



TO: Rick Donnelly, Pat Costinett, Tim Heier  
FROM: Barbara Arens  
DATE: 27 April 1997  
RE: TRANUS operating characteristics and capacity restriction parameters  
CC: Bill Upton (ODOT)

This memorandum describes the sources and variables for the TRANUS, File P0E, Section 4.0: Operating Characteristics, and Section 2.2: Capacity Restriction Parameters. Section 4.0 is made up of Section 4.1: Energy and other operating costs per vehicle and Section 4.2: Operating characteristics by link type (per vehicle). The specific values for use in this study area contained in an Excel workbook (opchar.xls), which is attached to this document. A listing of the worksheets in that workbook is attached at the end of this memo.

There are eight operators defined for the ODOT project and they are, as follows:

Number	Name	Mode <sup>a</sup>	Type <sup>b</sup>
1	Auto	1	1
2	Bus	1	2
3	Vanpool	1	2
4	Intercity Rail	1	3
5	Light Truck	2	1
6	Heavy Truck	2	1
7	Container	2	1
8	Rail Freight	2	3

a. Valid modes are 1=people and 2=freight

b. Valid types are 1=free, 2=public, 3=line, 4=pedestrian

### Section 4.1: Energy and other operating costs per vehicle

This section provides the parameters to calculate energy consumption and cost, and operating costs by vehicle for each operator. There are six parameters in this section to be identified for each operator. All parameters in this section are per vehicle.

*MinCons* is the minimum amount of energy consumed by a vehicle and a unit distance when the vehicle is circulating at optimum speed. *MaxCons* is the maximum amount of energy consumed by a vehicle and a unit distance when the vehicle is circulating near zero speed. The units are in gallons per mile. *Slope* is the parameter of the curve between the

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minimum and maximum value as speed is reduced. If only an average consumption figure is available, then  $\text{MinCons}=\text{MaxCons}=\text{Value}$ , and the  $\text{Slope}=0$ . The automobile and van-pool values were obtained from "Improving Automobile Fuel Economy, New Standards, New Approaches" by the Congress of the United States, Office of Technology Assessment.

The bus and intercity rail values are from the "Transportation Energy Data Book: Edition 12," page 2-20. Transit rail operates at approximately 12 times the energy used of a 1990 automobile and transit bus operates at approximately five (5) times the energy used of an automobile. The truck fuel economy for operators 5, 6, and 7 are based on percentage of trucks by weight class and miles per gallon from the "Transportation Energy Data Book: Edition 16," 1996, by Oak Ridge National Laboratory. A light truck is 6,000 lbs. or less and a heavy truck or container is over 33,000 lbs.

Operator 8, rail freight data, was obtained from "Railroad Facts, 1996 Edition," by the American Association of Railroads. The gallon per mile fuel consumption was obtained by dividing the number of revenue ton-miles by the revenue ton-miles per gallon of fuel consumed and the freight train miles. A train mile is the movement of a train the distance of one mile. The average number of cars per freight train was 66.3 in 1995. There are approximately 43 tons per car on a freight train by using revenue-ton miles divided by freight train miles, all divided by 66.3 cars per train.

The *EnerCost* is the cost of each unit being consumed. The unit is dollars per gallon and they are 1990 prices including taxes adjusted by the U.S. Consumer Price Inflation Index. These values are from the "Transportation Energy Data Book, Edition 12," by Oak Ridge National Labs.

*FixOpCost* is the fixed operating cost. It is a constant value added to a vehicle trip. Usually representing the administrative component of operating cost. "The Least-Cost Planning for Transportation, Chapter 3: Evaluating the Benefits and Costs of Transportation Alternatives," by Parsons Brinckerhoff/ECONorthwest, September 1995, p. 3-21 and "Transportation Cost Analysis: Techniques, Estimates, and Implications," by Todd Litman, 1994, p. ES-2, state that the fixed costs for a typical car, annualized and averaged over average annual vehicle miles, works out to be around 20 cents per mile. The total general administrative expense for transit divided by the total operating transit miles was used for bus and intercity rail from the "Transit Fact Book" by the American Public Transit Association, 1996. The American Trucking Association provided the fixed operating cost per mile. The rail freight value was obtained from "Railroad Facts, 1996 Edition," by the American Association of Railroads for general and administrative operating cost per mile for 1990 freight train miles (a train of approximately 66.3 cars).

