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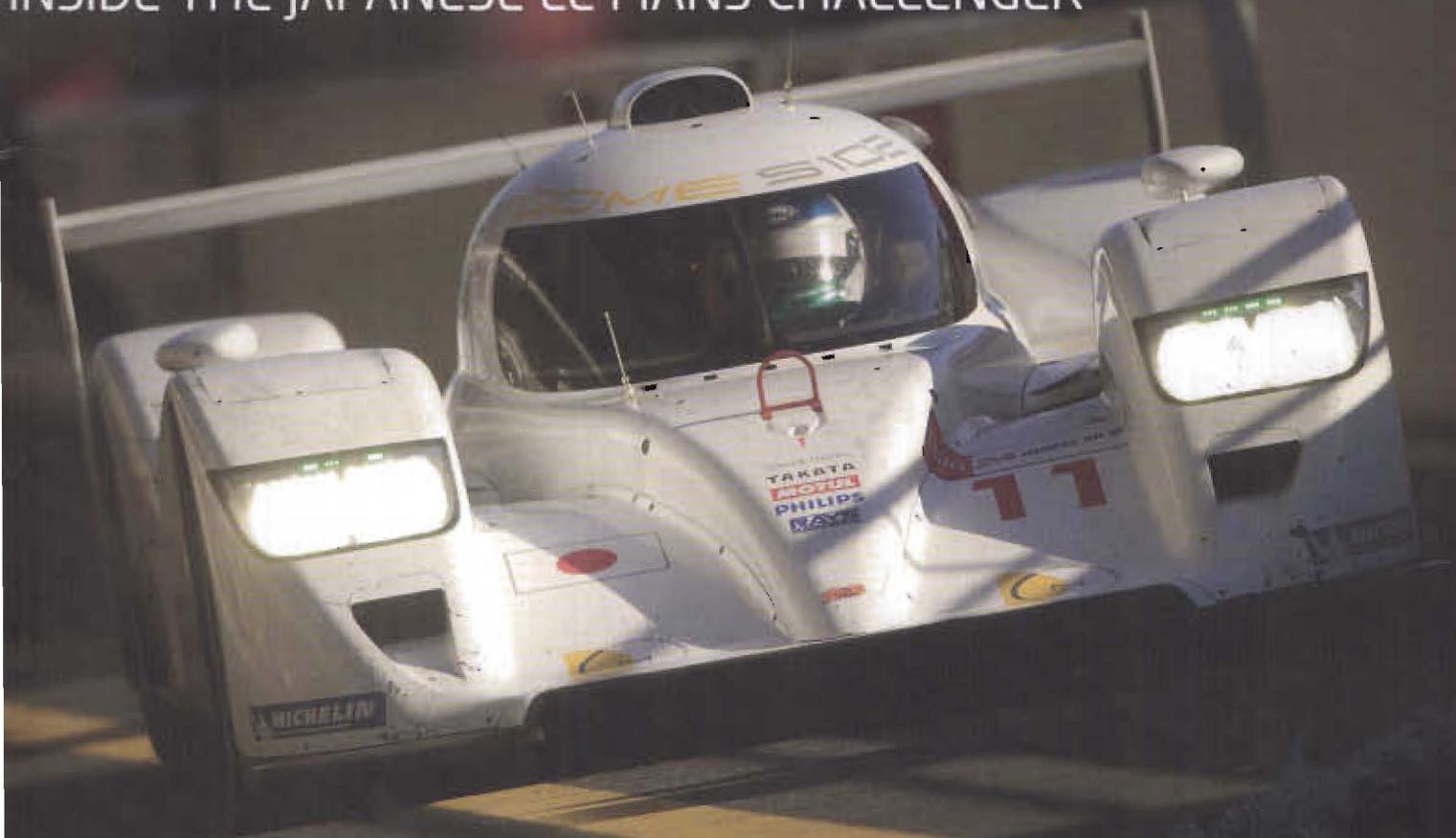
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Hindsight: Klaus Arning

The legacy of Ford's inspired suspension guru investigated





Independent thinker

Mario Andretti was going to kill himself, that's what they were saying. The handling of the Honker II Can-Am car (see lead pic above) was atrocious and Andretti, being Andretti, was trying to wring every last ounce of speed out of a machine that was at best unpredictable. Paul Newman's name may have been on the car but, in reality, it was a semi-factory Ford team and Andretti was a Ford factory driver. It just wouldn't do if Andretti killed himself.

