News Bureau
Ford Motor Company
Special Vehicles Activity
P.O. Box 608
Dearborn, Michigan 48121
337-5014 (Area Code 313)

THE AMERICAN CHALLENGE

At 4 p.m. on Sunday, June 19, 1966, a trio of Ford racing cars crossed the finish line for the Twenty-Four Hours of LeMans (France) road race, bringing the United States its first victory in the international classic.

Why and how Ford automobiles came to be the American challenge in international competition, and to be victorious, is a story that began long ago.

Ford Motor Company was a power in automobile racing even before it grew to become the nation's second biggest spectator sport, behind horse racing. The heritage dates back to company founder Henry Ford. Early in the century, Mr. Ford, himself, piloted the famed Ford "999" racer to capture the imagination of the American public and to promote his new cars.

The stage was set for the Ford LeMans program in June, 1962, when Mr. Henry Ford II announced Ford Motor Company's withdrawal from the five-year-old Automobile Manufacturers Association agreement to ban racing activities.

Three years later, even before the LeMans triumph, Charles H. Patterson, executive vice president of the company, explained Ford Motor Company's racing policy:

"Our racing program is . . . a prudent business investment. Our product improvements and sales records can be attributed to many factors, but we have no hesitancy in stating that racing is one of them."

He cited four main advantages of the Ford racing program:

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1. The main line product benefits from the development and usage of new ideas and materials. "The exacting requirements of our special performance vehicles make them a rich field for innovation, a thorough school for engineering excellence, and an ultimate challenge in quality control," said Mr. Patterson, citing a long list of items developed in racing and now featured in today's automobiles. "The list could go on and on," he said, "but the net result is safer, more reliable, more durable, more efficient automotive transportation, which is our own stock in trade."

2. Ford engineers are afforded a wide range of experience in a concentrated time period. Mr. Patterson stated that "when we say 'racing improves the breed' we don't mean just the mechanical aspects of our motor vehicles. We also mean it improves the breed of engineers, designers and manufacturing people who adapt these improvements for highway use. From their work on racing cars, these specialists learn more about automobiles — faster and perhaps sometimes more painfully — than they could ever have learned otherwise. Open competition is a valuable adjunct to our engineering and research facilities and to our normal testing operations on proving grounds and public highways. It enables and forces us to compress time, mechanical wear and human experience. It adds the imponderables of human action and reaction under the stress of competition that no computer can simulate."

3. An excellent promotional medium is provided by demonstrating products in open competition. "Our participation in racing is widely-publicized proof of the performance we are capable of putting into the vehicles we build, and proof of the confidence we have in our ability to put it there. Nothing does more to sell a product than respect and enthusiasm for it, and we believe that nothing generates enthusiasm and respect for a car faster than winning in flat-out competition. Of course, the reverse side of the coin is that losing can hurt your product reputation, but that's a gamble we are willing to take."

4. Company morale is uplifted. "Our competitive challenge in racing has made Ford a more competitive company, from the assembly lines to the executive suites," said Mr. Patterson, continuing: "We all know we are in business to sell automobiles, not to win races. But that checkered flag is more dramatic, more stimulating and more exciting than a 10-day sales report. The pride that runs through our company

when a Ford-powered vehicle wins another race is contagious and infects all of our operations. This rub-off may well be the biggest return of all that we get from our racing investment. The trophies that we so proudly display signify much more than so many competitive triumphs. In a very real sense, they have augmented the spirit and vitality of Ford Motor Company and added to our confidence that we can win our biggest race of all — sales leadership in our industry."

Early in 1963, the decision was made to extend Ford's participation in competition to the highly sophisticated sport of road racing. This arena of racing had been dominated by European manufacturers whose vehicles, over decades, had reached an extremely high state of technical development. Such famous marques as Bentley, Talbot, Lagonda, Aston Martin, Mercedes and Ferrari had figured prominently in the sport, while American efforts were left largely to individual enthusiasts.

The decision to enter this highly developed form of racing was influenced not only by the technical challenge involved but also by the fact that the cars had to be road-legal and raced mostly on commercial highways, such as the LeMans circuit in France. Consequently, sports racing vehicles are closely allied to normal passenger vehicles and encounter all the problems of highway driving including handling, driver environment, braking, stability and safety. The main difference, however, is that under racing conditions these problems are accentuated, thus providing an excellent development ground for new techniques and innovations.

