TRENDS OF VEHICLE DIMENSIONS AND PERFORMANCE CHARACTERISTICS FROM 1960 THROUGH 1970

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The past decade was unique because of the many styling and other engineering innovations, a proliferation of new models, and the emergence of the 2-door hardtop as the most popular model. Of equal importance and interest were the dramatic increases in available horsepower ratings and customer demand for equipment items that add significantly to the safety, comfort, and convenience of driving. Important changes were made in the physical dimensions and performance characteristics. Our survey reveals that cars became smaller, lighter, and less powerful from 1960 through 1962. These trends, however, were reversed after that time. A consistent reduction during the years in overall height and center of gravity and a widening of tread achieved important improvements in vehicle stability. The average eye height above the ground decreased 1.5 in. to 43.9 in. The minimum eye height decreased 3.0 in. to 39.3 in. From 1962 through 1970, there was a small downward trend in fuel economy. Important advances in vehicle performance contributed to more efficient use of highways.

•ONE OF the functions of the engineering staff at the General Motors Technical Center is the annual compilation of vehicle and body dimensions covering all U. S. domestic cars in the industry as reported in passenger car specifications of the American Manufacturers Association. This project is performed as a corporation service for the several GM engineering groups. These compilations constitute the source of the data used in developing trends relative to vehicle and body dimensions for the model years 1960 through 1970. The General Motors Proving Ground annually conducts an extensive engineering test audit of vehicles that GM and competitive companies have in current production. This program has existed since the beginning of GM Proving Ground activities in 1924. The data used in developing the trends for 1960 through 1970 with respect to vehicle economy and performance characteristics were extracted from this body of information.

The emphasis in this paper is directed to the trends from 1960 through 1970 because changes were made in test procedures and methods early in the past decade that do not permit direct comparisons with the trend studies published previously. The reader of this paper should bear in mind that the compiled domestic car registrations for 1970 indicate that vehicles 5 years of age or under represented 51 percent of the cars in use and those 10 years of age or under represented 88 percent. These facts should be considered in evaluations of the distribution of the trends among the vehicle population.

NUMBER OF BODY STYLES USED TO DETERMINE AVERAGE DIMENSIONS

An indication of the number of body styles available each year can be had from the number of dimensions used each year to determine the average dimensions. These numbers should not be interpreted to be the same as the number of car models available each year because models were grouped in various ways by the various manufacturers for stating body dimensions. For example, some companies made groupings for stating

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seat height that were different from those used in determining eye heights because those companies specified differing heights for manual seats, power seats, and bucket seats, each of which may have been the same for more than one model. The number of body styles used for stating dimensions increased from about 125 at the beginning of the decade to more than 300 at the middle of the decade (Fig. 1).

OVERALL LENGTH

From 1960 through 1962, average overall length decreased 10 in. from 213 to 203 in. (Fig. 2). Most passenger cars became shorter, but the greatest contribution was made by the first generation of the smaller type of cars. After 1962, overall length gradually increased as succeeding generations of new designs were introduced into production. By 1970, the average value had reached 210 in. The maximum and minimum values increased after 1962. The new generation of small cars will probably effect some reduction in average and minimum values. Overall length consists of 3 components: front overhang, wheelbase, and rear overhang. Analysis of each component is required for a proper understanding of the trends in dimensional characteristics.

Front Overhang

Front overhang length decreased from 1960 through 1962 when cars generally became smaller and shorter (Fig. 3). In 1963, however, an increase was initiated that continued through 1970. The rate of increase accelerated after 1967 because of the trend to long hood and short rear-deck styling, and the average value exceeded the 1960 level after 1965. The 1970 value was about 39 in. In the later years, both maximum and minimum values were also noticeably greater, 44 and 30 in.

Wheelbase

Wheelbase, the major component of overall length, became shorter on the average from 1960 through 1963 (Fig. 4). This was primarily a direct result of the introduction of several new lines of small economy-sized cars. The average wheelbase length, however, remained stable after that time. Although some of the larger models showed significant increases, the stabilization after 1963 at 118 in. was effected by the proliferation of the small and intermediate models. Accordingly, the range of values (97 to 133 in.) was wider in 1970 than it was in 1960. 1970 wheelbase lengths with respect to car-size groups were as follows:

Size	Avg	Range
Small	108	97 to 111
Intermediate	114	112 to 117
Full	123	117 to 133

Rear Overhang

Rear overhang, the rear component of overall length, became noticeably shorter from 1960 through 1962 when several new lines of small cars were introduced (Fig. 5). The average overhang increased from 1962 through 1965 (when some lines of small cars became of intermediate size) and then remained stable through 1968. The trend to a shorter overhang in the later years reflected a trend toward short rear-deck styling. Although the maximum overhang remained stable at about 62.5 in. after 1963, the minimum value decreased noticeably in 1965 and again in 1970 to a new low of 38 in.

ANGLE OF APPROACH

The length of the front overhang is one of the important design elements that determine the angle of approach. As the overhang increases, for example, the approach angle tends to decrease. The average approach angle increased considerably from 1960 through 1962 because of the shorter front overhang designed into most cars (Fig. 6). Significant decreases in the angle values are noted in 1963 and again during the 3 years

Figure 1. Body styles.

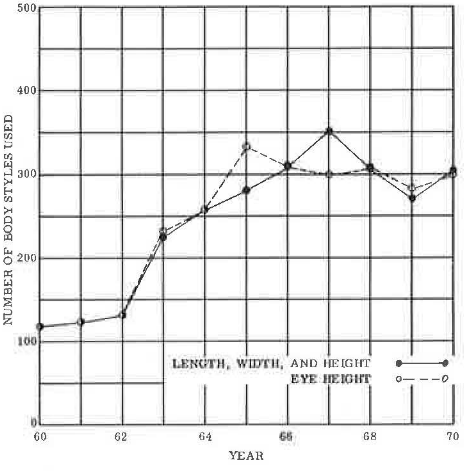


Figure 2. Overall length.