*TimeOpCost* is time related operating cost. *TimeOpCost* represents time related operating costs, such as drivers' salary and amortization of the vehicle. Average annual salary per year divided by the miles per year. The same sources were used as indicated above for the

operators, as well as the County Business Pattern Data for Oregon by SIC code. The American Trucking Association provided the cost per mile of driver costs and vehicle depreciation. The Railroad Facts provided the depreciation and total labor costs per mile of revenue dollars for rail freight.

#### Section 4.2: Operating characteristics by link type (per vehicle)

This section specifies operating characteristics that depend on link type and operator. Any operator/link type combination not included in this section will mean that the operator cannot circulate along links of this type. There are 14 link types, as follows:

LinkTyp	HPMS <sup>a</sup>	Description
1	01	Rural Principal Arterial-Interstate
2	02	Rural Principal Arterial-Other
6	06	Rural Minor Arterial
7	07	Rural Major Collector
8	08	Rural Minor Collector
9	09	Rural Local System
11	11	Urban Principal Arterial-Interstate
12	12	Urban Principal Arterial-Other Freeway
14	14	Urban Principal Arterial-Other
16	16	Urban Minor Arterial
17	17	Urban Collector
19	19	Urban Local System
61	— <sup>b</sup>	Intercity Passenger Rail
62	— <sup>b</sup>	Railroad Freight

a. The HPMS code is also used in OHMS to denote roadway functional classification.

b. These link types created for use in this study only (no OHMS analogue).

The *LinkTyp* is the number in the table above. The *Speed* is the maximum circulating speed (free flow speed) for operator (Oper) in link type (LinkTyp). The *StdVehic* is the factor that transforms the number of vehicles of operator (Oper) in link type (LinkTyp) into standard units.

The *OpCostDist* is the distance-related cost of vehicles for the operator and link type combination. The *OpCostDist* include other costs such as lubricants, tires, maintenance of vehicles, etc. The sources are the same as above. The transit value appears to be high, but it was only available for the transit industry as a whole, including motor bus, demand response, heavy rail, light rail, trolleybus, commuter rail, ferry boat, vanpool, intercity rail, and other. The transit industry vehicle maintenance expense was divided by the vehi-

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cle miles operated to obtain the cost per mile. Once again the rail freight cost is for a freight train with 66.3 cars.

The *Toll* is the monetary cost per unit distance that the administrator of link type charges to a vehicle operator. There are no tolls on the facilities.

*Maint* is the marginal cost of maintenance. It is the cost to the administrator of a link type when a vehicle operator circulates per unit distance. Penal is the penalizing factor that applies to the operating cost of vehicles due to link type conditions. We are working with ODOT to derive the marginal cost of maintenance figures, based on their expenditures by functional class. I hope to have these data to you shortly.

## **Section 2.2: Capacity restriction parameters**

This section defines the capacity restriction parameters. *% Reduct at V/C=1* represents the proportion in which the speed is reduced when the assigned vehicle/capacity ratio of the link is 1.0. For example, a value of 0.8 means that the speed is reduced by 80-percent when demand reaches capacity. *V/C for %Red=0.1* represents the vehicle/capacity ratio at which the speed becomes minimum (=0.1% of the free flow speed). The value must be greater than one. A value of 1.5, for example, means that when demand is 1.5 times the capacity, the speed adopts a minimum value of 0.1% of the free flow speed. These values are based on updated BPR curves from “Improved Speed Flow Relationships for Planning Applications,” by Skabardonis and Dowling, December 1996, and the “Highway Capacity Manual, Special Report 209,” updated in 1994.

The *Capacity Factor* multiplies the capacity of the links coded in the PIE file. The factor is based on I-5 and I-84 average daily traffic (ADT) and Highest Hourly Volume Percentage of ADT for inside and outside the Portland metropolitan area.