In the early stages of the program, consideration was given to acquiring Ferrari, an established builder of sports cars, but it was finally decided to create a unique Ford vehicle to challenge the established European supremacy in this form of racing.

Like most product programs, the design and performance objectives for the Ford LeMans project were largely established by the status of the leading competition. It was evident, from an analysis of competitors in 1963, that top speeds in excess of 200 mph, average laps of more than 130 mph, and durability to sustain an average of more than 120 mph for 24 hours would be necessary to compete successfully at LeMans in the ensuing years.

The racing objectives were also established. They required the cars to be potential winners in the long-distance races such as Daytona, Sebring, Spa, Nurburg Ring, Targa Florio, as well as LeMans, and to be capable of winning the FIA World Championship for this type of vehicle. Added to these targets was the timing objective that required the cars to be racing within one year of starting the program.

The primary goal was victory in the 24-Hours of LeMans — the most grueling race in international competition. The famous circuit is made up of conventional roads that are closed to commercial traffic only for the race in June and a short practice session in April. The cars travel clockwise on the 8.3 mile track and encounter road conditions which test every aspect of a car's capabilities. Speeds range from 215 mph on the main straight to 35 mph on the slowest corner. Race cars incur severe braking, acceleration and constant shifting up and down through the gears.

In 1962, a group from Ford Product Research and Styling areas had designed, constructed, and developed the Mustang I experimental sports car. The same personnel then were assigned to the LeMans program, and the information which evolved from the Mustang I study served as a starting datum for concept work on Ford sports-prototype vehicles.

The initial problem was to select a vehicle configuration which was likely to meet the performance objectives and could be packaged within the FIA rule limitations. The Mustang I exercise had clearly shown the advantages of using a midship engine configuration to attain a low, sleek vehicle silhouette. This arrangement also offered excellent weight distribution characteristics and had been well-proven in other spheres of racing, such as Formula I. It was therefore decided to pursue this same configuration for the LeMans vehicles.

Initial package studies showed that the essential components could be installed in a vehicle silhouette of 156 inches long, 40 inches high (hence the name, Mark I (GT-40)) and 95 inch wheelbase and still meet the FIA requirements. The overall arrangement included a forward hinged canopy top; twin radiators located behind the seats with side-ducting; the 256 CID V-8 engine developed for Indianapolis; crossover tuned exhausts; forward-located spare wheel, oil tank and battery; fixed seats and movable controls; side-sill gas tanks; and, because no suitable transaxle existed within the Company, a proprietary vendor-developed unit was selected.

Concurrently with package development a full size clay model was constructed for overall shape appraisal. The essential requirement was to encompass the basic mechanical ingredients and meet the FIA rule limitations. With these exceptions, however, the choice of shape was largely determined by what seemed right at that time as there was no previous knowledge of road car forms developed for speeds in excess of 200 mph.

It was evident from the outset of the project that aerodynamics would play a major part in the program. With the exception of land speed record cars, no vehicle had been developed to travel at speeds in excess of 200 mph on normal highways. The speeds involved were greater than the take-off speed of most aircraft, but, conversely, the main problem was to keep the vehicle on the ground.

Following initial package and shape studies, a 3/8 aerodynamic model was constructed, and a series of tests were carried out at the University of Maryland wind tunnel. Early tests showed that, although the drag factor was satisfactory, the lift at 200 mph was over half the weight of the vehicle. Subsequent tests with variations of nose height showed the low nose to have some advantage, but lifts were still totally unacceptable. The major improvement came with the addition of "spoilers" under the front end which not only reduced the lift to an acceptable standard, but quite surprisingly, also reduced drag.

The engine selected for the Mark I (GT-40) was the 4.2 liter (256 CID) unit that had been developed by Ford Motor Company for the 1963 Indianapolis Race. It was derived from the 289 Fairlane engine but included the use of aluminum block and heads, and a dry sump oil system, but, unlike the present Ford double overhead cam Indianapolis engine, still retained push rods. To adapt these units for road racing required detuning to run on commercial pump fuel; addition of full sized alternator and starter systems; changes to the scavenge system for greater variations of speed and cornering; providing an induction system with greater flexibility for road use in adverse climatic conditions; and general detail changes to suit the package installation. These engines gave approximately 350 hp in their detuned state for long distance races.

The vendor-developed transaxle was packaged into the concept despite its disadvantage of having only four speeds and non-synchromesh engagement. This unit had been used previously on lightweight vehicles in sprint events, but analysis showed that it should be capable of handling the Mark I (GT-40) power requirements. In addition, it was the only commercially available unit that would meet the timing objectives.