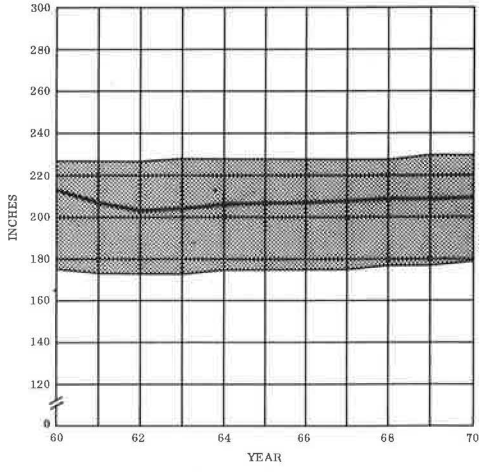


Figure 3. Front overhang.

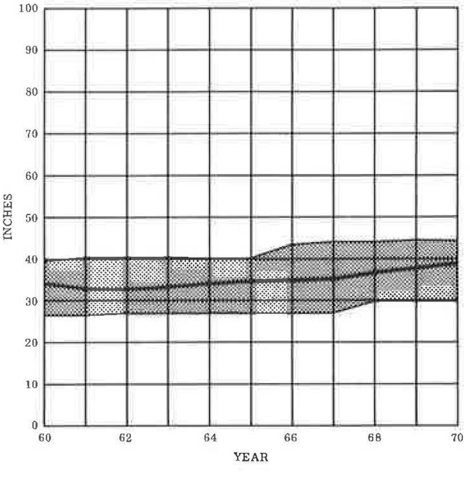


Figure 4. Wheel base.

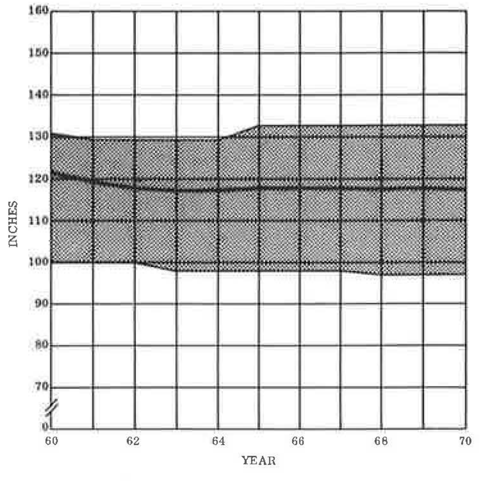


Figure 5. Rear overhang.

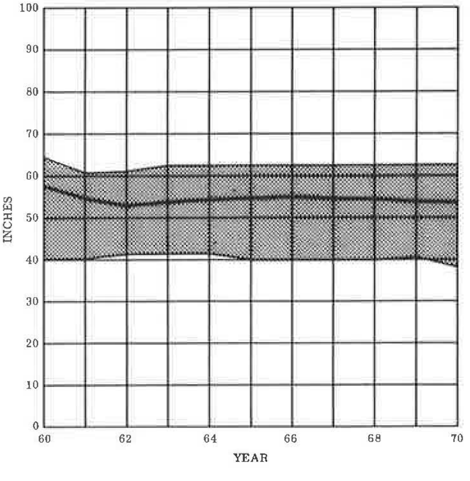
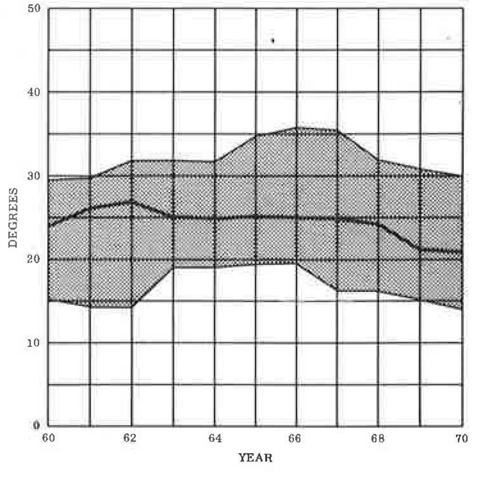


Figure 6. Angle of approach.



from 1968 through 1970 when the long hood and short rear-deck styling trend began. In 1970, the average approach angle was about 21 deg, noticeably less than it was in 1960. The maximum and minimum values also decreased in the later years. The minimum angle for 1970 was 14 deg.

ANGLE OF RAMP BREAKOVER

Ramp-breakover angle is controlled by wheelbase length and ground clearance near the center of the car. The average value increased slightly from 12.2 deg in 1960 to 12.9 deg in 1967, then declined to 11.4 deg in 1970 (Fig. 7). The range of values, however, was significantly wider in 1970 than in 1960.

ANGLE OF DEPARTURE

The angle of departure is controlled largely by the length of the rear overhang; the shorter the overhang is, the greater the angle is. The average angle increased from 1960 through 1962 when shorter and smaller models were made but decreased from 1963 through 1966 when some lines of small cars became of intermediate size and other larger models had extended rear decks (Fig. 8). The average angle increased after 1966 because of the shorter rear overhang that is characteristic of the short rear-deck styling trend. The range of angle values widened considerably in the past 3 years. The 1970 maximum angle of nearly 27 deg was much higher than it was in 1960. The minimum angle was 10 deg at the beginning and at the end of the decade.

TREAD WIDTH

Tread width is an important factor in vehicle stability. The average of the front and rear tread widths decreased noticeably from 1960 through 1963 (Fig. 9). This phenomenon was industry-wide because cars generally became narrower, including the large cars already in production as well as the small cars introduced during this period. Since 1963, there has been a consistent year-by-year trend to wider treads as cars widened to improve passenger comfort and vehicle stability. The average value in 1970 of 61.1 in. was somewhat greater than it was in 1960. The same is true regarding the maximum and minimum values. 1970 tread widths with respect to car-size groups are as follows:

Size	Avg	Range
Small	58.1	55.5 to 60.7
Intermediate	59.7	58.7 to 61.0
Full	62.8	59.7 to 64.3

OVERALL WIDTH WITH DOORS CLOSED

Average overall width with doors closed decreased considerably from 1960 through 1962 because of generally narrower designs and the advent of the small economy-sized cars (Fig. 10). From 1962 through 1967, the average width remained relatively stable; a wider trend is noted after 1967. The 1970 average of 77.3 in., however, was nearly 2 in. less than it was in 1960, which reflects the proliferation of small- and intermediate-sized cars during the past decade. The overall range was considerably narrower at the end of the period. The maximum value was limited to about 80 in. from 1964 through 1970. The minimum value remained stable after 1965 at about 69 in., which was somewhat more than the 1960 value.