**File POE, Section 4.0: Operating Characteristics**

**Section 4.1: Energy and other operating costs per vehicle**

Operator	MinCons. (gallon/mile)***	MaxCons. (gallon/mile)***	Slope	EnerCost* (\$/gallon)	FixOpCost** (\$/mile)	TimeOpCost (\$/mile)
1	.0273/.0250	.0435/.0398	0.63	1.04	0.20	0.00
2	0.13	0.13	0.00	0.99	0.98	0.69
3	.0379/.0362	.0604/.0577	0.63	1.04	0.20	0.00
4	0.39	0.39	0.00	0.99	0.98	0.69
5	0.06	0.06	0.00	0.99	0.45	0.48
6	0.18	0.18	0.00	0.99	0.45	0.48
7	0.18	0.18	0.00	0.99	0.45	0.48
8	8.21	8.21	0.00	0.99	7.24	0.44

00/00 = 1990/1995 data values

00 = 1990 value

\* 1990 prices represent the retail prices (including taxes) in \$/gallon for premium leaded gasoline on January 1, 1990. Adjusted by the U.S. Consumer Price Inflation Index.(p.1-9)  
 1990 prices represent the retail prices (including taxes) in \$/gallon for diesel fuel on January 1, 1990. Adjusted by the U.S. Consumer Price Inflation Index.(p.1-11)

*Transportation Energy Data Book, Edition 12, ORNL.*

*Railroad Facts, 1996 Edition* states that Diesel Fuel Consumption had an average cost per gallon in 1990 of \$0.69 and in 1995 of \$0.60, though the ORNL data is used in the table.

\*\* *Least-Cost Planning for Transportation, Chapter 3: Evaluating the Benefits and Costs of Transportation Alternatives*, by Parsons Brinckerhoff/ECONorthwest, September 1995, p. 3.-21 and *Transportation Cost Analysis: Techniques, Estimates, and Implications*, by Todd Litman, 1994, p. ES-2. The fixed costs for a typical car, annualized and averaged over average annual vehicle miles, works out to be around 20 cents per mile.) The 0.33 is from the *Transportation Energy Data Book: Edition 12*, p.2-37, source is AAA (1990 Constant Dollars). Trucking information provided by the American Trucking Association for 1995. *Railroad Facts, 1996 Edition* provided the rail 1990 data is in the table, 1995 data is \$0.61.

\*\*\*Fuel Consumption for Cars out of the *Transportation Energy Data Book, Edition 12, ORNL*, p.3-67, *Traffic Engineering Handbook, 4th Edition*, ITE (trucks), American Trucking Association Data (trucks), *Improving Automobile Fuel Economy, New Standards, New Approaches* by the Congress of the United States, Office of Technology Assessment. *Railroad Facts, 1996 Edition*; a train-mile is the movement of a train the distance of one mile. Average number of cars per freight train is 66.3 in 199 According to the *Transportation Energy Data Book: Edition 12 page 2-20*, transit rail operates at 12 time the energy used of a 1990 automobile and transit bus operates at 5 times the energy used of an automot *Transit Fact Book* states that the average operating speed in revenue service is 11.8 mph.

Operating Cost (P0E-4.2)