Word reached Dearborn, and the following morning a neatly dressed man with a slight German accent was seen in the paddock at Laguna Seca, site of that weekend's Can-Am race. The rumour was that he was a suspension engineer from Ford, named Klaus Arning. It didn't take the visitor long to discover the problem. The jounce bumper

Klaus Arning is not a name widely associated with racecar engineering yet without him Ford's motor racing programme in the 1960s would have been a very different place indeed

BY RICHARD NISLEY

on the right front coil shock was considerably longer than the others. 'The what? You mean the rubber doughnut that prevents a coil shock from bottoming out? Are you kidding?' Someone produced a razor blade and duly shortened the jounce bumper to match the other three, then Andretti did some further laps and returned to the pits smiling. The Len Bailey-designed Honker II was still too much of a dog to challenge the semi-factory Chevrolet team (aka Team McLaren), but at least it no longer threatened to launch its driver into the hedges every time he put the suspension under the slightest load.

Klaus Arning is not a name that resonates with car and racing enthusiasts in the same way as Zora Arkus-Duntov, another foreign-born engineer who worked in Detroit, but what Arkus-Duntov did for the Corvette, Arning did for the Mustang I prototype, the Shelby Mustang GT350, the Ford GT40, the 427 Cobra II, and AJ Foyt's

Coyotes. If Arning had had his way, the original production Mustang would have come equipped with an independent rear suspension, too. Carroll Shelby asked him to make his Mustang GT350 handle like a racecar. Dan Gurney consulted with him regularly and AJ Foyt - rarely given to compliments - called him 'brilliant'. Fellow



Arning and his homemade roadster, with independent suspension all round

“ the guy was extremely inventive. He was always thinking ”

REFERENCE MATERIAL

↘ The patent on Arning's four-link IRS has been referenced by GM for the Corvette, by Porsche for the 928 and by Mercedes Benz. To get around the patent, each installed a tie rod, or fifth link, creating what is called a five-link suspension, to achieve the same toe-steer Arning's IRS achieved with four links. He also talked about this in the 1993 interview. 'They [GM, Mercedes Benz and Porsche] circumvented the patent by doing what anybody could have done all along – steer the wheel axle to get your toe-steer independent of what it does going fore and aft. That was the clever part of the invention. It doesn't need steering arms, it does it anyway.'

Ford engineer Chuck Carrig said of him: 'Some people [at Ford] didn't like him because he was kind of a showman. But the guy was extremely inventive. He was always thinking.'

PROBLEM SOLVER

Like so many creative people, Klaus Arning was a dreamer. He worked out ideas in his head first, then put them down on paper. Before passing away in February of 2000, he said in an interview: 'When I designed my first little car back in Germany, with all the axles and all the suspension stuff that I did for it, I used engine parts that were tossed off, like an engine belt stamp and die. I went to the scrapheap, got them out, and that's how I made all my pivots. All these designs I make in my head, sitting in Sunday school or wherever, being grilled by the preacher.' In the 1960s, he was Ford's problem solver on all matters relating to suspension. In short, he was Ford's suspension guru.

Arning was born in Bremen, Germany, in 1921. Before the war, he put money down on an NSU 50cc motorcycle, fabricating a mechanism to convert it from hand to foot shift, but never took delivery. The Nazi government intervened and ordered the factory to re-tool for wartime production. He subsequently trained as a Luftwaffe fighter pilot, but never actually flew

a mission, as there were not enough aeroplanes. Instead, he was sent to Leningrad, on the Eastern Front, where his ankle was shattered when the vehicle he was riding in drove over a landmine. He was among the last to be evacuated.

After the war, he built the car he had been dreaming about for so long, from scrap DKW-Lloyd and BMW parts. He shaped and fitted the various pieces together in his attic, then brought them down to the street where he assembled them into a car. The small, lightweight, two-seater had fully independent front and rear suspensions, characteristics that would appear 15 years later in his designs for the Mustang I prototype. He was one of the few

“ Suspension was his passion ”

people to own a car in post-war Germany, and probably the only student attending University in Bremen to own one. As fate would have it, the car was stolen and involved in a police chase that was covered live by Frankfurt radio. It did not end well for Arning's hand-crafted car though, which was destroyed when the car thief crashed it.

PEOPLE EXCHANGE

In 1949, Arning graduated with a degree in mechanical engineering and went to work for the

Borgward Auto Company, where he had apprenticed before the war. In 1950, he participated in a 'professional people exchange' programme that took him to Detroit to work one year for the Ford Motor Company. He returned to Germany in 1951, and resumed work at Borgward. In 1953, while test driving a second experimental car of his own design, he crashed and was thrown through the windscreen, the unfortunate event being followed by nine months in traction in a nearby hospital. By then he was married and an expectant father. 'My dad was already in the hospital waiting for me when I was born,' his first son, Mike, says with a slight chuckle.