OVERALL WIDTH WITH DOORS OPEN

Overall width with doors open affects parking space requirements. Average width with doors open decreased from 1960 through 1962 (Fig. 11). This situation was generally typical throughout the industry for the large-sized cars, but the introduction of new small and narrower lines of cars was also an important factor. During this period and the years immediately following, 4-door models outnumbered the 2-door models with wider doors. Since 1962, the average width increased consistently and was significantly greater in 1970, at 154 in., than in 1960. This circumstance reflects not only a general widening trend for all models but also, and more important, the increased proliferation of 2-door models, which outnumbered the 4-door models in the more recent production years. The maximum width increased significantly in 1967 with the introduction of some large-sized specialty 2-door hardtops but remained stable after that time at 175 in. The minimum value was somewhat lower from 1968 through 1970 than it was in 1960 because of the appearance of some new small types of 4-door models.

WALL-TO-WALL TURNING DIAMETER

Turning diameter is not included in the AMA passenger car dimensions; therefore, these curves are based on tests of selected cars. Wall-to-wall turning diameter was influenced considerably by wheelbase and changes in length of the front overhang. The trends are closely related. Average turning diameter decreased from 1960 through 1963 as the result of the shorter front overhang designed into the established lines of cars as well as many the new shorter and smaller size cars (Fig. 12). Turning diameter increased from 1963 to 1970 as front overhang became longer for the large cars and as small cars lengthened to intermediate size. The average 1970 turning diameter value was about 45.5 ft, which was somewhat more than it was in 1960. The range of 1970 values (51.5 to 39.5 ft) was narrower, and the minimum was noticeably larger.

OVERALL HEIGHT

The styling trend during the past decade and since the early years of the industry has been toward reduced overall height of cars (Fig. 13). This trend has produced during the years a notable lowering of eye height above the ground and improved quality of vehicle stability. (These subjects will be discussed later.) A previous trend study showed that overall height is not correlated closely with the other commonly understood attributes of smallness. So it is that the range and the average of values were not influenced significantly in the early years of the decade by the advent of small cars. Only a modest reduction of 1.3 in. was achieved during the entire 10-year period, which resulted primarily from styling innovations for the specialty types of 2-door hardtops. During the 25-year period preceding the past 10 years, average overall height had been reduced 12 in. This evidence suggests that the average value is leveling out below 54 in. The maximum values did not change appreciably in the past 10-year period. The minimum values, however, decreased about 4 in. and reached a new low of 47.3 in. The factors that appear to put a practical limit on further decreases in minimum overall height include adequate interior headroom, acceptable seat height above the floor, body structural requirements, and satisfactory ground clearance.

EYE HEIGHT

One of the notable effects of reduction in overall height is the lowering of the eye height above the ground. The body-dimensioning procedures did not provide an eye-height measurement. The dimensions from which eye heights could be estimated changed twice during the past decade. The 3 methods for estimating the eye heights used in this report are as follows: 1960 to 1961, free A-point to ground minus A-point depressed depth plus 29.1 in.; 1962 to 1964, H-point to ground plus 25.0 in.; and 1965 to 1970, body zero to ground (front) plus body zero to ground (rear) divided by 2 plus H-point to body zero plus 25.0 in. These changes in methods do not appear to have affected the final results. The average value for 1969 and 1970 was about 44 in. (Fig. 14). During the 1960-1970 period, average eye height decreased 1.5 in., which correlates well with the reduction in overall height. The maximum eye height decreased less than 1 in., but the minimum decreased 3 in. to 39.3 in.

CENTER-OF-GRAVITY HEIGHT

The center-of-gravity data used for the trend chart and for this discussion are limited to the representative cars selected for this test. The trend study is shown for the

Figure 7. Angle of ramp breakover.

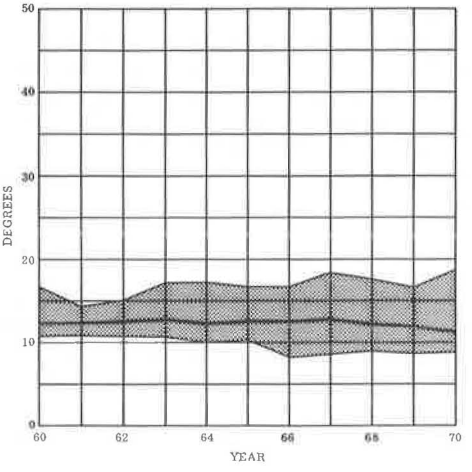


Figure 8. Angle of departure.

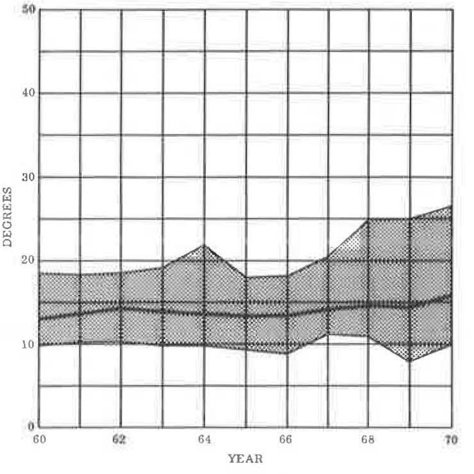


Figure 9. Tread width.

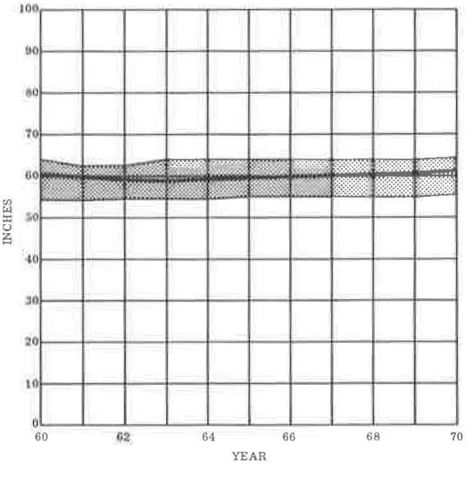


Figure 10. Overall width–doors closed.

