Attribute Expert Systems

About

An expert system is a computer program designed to simulate the problem-solving behavior of a human who is an expert in a narrow domain or discipline. An expert system is normally composed of a knowledge base (information, heuristics, etc.), inference engine (analyzes the knowledge base), and the end user interface (accepting inputs, generating outputs). The path that leads to the development of expert systems is different from that of conventional programming techniques. The concepts for expert system development come from the subject domain of artificial intelligence (AI), and require a departure from conventional computing practices and programming techniques. A conventional program consists of an algorithmic process to reach a specific result. An AI program is made up of a knowledge base and a procedure to infer an answer. Expert systems are capable of delivering quantitative information, much of which has been developed through basic and applied research (e.g. economic thresholds, crop development models, pest population models) as well as heuristics to interpret qualitatively derived values, or for use in lieu of quantitative information. Another feature is that these systems can address imprecise and incomplete data through the assignment of confidence values to inputs and conclusions. One of the most powerful attributes of expert systems is the ability to explain reasoning. Since the system remembers its logical chain of reasoning, a user may ask for an explanation of a recommendation and the system will display the factors it considered in providing a particular recommendation. This attribute enhances user confidence in the recommendation and acceptance of the expert system.

The Attribute Expert System **(AES)** is a web-enabled, database-driven, security-governed application that allows engineers at Ford to do a quick evaluation of vehicle parameters and the effect of changing them on attributes using intelligent statistical, empirical or neural network based knowledge driven models. For a slide show of the technical details used please Click Here.

This document is divided into the following sections:

- **Background**
- **Process**
- **Accessing AES**
- **Modules in AES**
- **Database definition**
- **Administration**
- **Technical Details**
- **Security Model**
- **References**

Background

Product Design and Verification is a highly iterative process which starts with gathering competitive information, new trends in technology and futuring requirements, cascading the requirements and setting targets for the product development lifecycle and finially doing the systems engineering process of design and verification iteratively through the different attributes of the vehicle system. The following image illustrates the design spiral in an automotive product development scenario:
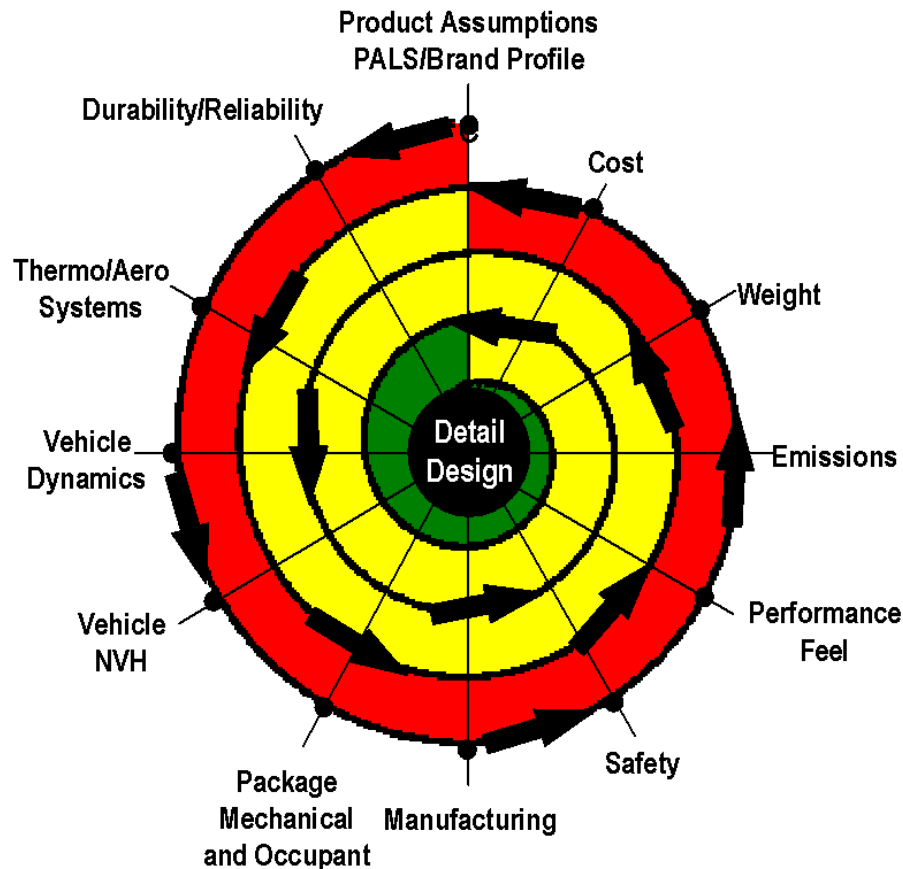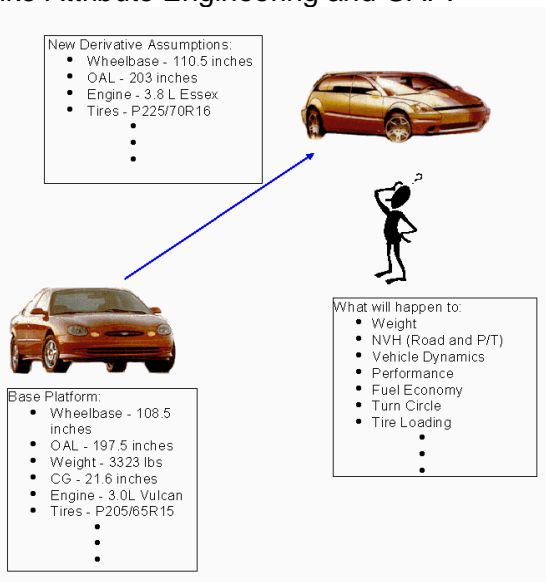

