An automobile is born in a rough sketch and finally hits the road years later, after a rigorous round of tests.

Between those points lie myriad steps, and the journey is shared by numerous parts suppliers and by suppliers to suppliers. In a viciously quick design cycle, pressure to save time and reduce costs gets passed from the top down to the little guy and from the little guy to the smaller guy. It's a dog-eat-dog world, where second- and third-tier automotive suppliers find themselves in the same position as the high school boy trying to win the hand of the head cheerleader: He gets to be with her, but only if he plays by her rules.

The rules in this case often dictate buying expensive technology that the top-dog automaker wants its suppliers to use.

As major auto producers have increasingly outsourced product development over the past two decades, suppliers who may have initially resisted jumping at their customer's demands to bring in this or that technology have learned the importance of giving in. If they have the computer-aided design program the customer uses, they just might get the bid.

"Maybe 10 or 12 years ago a supplier would use its own CAD program of choice," said Darren Cairns. He's the director of computer-aided engineering at Integral Powertrain Ltd., an engine supplier in Milton Keynes, England. "But nowadays we have all the major CAD systems out there, and we have to use the one that's appropriate to the manufacturer. That has its problems."

Expense, of course, is one of the problems. It's not cheap to house and maintain all those systems, and suppliers pay out of pocket to train their engineers on each application. The engineers do advanced design, after all, and have to know the ins and outs of each technology.

Environmental awareness and the demands of the marketplace have sped up design cycles, and automakers inevitably pass down that sense of urgency to their suppliers, Cairns said.

The last decade has seen enormous pressure in all industries to reduce design cycle time, of course. But the change has been significant in the automotive industry.
Ten years ago, vehicle manufacturers kept the same engine design through four or five years of the vehicle model's production.

"Now you're doing well to get two years out of an engine design because of legislative changes like new emission laws or drive-by noise requirements," Cairns said. Drive-by noise requirements dictate the decibel levels of vehicles as they're driven on a residential street.

"Five years ago, there was little concern about drive-by noise, but now it's very important. And emissions laws are obviously equally or more important," he added.

Swift changes in law reduce available time, and that affects the supplier. An engine maker can't spend five years designing an engine that may only be made for two.

Integral Powertrain's projects generally take three to five years from initial concept to manufacture. At the quicker end of the cycle are engine designs that need only tweaking and a slight redesign to meet changing environmental standards. An engine that takes five years to produce is most likely a completely new design, Cairns said.

"Imagine you make doors. It's likely they have two hinges, one at the bottom and one at the top. The hinges aren't side-by-side in the middle," Cairns said. "Though the arrangement seems logical, it's really just a design rule because of the door's weight.

"You could link your CAD model to certain rules for weight and then the model determines where the hinges need to be, based on what the door weighs," he said.

Engineers don't have to start from scratch with each design. They can check calculations already made for past models and can determine, based on archived information, where to best situate engine parts.

"We have a number of models of a crankshaft with rules on how to best design a crankshaft based on previous experience, and on analytical and mathematical calculations," Cairns said. "We need quality designs quickly, so we can't have people creating everything from scratch."

Last year, Integral's engineers completed the initial concept design for a V12 engine in six weeks. To design to the same level of detail would have taken them three to four months in the past, Cairns said. He attributed the stepped-up process to the knowledge system.

"When the customer came back with some changes, we could accommodate those very easily because all the rules and elements that had gone into the design were stored in the system," he said.

The traditional way of doing things in the automotive industry is no longer traditional, and that goes for the automotive design firms responsible for a vehicle's style, both inside and out.

Automotive stylists can be said to be the clothing of the industry. They help automakers refine the shape and the look of the vehicle so it appeals to customers, and looks cutting edge and modern.

Like parts suppliers, the design firms need to keep up with swift technology developments or they risk losing customers.

Stile Bertone of Turin, Italy, is one of those firms. For the most part, its designers still work traditionally, said Giuliano Biasio, the company's exterior design director.