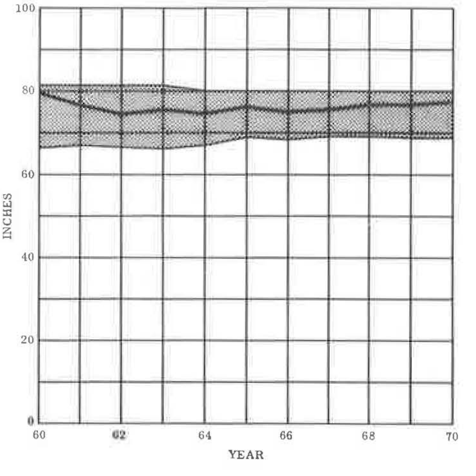


Figure 11. Overall width–doors open.

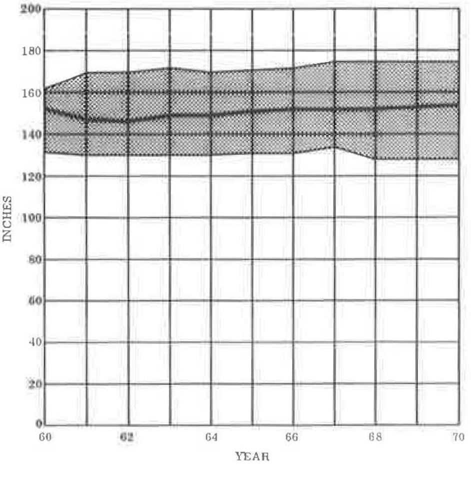
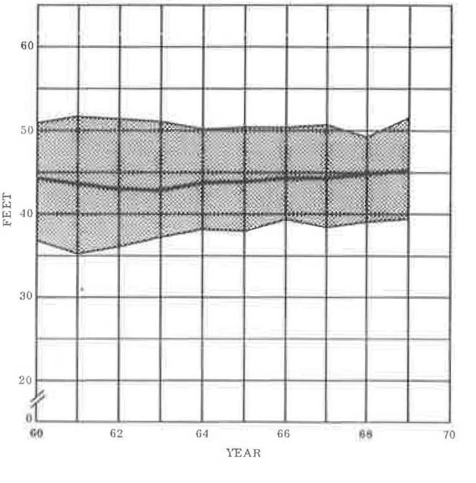


Figure 12. Turning diameter.



1960-1968 period (Fig. 15). The trend is toward lower overall height; the average height of the center of gravity was lowered about 5 in. between 1936 and 1968 and about 1.5 in. between 1960 and 1968. Although the lower center-of-gravity height was achieved largely through a reduction in overall height, other design changes contributed to the reduction. This is evidenced by the lower maximum, average, and minimum values. The reduction accomplished during the years contributed significantly to improved vehicle stability.

STABILITY FACTOR

The stability factor T/(2H), where T is the average of front and rear tread and H is the height of center of gravity, is a measure of the resistance of a car to overturning. From 1960 through 1968, the average stability factor of the representative cars improved from 1.4 to 1.5 (Fig. 16); in the preceding 25-year period, it had improved from 1.2 to 1.4. This substantial improvement was achieved through lowering the center of gravity in combination with widening the tread.

AVERAGE ENGINE DISPLACEMENT, TORQUE, AND POWER

A survey of engine sizes, based on the average of the announced engines, reveals dramatic changes during the past 20 years (Fig. 17). The displacement and advertised torque were the highest ever in 1970. The average of advertised horsepower, however, reached an all-time maximum of 260 in 1958, climaxing a period of intensive development of the modern high-compression V-8 engine introduced in 1948. An important decline in engine size developed during the 1959-1962 period, primarily from the increased use of the lower powered 6-cylinder engines prominently featured with the introduction of smaller economy cars. A sharply increasing trend was resumed during the period from 1964 through 1966. Changes in engine size, torque, and power were relatively small during the past 4 years. During the 10-year period, 1960 through 1970, there were increases in the numbers and ratings of higher horsepower engine options, particularly for the small, intermediate, and low-priced full-sized cars.

ENGINE TORQUE-TO-DISPLACEMENT RATIO AND POWER-TO-DISPLACEMENT RATIO

The trend of the averages of the ratios of torque to displacement and the ratios of power to displacement illustrates aspects of engine development. The ratio of torque to displacement can be increased by increasing compression ratio, reducing friction, and improving efficiency in other ways. The ratio of maximum power to displacement can be increased by these methods and by using larger carburetors, valves, and exhaust systems to improve breathing; by changing valve and ignition timing; and by building the engine to withstand operation at higher speeds. The ratios increased rapidly from 1950 through 1958 (Fig. 18). The power-to-displacement ratio increased more rapidly than the torque-to-displacement ratio. Both sets of ratios fell from 1959 through 1963 when small cars were introduced.

DISTRIBUTION OF ENGINE DISPLACEMENT

A survey of the distribution of displacements of engines produced in the 1962 and the 1970 model years reveals interesting trends (6). The cars equipped with engines of as much as 200 $in.^3$ displacement diminished from 32 percent of the cars produced in 1962 to less than 4 percent in 1970 (Fig. 19). Those with displacements ranging from 201 to 250 declined from 18 to 9 percent. Six-cylinder engines had displacements of 250 $in.^3$ or less. For 1970, the domestic automobile-makers produced no engines with displacements in the 251 to 300 $in.^3$ range, which as recently as the 1967 model year had accounted for 29 percent of all domestic passenger-car assemblies. Cars equipped with displacements in the 301 to 350 $in.^3$ range increased from 7 percent of production in 1962 to 45 percent in 1970. Those with displacements in the 351 to 400 $in.^3$ range increased slightly from 23 to 24 percent. Those with displacements larger than 400 $in.^3$ increased from 5 to 18 percent.

Figure 13. Overall height.

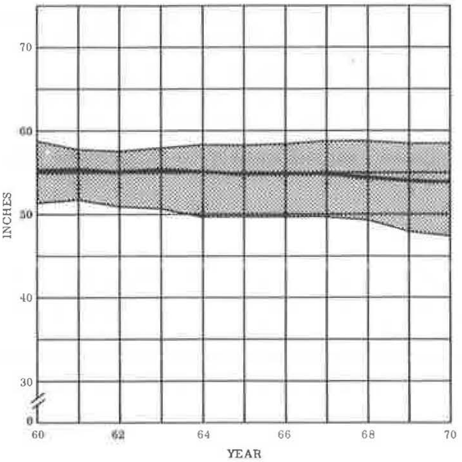


Figure 14. Eye height.