In 1954, Arning packed up his family and emigrated to the United States, where he applied for a job with all of the Detroit auto makers. Each made him an offer. 'I should have taken the job with General Motors because they had more money for more half-baked projects,' he said later. Instead, he joined Ford and was placed in Advanced Suspension and Chassis, where he moved up quickly to become department supervisor. It was where he wanted to be. Suspension was his passion, the stuff of his dreams, wheels moving through jounce and rebound, body roll affecting camber, toe-in becoming toe-out, causing roll oversteer under some conditions, roll understeer under other conditions – so many angles, so many forces acting on them, so many possibilities.

INDEPENDENT REAR SUSPENSION

In 1958, it came to him – a four-link independent rear suspension that acted consistently under all conditions, where you could tailor steer characteristics for handling that related to toe-in and toe-out wheel movements. This is how he described his suspension several years later, in a 1983 interview with Jerry Heasley of Mustang Monthly magazine: 'In the four-link IRS [independent rear suspension], the steer action is built in. Looking at it from the rear view, it was like any other double-wishbone suspension; however, the lower pivot of the lower arm at the wheel hub is



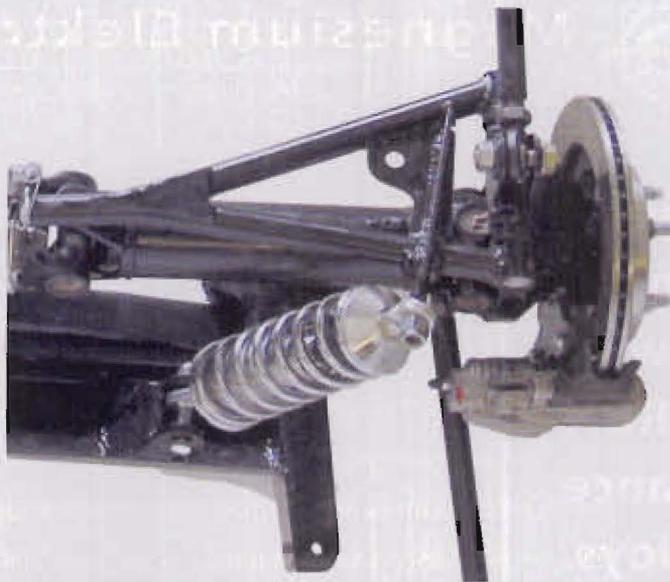
Arning's team was responsible for re-working the suspension on Ford's GT40, prior to the cars' period of domination in European endurance racing

not parallel to the ground, but inclined forward/upward. This very inclination of the hinge axis produces a steer effect that is more pronounced as you incline the axis further away from a parallel. In pictures that have been published of a Mustang I, GT40 and 427 Cobra rear suspension, as well as of the experimental IRS for a potential production Mustang, you will find this lower pivot axis (hinge axis) inclined as such and not parallel to the ground, as it was in the then-current, grand prix-type rear suspensions. This inclination produces, by the very nature of the geometry, a steer effect that counters the inherent wrong steer effect associated with anti-squat features, so for once we were able to have two features that were usually incompatible with one another.

The two features now made compatible were roll understeer and anti-squat/anti-dive. What did it mean? It meant enhanced accelerative capabilities with minimal effects of throttle-on/throttle-off in turns, especially acute with cars having large displacement, high-torque engines - Detroit's calling card at the time. It meant the 427 Cobra II would leap off the line with little wheelspin, and the 427-powered Ford MkII and Ford MkIV Le Mans cars were predictable and easy cars to drive fast. As a result, Ford patented the suspension in Arning's name, but in 1958, had no use for it. That would change . . .

At the start of the 1960s, Ford's image was in desperate need of a makeover. General Motors was known for its lavish styling, while its Chevrolet and Pontiac divisions cleaned up on NASCAR's super speedways. Chrysler had a reputation for engineering and a hemi-head engine that dominated drag racing. And Ford? It had the sporty Thunderbird, but then turned it into a bulky luxury liner, and introduced, and subsequently dropped, the Edsel. And there was the newly introduced Falcon, an artless economy car. Enter Lee Iacocca.

'Total Performance' was the brainchild of Lee Iacocca and the shot of adrenalin that Ford's stodgy image needed.



