

EVOLUTION OF THE 5-LINK SUSPENSION FOR C3 Corvettes

By Wayne Ellwood re-created for online publishing from a write-up in Vette Vues, Volume 40, # 11, June 2012

Scenario

Looking at the history of Corvette suspension systems, we see an evolution from solid axle cars to the trailing arm design (IRS) of C2 and C3. Then, in 1984, there was a switch to the five-link design that marked the modern Corvette. But it took a long time for GM to upgrade from the C3 to C4 IRS systems. Given the problems with the C2 and C3 trailing arm IRS, it was inevitable that racers and “tuners” would develop their own solutions.

Toe steer (also known as a quality of bump steer, or compliance steer) was a critical problem. (Uncontrolled movement affects handling, especially through turns where it is critical to carry higher exit speed for faster lap times). Initially, racers tried to increase the stiffness of the suspension and bushings to limit the compliance inherent to factory rubber bushings. The Greenwood BFG cars were good examples of how the C3 suspension could be upgraded with new bushings and other performance parts. The needle - bearing bushings, (such as those developed by Emery Donaldson), were expensive but far stiffer than factory parts. Even so, the ability to address overall vehicle dynamics was limited by two factors.....money and rules.

Money - Recall that, “pro” sports car racing was just getting on its feet. Amateur racing, while fiercely fought, did not reward contestants with cash. John Bishop saw an opportunity and created IMSA in 1971-72. Bishop succeeded in drawing racers away from SCCA with actual prize money. In response, the SCCA began moving into pro racing with a revamped Trans-am series in 1973. But the situation was short-lived. Both parties faced the fuel crisis. It had a two-pronged effect. First, it rewarded the more fuel efficient (and factory-backed) cars like Porsche. Amateur racers with low budgets could not compete. Second, while costs remained fixed, attendance was declining amidst an economic recession. This limited incentives and prize monies for competitors to foster and test new ideas.

Rules - SCCA was traditionally a “rules” oriented group that strongly favored stock-type cars. Most SCCA racing classes mandated stock suspension mounting points and (mostly) stock suspension pieces that also worked against innovation.

IMSA’s John Bishop was quicker to adapt. He indicated to GM that he was prepared to adjust his rules to permit lighter cars to compete with the (turbo) Porsches. The result was the big block MONZA of lighter weight unibody construction. With tubing added for the cage, the car was strong. Some great racing followed and the bigger teams competed quite well. (Al Holbert actually raced a Monza in IMSA and a factory backed Turbo Porsche 934 in Trans Am). For the smaller teams, however, it was still an expensive game.

Fortunately, several tuners emerged with “lower” budget ideas to adapt to the rules. We might best understand the evolution of the 5-link suspension if we look at John Greenwood’s 1974 wide-body race cars as a start point.

Greenwood Innovates with Bob Riley designs

By late 1973 John Greenwood had developed his first wide-body car. The wild shape caught everyone’s eye. But underneath the skin, it was Bob Riley’s design for the chassis and suspension that was the most important element. The car was still based on a full frame car built-up with tubular components for added strength and rigidity. But, more to the point, it carried the first professional five-link system.

Greenwood’s “mule” car was introduced at the 1974 Detroit hot rod show. It was raced off-and-on at various events in 1974. The suspension had teething problems but developmental work continued. In 1975 the car was run with some success as both the Spirit of Sebring ’75 and the Spirit of Riverside ’75, taking three straight Trans-am wins and the series championship. At the IMSA Finalé, Greenwood introduced his next car, the Spirit of Sebring ’76. A third chassis was built for the Greenwood team but never raced. These three cars were considered as “team” cars but were the first of twelve (and perhaps more) cars in this style. The remaining nine cars were sold to various racers and thus became known “customer cars”. They were ordered according to the series for which they were intended and sold at various prices, with or without engines, with or without coil-over spring configuration, and with or without the wide body.

It is equally important to note at this point in time that Bob Riley began marketing his system to other racers besides Greenwood under the name RPF (Riley, Prototfab, Foltz). Bob also began consulting with other tuners for their own systems. (I’ll elaborate on these developments after wrapping-up a few points on Greenwood’s racing program).