In a slideshow entitled "Knowledge Based Engineering - Pre-KO in a Day Using Simple Attribute Tools", Peter Creutz and Bob Thomas have illustrated the techniques used to intelligently decipher what-if scenarios so that upfront in the program design phase, parameters could be defined and interations in the process reduced.
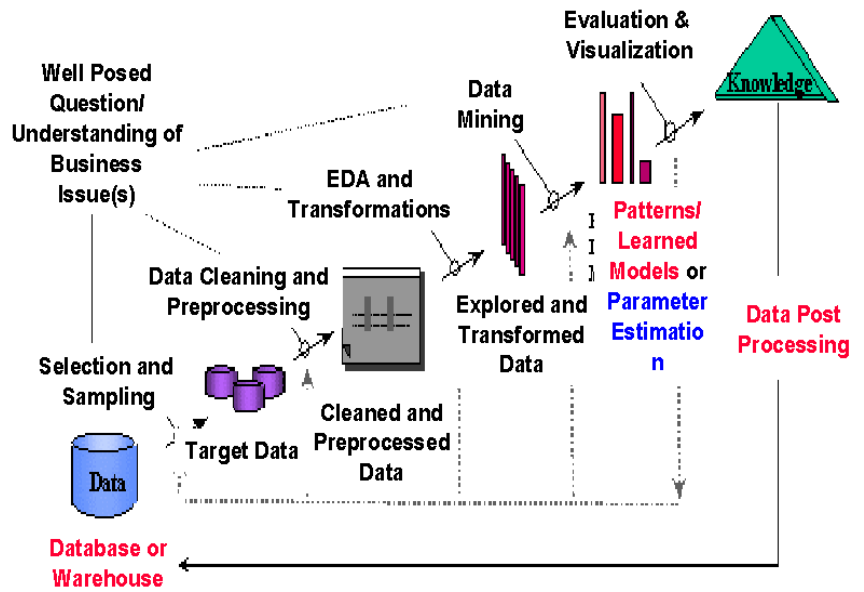
Process

Simple Attribute Tools utilize simple mathematical models to predict attribute performance when fundamental vehicle parameters are altered. These tools use 3 levels of math models:

1. Heuristic "Rule of Thumb" Models
2. Empirical Models

   - Statistical or Theory Driven (linear or non-linear)
   - Data Mining (classification trees or regression trees)

3. Paramteric Models (F=ma)

The Attribute Expert System was developed specifically to answer what-if type of questions during pre-KO. These questions are posed by: Product Strategy, VC Business Offices and various RVT Activities like Attribute Engineering and GAP.

New Derivative Assumptions:
- Wheelbase - 110.5 inches
- OAL - 203 inches
- Engine - 3.8 L Essex
- Tires - P225/70R16

Base Platform:
- Wheelbase - 108.5 inches
- OAL - 197.5 inches
- Weight - 3323 lbs
- CG - 21.6 inches
- Engine - 3.0L Vulcan
- Tires - P205/65R15

What will happen to:
- Weight
- NVH (Road and P/T)
- Vehicle Dynamics
- Performance
- Fuel Economy
- Turn Circle
- Tire Loading

Well Posed Question/ Understanding of Business Issue(s)

Selection and Sampling

Data Cleaning and Preprocessing

EDA and Transformations

Data Mining

Evaluation & Visualization

Knowledge

Data

Target Data

Cleaned and Preprocessed Data

Explored and Transformed Data

Patterns/ Learned Models or Parameter Estimation

Data Post Processing

Database or Warehouse

Modules in AES

The front page of the Attribute Expert System allows users to access all the modules as depicted below

All About Quick Attribute Assessment – Prediction Utilities

Whats New in this version

Prediction Tools

- **Vehicle Weight**
  English Units
  Metric Units

- **Turn Circle and Ride Height**
  English Units
  Metric Units

- **Vehicle CG** NEW
  English Units
  Metric Units

- **Road NVH**
  English Units
  Metric Units

- **Powertrain NVH** NEW
  English Units
  Metric Units

- **Performance and Fuel**
  English Units
  Metric Units

- **Safety**
  English Units
  Metric Units

- **Star Rating** NEW
  English Units

Other Utilities

- **Digidot Plot**
  English Units
  Metric Units

- **Ranked Order** NEW
  English Units
  Metric Units

- **Prediction Assessment** NEW
  English Units
  Metric Units

- **Combined Attributes Radar Chart**
  English Units
  Metric Units

- **Vehicle Data Retriever**
  English Units
  Metric Units

Data Administration

- **Maintain Vehicle Data**
  English Units
  Metric Units

The TASE Aero Expert System

- B–Car Rear End Shape Study
- C–Car Quarter Panel Study
- CD–Car Backlite Study
- D–Car New Edge
- Light Truck Underbody Study
- Heavy Truck Study

Safety Design Knowledge Base Prediction Tools

- Pedestrian Crash Mode
  1. Pedestrian Leg Impact Calculator
- Front Crash Mode
  1. Front Crash Energy Calculator
- Side Impact Mode
  1. Side Impact Occupant Calculator
     □ Front Occupant
     □ Rear Occupant

This page has been accessed **001760** *times*

The utiltites are divided into

1. Individual Prediction Tools that consist of:
   a. Vehicle Wieght Calculator
   b. Turn Circle and Ride Height Calculator
   c. Vehicle CG Calculator
   d. Road NVH Calculator
   e. Powertrain NVH Calculator
   f. Performance and Fuel Economy Calculator
   g. Safety Indicator
   h. Star Rating Calculator
2. Integrated Tools that consist of
   a. Digidot Plot
   b. Ranked Order Computer

     c.   Prediction Assessment Utility
     d.   Combined Attributes Radar Chart
     e.   Vehicle Dataq Retriever
     f.   Data Administration Utility
     g.   Maintenance Utility
3.   The Aero Expert System
4.   Safety Design Knowledge Base Prediction Tools

Each of the Prediction Tools consist of the Calculator Portion that allows input of the different parameters and prediction of the desired attribute. It links to the Vehicle Database to pick individual vehicle parameters as they exist in the database and automatically insert these into the parameter fields and compute the outcome. By varying a certain parameter, its trend can be tracked and depicted with a graph plotting utility. Represented below are screen shots of usage of the Vehicle Weight Calculator.

Vehicle Information

Make	FORD
Year	ALL
Style	SUV
Image	ALL

Apply Criteria

```
1999 FORD EXPEDITION 2WD 2-ROW
1999 FORD EXPEDITION 4WD 2-ROW
1999 FORD EXPEDITION 4WD 3-ROW
2000 FORD EXPEDITION EDDIE BAUER 4X4 SUV
1999 FORD EXPEDITION EDDIE BAUER 4X4
2000 FORD EXPEDITION XLT 4X2 SUV
1999 FORD EXPEDITION XLT 4X2
2000 FORD EXPEDITION XLT 4X4 SUV
1999 FORD EXPEDITION XLT 4X4
1999 FORD EXPLORER EDDIE BAUER 4X4
```

25 Vehicles matching the above Selection Criteria

Units : ⌃English ⌄Metric

Apply **Close**

Base Vehicle: 1999 FORD EXPEDITION 2WD 2-ROW   Weight (lbs): 4808

Please Input Parameters in english units

Vehicle Information

PARAMETER	RANGE	SETTING
Style		SUV ⬜
Car or Truck		Car ⬜
Overall Length (inches)	142-247	204.6
Wheelbase (inches)	89-158	119.1
Vehicle Height (inches)	48-85	74.3

