MACHINING

Trifles make perfection, and perfection is no trifle.

Michelangelo



The above bracket is a stiffening brace to minimize flex of the front shock tower. We machined a dish into the top of the bracket for shock clearance. Notice the tapered hole for a flat head bolt. The area is too tight for anything else.



Left trunk brace. It has many different angles on it that had to be fixtured so they could be machined accurately. The "sheet metal" was milled directly into this part to save weight.



We made many different fixture plates to machine all the different angles in the parts.

Below: A fixture plate in action on the 4th axis. The 4th axis is for spinning the part around. Many parts, like this one, had to be machined on all six sides—requiring many operations.





Left: The cross member in the top of the photo is recessed for the transmission mount. The cross member in the lower part of the photo goes in front of the differential. This design was later superseded when we made provisions for a drive shaft safety loop. The small, tapped holes in the bottoms of both cross members are for mounting the belly pans.

Below: The prototype's front jack hook arms that support the jack hooks and radiator—this piece too was later superseded with a lighter design.







Every part on the chassis was pressure washed before assembly so the Loctite would have a clean surface to stick to. Every fastener in the car that went into a blind hole was secured with Loctite.

Differential upper mounts.



This is part of the cross member behind the passenger's seat. The sharp triangular area is where the door sill plate bolts in.



The motor mounts are a fail-safe design with through bolts to prevent the engine from breaking loose if the urethane should ever fail. The motor mounts are also quite stout with 1/2 inch walls. We have seen too many motor mounts fail in accidents.



The motor mounts are designed to spread the load over the entire frame rail by tying the top and bottom of the main rail together.



The steering arm (at the top of the upright) was designed to capture the outer tie rod in double shear to eliminate any cantilever loads on the tie rod bolt. The steering arm was later superseded by a stiffer part. The big bore in the center of the upright is for the large Lexus bearing we now use in all our cars. The bearing is rated for a life of 300,000 kilometers—in cars with twice the mass.



The front upright was a challenge to design with everything we wanted. Notice the upper and lower ball joints are captured in double shear. The upright is hollow to allow airflow for brake cooling. The brake caliper side of the upright is not hollow because it has to feed braking loads into the wheel bearing to stop the car.



This is the top plate of the rear suspension box during manufacturing. The cut out in the center enables the plate to clear the top of the differential.

Right, top of photo: The upper bracket that connects the rear upper control arm to the rear upright. Notice the rod ends are captured in double shear. Bottom of photo: The special bolts are the pins for the upper and lower control arms. The threaded sleeve nuts are designed with external right-hand threads and internal left-hand threads to allow alignment adjustments without disconnecting the control arms. The parts are made from 17-4 PH stainless steel.







Many parts fell by the wayside as we constantly refined the car during the prototype phase. Any time we came up with a better idea, we immediately redesigned and manufactured a new part.





Closeup of the rear bulkhead and main frame rail junction.

On the opposite page is the evidence of many hours of work that could be considered "tuition." We learned from every abandoned part. Some were made several times—until we were satisfied with them. Even the CNC tool paths were programmed so the milling marks left by the cutters in the parts would be beautiful. We wanted every part to be a sculptural and engineering masterpiece.



Even tiny machining marks make tiny stress risers in a part. The stresses on the above control arm are concentrated where the two legs of the control arm join. We conscientiously programmed the tool paths to run around the control arm in long sweeping arcs—without stopping—to minimize any stress risers from the machining process.



All machined parts had deburring passes painstakingly programmed into the sweeps and curves of the CNC milling paths for consistency and beauty. This is the rear shock rocker.