In 1975, Greenwood turned his attention to developing his new tube-frame cars...Bob Riley (still working at Ford) was doing the design work at his home while Greenwood was developing the manufacturing and assembly capacity. A major refinement to the 5-link system was the development of a new design for the bearing housing (hub). The first tube-frame appeared at Brainerd in 1977. It featured a major update to the earlier hub design.

All of the above might lead one to conclude that the evolution of the five-link, from Greenwood’s customer cars to GM’s final 1984 design, was pretty straight-forward. But that was not the case. While IMSA moved on with its AAGT and GT categories, the SCCA answered with its Trans Am Category I (unlimited) and Trans Am Category II (10” wheels). The parity did not last long. In 1981 IMSA raised the game, almost a quantum leap, creating what became the wildly successful GTP category for prototypes. That left the lesser financed teams, Corvettes among them, to race in the SCCA TA Series. Against this volatile background, pro sports car racers were looking even more for economical fixes that would extend the competitive lives of their category II cars.

5 - Link kits

There were three major kits developed by Dick Guldstrand, by Tom Ryding and Bill Trueasdale (CVC-APEX) and by John Greenwood. Each were from a different part of the country and each targeted slightly different audiences. Dick Guldstrand's kit from California was SCCA-legal (club and pro) and was also viable for the street. The kit developed by CVC-APEX in the Chicago area was much more of single-purpose design for the various SCCA series. And Greenwood from the Detroit area offered different kits for street and race, as well as complete cars.

It is hard to credit who was first to develop and sell these new 5-link kits, apart from the obvious head start that Greenwood got by virtue of his early race work with Bob Riley. Bob also consulted with Dick Guldstrand for his initial sales venture....the kit was advertised as an RPF 5-bar system. And the system developed by CVC-APEX was the work of Tom Ryding, a GM Engineer involved in the ongoing development of suspension systems. So, rather than try to give credit to one group, let's just see what each group offered.

CVC- APEX from Chicago

The Chicago area is a hot bed of racing activity and it is close to several tracks and close to the major manufacturers in Detroit. Tom Ryding had an after-hours automotive business, Competition Vehicle Chassis (CVC) to develop new suspension systems. Tom was also a friend of Paul DePirro, a veteran racer in the area. So when Tom had his idea on how to improve the C3 cars, he convinced Paul to serve as his developmental program. As with other racers, Paul was battling the suspension issues of the C3, so he quickly agreed. Bill Trueasdale owned APEX Engineering that built and prepared race cars. Paul DePirro was a customer. Through this association, APEX engineering became the manufacturer and sales distributor for the new system. Tom Ryding (CVC) and Trueasdale (APEX) began offering their kit in 1978. Racers could buy the kit and install it themselves or have CVC-APEX install it in their shops.

Of course, it wasn't that simple. One problem was that the SCCA rules required stock suspension pick-up points and limited the variety of stock suspension parts. The system developed by CVC-APEX stuck closely to the rules and, as a result, was not quite as sophisticated looking as some other systems that went a little bit further in their interpretations of the rules.

The CVC-APEX system required that the trailing arm be cut and welded into a fully boxed member. New pick-up points were welded in the stock locations. And they sub-contracted the manufacture of harder rubber bushings.

Another problem was that the stock differential was failing under the stresses of racing. The new suspension did not improve this situation. After some experimentation, it was determined that the Franklin quick-change rear-end with shortened half-shafts was the answer to the durability issue. This piece became a central component of the new "kit" offered by CVC-APEX. Years later, the Franklin quick-change rear-end was still the solution to solve driveline failures on the Greenwood tube-frame cars. Greg Pickett installed one in his # 6 Pacific Diesel car.

Only a few people actually saw the new CVC-APEX suspension and subsequently asked about the installation. Dale Lepke and Dave Landis were the first to buy improved versions of the prototype in DePirro's car. Dale Lepke had an old Greenwood chassis which he updated with the new system. Dave Landis updated his own car which he built in 1975. Both drivers were pleased with the results. Sales grew as word spread. Paul recalls that perhaps some 25 kits were sold and that APEX installed many kits in their own shops. Other racers that might be familiar include Marcus Oppie, Craig Leifheit, Herb Forrest and Warren Fairbanks.