Powertrain Information

PARAMETER	SETTING
Drive Configuration	RWD ⬜
Horse Power (HP)	---	240
Displacement (Lt)	---	4.6

Package Information

PARAMETER	SETTING
Rows Of Seat	2 ⬜
Image	NON_LUXURY ⬜

Calculate Weight | **Reset**

Parameter	Overall Length ⬜	Weight lbs
	204.6	4692.657

AXIS	MIN	MAX	INC
X-axis			
Y-axis			

Plot Graph | **Clear Table**

The intent of the Attribute Expert System is to provide rough estimates of vehicle attribute performance. These estimates may be used to provide design directions during the very early stages of a vehicle program. This tool is based on available vehicle parameters and is specific to the indicated attributes. This does not imply the parameters included in this tool are the only parameters that influence vehicle attribute performance.

Base Vehicle: 1999 FORD EXPEDITION 2WD 2-ROW   Weight (lbs): 4808

Please Input Parameters in english units

Vehicle Information

PARAMETER	RANGE	SETTING
Style		SUV ▭
Car or Truck		Car ▭
Overall Length (inches)	142-247	204.6
Wheelbase (inches)	89-158	119.1
Vehicle Height (inches)	48-85	74.3

Powertrain Information

PARAMETER		SETTING
Drive Configuration		RWD ▭
Horse Power (HP)	- - -	240
Displacement (Lt)	- - -	4.6

Package Information

PARAMETER	SETTING
Rows Of Seat	2 ▭
Image	NON_LUXURY ▭

Calculate Weight **Reset**

Parameter Wheelbase ▭	Weight lbs
119.1	4692.657

AXIS	MIN	MAX	INC
X-axis			
Y-axis			

Plot Graph **Clear Table**

The intent of the Attribute Expert System is to provide rough estimates of vehicle attribute performance. These estimates may be used to provide design directions during the very early stages of a vehicle program. This tool is based on available vehicle parameters and is specific to the indicated attributes. This does not imply the parameters included in this tool are the only parameters that influence vehicle attribute performance.

Base Vehicle: 1999 FORD EXPEDITION 2WD 2-ROW   Weight (lbs): 4808

Please Input Parameters in english units

Vehicle Information

PARAMETER	RANGE	SETTING
Style		SUV ▭
Car or Truck		Car ▭
Overall Length (inches)	142-247	204.6
Wheelbase (inches)	89-158	130
Vehicle Height (inches)	48-85	74.3

Powertrain Information

PARAMETER		SETTING
Drive Configuration		RWD ▭
Horse Power (HP)	---	240
Displacement (Lt)	---	4.6

Package Information

PARAMETER	SETTING
Rows Of Seat	2 ▭
Image	NON_LUXURY ▭

Calculate Weight | **Reset**

Parameter	Wheelbase ▭	Weight lbs
	119.1	4692.657
	125	4695.187

AXIS	MIN	MAX	INC
X-axis			
Y-axis			

Plot Graph | **Clear Table**

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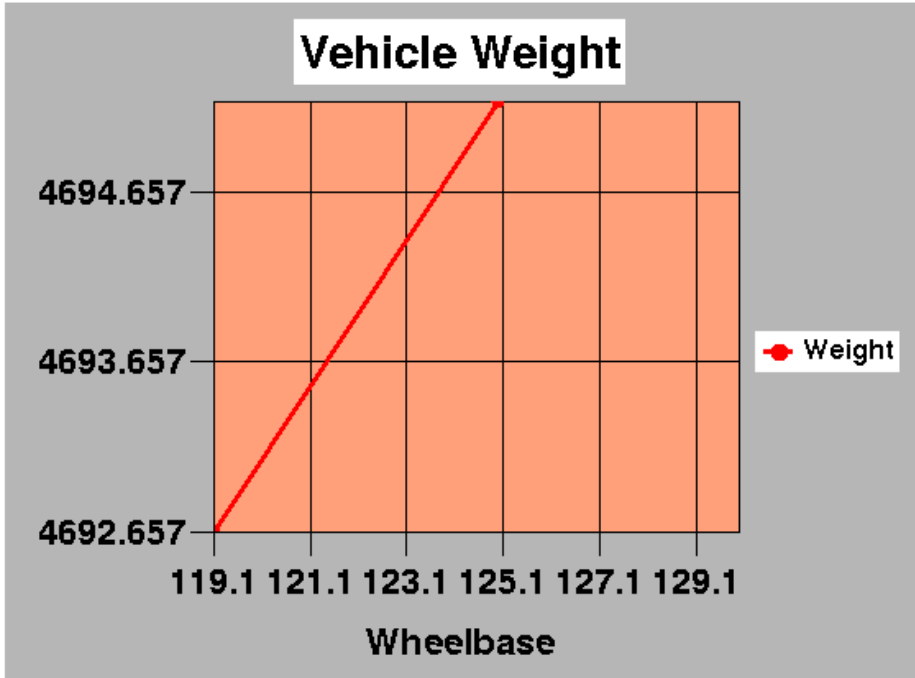
Vehicle Weight

Wheelbase	Weight
119.1 121.1 123.1 125.1 127.1 129.1	4694.657 / 4693.657 / 4692.657

By Simply selecting the Safety Star Rating from the pull down list on the top left hand side, the caluculator for this utility is enabled.

Please Input Parameters in english units

Vehicle Information

PARAMETER	RANGE	SETTING
Weight (lbs)	-	
Height (inches)	-	
Horse Power (HP)	-	
Displacement (Lt)	-	
Front Over Hang (inches)	-	
Leg Room (inches)	-	
Vehicle Cg (inches)	-	N/A
Vehicle Weight Distribution (%)	-	N/A
Head Room (inches)	-	N/A

Calculate Star Rating | **Reset**

Parameter	Star Rating	
Weight	Driver	Passenger

AXIS	MIN	MAX	INC
X-axis			
Y-axis			

Plot Graph | **Driver Star Rating** | **Clear Table**

The intent of the Attribute Expert System is to provide rough estimates of vehicle attribute performance. These estimates may be used to provide design directions during the very early stages of a vehicle program. This tool is based on available vehicle parameters and is specific to the indicated attributes. This does not imply the parameters included in this tool are the only parameters that influence vehicle attribute performance