Designers traditionally create new-vehicle designs by sketching on paper or modeling with clay. The sketch or the model then must be digitized to include tooling and engineering instructions. This is done via a computer-aided styling system, which operates much like a CAD system but does not contain engineering information.

Many Stile Bertone clients request a hand sketch of important internal or external automotive features, and other parts are designed directly on the computer. The hand sketches are later rendered in CAS software to include important styling details.

But when executives at sports-car maker Alfa Romeo, which is also based in Turin, asked Stile Bertone to help create its Alfa GT, they wanted to move from early sketch
to final product in 30 months. Alfa Romeo also wanted early designs to have the look of hand-sketched drawings, although they wanted those designs done digitally.

The design firm turned to a suite of tools that lets them integrate the entire design process, from concept sketches and CAS to engineering. The software, called StudioTools, from Alias of Toronto, lets designers digitally sketch a variety of designs, like the shape of the windshield, see the results, and quickly change them if necessary. The software will create 3-D models from two-dimensional sketches.

Automakers are much more concerned with fine-styling details than they've been in the past, Biasio said. The auto customers have also passed on their shorter-time-to-market requirements to Biasio's company.

His firm uses the tool to see, in three dimensions, how a particular part of the automobile would look if built. Sometimes designers can even get around building a prototype.

"It's fascinating to enjoy the feeling of getting into or opening the door of a vehicle by means of a 3-D visualization," Biasio said. "Some stylistic trimmings are presented only in a virtual environment to facilitate decision making and accelerate the process."

Technology tools, like the CAS software, save design time and cut costs because Stile Bertone employees can first visualize their designs in three dimensions, then build a mockup later in the process. Traditional designers, who model by hand with clay, also work with CAS operators early in project development, Biasio said.

The company also uses the software to restyle projects. Employees can update models quickly by giving an interior a sportier look or by changing the steering wheel material, without changing design mathematics.

Sometimes automakers encourage suppliers to use software and hardware that just isn't practical to implement. In that case, suppliers do the best they can.

Integral Powertrain's customers usually ask the company to bring in a product data management system to keep track of information flowing between engine maker and automaker. A PDM system also makes for quicker and easier online communication about parts and deadlines.

But it's impractical, not to mention expensive, for Integral to bring in every PDM system a potential customer might use. Sometimes, Integral uses the same system as its customer. According to Cairns, even in those cases, if the customer configures its software differently, the systems aren't particularly compatible.

Currently, Integral uses the SmarTeam product lifecycle management system from Dassault. It works well for engineers' needs right now, Cairns said.

"When we're designing an engine, we manage the data internally and then we transfer the data to the customer," he said. "Customers are only interested in packaged data, not details. They want an overview. They don't need to see every detail inherent in the design. So that kind of information does migrate to our customers' systems in the end. "Still, I've got to be honest; in terms of PLM, we have a tremendous way to go," he added.

The company now uses the system to track and manage only CAD data. Engineers want a system that can manage other data related to the design, like test information, bills of material, and photographs of a component. To that end, Integral is eyeing an Enovia product from Dassault.

But sometimes Integral gets to be on the other side of the fence when it comes to dictating to suppliers. Over the course of a project, Integral buys engine components from its own suppliers. That's when Integral the supplier morphs into Integral the customer, encouraging suppliers to implement SmarTeam for their own operations.

A large percentage of Integral's approximately 80 suppliers now use the product to pass information back and forth to the engine maker.

"Some of our suppliers are relatively small, and the companies don't want to invest tens of thousands of pounds in a new technology," Cairns said. "Just like us, automotive industry suppliers are under increasing pressure to drop their prices on components and are loath to take on more costs. So we've tried to tell them, there's a huge productivity benefit to taking on these tools."

Integral's small-guy suppliers can rest assured. Their big customer knows what it's like to be the little guy, too.