**Section 4.2: Operating characteristics by link type (per vehicle)**

LinkTyp	Oper	Speed	StdVehic.	OpCostDis. (\$/mile)	Toll.	Maint.	Penal
1	1	70	1.0	0.03	0	0	1.0
1	2	70	1.5	0.95	0	0	1.0
1	3	70	1.0	0.03	0	0	1.0
1	5	70	1.0	0.10	0	0	1.0
1	6	55	1.5	0.18	0	0	1.0
1	7	55	1.5	0.18	0	0	1.0
2	1	50	1.0	0.03	0	0	1.0
2	2	50	1.5	0.95	0	0	1.0
2	3	50	1.0	0.03	0	0	1.0
2	5	50	1.0	0.10	0	0	1.0
2	6	50	1.5	0.18	0	0	1.0
2	7	50	1.5	0.18	0	0	1.0
3	1	50	1.0	0.03	0	0	1.0
3	2	50	1.5	0.95	0	0	1.0
3	3	50	1.0	0.03	0	0	1.0
3	5	50	1.0	0.10	0	0	1.0
3	6	50	1.5	0.18	0	0	1.0
3	7	50	1.5	0.18	0	0	1.0
4	1	45	1.0	0.03	0	0	1.0
4	2	45	1.5	0.95	0	0	1.0
4	3	45	1.0	0.03	0	0	1.0
4	5	45	1.0	0.10	0	0	1.0
4	6	45	1.5	0.18	0	0	1.0
4	7	45	1.5	0.18	0	0	1.0
5	1	40	1.0	0.03	0	0	1.0
5	2	40	1.5	0.95	0	0	1.0
5	3	40	1.0	0.03	0	0	1.0
5	5	40	1.0	0.10	0	0	1.0
5	6	40	1.5	0.18	0	0	1.0
5	7	40	1.5	0.18	0	0	1.0
6	1	35	1.0	0.03	0	0	1.0
6	2	35	1.5	0.95	0	0	1.0
6	3	35	1.0	0.03	0	0	1.0
6	5	35	1.0	0.10	0	0	1.0
6	6	35	1.5	0.18	0	0	1.0
6	7	35	1.5	0.18	0	0	1.0
7	1	60	1.0	0.03	0	0	1.0
7	2	60	1.5	0.95	0	0	1.0
7	3	60	1.0	0.03	0	0	1.0
7	5	60	1.0	0.10	0	0	1.0
7	6	60	1.5	0.18	0	0	1.0
7	7	60	1.5	0.18	0	0	1.0
8	1	60	1.0	0.03	0	0	1.0
8	2	60	1.5	0.95	0	0	1.0
8	3	60	1.0	0.03	0	0	1.0
8	5	60	1.0	0.10	0	0	1.0
8	6	60	1.5	0.18	0	0	1.0
8	7	60	1.5	0.18	0	0	1.0

Operating Cost (P0E-4.2)

LinkTyp	Oper	Speed	StdVehic.	OpCostDis. (\$/mile)	Toll.	Maint.	Penal
9	1	45	1.0	0.03	0	0	1.0
9	2	45	1.5	0.95	0	0	1.0
9	3	45	1.0	0.03	0	0	1.0
9	5	45	1.0	0.10	0	0	1.0
9	6	45	1.5	0.18	0	0	1.0
9	7	45	1.5	0.18	0	0	1.0
10	1	45	1.0	0.03	0	0	1.0
10	2	45	1.5	0.95	0	0	1.0
10	3	45	1.0	0.03	0	0	1.0
10	5	45	1.0	0.10	0	0	1.0
10	6	45	1.5	0.18	0	0	1.0
10	7	45	1.5	0.18	0	0	1.0
11	1	40	1.0	0.03	0	0	1.0
11	2	40	1.5	0.95	0	0	1.0
11	3	40	1.0	0.03	0	0	1.0
11	5	40	1.0	0.10	0	0	1.0
11	6	40	1.5	0.18	0	0	1.0
11	7	40	1.5	0.18	0	0	1.0
12	1	30	1.0	0.03	0	0	1.0
12	2	30	1.5	0.95	0	0	1.0
12	3	30	1.0	0.03	0	0	1.0
12	5	30	1.0	0.10	0	0	1.0
12	6	30	1.5	0.18	0	0	1.0
12	7	30	1.5	0.18	0	0	1.0
61	4	80	1.0	0.95	0	0	1.0
62	8	60	1.0	11.27	0	0	1.0

OpCostDist. = Operating cost for lubricants, tires, maintenance of vehicles, etc. (p.2-37 from the *Transportation Energy Data Book: Edition 12*, Oak Ridge National Laboratory, includes maintenance and tires. Constant 1990 \$/mile, adjusted by the Consumer Price Inflation Index.) *Railroad Facts, 1996 Edition* for rail information. Average of 66.3 cars per freight train.