Digidot Plot - home

Welcome to the Digidot Plot Module

Please click on "Pick Vehicle" and choose the required set of vehicles

Version Number	Authors	Date of Issue
Revision: 3.0		May 21, 2000 - Third Version
Revision: 2.0	Peter Creutz, Tom Gallery, Bob Thomas, Nanda Motikane & Nitin Uchil	Feb 21, 2000 - Second Version
Revision: 1.0		Nov 11, 1999 - First Version
Revision: 0.1		May 17, 1999 - Alpha Version

Digidot Plot - vehicle selection

Digidot Plot - attribute selection

* Ready For Field Use *** Under Development**

Module	Attribute	Select
Vehicle Weight	Vehicle Weight	⦿
	Weight Distribution	○
Package	Turn Circle	○
	Tire Load Capacity	○
	Ride height	○
	Preliminary Tire Size	○
Road NVH	Glen Eagles Road (30 mph)	○
	Rough Road (40 mph)	○
Powertrain NVH	Interior Sound (WOT)	○
	Engine Radiated Noise (WOT)	○

Module	Attribute	Select
Vehicle Dynamics	Ride Frequency	○
	Roll Gain	○
	Steering Gain	○
	Understeer Budget	○
Performance And Fuel	City Fuel Economy	○
	Highway Fuel Economy	○
	0 - 60 miles/hr Performance	○
Safety	NCAP Front - Driver Star Rating	○
	NCAP Front - Driver CPI	○
	NCAP Front - Passenger Star Rating	○
	NCAP Front - Passenger CPI	○

Apply Selected Module

Digidot Plot - attribute values for selected vehicle

| SI No | Vehicle | Model Year | Weight (lbs) | | Check For Plot |
			Actual	Predicted	
1	FORD - CONTOUR I4 AUTO	1999	2821	2741	☑
2	FORD - CONTOUR I4 MAN	1999	2769	2741	☑
3	FORD - CONTOUR LX	1999	2603	2750	☑
4	FORD - CONTOUR SE	1999	2774	2750	☑
5	FORD - CONTOUR SPORT	2000	2769	3042	☑
6	FORD - CROWN VICTORIA LX	1999	3941	3843	☑
7	FORD - CROWN VICTORIA LX	2000	3941	3843	☑
8	FORD - CROWN VICTORIA SEDAN	1999	3908	3843	☑
9	FORD - CROWN VICTORIA SEDAN	2000	3908	3843	☑
10	FORD - CROWN VICTORIA	1999	3917	3842	☑
11	FORD - ESCORT LX	1999	2457	2482	☑
12	FORD - ESCORT SE SEDAN	1999	2468	2482	☑
13	FORD - FOCUS LX	2000	2564	2757	☑
14	FORD - TAURUS LX	1999	3237	3181	☑
15	FORD - TAURUS LX	2000	3354	3298	☑
16	FORD - TAURUS SE COMFORT SEDAN	2000	3340	3395	☑
17	FORD - TAURUS SE SEDAN	2000	3340	3263	☑
18	FORD - TAURUS SHO	1999	3518	3504	☑
19	FORD - TAURUS	1999	3360	3181	☑
20	FORD - THUNDERBIRD V6 COUPE	1996	3571	N/A	☐
21	FORD - THUNDERBIRD V8 COUPE	1996	3699	N/A	☐

Color By [Regression Equation ▼]   Plot Regression Vs Actual Values

Digidot Plot - chart

Actual and Predicted Vehicle Weight Difference Plot
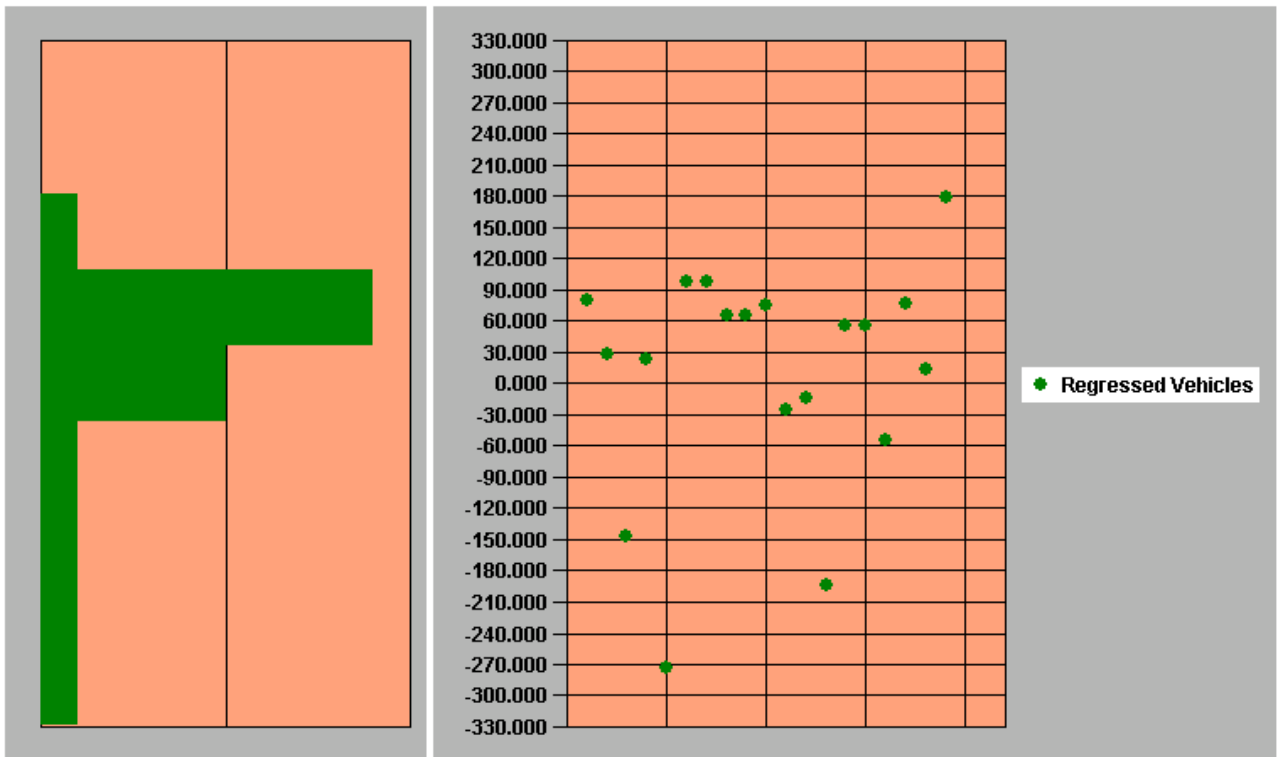
Rank Order - home page