An example of Arning's four-link IRS with built-in steer action

As newly promoted manager of the Ford division, he wasted no time in making it a reality. In a span of just 12 months, from August 1961 to July 1962, Iacocca authorised the Shelby Cobra-Ford deal, the Lotus-Ford Indy project and the Mustang I prototype. In September of 1962, he convinced Henry Ford II to sign off on production of a new sporty car - the Mustang. At last, there would be a use for Arning's unique IRS.

Mustang I prototype

Englishman Roy Lunn was put in charge of what was a rush project. Arning's team designed a tubular spaceframe chassis with F1-type, double-wishbone front suspension and Arning's four-link IRS.

The lightweight two-seater was completed in eight weeks and unveiled at the US Grand Prix, in October. At

the same time, Arning's IRS was retro-fitted into a Falcon Sprint and tested at Riverside by Richie Ginther as the first step toward productionising an optional IRS for the Mustang.

Ford GT40

Ford also wanted to compete at the next 24 Hours of Le Mans and did not have time to develop a complete new car. Instead, the company bought the rights to the Lola GT, a sleek new coupé designed by

Englishman, Eric Broadly. The car hadn't won a race, but it was powered by a 260ci Ford V8. Once again, Roy Lunn headed up yet another rush project. Ford Styling gave the body a facelift, while Arning's staff re-did the suspension. Meanwhile, Ford had a bright young engineer, named Chuck Carrig, who had recently created the industry's first computer program that could plot suspension geometry. First application: the Ford GT40.

Shelby AC Cobra

Carroll Shelby and his hot rod friends had little trouble installing a 289ci Ford engine in an AC chassis and making it work, but when they stuffed in a 427 engine, they realised

Indy Car was changed over from symmetrical to asymmetrical suspension, bump steer became a problem. In 1964 and 1965, as tyres grew wider, the problem became more acute. By 1966, with tyres wider still and asymmetrical suspension commonplace, Ford stepped in. Word went out to all Ford racers - bring your car to Dearborn. First up was AJ Foyt, who was having his worst season ever, driving a Lotus 38. 'I remember when we got in Foyt's Lotus,' says Bob Riley, who was with Kar Kraft at the time, 'the bump steer was terrible. We could get rid of it in front but, on the independent rear cars, we didn't exactly know how to get rid of it.' The solution was to add positive camber to the rear uprights as per Arning's IRS geometry.

Coyote-Ford

AJ Foyt bristles whenever someone suggests his Coyotes were Lotus 38 copies. Yes, the 1966-'70 Coyotes resembled a Lotus 38, but that was as far as it went. The front and rear suspension was pure Klaus Arning. 'A lot of people were wondering why I had to run so much caster to get the bump steer right,' Foyt said recently. 'Well, it was because of the way Klaus designed the suspension. We had a lot of anti-squat in the car and ran a lot of anti-dive in the front. He taught me a lot of things when I worked with him.'

Mustang

In 1963, while the Mustang was being tooled for production, Arning and his staff developed a special handling

↳ a four-link independent rear suspension that acted consistently under all conditions ↳

the AC's leaf-spring suspension wasn't up to it. Arning caught up with Shelby's team at the 1964 Sebring 12 Hour, only to see Ken Miles wrap the prototype 427 Cobra around a palm tree. Arning's recommendation: replace the antiquated AC suspension with a beefier version of the Mustang I suspension, with geometry calculated on Ford's new computer in Dearborn.

Ford Indy program

The moment the 1963 Lotus 29

package that included revised front suspension and a specially designed four-link IRS that would fit neatly in place of a standard live rear axle. 'The rear suspension was designed so that the fore and aft linkages would fit into the same pivot points that the leaf springs would normally occupy,' explained Arning. 'Of course, a new crossmember had to be added near the wheel centre to accommodate the fixed differential. The axle halfshafts were of fixed length

and functioned also as the upper suspension arms.' After initial tests were completed on the Falcon, three Mustang prototypes were built for evaluation. Everyone who drove these cars raved about their responsive handling. Then, in April of '64, the Mustang made its public debut and was greeted with record sales. 'Efforts did continue to try to productionise the IRS,' Arning said later, 'but it was cancelled because the Mustang sold so well that it was felt we really did not need this special option, which would have required a very high investment in tooling.'

Shelby Mustang GT350

The cancellation came late in the summer of 1964, after Ken Miles and Bob Bondurant met with Arning at Willow Springs Raceway in California's Mojave Desert for a comparison test of Mustangs. Both cars featured Arning's modified front suspension, but one had been race prepped by Miles and had a standard equipment, live rear axle (with over-ride traction bars), while the other was equipped with the optional IRS handling package. On Willow's glass smooth racing surface neither car showed an advantage over the other and, as Miles' prototype was cheaper to produce, it became the Shelby Mustang GT350.