It was elected to use a thin sheet steel (.024"-.028") construction to avoid lengthy development of exotic lightweight materials. The strength carrying structure consisted of a unitized underbody with torque box side sills to house the fuel cells, two main bulkheads, a roof section, and end structures to pick up suspension mountings. Front and rear sub-structures were attached to provide for body support, spare wheel, radiator, and battery mounting, and to give supports for the quick lift jacks. The original hinged canopy idea was dropped. The doors were cut extensively into the roof to provide reasonable entry and exit and, together with end sections and rocker panels, were made of hand-laminated fiberglass materials.

Great care was taken to design all fittings flush with the body panels, including the glass sections which were installed by adhesive techniques.

The front suspension was designed as a double "A" frame, with the cast magnesium upright supporting the live wheel spindle and the Girling aluminum brake caliper. The foot well and the position of the spare wheel necessitated an unusually short top arm. The support axes of the "A" frames were arranged to provide an anti-dive feature of approximately 30 per cent.

The rear suspension used double-trailing links from the main bulkhead and transverse links comprising a top strut and an inverted lower "A" frame. The angling of the "A" frames to the magnesium upright casting, combined with the arrangement of linkage geometry, provided anti-lift and anti-squat features of approximately 30 per cent.

A rack and pinion was selected for the steering system, mainly because it was particularly suitable for the package conditions involved. The rack had a ratio of 16:1 which in turn gave an overall ratio of 2-1/4 turns of the steering wheel from lock-to-lock.

Girling CR and BR racing calipers were used front and rear, respectively, with solid cast iron discs, which were 11-1/2 x 1/2 inch thick. A dual master cylinder was employed for separate front and rear systems which incorporated a balance mechanism for adjustment of braking distribution.

Cast magnesium wheels were originally specified, but development problems precluded their use on the first cars. Prototypes were therefore fitted with wire wheels with alloy rims of 15-inch diameter with a 6-1/2-inch wide front rim and an 8-inch wide rear rim.

Driver environment was a major consideration as long-distance races require maximum driver concentration for periods of up to four hours. The fixed-seat, movable-pedal concept was carried over from the Mustang I project. This arrangement offered structural advantages and provided snug support around the driver to help prevent fatigue from high speed cornering effects. A nylon netting was used for the basic support medium and was covered with a pad containing ventilation holes to help evaporate driver perspiration. The pedals were mounted on a cast alloy member which could be adjusted for variation in driver size.

Instruments were positioned so that their faces pointed directly at the driver in order to minimize distortions and reflections. All switches and controls were located and formed so that they could be reached easily and recognized visually or by touch. Flow through ventilation was provided, together with full protection from adverse weather conditions.

To contain the allowable 42 gallons of fuel in this small package, provide for rapid filling, devise a means of picking up the fuel, and provide adequate driver safety was a study within itself. The arrangement selected was two separate tank systems in the side sills, each with its own filler cap and fuel pickup box. These separate systems were designed with individual electric pumps feeding a common supply pipe to the carburetors. Provision was also made in one tank for a reverse pickup unit. The steel shell of the tanks was, of course, part of the main structure. In these were fitted neoprene bags to aid in crash safety. Baffling was attained by means of a plate supported from the top inspection cover.

The design and analytical studies were completed during the summer of 1963, together with a clay model reflecting the package changes. The problem was then how and where to execute the final design build and development.

It was finally decided to execute this phase of the program in Europe, since many of the proprietary components were readily available in this area, as were experienced craftsmen in this field of racing. An arrangement was made with the Lola Company to use their resources and facility for one year, as they already had some experience in GT sports cars with a midship engine configuration. In forming this alliance, Ford also was able to use one of the Lola prototypes for the installation and development of the Ford suspension and driveline components.

In September of 1963, the center of activity was moved from Dearborn to England, together with a nucleus of Ford engineers, car layouts, power pack components, and full size models.

Component testing was completed by the end of November, 1963, and the remainder of that winter was spent in detailing and procuring items for the first prototype builds. The first Mark I (GT-40) car was completed on April 1, 1964. A second vehicle was completed ten days later, and hectic preparations were made to get both vehicles to the LeMans practice on April 16. Bad weather conditions in England prevented any serious testing and the cars had an aggregate of only four hours running time with no high speed experience before being shipped to France. The first day of practice also proved to be rain drenched and after very few laps, the first car was totally wrecked on the Mulsanne Straight when it left the road at over 150 mph. The second vehicle also experienced trouble and suffered a minor collision. Luckily, both drivers were unharmed.