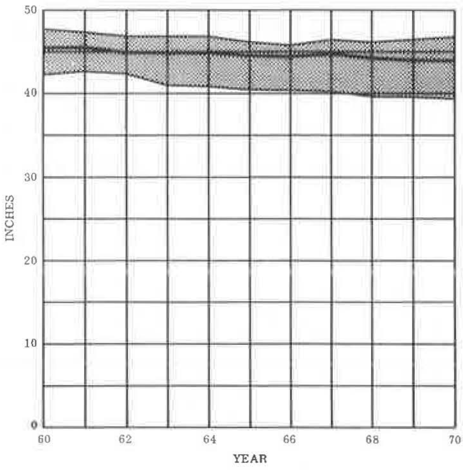


Figure 15. Center-of-gravity height.

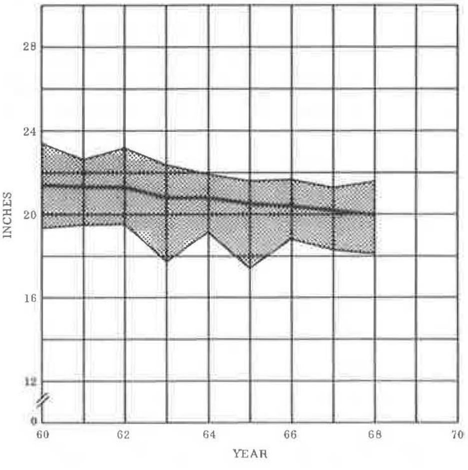


Figure 16. Stability factor.

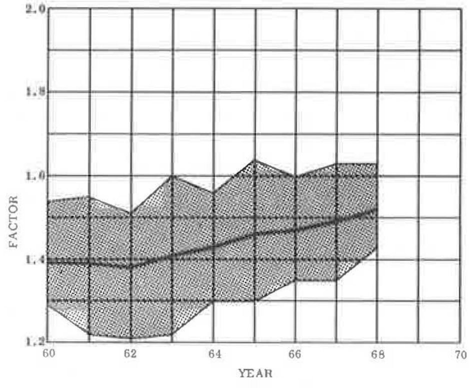


Figure 17. Engine size.

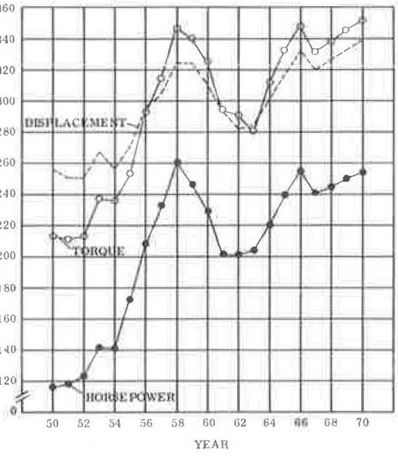
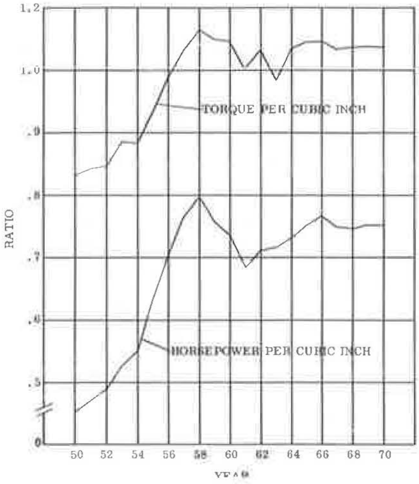


Figure 18. Displacement ratios.



ADVERTISED BRAKE HORSEPOWER

As stated in the introduction, the data selected to develop the trends of vehicle performance and fuel economy were extracted from the body of information accumulated from the annual engineering audits conducted at the GM Proving Ground. These audits are made by skilled test crews on models selected from the current engineering and distribution fleet. This group of cars is generally representative of production from year to year but is not all-inclusive for reasons of economics. Accordingly, the availability and the selection of models for the audit are somewhat restricted and arbitrary. Our survey of the average engine brake horsepower ratings reveals that the trends during the past 10 years of those selected for the Proving Ground audit parallel closely the trends of those available in the industry (Fig. 20). The Proving Ground level, however, is consistently higher than that of the industry average. This is because the lower powered 6-cylinder engines had a relatively small representation. It is also true that some of the highest performance options available were not tested. The Proving Ground audit, however, is representative of most of the cars in use because those equipped with the minimum and maximum horsepower ratings rank relatively low in percentage of the total number of cars sold.

POWER EQUIPMENT INSTALLED

Advertised brake horsepower is not, in itself, an absolute measurement of vehicle performance. It is well known, for example, that power is lost in transmission through the power train. Significant developments have occurred in past years that involve the proliferation of optional equipment items that not only contribute to the safety, comfort, and convenience of driving but also may affect performance and fuel economy. Automatic transmission installations increased from 72 percent in 1960 to 91 percent in 1970 (Fig. 21). Power steering use went up from 39 to 85 percent. Power brakes increased from 26 to 59 percent. Air conditioner installations rose from 5 to 60 percent. The greatly expanded installations of V-8 engines—from 57 percent in 1960 to 88 percent in 1970—and increased horsepower served to restore the power losses involved in the use of the equipment listed above and to provide additional power reserve for emergency performance requirements.

OBSERVED WEIGHT

Observations of vehicle weight are included in the Proving Ground audits because weight is related to the performance and economy results. The data used here were observed on the representative cars selected for performance and economy tests. The average weight was reduced considerably from 1960 through 1962 when cars generally became smaller and, therefore, lighter (Fig. 22). After 1962, they became heavier because of size increases, greater use of heavier V-8 engines, and expanded customer demand for optional equipment. The average weights for 1966 through 1970 were not much different from those for 1960. The maximum values after 1966 were lower than those in 1960, but the minimum values were somewhat higher. The weight increases from 1962 through 1966 must be included among the factors that partially nullified the potential gains from increased advertised engine horsepower ratings previously described.

