

AutoBid 2.0

The Microcomputer System for Police Patrol Vehicle Selection

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ABSTRACT

This report is the user manual for a microcomputer system designed to help police fleet administrators select the patrol vehicle that is best suited to their needs. The system is called AutoBid and uses vehicle performance test data for police patrol package models published annually by the Michigan State Police. The system offers two vehicle selection methods: performance-based and value-based. Performance selection is based on vehicle test scores alone. It ranks vehicles by their overall test performance independent of cost. Value selection is based on both vehicle cost and test scores. It identifies which vehicle is the "Best Buy" in terms of the lowest cost for equivalent test performance and ranks the vehicles by the bid price adjusted for performance. Either or both of these methods may be used for a given fleet acquisition decision. Help screens explaining both the underlying concepts as well as how to use the software are available throughout the program. AutoBid runs on an MS-DOS[™] microcomputer with at least 512 kilobytes of RAM. It may be run from a floppy drive or it may be installed on a hard drive.

Key words: acquisition decisions; fleet administration; microcomputer; multi-attribute decisions; performance ranking; police patrol vehicles; police equipment; optimization; software; vehicles.

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MAJOR FEATURES INTRODUCED IN AUTOBID 2.0

Version 2.0 of AutoBid was first released in September 1990 and included the 1991 model year data. The major features introduced with this version are summarized here:

1. A method of developing appropriate weighting factors based on the Analytic Hierarchy Process is available as an alternative to the current direct entry of weights. The method is more convenient to use and results in more reliable and consistent weighting factors. Users are asked to compare criteria in pairs by answering simple direct questions. For example, "Braking is how many times as important as Top Speed?" AutoBid uses a modern mathematical technique to derive both the weights represented by the answers to these questions and a measure of how consistent the answers are. The answers can be easily edited to derive a new set of weighting factors.
2. Bar graphs are used to display results of both performance-based and value-based selections more effectively.
3. The latest Michigan State Police test results for the current model year are included as the default model year. In addition, the Michigan State Police test results for all prior model years starting with 1988 may be easily selected for analysis from the main menu.
4. A comprehensive report describing the results of both performance-based and value-based selections can be printed. The Michigan State Police test scores for any model year may be viewed on screen and printed.
5. Detailed hardware specifications of all models as they were tested can be reviewed on screen for any model year.

HOW TO INSTALL AND START AUTOBID 2.0

AutoBid runs on an MS-DOS[™] microcomputer with at least 512 kilobytes of RAM and a floppy diskette drive. It may be run from a floppy drive or it may be installed on a hard drive.

To run from a floppy drive:

To run AutoBid on a high-density floppy drive (either 1.2MB 5.25 inch or 1.44MB 3.5 inch), you must first copy all the files in both directories (i.e., both \ALLUSERS and \NEWUSERS) on the distribution diskette to the root directory of a write-compatible high-density diskette. Insert the diskette into the drive (e.g., drive A), type **A:** and press **↵** to go to the A drive. To run the program, type **AUTOBID** and press **↵**, or **AUTOBID M** for monochrome graphic systems. If you have a hard drive, AutoBid will run much faster if you install it on the hard drive.

To install AutoBid 2.0 on a hard drive:

Type **C:** and press **↵** to go to the hard drive on which AutoBid 2.0 is to be installed. Insert the distribution diskette into drive A and type **A:INSTALL** and press **↵**. All of the AutoBid 2.0 program and data files will be automatically copied to a directory called \AUTOBID on drive C. If an earlier version of AutoBid is already installed on the drive, your current data will be preserved. To install AutoBid 2.0 on another drive, say drive D, first type **D:** and press **↵** before typing **A:INSTALL**. To install AutoBid in another directory or from a drive other than A:, simply create the directory and copy all of the files in both directories (i.e., both \ALLUSERS and \NEWUSERS) on the distribution diskette to that directory.

To run from a hard drive:

Go to the directory in which AutoBid 2.0 is installed by typing **CDAUTOBID** and pressing **↵**, then type **AUTOBID** and press **↵**, or **AUTOBID M** for monochrome graphic systems.