Mustang Mach II

There was one last chance for Arning's IRS to see production. It came in 1967, when word reached Ford that Chevrolet was planning a mid-engine Corvette for Class B Production racing. Ed Hull, who designed the Ford MKIV that won Le Mans in 1967, designed what was to be a limited production sports car. It was based on the 1967 Mustang underbody, modified to accommodate a mid-mounted 351ci engine, ZF transaxle and Arning's IRS. Two prototypes were built, but high production costs, coupled with the fact Chevrolet had dropped its mid-engine Corvette, killed that, too.

All American Racers

From 1964 until Ford pulled out of racing in 1970, Dan Gurney and Klaus Arning spoke regularly by telephone. Gurney explains: 'I had a lot of desire to understand not just the math, but the actual reality of what was going on with a whole lot of things in terms of suspension.' Arning never assisted All American Racers with design, as he did with Foyt and Shelby, nor did he ever attend a test session - at least, not one that Gurney recalls. What they did was have a series of bull sessions, talking about roll centres and camber curves, vehicle dynamics and the way a car felt and worked under a variety of conditions. 'Klaus was much more open and more knowledgeable than anyone that I had access to,' says Gurney today. 'I was asking more for the

“ a steer effect that counters the inherent wrong steer effect associated with anti-squat ”

sake of understanding than I was for what to do. He helped a lot.'

Other projects

The 1969 Mustang Boss 429 was the last Ford 'hot rod' Arning spent time on, resolving problems with the rear suspension, naturally. Ford pulled out of racing in 1970, after which Arning managed a group of ex-Kar Kraft employees engaged in safety and structural engineering and special vehicle projects. He also continued in his role as Ford's expert on suspension, ride and handling, resolving various issues with production cars.

One of the more bizarre projects to cross his path was a special limousine being built for the President of the United

States. Weighed down by its protective armour, the Lincoln chassis was fitted with F350 truck suspension and brakes. 'You would never know it was as heavy as it was - over 6000lb,' Arning said. 'Everything was tuned to the new weight, so the ride frequencies were not too different from a normal Lincoln.' He retired in 1986, but continued working for Ford as a consultant.

Arning applauded the rise of technology in motor racing that led to ground effect cars, but lamented the extremely stiff suspensions that resulted. 'Our GT40 had anti-dive and anti-squat. In those days, you had suspensions on cars. Today, all or most of it is the tyres.'

Several books have been written about Ford's racing involvement in the 1960s, some giving credit where credit wasn't due. The 427 Cobra II is a case in point. AC has been quoted as saying they designed the Cobra II suspension,

not Ford. In an interview with Duane Carling in 1993, Arning said: 'The principle of the rear suspension was the same as with the Mustang IRS. It was executed in its final form by [Ford engineer] Bob Negsted. The English tried to fit stuff they had from the old Cobra into the new design, and some changes were made to accommodate that, but not many, and if that required a different location of, say, a pivot point, Negsted would call and I would feed those points into a computer to recreate the outcome of the geometry to be identical to our intent.' Carroll Shelby put it more bluntly: 'The chassis was done by Klaus Arning. AC didn't have a damn thing to do with it.'



▲ Foyt's winning Coyotes also used Arning's independent rear suspension



Raynald LeBlond/ultramaine.com

AND FINALLY...
 Klaus Arning passed away in February of 2000, but lived long enough to see the Mustang IRS make a comeback, firstly as an aftermarket product for 1964-'73 and 2005 Mustangs, and secondly, as an option for new Mustangs from 1999. The aftermarket IRS is an exact recreation of Arning's design and is available from CTM Engineering. The optional IRS for the 1999-2004 Mustang SVT Cobra is a completely different design, and Arning saw it for the first time at SEMA in '98.

'A young engineer pulled a sheet off the IRS assembly and spent quite a bit of time explaining how it worked,' says Duane Carling, owner of CTM Engineering. 'It was a five-link suspension, very impressive looking, but complicated. As the room cleared out, Klaus turned to me and said in a voice loud enough for the engineer to hear, "It éez a piece of sheet." Owners subsequently complained of wheel hop and something called 'tip-in clunk' - a clunking sound that occurred whenever going in and out of throttle. Ford dropped it at the end of 2004, designed yet another new IRS for 2006, but then cancelled it as too costly. 'I think it's more difficult to make something simple than it is complicated, and Klaus definitely did the former,' says Carling.