BRAKES

Brake test procedures changed during the 10-year period. New tests were added. The methods of summarizing test results changed. Therefore, it would be difficult to produce a trend chart. Brake system features and the year they were available are given in Table 1. The modern automobile achieves effective deceleration rates under normal conditions with moderate pedal force, which may be as low as 50 lb or less with power booster assist that is now installed on 54 percent of production. Drivers today have no difficulty in developing deceleration rates close to 1.0 g on dry pavements when the brakes have been adequately maintained. The industry-wide adoption of automatic brake shoe adjusters during the past decade has been a practical benefit in this regard.

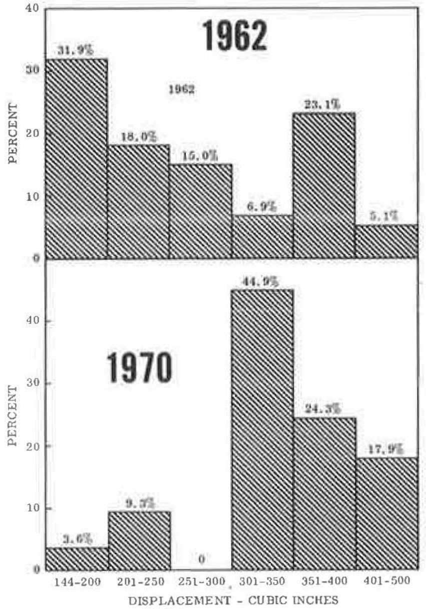


Figure 19. Engine displacement.

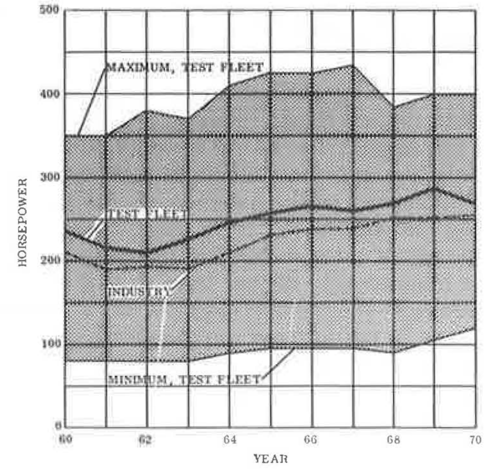


Figure 20. Brake horsepower.

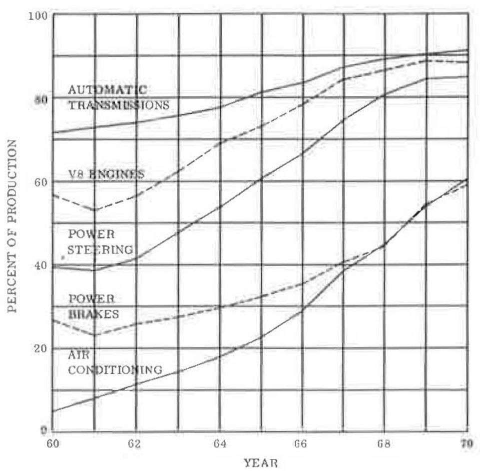


Figure 21. Power equipment.

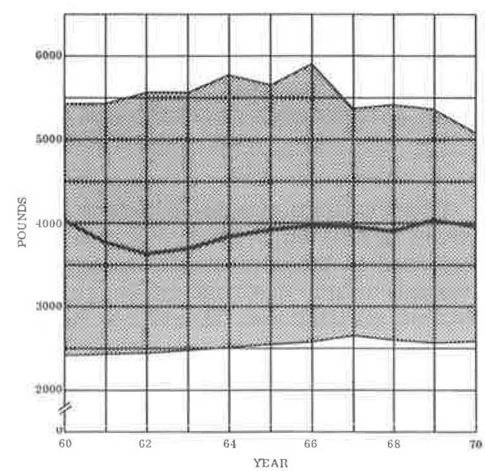


Figure 22. Weight.

Table 1. Break features.

Feature	Availability 1960	Availability 1970	Benefits
Automatic brake shoe adjusters	Few	Universal	Maintain brake effectiveness till linings are worn out
Dual-master cylinder and divided system	None	Mandatory	All 4 brakes are not apt to fail at same time
Disk brakes on front wheels	None	Standard with booster on some heavier cars; optional with booster on most other cars	Diminish effects of heat and water
Controlled brakes on rear wheels	None	Standard on 1 luxury car; optional on a few other luxury cars	Prevent wheel lockup during emergency stops and, thus, provide better control and reduce tire damage

Wet pavements, however, have presented, and continue to present, a serious highway safety problem. Generally speaking, the maximum friction reaction of a wet pavement is less than that of a dry pavement, and all too frequently it is very much less. The condition is aggravated as the pavement becomes progressively polished under traffic. Some progress in highway improvement has developed through past research on the effect of aggregates and other surface treatments on the control of slipperiness of pavements. Continued improvement in this direction will be dependent on how well the research results are actually applied to reducing the slippery conditions.

50-MPH FUEL ECONOMY

The level fuel economy test is conducted on a large number of selected cars. The vehicle moves at a constant speed of 50 mph on a level, paved road surface. The factors that affect the test results include engine efficiency, power train losses, and wind and rolling resistance. The inertial effects of car weight and rotating components are not among the factors that influence the results. Level fuel economy for the average test car improved from 1960 through 1962 but decreased in 1963 and again in 1964 (Fig. 23). Substantial increases are noted in 1965 and 1967. After 1967, economy decreased to the 1970 value of 19.0 mpg, only 0.4 mpg below the 1960 average.

CITY FUEL ECONOMY

The city fuel economy test is conducted on a schedule that simulates city driving under normal traffic and operating conditions. The Proving Ground has used this test in its present form since 1960. The test results are influenced by engine efficiency, power train losses, wind and rolling resistance, inertial effects of vehicle weight and rotating parts during starting and accelerating operations, and power losses deriving from the requirements of energy-consuming optional equipment items. City fuel economy for the average test car improved slightly in 1962 and 1967, but the dominant trend is a year-by-year decrease after 1962 (Fig. 24). The 1970 value of 14.4 mpg is about 1.1 mpg lower than the 1960 value.

HIGHWAY FUEL ECONOMY

During 1960, the Proving Ground developed a more severe highway fuel economy test schedule that simulates driving on expressways and other types of roads commonly in use under modern traffic and operating conditions. The Proving Ground has used this test in its present form since the beginning of the 1961 model year. The test results are influenced by the same elements as those involved in the city fuel economy test, but to a different degree. Highway fuel economy for the average test car decreased from 1962 through 1965 (Fig. 25). Some improvement is noted for 1967. The 1970 value of 15.4 mpg is about 1.3 mpg lower than the 1961 value.

