

# Die-cast aluminum squeezes out steel

"Lighten it up" is the mantra of every automotive designer. But there's obviously a fine line between the right amount of weight and going too far. The result can be components that aren't strong or durable enough.

That was the challenge facing **SPX Contech, a Div. of SPX Corp.**, Portage, Mich., when **Jaguar** approached the company about producing steering knuckles for XJ and S-Type sedans. Steering knuckles are typically forged or cast from alloys of iron and steel. But SPX Contech's proprietary squeeze casting process had successfully produced die-cast aluminum parts with enough strength to replace steel and iron.

Jaguar had pursued a hybrid casting/forging process for the steering knuckles, but it took far longer than anticipated and generated too much scrap. Scrap at the foundry/forge was about 50%, with an additional 33% fallout during machining. This led the automaker to consider sources in France and Scandinavia and eventually SPX Contech.

SPX Contech had an advantage, says Kevin McMullen, manager, sales administration at SPX Contech. "We had previous experience producing smaller, less-complex steering knuckles from an A.356.2 (T6) alloy using our proprietary squeeze-casting (P2000 HVSC) process. To meet

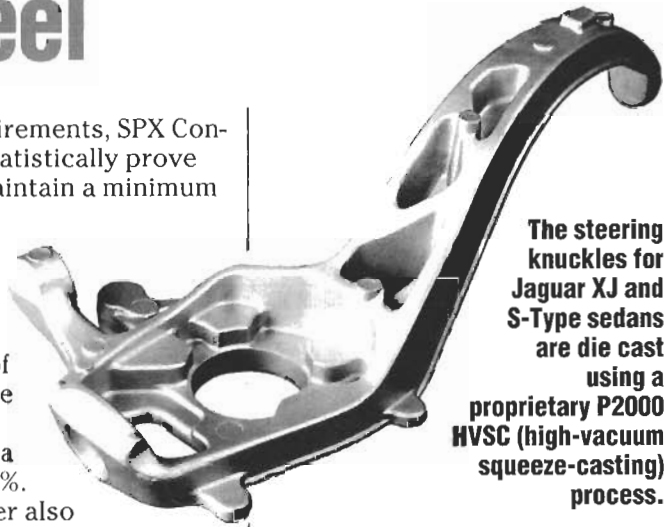
Jaguar's requirements, SPX Contech had to statistically prove they could maintain a minimum ultimate tensile strength of 276 MPa and a minimum 0.2% proof stress of 207 MPa, while also limiting elongation to a minimum of 6%.

The automaker also expected zero defects and a competitive price.

Surrogate data from suspension link castings served as the initial proof that the P2000 HVSC process would work, says McMullen. Data from 10 sample bars revealed a mean tensile strength of 306 MPa, a mean 0.2% proof stress (yield strength) of 242 MPa, and a mean elongation of 10%.

SPX Contech also studied test pieces to confirm alloy chemical analysis and hardness (finding a mean of 100 BHN). An optical metallographic examination studied the microstructure of sections through the castings at both the casting surface and deep within the core. An independent lab verified results. SPX Contech produced a catalog of strain-life-fatigue and stress-life-fatigue test data to prove the process and material was up to the task.

SPX Contech began producing first one-off parts using the P2000 HVSC process, which incorporated a vertical shot and



The steering knuckles for Jaguar XJ and S-Type sedans are die cast using a proprietary P2000 HVSC (high-vacuum squeeze-casting) process.

die blocks horizontally moving. In the P2000 process, metal injects slowly into the die. Large in-gates reduce jetting and turbulence to produce laminar flow as the metal spreads throughout the die. As metal in the die solidifies (from the outside in), voids normally form in the center of large sections.

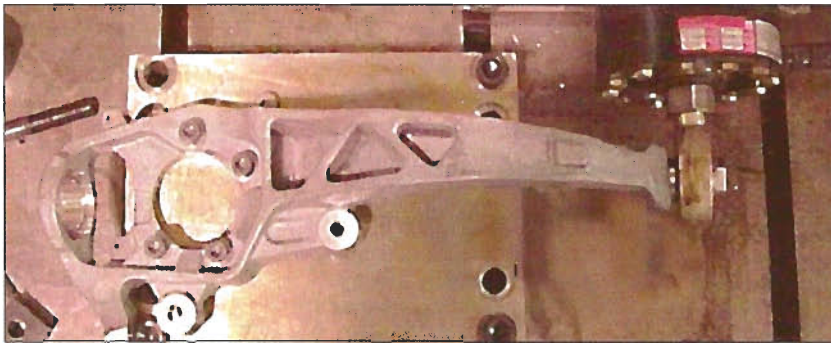
The SPX process virtually eliminates voids by applying pressure continuously while the part solidifies. The pressure builds during casting solidification and peaks at about 16 kpsi. Castings then get heat treated to obtain the right mechanical properties.

## COMPONENT TESTING

The initial parts were subjected to brutal testing at Jaguar's lab and on test vehicles. To double-check results, SPX Contech ran parallel bench tests in its own lab. The company also tested the previous supplier's parts for comparison.

In the lab, knuckles went on a

Edited by Jean M. Hoffman



The cast-aluminum steering arms were fatigue tested by applying loads for 2.5 million cycles.



After 2.5 million cycles, the parts were tested to destruction at maximum loading, with the first failure occurring after an additional 2,481 cycles.

“Hub” fatigue test rig with a cornering load of 0.8 gm for a minimum pass number of 100,000 cycles. Tests continued to destruction, with the lowest failure coming at 350,192 cycles. Three of six castings tested also survived 1 million cycles before Jaguar stopped testing.

Next came a fatigue test on the steering arm. Each of six parts saw 2.5 million cycles at various loads from  $\pm 2.0$  kN (2.3 million cycles) up to  $\pm 11$  kN (1,500 cycles). Afterwards, parts were reset on the maximum loading and tested to destruction with the first failure at an additional 2,481 cycles.

Parts then went on vehicles for

more punishment. These tests culminated in building the knuckles into a car, then driving it downhill at speed into a 6-in.-high, 45° curb to see if the castings withstood the impact. They did.

#### MANUFACTURING PROCESS

To gear up for production at Jaguar’s Welshpool, U.K., facility, SPX needed a 2,000-ton die-casting machine built specifically for the P2000 process. Also needed was a tower-melting furnace capable of melting in excess of half a ton of alloy/hr and robotics to fully automate the cell.

The system included a part-numbering device for individu-

## Die-cast steering knuckles K.O. the competition

The die-cast steering knuckles from **SPX Contech**, took the *Aluminum, Squeeze/Semi-Solid* top prize in the **North American Die Casting Association (NADCA) 2006 Die Casting Competition**. The organization honors outstanding die-casting designs in nine categories (see the July 13, 2006 issue of *MACHINE DESIGN* for other award-winning parts). Entries for this year’s competition must be submitted by Friday, Feb. 23. Winners will be displayed during the 111<sup>th</sup> Casting Congress, May 15-18 at the Hilton Americas in Houston. For more information, visit: [diecasting.org/castings/competition](http://diecasting.org/castings/competition)

ally numbering every casting and an X-ray facility that works in real time to eliminate any subjectivity in acceptance standards.

During heat treatment there are test bars taken from three locations in the casting to check material properties. The X-ray checks all castings to ASTM standards in eight separate views. Finally, parts get gauged and undergo die-penetrant, ultrasonic, and hardness checks before leaving the plant. **MD**

#### MAKE CONTACT

**SPX Contech, a Div. of SPX Corp.,**  
(800) 314-4779, [spxcontech.com](http://spxcontech.com)

Circle 624