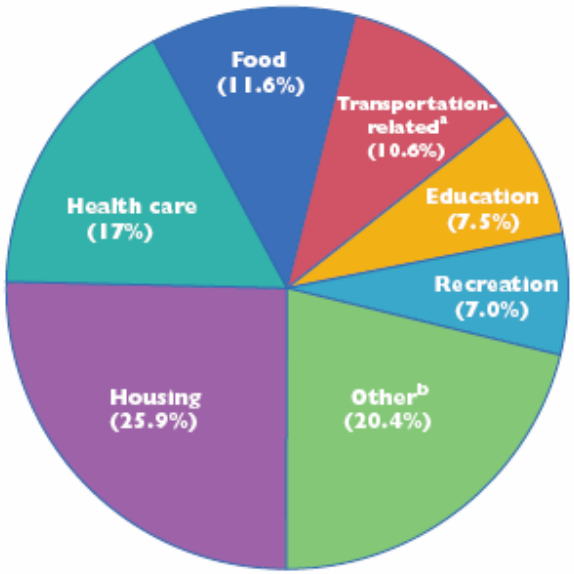
Elements of the Transportation Sector of the Economy: the players, the technologies

- Orf 467 Fall 2007 Syllabus (pdf)
- Transportation Defined
  - Transportation is an intermediate good
  - Transportation is the creation of **place** and **time utility** while incurring a **cost**.
  - Purchaser of transportation acquires a bundle of services
    place, time, comfort (l&d) , convenience (information)
    - utility of goods = f(1 / landed costs, time, …)
  - Place Utility: Lardner's Law: law of squares in transportation:
    - 1-Dimensional:
      - Let MarketArea (πR^2) be that area for which Fixed$ + Trans$ $\leq$ Demand$
      - Let Trans$ = C * D , C = Const(technology, management, policy), D = distance
      - Then R = (Demand$ -Fixed$)/C
      - So.. MarketArea = $(\pi$ (Demand$ -Fixed$)$^2)/C^2 = K/C^2$; where K = $(\pi$ (Demand$ -Fixed$)$^2)$, a const.
      - So… If, say, technology causes C_{new} = ½ Cold ,then $MarketArea_{new} = 4 * MarketArea_{old}$
  - Demand for transportation:
    - Elasticities: % change quantity / % change in attribute
    - Attributes: price, travel time, reliability, accessibility, security, l&d, information, comfort, etc

- "Modes" of transportation: Major Categorization, by what it carries, by function, by what is carrying (supporting) it
  - Carries:
    - People
    - Non-people (freight)
      - Regulation split this way
  - Function (purpose)
    - Intra-urban
    - Inter-urban
  - by "way" (the support of the transportation or other physical characteristic or function)
    - highway, airway, railway, waterway, pipeway,
    - intermodal
  - by "technologies"
    - bus, car, light rail, truck, LTL, TL, overnight, before 10:00 am, 2nd day, road-railer, PRT, AGT, dial-a-ride, jitney
- Externalities:
  - Environment, safety, independence, economy
- US Transportation Elements

Macro-economic Aspects of transportation

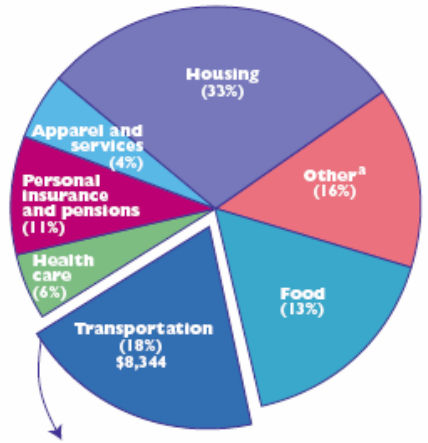
5-1
U.S. Gross Domestic Product by Major Societal Function: 2005



[a] Includes all consumer and government purchases of goods (e.g., vehicles and fuel) and services (e.g., auto insurance) and exports related to transportation. [b] Includes all other categories (e.g., entertainment, personal care products and services, and payments to pension plans).

Source: U.S. Department of Transportation, Bureau of Transportation Statistics, calculated from data in U.S. Department of Commerce, Bureau of Economic Analysis, *Survey of Current Business*, October 2006.

5-2
Average Household Expenditures by Major Spending Category: 2005
(Current dollars)



Private vehicle expenditures	=	$7,896
Vehicle purchases	=	$3,554
Gasoline and motor oil	=	$2,013
Other vehicle expenditures	=	$2,339
Public transportation expenditures	=	$448
Airline fares	=	$285
Mass transit fares	=	$52
Ship fares	=	$42
Taxi fares	=	$24
Intercity train fares	=	$19
Intercity bus fares	=	$12
Local transportation on out-of-town trips	=	$11
School bus	=	$3

[a] Includes entertainment, personal care products and services, education, tobacco products and smoking, and miscellaneous.

