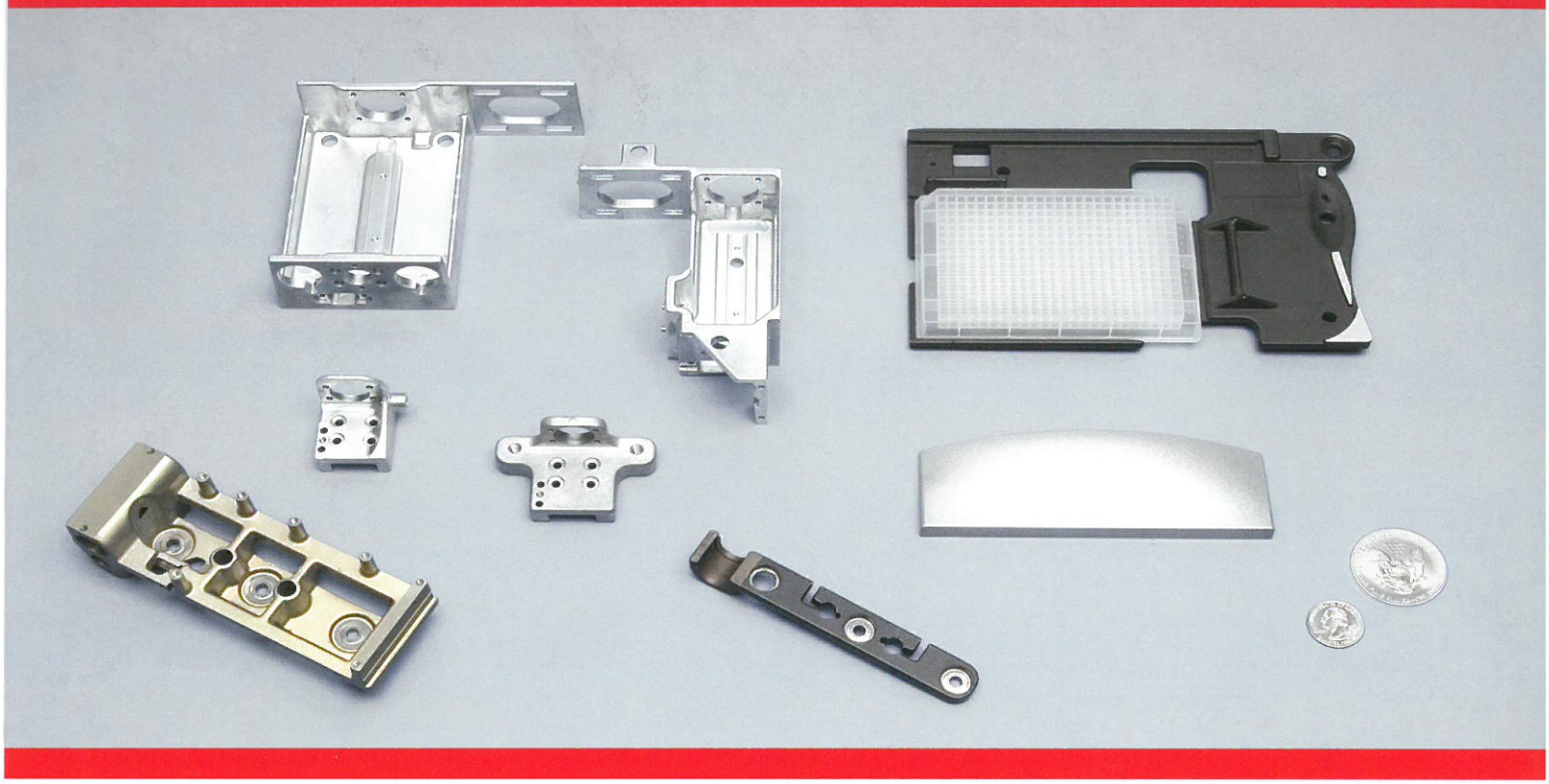
The Graphicast Advantage



- Rapid turnaround
- Lower total acquisition cost
- Ideal for production volumes of 300 to 20,000 parts per year
- Permanent graphite molds reduce mold production costs and shorten time-to-market
- ZA-12 zinc alloy is harder and stronger than aluminum, yet requires no heat treating, will not warp
- Tolerances of ± 0.005" per inch or better
- Smooth lustrous appearance requires no additional preparation or coating
- Simultaneous part and mold design using Pro/ENGINEER and SolidWorks® solid modeling CAD software
- Graphite mold production and maintenance
- Proprietary LTA filling technology yields castings of greater density, lower porosity, better surface finish, and more consistent dimensions
- Secondary machining capabilities
- Optional coatings include any commercial paint or powder coating system
- Light assembly involving bearings, bushings, dowel pins, springs, etc.

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