HIGHWAY CRUISING RANGE

Cruising range is defined as the mileage that a car will operate from a full tank of fuel. It is, therefore, by definition a function of highway fuel economy in miles per gallon and of the tank capacity in gallons. The cruising range for the average car increased year-by-year from 1960 through 1967 and again in 1969 (Fig. 26). The overall gain was from 310 miles in 1961 to 340 miles in 1969. The cruising range improvement was obviously achieved by the use of larger tanks. A 20 percent increase in capacity was responsible for a 10 percent increase in cruising range.

TIME TO ACCELERATE FROM 0 TO 60 MPH

The trends relating to engine brake horsepower ratings during the past decade were responsible for important improvements in vehicle performance capabilities. Observations of acceleration time in seconds from 0 to 60 mph, either shifting through the gears or being in drive range, provide a yardstick for comparisons from year to year. This test was run on a large number of selected cars. Our survey reveals a dramatic improvement for the poorest performing test cars from 1960 through 1964 and again in 1969 (Fig. 27). The time was reduced from 32.5 to 18.9 sec, an improvement of 42 percent. The time for the average test car decreased from 14.2 to 11.5 sec, a 19 percent improvement. The best performing test cars registered a reduction from 8.9 to 6.6 sec, a 26 percent improvement.

PASSING SIGHT DISTANCE FROM 30 MPH

Important improvement was also achieved in passing sight distance as a direct result of the better performance capabilities previously described. The Proving Ground conducted such tests from 30 and 50 mph on a more limited selection of representative cars for the model years from 1963 through 1969. Passing sight distance from 30 mph represents the driver's mental judgment of the distance required for a passing maneuver on a 2-lane road to avoid interference with a vehicle approaching from the opposite direction. For test purposes, it is defined as the distance required for a vehicle to pass a truck, 50 ft long and moving at 30 mph, from a point 50 ft behind the truck to a point in the right lane 100 ft ahead of the truck so that there is no interference with the oncoming vehicle moving at 65 mph. Passing sight distance tests at 30 mph during the years reveal that performance improvements achieved a major reduction in the distance required for the passing maneuver and a major increase in the safety factor (Fig. 28). The distance was reduced from 2,100 to under 1,700 ft for the poorest performing test car and from 1,550 to 1,350 ft for the average test car.

PASSING SIGHT DISTANCE FROM 50 MPH

The procedure for tests of passing sight distance from 50 mph and from 30 mph is the same except that, at the start of the former test, the test vehicle and the truck are traveling at 50 mph. Tests from 50 mph likewise indicated major improvement. The distance was reduced from 2,740 to 2,490 ft for the poorest performing test car and from 2,090 to 1,880 ft for the average test car. The improvements described above may be described in other terms for emphasis. The exposure time to traffic interference at 30 mph was reduced from 9.7 to 8.1 sec for the average test car; the 50-mph test revealed a reduction from 11.2 to 9.9 sec. The poorest performing test cars achieved a reduction from 13.7 to 10.7 sec at 30 mph and a reduction from 16.0 to 13.6 sec at 50 mph.

SUMMARY

During the decade from 1960 through 1970, the average passenger-car length, weight, and power first decreased until 1962 and then increased (Table 2). The average length was 3 in. shorter in 1970 than in 1960, and the average weight was about the same in 1970 as in 1960; but the average power was 14 percent more in 1970 than in 1960. The use of power-consuming equipment increased greatly during the decade. These factors resulted in a reduction in average fuel economy of the cars tested by about 7 percent and an increase in average performance so that the average time to accelerate from to 60 mph was reduced about 19 percent to 11.5 sec. The minimum acceleration time for any car tested was 8.9 sec in 1960 and 6.6 sec in 1970. During the second quarter of the decade, the number of body styles more than doubled. The overall width of passenger cars was limited to 80 in. after 1964. The average overall width with doors open changed little, but the maximum widths increased from 162 to 175 in. As a result of changed styling, the average front overhang was increased by about 5 in. and the rear overhang was reduced by about 5 in. The average wheelbase was reduced 3.7 in. The average angle of approach decreased to 20.9 deg, and the average angle of departure increased to 15.8 deg; but the minimum angle of departure changed little from 10 deg. The minimum ramp-breakover angle decreased from 10.7 to 8.9 deg. Car heights became lower. The average eye height was reduced from 45.4 to 43.9 in. The minimum eye height decreased from 42.3 to 39.3 in. The extrapolated average center-of-gravity height of the cars tested went down from 21.4 to 19.6 in., resulting in a 12 percent improvement of the stability factor.

Figure 23. 50-mph fuel use.

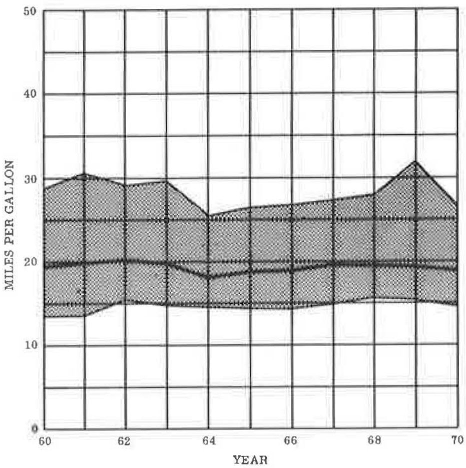


Figure 24. City fuel use.

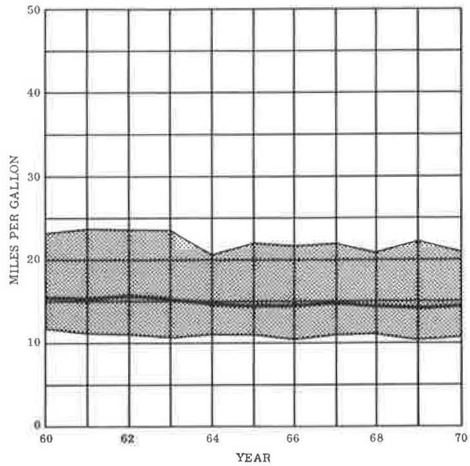


Figure 25. Highway fuel use.