Note: Numbers do not add to totals due to rounding.

Source: U.S. Department of Labor, Bureau of Labor Statistics, Consumer Expenditure Survey, 2005; and personal communication, November 2006.

4 Mobility

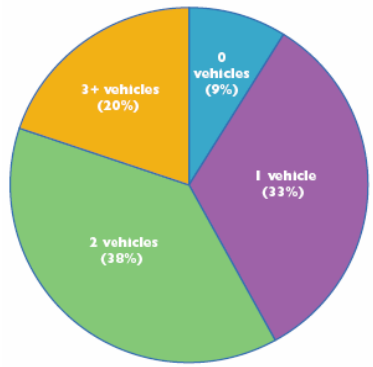
The U.S. transportation network makes possible a high degree of personal mobility and freight activity. The data in this section show growth in travel and freight shipments over time. Factors influencing this growth include, among others: vehicle availability, travel costs, population, congestion, the economy, and consumer income.

4-1
Passenger Travel and Freight Transportation Per Capita

	Number
Passenger travel (2001)	
Trips	
Daily trips per person	4.1
Daily trips per person per year[a]	1,483
Miles	
Daily miles per person	40
Daily miles per person per year[a]	14,524
Domestic freight transportation (2002)	
Tons per person, annually	R68
Ton-miles per person, annually	R15,311

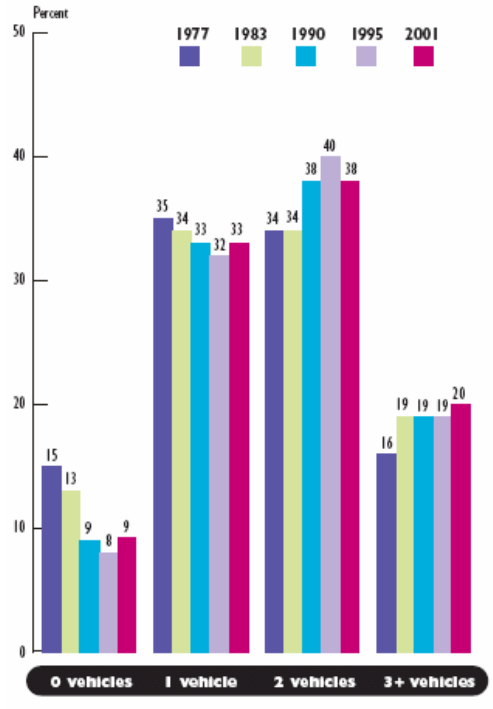
[a] Calculated on an annualized basis.

4-6
Households by Number of Vehicles: 2005



Note: Data covers the household population and excludes the population er group quarters.
s Bureau, American ww.census.gov/

Households by Number of Vehicles



Fatalities

2 Safety

The safety of the traveling public is of major concern for the U.S. Department of Transportation. Although progress has been made in reducing fatalities, roughly 43 percent of U.S. deaths due to unintentional injury involve transportation. Roughly 96 percent of transportation fatalities arise from motor vehicle crashes.

2-1
Transportation Fatalities by Mode

Mode	1980	1990	2000	2005
Air				
Large U.S. air carrier[a]	1	39	92	P22
Commuter air carrier[a]	37	6	5	P0
On-demand air taxi[a]	105	51	71	P18
General aviation[a]	1,239	770	596	P562
Highway[b]	51,091	44,599	41,945	43,443
Pipeline, gas and hazardous liquid	19	9	38	19
Railroad[c]	584	599	512	535
Transit[d]	N	339	295	183
Waterborne				
Commercial vessel				
Vessel related, commercial ship	206	85	53	U
Nonvessel-related[e], commercial ship	281	101	134	U
Recreational boating	1,360	865	701	697

[a] Includes people on planes and on the ground. [b] Includes motor vehicle occupants, nonoccupants, and fatalities at railroad crossings. [c] Includes fatalities from nontrain incidents as well as train incidents and accidents. Also includes train occupants and nonoccupants except motor vehicle occupants at grade crossings. [d] Fatalities resulting from all reportable incidents, not just accidents. Includes commuter rail, heavy rail, light rail, motorbus, demand response, van pool, and automated guideway. [e] Fatalities unrelated to vessel accidents, e.g., individual falling overboard and drowning.

Key: N = data are nonexistent or not cited because of reporting changes; P = preliminary.; U = unavailable.