Greenwood "Street" Car applications

In his story about CVC-APEX, Paul DePirro noted there was a link between the CVC-APEX (DePirro) concept and some Greenwood developments. Rick Mancuso (another Chicago area racer and Chevrolet dealer) and John Greenwood were both friends and business partners in several projects. The Sebring GT "street" car is one example. Mancuso initially ordered 15 of these cars for sale through his Lake Forest dealership. It is believed that Rick initially brought two new cars to APEX for the installation of the new five-link rear suspension and then delivered these to Greenwood for the installation of the Sebring GT bodywork. After that, Tom Ryding gave permission for Greenwood to install them in his new Florida shops.

Of course, this was immediately after Greenwood's work on his race cars with Bob Riley. Because Greenwood was busy with his race program it is possible that the CVC-APEX system may have been an early solution to delivering the first customer cars. However, the existing "race" version was much more sophisticated and was ultimately used as the basis for a new five-link (street) suspension design. The GT Turbo cars featured a new central hub carrier supported by five fully separate links (two trailing two lateral) and one upper for toe control, effectively freeing that element from bearing weight.

This car was followed by the Daytona and GTO "street" cars, all featuring the same suspension. The number of these kits incorporated into Greenwood cars (or sold through the catalog) is difficult to estimate. Customers always had choices and there was no real "fixed" option packages.

Guldstrand Engineering Inc.

Dick Guldstrand from California was also consulting with Bob Riley. Around 1978, Dick began advertising the RPF 5-bar system for race applications. The system was SCCA-legal and it worked. Sales were good and a lot of racers took advantage of this system. The Guldstrand system evolved like the others. Dick figures that he and Greenwood and APEX came up with their own variations around the same time. The overall geometry was pretty clear. But each approached the details in a different manner. For example, the Guldstrand-RPF system used two lower strut rods to control toe settings while Greenwood insisted that you had to have one control link up top. The Greenwood idea was seen in both the Greenwood and APEX systems; each used only one (rear-mounted) strut rod for toe control. They also had differences in manufacture. The Guldstrand system evolved from the welded-up hub carrier for the RPF system to a beautifully cast aluminum hub carrier, complete with DG initials embossed on the hub carrier. Of course, the cosmetics were also reflected in a higher price yet the Guldstrand system far outsold the others.

The idea that the Corvette suspension could be improved wasn't just limited to just the C3 generation. Guldstrand continued to improve on the factory set-up with his GS-80 and GS-90 designs when the C4 came out. Guldstrand began with higher-rate springs that lowered the car and Monroe Formula GP shock absorbers. The control arm and sway bar bushings were replaced with less compliant polyethylene units and the sway bar ends were heim-jointed for increased effectiveness. Finally Guldstrand installed his own camber kit and a roll steer control package for the rear.

Echoing the above and looking back, Dick recalls that discussions to improve the C3 suspension problems and the need for a new suspension for C4 went on for a long time. As Zora Duntov was preparing to retire (circa 1975), he introduced Dick to his successor Dave McLellan. Dick was part of the old Grand Sport gang and Zora wanted to make sure that McLellan had access to ongoing sources of "testing". Over the next years, they would meet frequently, both in Detroit and in California. Discussions consistently returned to the fact that while the C3 IRS had been a good system, it needed to be improved. But until GM decided to commit to a fourth generation of Corvette, these were just discussions. The "tuners" would do their thing and the Corvette group would be limited to weight reduction and fine-tuning.

The Legacy of Bob Riley

Those who read this far will note that the name of Bob Riley lurks throughout. The book on Bob Riley has yet to be written but it will be a thriller.

Through it all, these "5-Link" kits still exist and are still being sold for C3 Corvettes. And there are individuals out there with new ideas for their own systems, using new materials, new manufacturing technologies, new testing and other developments. A good idea like the five link suspension has legs.