The solution to the stability problem uncovered at LeMans was found within one week after returning to England, where further testing was carried out at MIRA proving ground. The fault was found to have been an aerostability condition which caused a rotary motion of the rear end of the vehicle comparable to that of an arrow without feathers. The motion had increased with speed and, accentuated by the wet track, eventually resulted in rear end breakaway. Subsequently, it was found that the adaptation of a rear end "spoiler" not only had the effect of putting feathers on an arrow, but also slightly reduced drag.

The second car from the LeMans practice was modified by the addition of the "spoilers" and was rebuilt in readiness for the Mark I vehicle's first race outing at Nurburg Ring, Germany, on May 31, 1964. The car performed most favorably in practice and qualified second only to the fastest Ferrari. It ran second in this 1000 Kilometer race in the early hours but retired after 2-1/2 hours. The reason for the retirement was a suspension bracket failure because of an incorrect welding process, but when the vehicle was examined, there were several other areas showing distress and near failure. The outing was, therefore, most successful as a development exercise, and the lessons learned were quickly incorporated in the three vehicles being built for the LeMans race in mid-June, 1964. These vehicles were completed and weighed in at LeMans scrutineering at 1960 pounds, less driver and fuel.

In practice, the cars qualified second, fourth, and ninth. During the race, one car held the lead for the early hours before retiring with a transmission failure. The second car retired after five hours with a broken fuel line, and the third car retired after 13-1/2 hours with transaxle problems but not before establishing an all-time lap record.

Every attempt was made to correct the transaxle problems within the limited time available before the next race at Rheims, France, on July 5, 1964. Again, the cars led the race in the early hours, set new lap records, but all retired with transaxle failures. In addition, the nature of this circuit showed insufficient cooling of the brake discs which remained red hot during the entire time the cars were running.

Ford's first season of international competition in 1964, therefore, showed seven starts in major events with no finishes. The cars had demonstrated that they met the performance objectives but failed badly on durability aspects. The winter of 1964 was devoted to detail preparation of the cars for the 1965 season. Twenty-one modifications were executed on the transaxles, the rubber driveshafts were replaced with Dana couplings, and the decision was made to install standard 289 CID cast iron engines, using wet sump lubrication. The orginal cast wheels also were installed and increased to 8-inch front and 9-1/2-inch rear rims. Two of these cars made their first appearance in the 1965 season at the Daytona 2000 Kilometer Race on February 28, 1965. They finished first and third in this event, setting an average speed record of 99.9 mph for the distance in 12 hours and 20 minutes. Two vehicles also were entered in the Sebring Race in March, 1965, and finished second overall and first in class, once more demonstrating that a fair degree of durability had been attained. These cars were raced by the Company once more in 1965 at LeMans, but without success.

The decision then was made to manufacture 50 of these cars in order to qualify them for the production sports car category. These cars were completed in the 1965 period after detailed changes and the adoption of the 5-speed ZF transaxle. These GT-40's were sold to the public and, in the hands of private race teams and individuals, won the World Championship for production sports cars in 1966.

In the fall of 1964, the Ford engineering team relocated in Dearborn and started operations at Kar-Kraft, a Ford contracted facility. This team continued engineering on the Mark I and started a new experimental vehicle project.

The 1964 season had shown the Mark I prototypes were competitive on performance factors but lacked durability. Although work was progressing on correcting durability problems, it was obvious that the Mark I performance, in the fast moving racing field, would soon be outmoded. The problem was, therefore, how to get an improved power-to-weight factor and at the same time achieve a high durability level. The alternatives were to generate more power from the 289 CID series engine or adapt the 427 CID engine which had been developed for production cars but proved highly competitive in stock car racing. The big engine approach would also involve the development of a unique transaxle to handle the higher power. The other indeterminates were whether the additional weight (some 250 pounds) for the larger engine and heavier transaxle and driveline would unduly deteriorate handling and accentuate braking problems. It was decided, however, to explore this approach by constructing a test vehicle and physically evaluating its performance. The program was initiated in the winter of 1964 and was designated the MK II project.