**Section 2.4: Administrators**

No.	Name
1	Govrnm
2	Railrd

Link types defined from HPMS roadway functional classes used in Oregon are as follows:

**Section 2.5: Link Types**

No.	HPMS	Name	Admin	Penaliz.	MinMaintCost
1	01	Rural Principal Arterial-Interstate	1	1	
2	02	Rural Principal Arterial-Other	1	1	
3	06	Rural Minor Arterial	1	1	
4	07	Rural Major Collector	1	1	
5	08	Rural Minor Collector	1	1	
6	09	Rural Local System	1	1	
7	11	Urban Principal Arterial-Interstate	1	1	
8	12	Urban Principal Arterial-Other Freeway	1	1	
9	14	Urban Principal Arterial-Other	1	1	
10	16	Urban Minor Arterial	1	1	
11	17	Urban Collector	1	1	
12	19	Urban Local System	1	1	
61		Intercity Rail	2	1	0.18
62		Railroad Freight	2	1	0.18

## 2.2 Capacity restriction parameters

Link type	% Reduct at V/C=1	V/C for %Red=0.1	Capacity Factor
1	0.83	1.42	11.7
2	0.82	1.58	11.7
3	0.82	1.55	11.7
4	0.82	1.60	11.7
5	0.82	1.62	11.7
6	0.82	1.65	11.7
7	0.83	1.45	11.7
8	0.83	1.45	11.7
9	0.82	1.60	11.7
10	0.82	1.60	11.7
11	0.82	1.62	11.7
12	0.82	1.67	11.7

% Reduction at V/C =1 and V/C for %Red=0.1 is based on updated BPR curves from "Improved Speed Flow Relationships for Planning Applications", by Skabardonis, A. and Dowling, R., December 1996, and the "Highway Capacity Manual, Special Report 209", updated in 1994.

Capacity Factor based on I-5 and I-84 ADT and Highest Hourly Volume % of ADT for inside the Portland and outside the Portland Metropolitan Area.

**Railroad Facts, 1996 Edition, by the American Association of Railroads**

Operating Expenses include labor, materials and supplies, fuel, depreciation, purchased services, and other miscellaneous expenses; fixed charges and income taxes are excluded.

The four basic functional categories of operating expense are transportation (expenses such as train crews and fuel), which accounted for 41.1 percent of operating expenses in 1995; equipment 25.2 percent; way and structures, 19.5 percent; and general and administrative, 14.3 percent.

**Operating Expenses** (Amounts shown in thousands)

Year	United States	East	West
1990	24651542	10609981	14041561
1995	27896748	11167080	16729668

Transport.	Equipment	Way&Struct.	Gen./Admin
11276732	6349784	4278075	2746951
11455439	7018921	5446567	3975821

**Revenue Ton-Miles** (Amount shown in Millions)

Year	United States	East	West
1990	1033969	368924	665045
1995	1305688	410621	895067

**Railroad Mileage Operated in Each State-1995**

Total US	Oregon
124,181	2,139

**Tons Originated** (Amounts shown in thousands)

Year	United States	East	West
1990	1424880	746984	677897
1995	1549634	737791	811843

In 1990 and 1995 all locomotives in service are diesel electric units.

**Freight Train-Miles** (Amounts shown in thousands)

Year	United States	East	West
1990	379582	135906	243675
1995	458271	163539	294732

**1995 Revenue Dollar**

Payroll taxes (included in total labor cost)	\$0.06
Depreciation	\$0.10
Fuel	\$0.07
Total labor costs	\$0.34
Net railway operating income	\$0.09
Loss and damage, injuries and insurance	\$0.04
All other expenses plus income taxes	\$0.36
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	\$1.06

**Revenue Ton-Miles/Gallon of Fuel Consumed**

Year	Revenue Ton-Miles (million)	Fuel Consumed (million gal)*	Rev. Ton-Miles/Gal**
1990	1033969	3115	332
1995	1305688	3480	375

\* Fuel consumed in Freight Service (million gallons)

\*\* Revenue ton-miles per gallon of fuel consumed

Year	US FixCost
1990	7.24
1995	8.68

US Fixed Cost based on operating expenses and freight train miles.

**Freight Car Miles** (Amounts shown in millions)

Year	United States	East	West
1990	26159	10036	16124
1995	30383	10648	19735

**Operating Cost per Mile 1990 and 1995 (freight car miles)**

Year	Total	Transportation	Equipment	Way&Str.	Gen&Adm
1990	0.94	0.39	0.24	0.18	0.13
1995	0.92	0.38	0.23	0.18	0.13