The AutoBid 2.0 system consists of the following files:

AUTOBID.EXE	.....	The executable program.
SCRSyyyy.DBF	.....	Data file of test scores for Model Year yyyy.
HDWRyyyy.DBF	.....	Data file of hardware details for Model Year yyyy.
HDWRyyyy.DBT	.....	Text file of hardware details for Model Year yyyy.
CONFIG.MEM	.....	File of current configuration settings.

1. OVERVIEW

AutoBid is a microcomputer system designed to help police fleet administrators select the patrol vehicle that is best suited to the needs of their department. Help screens explaining both the underlying concepts as well as how to use the software are available throughout the program. Complete instructions on how to install and start AutoBid are on page vii. The system is based on vehicle performance test data for police patrol package models published annually by the Michigan State Police.¹

AutoBid offers two methods to select the best patrol vehicle: performance-based selection, and value-based selection. Performance selection is based on vehicle test scores alone. It identifies which vehicle has the highest overall test performance independent of cost and ranks the vehicles by performance. Value selection is based on both vehicle cost and test scores. It identifies which vehicle is the "Best Buy" in terms of the lowest cost for equivalent test performance and ranks the vehicles by the bid price adjusted for performance. Either or both of these methods may be used for a given fleet acquisition decision.

The performance approach is particularly helpful when an evaluation is needed before a request for bids has been prepared and there is little or no information on the cost of the candidate vehicles. The results of this initial performance analysis could be used to determine which models warrant a request for bids. The value approach is best used once the actual bids have been received and a determination of the winning bid must be made. Figure 1 summarizes the two methods of vehicle selection. The basic elements of each of the two methods are explained in the next two sections.

Figure 2 presents the Main Menu of AutoBid 2.0, which offers five major functions. The first two options access the menus for the two selection methods. The third option, test score summary, displays and prints the performance test results for the models. The fourth option displays a summary of the hardware specifications of the tested vehicles. The fifth option permits you to select one of the model years from 1988 to the current year for analysis. The current model year is selected by default when the program starts.

¹Curtis L. Van Den Berg, David B. Storer, and William F. McFall, "Police Patrol Vehicle Evaluation and Purchasing Program," State of Michigan, Department of State Police and Department of Management and Budget, East Lansing, Michigan, Annual Series.

Figure 1. Overview of Vehicle Selection Methods.