Welcome to the Rank Order Module

Please click on "Pick Vehicle" and choose the required set of vehicles

Version Number	Authors	Date of Issue
Revision: 3.0		May 21, 2000 - Third Version
Revision: 2.0	Peter Creutz, Tom Gallery, Bob Thomas, Nanda Motikane & Nitin Uchil	Feb 21, 2000 - Second Version
Revision: 1.0		Nov 11, 1999 - First Version
Revision: 0.1		May 17, 1999 - Alpha Version

Rank Order - vehicle selection

Rank Order - attribute selection

Please Choose an Attribute For Study						
* Ready For Field Use				* Under Development		
Module	Attribute	Select		Module	Attribute	Select
Vehicle Weight	Vehicle Weight	⦿		Vehicle Dynamics	Ride Frequency	○
	Weight Distribution	○			Roll Gain	○
Package	Turn Circle	○			Steering Gain	○
	Tire Load Capacity	○			Understeer Budget	○
	Ride height	○		Performance And Fuel	City Fuel Economy	○
	Preliminary Tire Size	○			Highway Fuel Economy	○
Road NVH	Glen Eagles Road (30 mph)	○			0 - 60 miles/hr Performance	○
	Rough Road (40 mph)	○		Safety	NCAP Front - Driver Star Rating	○
Powertrain NVH	Interior Sound (WOT)	○			NCAP Front - Driver CPI	○
	Engine Radiated Noise (WOT)	○			NCAP Front - Passenger Star Rating	○
					NCAP Front - Passenger CPI	○
Apply Selected Module						

Rank Order - vehicle and attribute values

SI No	Vehicle	Model Year	City Fuel Economy (Miles/Gallon)		Check For Plot
			Actual	Predicted	
1	FORD - CONTOUR I4 AUTO	1999	23.0	22.72294554	☑
2	FORD - CONTOUR I4 MAN	1999	24.0	22.79390698	☑
3	FORD - CONTOUR LX	1999	24.0	23.61344469	☑
4	FORD - CONTOUR SE	1999	24.0	22.75676917	☑
5	FORD - CONTOUR SPORT	2000	N/A	19.93324734	☐
6	FORD - CROWN VICTORIA LX	1999	17.0	17.45152213	☑
7	FORD - CROWN VICTORIA LX	2000	17.0	17.45152213	☑
8	FORD - CROWN VICTORIA SEDAN	1999	17.0	17.52016213	☑
9	FORD - CROWN VICTORIA SEDAN	2000	17.0	17.52016213	☑
10	FORD - CROWN VICTORIA	1999	17.0	17.50144213	☑
11	FORD - ESCORT LX	1999	28.0	25.99259631	☑
12	FORD - ESCORT SE SEDAN	1999	28.0	25.86663602	☑
13	FORD - FOCUS LX	2000	28.0	24.75264127	☑
14	FORD - TAURUS LX	1999	20.0	20.61468282	☑
15	FORD - TAURUS LX	2000	19.0	20.33041612	☑
16	FORD - TAURUS SE COMFORT SEDAN	2000	20.0	N/A	☐
17	FORD - TAURUS SE SEDAN	2000	19.0	20.42017063	☑
18	FORD - TAURUS SHO	1999	16.0	18.65755290	☑
19	FORD - TAURUS	1999	20.0	20.51557352	☑
20	FORD - THUNDERBIRD V6 COUPE	1996	N/A	N/A	☐
21	FORD - THUNDERBIRD V8 COUPE	1996	N/A	N/A	☐

Order By [Actual To Predicted Differance ▼]   [Rank Order List]

Rank Order - Rank order list

Actual and Predicted City Fuel Economy Difference Order List

Year	Make	Model	Attribute (unit)			
			Actual	Predicted	% Residual	Delta
2000	FORD	FOCUS LX	28.0	24.752641275563803	11.5977097301293	3.2473587244362
1999	FORD	ESCORT SE SEDAN	28.0	25.86663602981319	7.61915703638146	2.13336397018681
1999	FORD	ESCORT LX	28.0	25.992596318128587	7.16929886382647	2.00740368187141
1999	FORD	CONTOUR SE	24.0	22.756769175038702	5.18012843733874	1.2432308249613
1999	FORD	CONTOUR I4 MAN	24.0	22.793906982195	5.0253875741875	1.206093017805
1999	FORD	CONTOUR LX	24.0	23.6134446979479	1.61064709188374	0.386555302052098
1999	FORD	CONTOUR I4 AUTO	23.0	22.722945541795003	1.20458460089129	0.277054458204997
2000	FORD	CROWN VICTORIA LX	17.0	17.451522130537974	2.65601253257632	-0.451522130537974
1999	FORD	CROWN VICTORIA LX	17.0	17.451522130537974	2.65601253257632	-0.451522130537974
1999	FORD	CROWN VICTORIA	17.0	17.501442130537974	2.94965959139985	-0.501442130537974
1999	FORD	TAURUS	20.0	20.515573525870487	2.57786762935243	-0.515573525870487
2000	FORD	CROWN VICTORIA SEDAN	17.0	17.520162130537976	3.05977723845868	-0.520162130537976
1999	FORD	CROWN VICTORIA SEDAN	17.0	17.520162130537976	3.05977723845868	-0.520162130537976
1999	FORD	TAURUS LX	20.0	20.614682825870485	3.07341412935243	-0.614682825870485
2000	FORD	TAURUS LX	19.0	20.33041612116903	7.00219011141595	-1.33041612116903
2000	FORD	TAURUS SE SEDAN	19.0	20.420170638169033	7.4745823061528	-1.42017063816903
1999	FORD	TAURUS SHO	16.0	18.657552903642454	16.6097056477653	-2.65755290364245

Prediction Assesment - Home page

Welcome to the Prediction Assessment Module

Please click on "Pick Vehicle" and choose a vehicle

Version Number	Authors	Date of Issue
Revision: 3.0		May 21, 2000 - Third Version
Revision: 2.0	Peter Creutz, Tom Gallery, Bob Thomas, Nanda Motikane & Nitin Uchil	Feb 21, 2000 - Second Version
Revision: 1.0		Nov 11, 1999 - First Version
Revision: 0.1		May 17, 1999 - Alpha Version