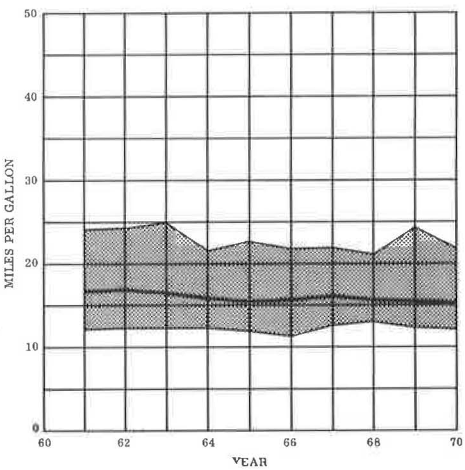


Figure 26. Cruising range.

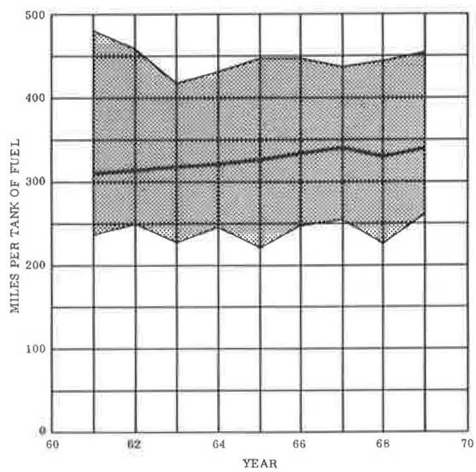


Figure 27. Acceleration to 60 mph.

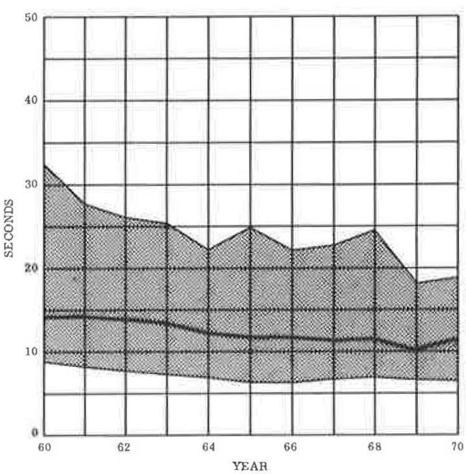


Figure 28. Passing sight distance—30 mph.

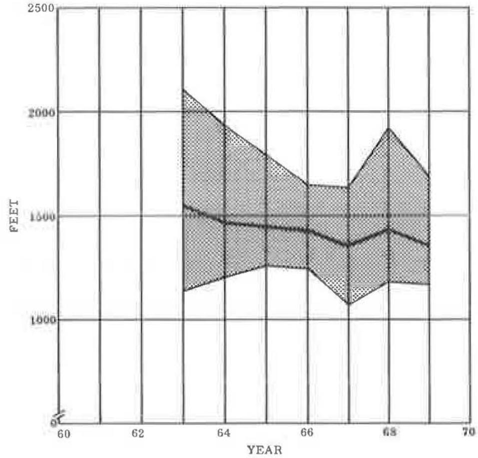


Figure 29. Passing sight distance—50 mph.

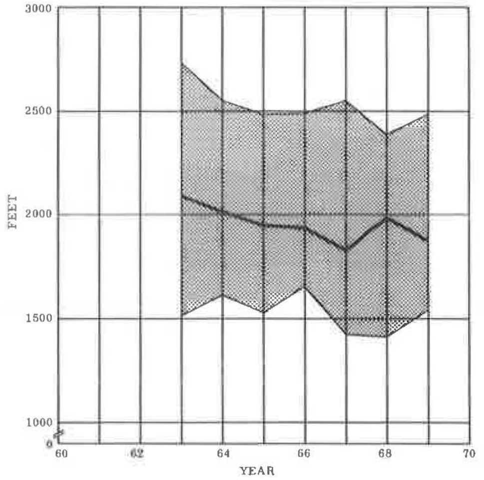


Table 2. Summary.

Item	1960	1962	1967	1970	Change (percent)
Number of body styles used to determine avg dimensions	118	132	352	305	+158
Avg overall length, in.	213	203	208	210	-1
Avg front overhang, in.	34	32	35	39	+15
Avg wheelbase, in.	121	118	118	118	-2
Avg rear overhang, in.	58	53	55	53	-9
Avg angle of approach, deg	23.9	26.9	24.9	20.9	-13
Angle of ramp breakover, deg					
Avg	12.2	12.5	12.9	11.4	-7
Min	10.7	10.8	8.6	8.9	-17
Avg angle of departure, deg	13.0	14.2	14.1	15.8	+22
Avg tread width, in.	60.5	59.1	60.1	60.9	+1
Avg overall width, with doors closed, in.	79.1	74.7	75.4	77.3	-2
Overall width, with doors open, in.					
Avg	152	146	152	154	+1
Max	162	170	175	175	+8
Avg wall-to-wall turning diameter, ft	44	43	44	46[a]	+2[a]
Avg overall height, in.	55.2	55.0	54.9	53.9	-2
Eye height, in.					
Avg	45.4	44.8	44.7	43.9	-1
Min	42.3	42.3	40.2	39.3	-7
Avg center-of-gravity height, in.	21.4	21.3	20.2	19.6[a]	-8[a]
Avg stability factor	1.39	1.38	1.49	1.56[a]	+12[a]
Avg engine displacement, in.^{3}	311	281	320	338	+9
Avg engine torque, ft-lb	325	291	331	351	+8
Avg engine horsepower	236	211	261	269	+14
Avg observed weight, lb	4,007	3,626	3,953	3,966	-1
Avg city fuel economy, mpg	15.5	15.7	14.7	14.4	-7
Avg highway fuel economy, mpg	16.7[a]	16.9	16.1	15.4	-8[a]
Time to accelerate from 0 to 60 mph, sec					
Avg	14.2	14.0	11.5	11.5	-19
Max	32.5	26.2	22.8	18.9	-42
Min	8.5	7.8	6.8	6.6	-26

[a]Extrapolated.

ACKNOWLEDGMENT

This survey was made and this paper was prepared at the request of the HRB Committee on Vehicle Characteristics. The purpose of the project is to continue through 1970 the trend data studies initiated in 1958 and updated in 1960 and 1962 (1, 2, 3, 4, 5).

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