**Time Operating Cost per Mile**

Year	Transportation	Labor	Fuel
1990	0.39	0.33	0.06
1995	0.38	0.32	0.06

Labor plus fuel

34.6 + 6.5 = 41.1                      0.8418              0.1582

Labor is 84.19 percent of transportation

Fuel is 15.82 percent of transportation

**Operating Cost per Mile 1990 and 1995 (freight train miles)**

Year	Total	Transportation	Equipment	Way&Str.	Gen&Adm
1990	64.94	29.71	16.73	11.27	7.24
1995	60.87	25.00	15.32	11.89	8.68

**Gallon Per Mile Fuel Consumed (Average)**

Revenue Ton-Miles per Gallon of Fuel Consumed in 1990/1995 = 332/375

Revenue Ton-Miles (millions) in 1990/1995 = 1,033,969/1,305,688

Freight Train Miles (thousands) in 1990/1995 for USA = 379,582/458,271

Freight Car Miles (millions) in 1990/1995 for USA = 26159/30383

1033969000000 / (332 \* 379582000) =              8.205

1033969000000 / (332 \* 26159000000) :              0.119

(Rev-Ton Miles/Freight Train Miles)/66.3 cars/train=42.97 Rev-Tons per car

CountyBusiness

**County Business Pattern Data for Oregon**

1990 The State-Establishments, Employees, & Payroll, by Major Group

SIC	Major Group	# of Establ.	# of Employee	Annual Payroll (\$1,000)
41	Transp.& Public Utilities	3,594	63,229	1,782,853
	Local & Interurban Transit	157	(H)	(D)
42	Trucking & Warehousing	1,788	22,422	559,408

(H) = 2,500 to 4,999

(D) = No data provided or disclosed

1994 The State-Establishments, Employees, & Payroll, by Major Group

SIC	Major Group	# of Establ.	# of Employee	Annual Payroll (\$1,000)
41	Local & Interurban Transit	178	4,237	48,805
42	Trucking & Warehousing	1,912	25,882	725,507

**41 SIC Code**

Year	Avg. Annual Salary/Employee
1990	N/A
1994	11,518.76

**42 SIC Code**

Year	Avg. Annual Salary/Employee
1990	24,949.07
1994	28,031.33

**TRANSIT Fact Book by American Public Transit Association, 1981 & 1996**

## Passenger Modes

Carrier	Million of Pax Trips 1980	Million of Pax Trips 1994	Million of Pax Miles 1980	Million of Pax Miles 1994	Pax Miles Per Trip 1980	Pax Miles Per Trip 1994
Transit	8577	8435	40600	41084	5	4.9
Intercity Bus	373		27700		74	
Amtrak	21		4500		214	

1980/1994 Urban Transit Fleet in mph	<u>Motorbus</u>	<u>Heavy Rail</u>	<u>Light Rail</u>	<u>Trolley Coach</u>
Average Operating Speed in Revenue Service	11.8 /13	19.8/20.7	9.6/14.4	8.3/8.2

Transit Industry Expense 1980 & 1994	1980 \$	1994 \$
Transportation Expense	3248200000	8654100000
Vehicle Maintenance	1274300000	3395800000
Non-Vehicle Maintenance	499700000	1874000000
General Administration Expense	1224300000	4858400000
Total Operating Expense	6246500000	18782300000
Depreciation and Amortization	277600000	2902400000
Other Reconciling Items	186500000	1009900000
Total Expense	6710600000	22694600000

## 1980/1990 Transit Industry

Mode	Veh.owned/Leased	Veh. Miles Operated (millions)	Oper. Rev. (millions)	Oper. Exp. (millions)
Transit	59411/70927	1677.2	2162.7	1899
Total	75546/121338	2260.8	3180	7601/18782.3

Transit Expense	1980	1990
Transportation Expense	49.30%	56.40%
Maintenance Expense	27.30%	18.08%
Miscellaneous Expense	7.10%	9.98%
General Administration Expense	16.30%	15.54%
	100.00%	100.00%

transitdata

Transit Operating Expense 1980 and 1994

Function and Object Class	1980		1994	
	Total in \$	Percent	Total in \$	Percent
Salaries and Wages	3280900000	52.52	8648500000	46.05
Fringe Benefits	1353100000	21.66	4769300000	25.39
Services	237600000	3.80	869200000	4.63
Materials and Supplies	759400000	12.16	1673300000	8.91
Utilities	231300000	3.70	651100000	3.47
Casualty and Liability Costs	237800000	3.81	651400000	3.47
Purchased Transportation	146400000	2.34	1939000000	10.32
Other	0	0.00	-419500000	-2.23
Total	6246500000	100.00	18782300000	100.00