Package studies showed the 427 CID engine could be accommodated in the Mark I basic structure by modifying the seating position and rear bulkhead members. The basic suspension units were unchanged, but provision was made for 8-inch wide cast magnesium front wheels and 9-1/2 inch rear wheels. Housing of the wider spare wheel necessitated revising its position, and the new front end arrangement made provision for a remote engine oil tank on the bulkhead and a larger radiator.

A major problem was to generate a transaxle unit which would handle the 427 CID power and the extra weight of the vehicle. For expediency the gear cluster from the conventional 427 CID driveline was used but with completely new housings and axle unit. This approach resulted in a heavier and less efficient arrangement than a direct transfer box, but had the advantage of using developed components. The housings were designed in magnesium, and a pair of quick-change gears transmitted the power to the pinion shaft. The resulting overall package from these changes required new front and rear structures and body shells.

The first experimental MK II vehicle was completed during April, 1965, and was evaluated on the 5-mile oval at Ford's Michigan Proving Ground. After only a few hours of tailoring, the car lapped this circuit at an average speed of 201-1/2 mph and exceeded 210 mph on the straight-away. Subsequent testing on road circuits showed that handling had deteriorated only slightly. From the results of these tests, it was calculated that this vehicle should be capable of lapping the LeMans circuit in 3 min. 30 sec. to 3 min. 35 sec. without exceeding 6200 rpm. If these lap times could be realized at this relatively low engine rpm, the car would obviously have high potential to win at LeMans. The decision was made to attempt to run two of these experimental cars in the 1965 LeMans event. This decision was made at the end of April, and the cars went to the event without the benefit of the practice week-end.

In the ensuing five weeks, the first car underwent initial testing and rebuild, and a second car was hurriedly constructed. The second car actually arrived at LeMans without even having turned a wheel. Having missed the April practice, the first evening of pre-race practice was spent in tailoring the cars to the circuit. On the second evening, the car that had never turned a wheel before arriving at the track set an all-time record lap of 3 min. 33 sec. — an average of 141 mph.

One car qualified first, and when the race started on Saturday, both cars went out ahead of the field and comfortably lapped at 3 min. 40 sec. without exceeding 6000 rpm. Unfortunately, hurried preparation resulted in the cars being retired after two and seven hours, respectively, with non-fundamental driveline problems. The cars, however, achieved their purpose of establishing the capability of the engine-driveline combination. The potential indicated in this initial experimental outing resulted in the 1966 program being based on the MK II vehicle.

In preparation for 1966, a concentrated vehicle development program was planned using the Daytona, Sebring, and Riverside tracks.

A major contribution to speeding up development was originated by the Ford engine and transmission engineers. They evolved a dynamometer which could run the engine and driveline units under simulated road conditions that had been recorded on tape in an instrumented vehicle. This device allowed component testing to proceed independently of vehicle availability and climatic conditions.

Major changes that resulted from testing and development included:

- New shorter nose configuration to save weight and improve aerodynamics.
- Addition of external rear brake scoops.
- Higher efficiency radiators.
- Strengthened chassis brackets for durability.
- Live rear hubs for improved durability.
- Internal scavenge pump to minimize vulnerability and save weight.
- Generally improved ducting to radiators, carburetors and brakes.
- Crossover fuel system with a single filler neck.
- Ventilated brake discs to improve durability.
- Quick-change brake disc design to facilitate changes during pit stops.

All of these changes were incorporated in the Mark II-A vehicles that made their first appearance at the Daytona 24-hour Race on February 5-6, 1966. The new MK II cars virtually led the race all the way, finishing first, second, and third for their first victory.

The second race in 1966 was the Sebring event, where Mark II-A cars finished first and second setting new distance and lap records, and a GT-40 finished third overall. The car that finished first was an open version of the MK II with an aluminum underbody that was designated the Mark II-A (X-1).

One car was entered in the Spa 1000 Kilometer Race and finished second.

After attending the practice session in April, eight cars were prepared for the LeMans event that took place on June 18-19, 1966. Mark II-A vehicles qualified in the first four places and set a new lap record of 3 min. 31 sec. or 142 mph. The race took place in cloudy weather with intermittent showers during the 24 hours. Fords finished first, second, and third and, despite the weather conditions, established a new record for the 24 hours of 126 mph (previous best was 122 mph on a dry track).

As a result of winning Daytona, Sebring, LeMans, and finishing second at Spa, Ford won the World Championship for prototype cars in 1966, thereby meeting the original objectives set forth in 1963.

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