Prediction Assesment - Vehicle Selection

Vehicle Information

Make	FORD ▼
Year	ALL ▼
Style	SEDAN ▼
Image	ALL ▼

Apply Criteria

```
1999 FORD CONTOUR I4 AUTO        ▲
1999 FORD CONTOUR I4 MAN
1999 FORD CONTOUR LX
1999 FORD CONTOUR SE
2000 FORD CONTOUR SPORT
1999 FORD CROWN VICTORIA LX
2000 FORD CROWN VICTORIA LX
1999 FORD CROWN VICTORIA SEDAN
2000 FORD CROWN VICTORIA SEDAN
1999 FORD CROWN VICTORIA         ▼
```

21 Vehicles matching the above Selection Criteria

Units : ⦿ English ○ Metric

Apply   Close

Prediction Assesment - Attribute Selection

Vehicle: 1999 FORD CONTOUR I4 AUTO		
Attribute	Actual	Predicted
Weight	2821	2741
Turn Circle	36.5	N/A
Tire Load Capacity	N/A	N/A
Road NVH - Coarse Road	70.3	68.5
Road NVH - RoughRoad	74.4	
City Fuel Economy	23.0	22.72294554
Highway Fuel Economy	31.0	33.23185941
NCAP Driver Star Rating	N/A	N/A
NCAP Driver CPI	N/A	N/A
NCAP Front Passenger Star Rating	N/A	N/A
NCAP Front Passenger CPI	N/A	N/A
Prediction Assessment Report		

Prediction Assesment - List

Attribute Prediction Assessment Report

Vehicle Attribute Profile For: 1999 FORD CONTOUR I4 AUTO

| Dimension/Parameter Table		
Parameter	**Units**	**Value**
Overall Length		184.6
Wheelbase		106.5
Height		54.4
Vehicle Type		SEDAN
Vehicle Image		NON_LUXURY
Construction		UNITIZED
Tire Width		185
Wheel Diameter		14
Driver Legroom		N/A
Rows Of Seats		2
Number Of Cylinders		4
Engine Displacement		2.0
Engine HP		125
Valves/Cylinder		N/A
Engine Orientation		E/W
Axle/FD Ratio		3.92
Transmission		AUTO
Drive Configuration		FWD

Combined Attributes Radar Chart - attribute selection

Please Choose The Attribute Group(s) For Radar Plot

Select	Attribute
☑	**Weight**

☑	**Road NVH**
	  Glen Eagles Road
	  Rough Road

☑	**Fuel Economy**
	  City
	  Highway
	  0 - 60 miles/hr Performance - (Under Development)

☐	**Turn Circle**
	  Turn Circle
	  Ride height - (Under Development)
	  Tire Load Capacity

☐	**Safety**
	  Driver
	    CPI
	    Star Rating
	  Passenger
	    CPI
	    Star Rating

Please Input Parameters in english units

Package Information

PARAMETER	SETTING	
Style	SEDAN	☑
Rows Of Seat	2	☑
Construction	UNITIZED	☑
Image	NON_LUXURY	☑

Tire Information

PARAMETER	UNIT	SETTING	
Tire Width	mm	205	☑
Tire Aspect Ratio		65	☑
Tire Wheel	inches	15	☑
Tire Pressure	psi	33	☐
Tire Tread		78	☐
Front Ride Frequency	cpm	55	☐

Dimension Information

PARAMETER	UNIT	SETTING	
Overall Length	inches	197.5 ?	☑
Wheelbase	inches	108.5 ?	☑
Vehicle Height	inches	55.1 ?	☑

Powertrain Information

PARAMETER	SETTING	
Engine Configuration (No. of Cylinders)	6	☑
Transmission	AUTO	☑
Gear Box	4	☑
Drive Configuration	FWD	☑
Engine Orientation	E/W	☑

PARAMETER	UNIT	SETTING	
Valves Per Cylinder		4	☑
Axle Ratio		3.77	☑
Horse Power	HP	145	☑
Displacement	Lt	3.0	☑

Other Information

PARAMETER	UNIT	SETTING	
Design Corner Weight - Front	lbs	N/A	☐
Design Corner Weight - Rear	lbs	N/A	☐
2 Pass Corner Weight - Front	lbs	N/A	☐
2 Pass Corner Weight - Rear	lbs	N/A	☐
Front Of Engine To Front Of Vehicle	inches	N/A	☐
Rear Surface Of Vehicle To Front Of Engine	inches	N/A	☐
Front Over Hang	inches	N/A	☐
Leg Room	inches	N/A	☐
Driver Head To Windshield	inches	N/A	☐
Driver Knee To Dash	inches	N/A	☐
Passenger Knee To Dash	inches	N/A	☐
Passenger Chest To Dash	inches	N/A	☐
Adjustable Belt Anchors		N/A	☐

Predict Selected Attributes

Attribute Result

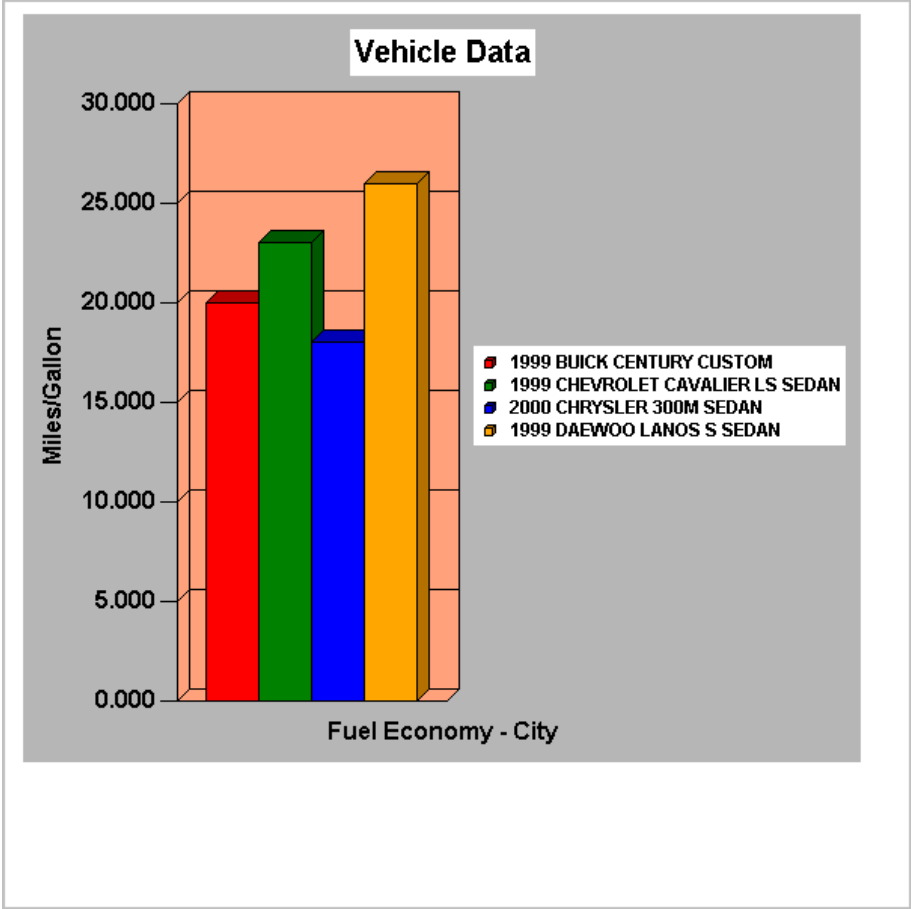| Attribute	Unit	Base Vehicle Value	Transfer Predicted Values	Predicted Value	Check For Radar Plot
Weight	lbs	3360	<---	3290.8	☑
Road NVH - Glen Eagles Road	dB(A)	67.1	<---	67.7	☑