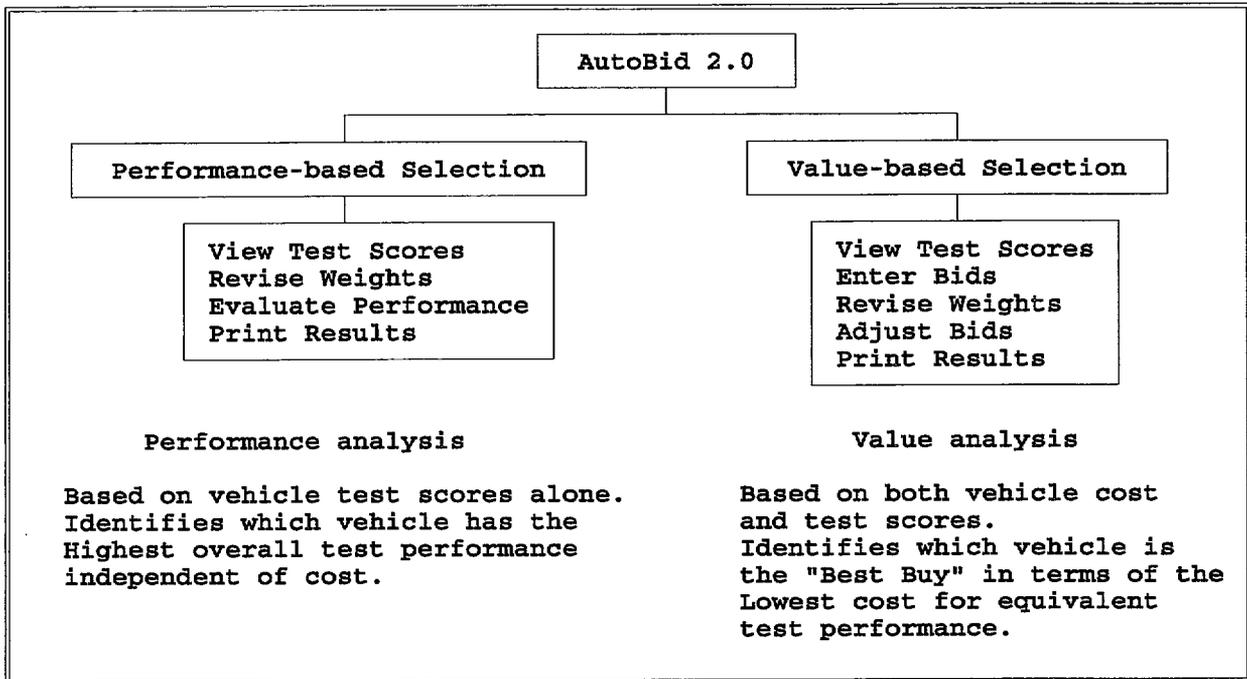
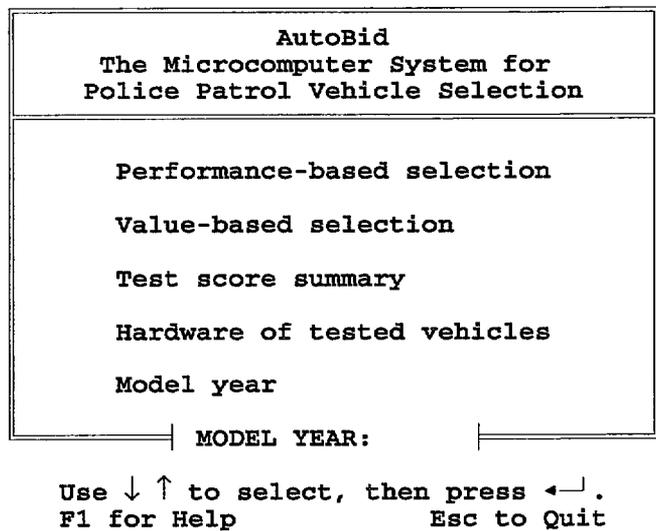


Figure 2. Main Menu of AutoBid.



2. PERFORMANCE-BASED SELECTION

Performance-based selection considers the test performance of the vehicles in light of the weighting factors assigned by you to each test category. Two steps are involved:

1. Review and revise the weighting factors to be used in the analysis. These weights should reflect the relative importance that your department assigns to each of the seven test performance categories. Alternatively, use the pairwise comparison method to enter and revise weighting factors to be used in the analysis. AutoBid uses the pairwise comparisons you enter to compute the weighting factors reflecting the relative importance of each of the seven test performance categories. This method is discussed in more detail below.
2. AutoBid evaluates overall vehicle performance by deriving a combined, weighted average score that reflects the performance of the vehicle relative to the best score in each test category.

As indicated under the first step, two methods are available for setting the importance weights to combine the test categories. You may directly enter the weights or you may have them computed based on pairwise comparison judgments you enter. Direct entry requires fewer key strokes and is appropriate when the test category weights are clearly known or already established by rule.

For those situations when the weights are not clearly known in advance, AutoBid 2.0 offers a method to help you establish appropriate and consistent weighting factors. The pairwise comparison method establishes weighting factors based on your judgments about the relative importance of each of the test categories when compared two at a time. With seven test categories to be weighted, there are 21 pairwise comparisons to be made. This is because of two assumptions: (1) each category is of equal importance to itself; and (2) if A is twice as important as B, then B is half as important as A. When all the pairwise comparisons are entered, AutoBid derives a system of weights that sum to unity by computing the normalized eigenvector of the largest eigenvalue of the matrix of pairwise comparison values.²

²AutoBid computes the normalized eigenvector by raising the matrix of pairwise comparisons to powers that are successively squared each time. This is the computational method suggested in Thomas L. Saaty, Multicriteria Decision Making: The Analytic Hierarchy Process, University of Pittsburgh, Pittsburgh, PA, 1988, p. 179.