Photos 1 – 21 captions

PHOTO 1

Subject: # 77 tube frame at 1977 Watkins Glen race
Caption: lead photo – no caption
Photo Credit: Greenwood Archives

PHOTO 2

Subject: # 83 Dale Lepke – circa 1978
Caption: Low budget racers could turn out a well-prepared car but their efforts tended to be limited to “local” races
Photo Credit: Paul DePirro

PHOTO 3

Subject: # 75 at Carlisle
Caption: The first wide-body car was introduced in 1974 but was most famous for its 1975 Spirit of Sebring '75 livery
Photo Credit: Wayne Ellwood

PHOTO 4

Subject: Kunicki replica
Caption: Dave Kunicki's restoration of the 1978-79 Grant Robertson car was faithful to Greenwood's five-link rear suspension with welded-up rear hub
Photo Credit: Wayne Ellwood

PHOTO 5

Subject: Mike Olyear/EF Miller chassis # 011
Caption: The Mike Olyear/EF Miler car (chassis # 011) was sold in narrow body with flares; customers often opted for more economical layouts
Photo Credit: Wayne Ellwood

PHOTO 6

Subject: Tubeframe # 1 – overview shot
Caption: No caption
Photo Credit: Greenwood Archives

PHOTO 7

Subject: Tubeframe # 1 – rear suspension
Caption: For 1977 the new tubeframe car had a new style hub carrier and attachment points but still had the original Bob Riley geometry
Photo Credit: Greenwood Archives

PHOTO 8

Subject: R.J.Valentine # 68
Caption: The five link suspension on R.J. Valentine's IMSA Corvette at Daytona in 1979
Photo Credit: Unknown

Photo 9

Subject: Greg Pickett # 6
Caption: The five link suspension on Greg Pickett's TA Corvette at Sears Point in 1982. Exceptionally high quality fabrication as the C3 neared the end of production.
Photo Credit: Brent Martin

PHOTO 10

Subject: CVC-APEX rear suspension
Caption: Paul DePirro's # 78 car was the "mule" for the development of the CVC-APEX 5-link system
Photo Credit: Paul DePirro

PHOTO 11

Subject: CVC-APEX system on Herb Forrest car
Caption: Tommy Richardson recently purchased the 1978-80 Herb Forrest car for restoration
Photo Credit: Tommy Richardson

Photo 12

Subject: Joe Chamberlain # 76
Caption: The five link suspension on Joe Chamberlain's IMSA GTX and TA Corvette at Sears Point in 1980. Don Lee rescued the car. Lance Smith is restoring it.
Photo Credit: Unknown

Photo 13

GM 5-Link diagram

Photo 14

GM 5-Link diagram

PHOTO 15

Subject: blow-apart diagram for coil-over application
Caption: Blow-apart diagram illustrates the CVC-APEX assembly manual. Diagram shown here is for coil-over application
Photo Credit: Paul DePirro

PHOTO 16

Subject: Greenwood 5-link for Turbo GT
Caption: Greenwood's sophisticated street cars also benefitted from his race-proven 5-link system; the system illustrated here could be ordered on the Turbo GT
Photo Credit: Greenwood Press Photo

PHOTO 17

Subject: Greenwood's 1982 system
Caption: As time progressed, tuners like Greenwood would simplify their systems to be more price competitive for street applications
Photo Credit: Greenwood Press Photo

PHOTO 18

Subject: RPF system
Caption: In the early days, Dick Guldstrand offered the RPF system in his performance catalog; as the system evolved, it was re-named as the Guldstrand 5-link
Photo Credit: P Mazza posted on VETTEMOD Forum.com

PHOTO 19

Subject: RPF system
Caption: Guldstrand 5-Link installation
Photo Credit: P Mazza posted on VETTEMOD Forum.com

PHOTO 20

Subject: Guldstrand catalog (1983)

Caption: By 1983, the Guldstrand Performance catalog featured a 5-link system with cast aluminum hub carrier, embossed with DG initials
Photo Credit: Guldstrand Catalog

PHOTO 21

Subject: GS-90
Caption: By 1995 Guldstrand's GS-80 and GS-90 both featured enhanced 5-link designs, using parts developed for the earlier 5-link suspension kits
Photo Credit: Wayne Ellwood