Combined Attributes Radar Chart - Chart
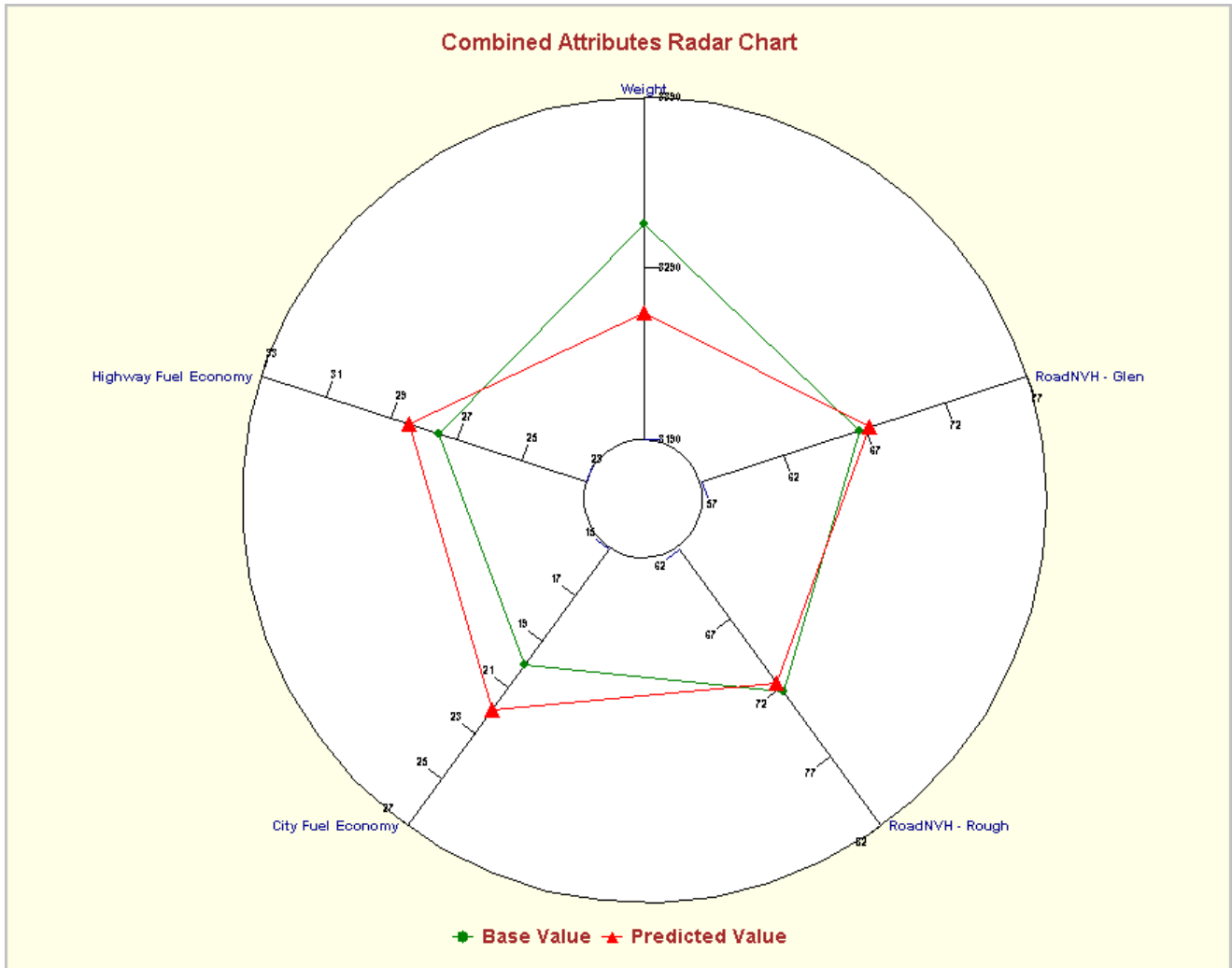
Vehicle Data Retriever - Attribute selection

Parameter	1999 BUICK CENTURY CUSTOM	1999 CHEVROLET CAVALIER LS SEDAN	2000 CHRYSLER 300M SEDAN	1999 DAEWOO LANOS S SEDAN	Action
Model Year	1999	1999	2000	1999	
Vehicle Type	SEDAN	SEDAN	SEDAN	SEDAN	
Curb Weight (lbs)	3349	2723	3585	2522	Plot Curb Weight
Overall Length (inches)	194.6	180.7	197.8	166.8	Plot Overall Length
Wheelbase (inches)	109.0	104.1	113.0	99.2	Plot Wheelbase
Overall Height (inches)	56.6	54.7	56.0	56.4	Plot Overall Height
Row Of Seats	2	2	2	2	
Construction	UNITIZED	UNITIZED	UNITIZED	UNITIZED	
Base Tire	205/70/R15	195/65/R15	225/55/R17	185/60/R14	
Vehicle Image	NON_LUXURY	NON_LUXURY	NON_LUXURY	NON_LUXURY	
Engine Displacement (Lt)	3.1	2.2	3.5	1.6	Plot Engine Displacement
No Of Cylinders	6	4	6	4	Plot No. of Cylinders
Drive Configuration	FWD	FWD	FWD	FWD	
Fuel Economy EPA City (Miles/Gallon)	20.0	23.0	18.0	26.0	Plot Fuel Economy City
Fuel Economy EPA Hwy (Miles/Gallon)	29.0	31.0	27.0	36.0	Plot Fuel Economy Hwy
Engine HP	160	115	253	105	Plot Engine HP
Valves Per Cylinder	N/A	N/A	N/A	N/A	
Transmission	4	4	4	5	
Engine Orientation	E/W	E/W	N/S	E/W	
Axle Ratio	3.29	3.63	3.66	N/A	Plot Axle ratio
Road NVH Glenn Eagles (Db)	N/A	N/A	N/A	N/A	Plot Road NVH Glenn
Road NVH LST (Db)	N/A	N/A	N/A	N/A	Plot Road NVH Rough
Turn Circle Curb to Curb (Feet)	N/A	N/A	N/A	N/A	