Test categories are weighted by using a scale of 0.100 to 9.900 to indicate how many times as important the category of each row is compared with the category of each column. If the two are equally important, enter a **1.0**. If the row category is MORE important than the column category, enter the value (greater than one) comparing row to column. If the row category is LESS important than the column category, either directly enter the value (between zero and one) comparing row to column, or enter the value (greater than one) comparing column to row and then press **F2**. Pressing F2 automatically reverses the comparison by inverting the value. To change any comparison value, use the \uparrow and \downarrow keys to move to the desired field and enter the correct value.

The pairwise comparison method permits inconsistencies among the comparisons. For example, A need not be four times as important as C just because A is twice as important as B and B is twice as important as C. In technical terms, this means that the user is not forced to preserve cardinal transitivity among comparisons. AutoBid reports an Inconsistency Ratio that measures how far all the pairwise judgments deviate from perfect cardinal transitivity. If the Inconsistency Ratio exceeds 0.10, it is advisable to redo the pairwise comparisons. Otherwise, the combined scores may be distorted.

There is a convenient method to force consistency by using the comparison values in the first row to derive the perfectly consistent values for the remaining comparisons. The method assumes the user has the most confidence in the first row comparisons. The consistent comparison value is the ratio of the first row value for the current column category to the first row value for the current row category. The best way to improve consistency, however, is to make better informed comparisons.

Whatever the method for establishing weights, the performance-based selection approach uses them to combine the test scores into a single performance rating. A combined score is computed as the weighted average of the score deviations from the Best score in each test category. This combined score is calculated by multiplying the absolute value of each raw score percentage deviation by the category weight and then summing across categories for each vehicle. Because this score is a measure of the combined shortcomings of the vehicle compared with the ideal performance, it is called a Penalty Score. For example, a 2 point Penalty Score means the overall performance is 2 percent LESS than that of a vehicle that would score Best in EVERY test category.

The Penalty Score determines which vehicle has the best overall performance independent of cost. The vehicle with the LOWEST Penalty Score has the least combined percentage deviation from the Best scores among all vehicles tested. The LOWEST Penalty Score indicates the HIGHEST overall performance. AutoBid computes the Penalty Scores for all vehicles that completed the Michigan State Police testing program and displays a complete ranking of the vehicles from the LOWEST Penalty Score (HIGHEST performance) to the HIGHEST Penalty Score (LOWEST performance).

3. VALUE-BASED SELECTION

Value-based selection considers the test performance of vehicles, the weighting factors assigned to each test category, as well as the cost of vehicles. Three steps are involved:

1. Review and revise the weighting factors to be used in the analysis. These weights should reflect the relative importance that your department assigns to each of the seven test performance categories. Alternatively, use the pairwise comparison method to enter and revise weighting factors to be used in the analysis. AutoBid uses the pairwise comparisons you enter to compute the weighting factors reflecting the relative importance of each of the seven test performance categories. For more on the pairwise comparison method, see Section 2: Performance-Based Selection.
2. Enter the bid price of each vehicle to be included in the analysis. The bid price of a vehicle is the dollar cost to the purchasing department. To EXCLUDE a vehicle from the analysis, simply enter a ZERO dollar bid price for it. Value-based selection cannot be conducted until some dollar bids have been entered.
3. AutoBid determines the adjusted bid price based on the actual bid price plus the Bid Adjustment, which is described next.

The Bid Adjustment of a vehicle is the product of two factors: (1) the Penalty Score of the Vehicle; and (2) the dollar cost of a Penalty Score point. As described above, the Penalty Score is the weighted average of the raw score percentage deviations from the Best score in each test category. For example, a 2 point Penalty Score means the overall performance is 2 percent LESS than that of a vehicle that would score Best in EVERY test category. The Penalty Score is computed by multiplying the absolute value of each raw score percentage deviation by the category weight and then summing across categories for each vehicle. AutoBid makes these computations for you.

The dollar cost of a Penalty Score point should be set at 1 percent of the likely cost of a vehicle that would score Best in EVERY test category. This ideal vehicle is called the Benchmark Vehicle. The Benchmark Vehicle cost is selected by you.

AutoBid computes the Penalty Score, the Bid Adjustment, and the Adjusted Bid Price for those vehicles for which a non-zero actual bid price was entered. AutoBid then displays a complete ranking of the vehicles from the LOWEST Adjusted Bid Price to the HIGHEST Adjusted Bid Price.