TimeOpCost = salary and amortization of the vehicles/miles per year    veh miles/# of owned&leased veh=2162.7/(59411+70927)=16593.01  
 TimeOpCost = 

1.574000354 \$/mile in 1980	3.248284589 \$/mile in 1994
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 Av salary/av miles/veh=11518/16593=**.69**  
 OpCostDist = Distance-related operating cost (lubricants, tires, maintenance of vehicle)  
 OpCostDist = 

0.563650035 \$/mile in 1980	0.954949381 \$/mile in 1994
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 FixOpCost = General Administration Expense/Miles operated per year    Total Exp x 15.54%/Total miles=**0.98**  
 FixOpCost = 

0.54153397 \$/mile in 1980	1.366254218 \$/mile in 1994
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1994 Data Mode	Energy Consumption Gallons (millions)	Operating Exp. Millions of \$	Vehicle Miles Millions	Average Speed (mph)	Average Trip Length (miles)	Pax Miles Millions
Motor Bus	602.1	10820.9	2162.7	13	3.7	20238
Demand Response	76.9	1145.7	552.7	14	7.3	636
Heavy Rail	0	3786.2	531.8	20.7	4.9	10780
Light Rail	0	413.3	33.9	14.4	3.6	722
Trolleybus	0	132.9	13.7	8.2	1.6	187
Commuter Rail	60.9	2224.8	230.7	33.8	23.7	7996
Ferry Boat	20.4	200.4	2.1	8.4	5.7	294
Vanpool	2.2	16.7	26.1	32.6	32.4	204
Other	0	41.4	2.3	5.7	1	27
Total	762.5	18782.3	3556	14.7	4.9	41084

Motor Bus Operating Cost per Mile (operating expense/vehicle miles) = 5.00 \$/mile  
 Commuter, Heavy & Light Rail Oper. Cost per Mile (oper. expense/vehicle miles) = 8.07 \$/mile

ATA data

American Trucking Association Provided the following 1995 cost per mile in cents per mile:				
Interest on Tractor and Trailer	2.9	2.9		
Vehicle Depreciation	8.7			8.7
Insurance	10.0	10.0		
Management and Overhead	16.0	16.0		
Depreciation and Interest on other items	1.6			1.6
Miscellaneous	6.7	6.7		
Driver	37.5			37.5
Tires	2.7		2.7	
Fuel	19.2			
Maintenance	15.4		15.4	
License	9.5	9.5		
Total	130.2	Fixed Cost: 45.1	Op. Costs 18.1	TimeOpcost 47.8

Fuel Consumption by Average Speed for Trucks, *Transportation Energy Data Book: Edition 16, 1996.*

Speed (mph)	MPG	Gallon/Mile
48	6.9	0.14
50	6.6	0.15
52	6.3	0.16
54	6.0	0.17
56	5.8	0.17
58	5.5	0.18
60	5.2	0.19
62	4.9	0.20
64	4.6	0.22
66	4.3	0.23
68	4.0	0.25

Truck Fuel Economy

Size Class	Average Weight	Percentage by Size		Miles Per Gallon		Gallon/Mile	
		1987	1992	1987	1992	1987	1992
1	6,000 lbs. and less	85.4	85.4	15.0	16.1	0.07	0.06
2	6,001 - 10,000 lbs	6.5	7.9	10.9	12.2	0.09	0.08
3	10,000 - 14,000 lbs	1.2	1.2	8.1	9.2	0.12	0.11
4	14,001 - 16,000 lbs	0.5	0.5	7.5	8.5	0.13	0.12
5	16,001 - 19,500 lbs	0.6	0.5	7.1	8.1	0.14	0.12
6	19,501 - 26,000 lbs	1.7	1.2	6.4	7.2	0.16	0.14
7	26,001 - 33,000 lbs	0.8	0.7	6.1	6.8	0.16	0.15
8	33,001 lbs and over	3.3	2.8	5.3	5.5	0.19	0.18
Average Weight by Year (pounds)		6861	6630				