Vehicle Data Retriever - Selected attributed chart

Vehicle Data

Legend:
- 1999 BUICK CENTURY CUSTOM
- 1999 CHEVROLET CAVALIER LS SEDAN
- 2000 CHRYSLER 300M SEDAN
- 1999 DAEWOO LANOS S SEDAN

Y-axis: Miles/Gallon

X-axis: Fuel Economy - City

Maintain Vehicle Data

Vehicle Information

PARAMETER	SETTING
Make	ACURA
Year	1999
Model	INTEGRA GS COU
Car or Truck	Car

Package Information

PARAMETER	SETTING
Style	COUPE
Rows Of Seat	2
Doors	N/A
No. Of Rear Wheels	N/A
Construction	UNITIZED
Image	LUXURY

Safety Information

PARAMETER	SETTING
Front - Driver Star Rating	N/A
Front - Driver CPI	N/A
Front - Passenger Star Rating	N/A
Front - Passenger CPI	N/A
Adjustable Belt Hangers	N/A

Powertrain Information

PARAMETER	SETTING
Engine Configuration (No. of Cylinders)	4
Transmission	AUTO
Gear Box	4
Drive Configuration	FWD
Valves Per Cylinder	N/A
Axle Ratio	4.36
Horse Power (HP)	140
Displacement (Lt)	1.8
Engine Orientation	E/W
Fuel Type	Gasoline
Fuel City (Miles/Gallon)	24.0
Fuel Highway (Miles/Gallon)	32.0
0 - 60 Performance (Miles/hr)	N/A
Air HP (hp)	18.4
Std. Towing Capacity (lbs)	1250
Opt. Towing Capacity (lbs)	1750
Front Track (inches)	61.6
Rear Track (inches)	62.1
Sg RP To Ground (inches)	N/A
Stroke (inches)	N/A
Bore (inches)	N/A
Rpm (rev/min)	N/A

Dimensional Information

PARAMETER	SETTING
Overall Length (inches)	172.4
Wheelbase (inches)	101.2
Vehicle Height (inches)	52.6
Front Of Engine To Front Of Vehicle (inches)	N/A
Rear Surf. Of Veh. To Frnt. Of eng. (inches)	N/A
Front Over Hang (inches)	N/A
Leg Room (inches)	N/A
Driver Head To Windshield (inches)	N/A
Driver Knee To Dash (inches)	N/A
Passenger Knee To Dash (inches)	N/A
Passenger Chest To dash (inches)	N/A

Noise Information

PARAMETER	SETTING
Glenn Road NVH (dB(A))	N/A
Rough Road NVH (dB(A))	N/A

Tire Information

PARAMETER	SETTING
Tire Width (mm)	195
Tire Aspect Ratio	55
Tire Wheel (inches)	15
Tire Tread	N/A
Tire Pressure	N/A
Front Ride Frequency (cpm)	N/A
Tire Load Capacity (lbs)	N/A
Turn Circle Curb-Curb (Feet)	N/A

Weight Information

PARAMETER	SETTING
Weight (lbs)	2681
% Front Weight	64
Dsgn. Corner Weight - Front (lbs)	N/A
Dsgn. Corner Weight - Rear (lbs)	N/A
2 Psg. Corner Weight - Front (lbs)	N/A
2 Psg. Corner Weight - Rear (lbs)	N/A

Maintain Record

Delete | Update | Cle

Database Schema Definition

The first iteration of the Attribute Expert System consisted of a flat file data structure. To enable better searches and queries, and to integrate it well with other existing and future applications, the data was migrated to reside in a relational database of the Benchmarking schema. Since this data was tabular and encompassed several line items of the Benchmarking schema, a view was created so that input and extraction of this data could be facilitated.

Technical Details

Versions 1 to 3 consisted of a Perl application that talked to the flat file data structure. Version 4 is a pure Servlet implementation and consists of the Benchmarking schema in the backend.

Security Model

- All user with a valid Ford CDSID are allowed to use the expert system
- Only administrators can add/delete/modify items in the database

References
What is an expert system

Nitin Uchil is founder and President & CEO of Mindware, Inc. For the past three years he has been consulting at Ford Motor Company building a knowledge management framework to depict design verification, competitive intelligence, web-based training and content management. He has architectured web-enabled enterprise knowledge bases and expert system tools to house and intelligently mine competitive vehicle information, schedule/archive/correlate Test and CAE analysis, build prediction tools using statistical analysis, rule based systems and artificial intelligence to automatically store and sign-off deliverables using historical data via the Verification Portal. He is also responsible for administering the Computer Based Enhancement (CBE) curriculum at the Ford Design Institute that provides web-based training and testing courses that deliver interactive content using Java Applets & Servlets, Livewire, multi-media based CD-ROM using a back-end Oracle database. He is a graduate of the University of Oklahoma (1987) and has over ten years of experience working with engineering simulations related to aerospace and automotive applications in the fields of structural analysis and computational fluid dynamics. He has held engineering positions at Universal Analytics (1988-1989), the developers of UAI/NASTRAN, eBASE and ASTROS (structural analysis and optimization packages employing the finite element methodology) now part of MSC Software, Analysis and Design Application Co. (adapco) (1989-1996), consultants in aerospace and automotive engineering and the developers of the pre- and post- processor for STAR-CD (a computational fluid dynamics code), and TechneGroup Design (1996-1997), consultants in CAE Simulations now part of ICEM-CFD, a subsidiary of ANSYS Inc. He is currently in the process of defining BDRIVE.COM, a company created to integrate middleware to accelerate eBusiness.

Mindware is a Michigan based IT company dedicated to providing enterprise solutions in engineering and technology using intelligent mining schemes, client-server techniques and the object oriented methodology to deliver content with dynamic and interactive capabilities. More information can be found at http://www.mindware-inc.com.