Distribution of Transportation Fatalities: 2004

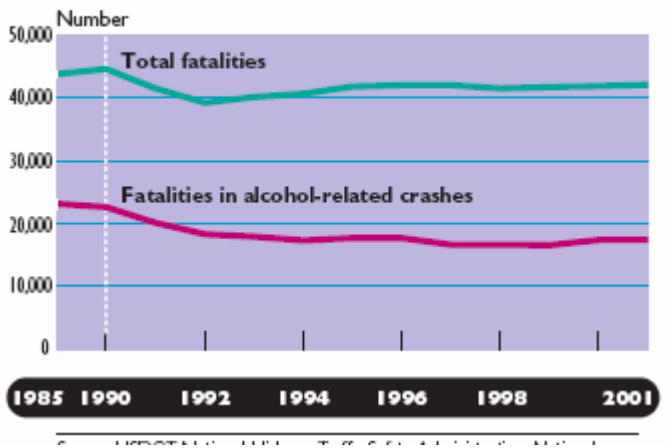
Category	Number	%
Passenger car occupants	19,091	42.6
Light-truck occupants	12,602	28.1
Pedestrians struck by motor vehicles	4,641	10.4
Motorcyclists	4,008	8.9
Large-truck occupants	761	1.7
Pedalcyclists struck by motor vehicles	725	1.6
Recreational boating	676	1.5
Other or unknown motor vehicle occupants	639	1.4
General aviation	558	1.2
Railroad trespassers (excl. grade crossings)[a]	482	1.1
Other nonoccupants struck by motor vehicles[b]	128	0.29
Grade crossings, not involving motor vehicles[a]	83	0.19
Air taxi	64	0.14
Heavy-rail transit (e.g., subway)	59	0.13
Waterborne transportation (nonvessel-related)	57	0.13
Bus occupants (school, intercity, transit)	41	0.09
Waterborne transportation (vessel-related)	36	0.08
Private grade crossings, with motor vehicles[a]	33	0.07
Rail employees on duty and contractors[a]	25	0.06
Light-rail transit	22	0.05
Rail-related, not otherwise specified[a]	20	0.04
Gas distribution pipelines	18	0.04
Transit buses, not accident-related	16	0.04
Air carriers	14	0.03
Hazardous liquid pipelines	5	0.01
Passengers on railroad trains	3	<0.01
Total, all modes	**44,807**	**100**
Other counts, redundant with above		
Large-truck occupants and nonoccupants		5,190
Public grade crossings, with motor vehicles[c]		252
Commuter rail[a,d]		86
Transit buses, accident-related[e]		61
Outside planes in crashes[f]		1

2-3
Fatalities by Number of Motor Vehicles in Crash and by Alcohol Involvement: 2005

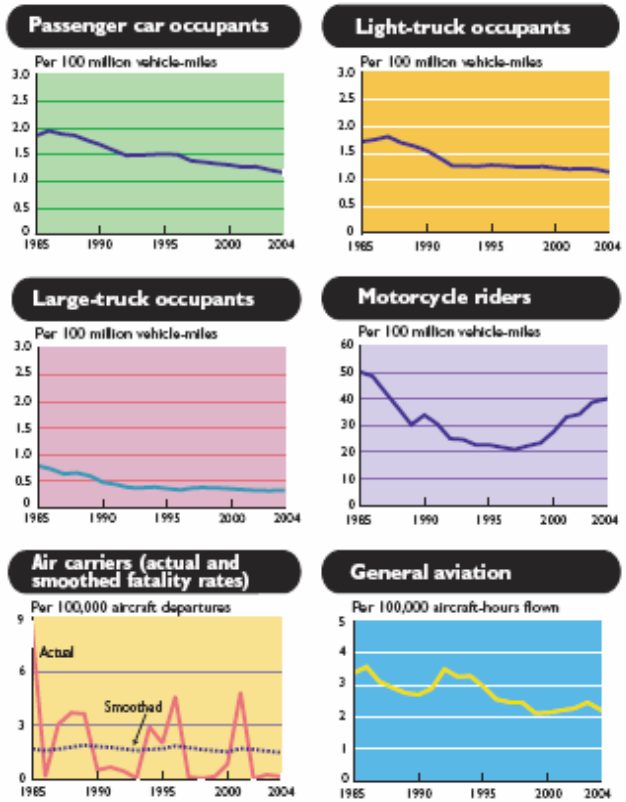
Crash category	Number of fatalities in category	Alcohol involvement[a]	Percent[b]
Occupants	37,594	14,370	38
Single-vehicle crashes	18,806	9,016	48
Two-vehicle crashes	15,649	4,449	28
More than two-vehicle crashes	3,139	905	29
Pedestrians	4,881	2,180	45
Single-vehicle crashes	4,443	1,946	44
Multiple-vehicle crashes	438	234	53
Pedalcyclists	784	281	36
Single-vehicle crashes	755	268	35
Multiple-vehicle crashes	29	14	48
Others/unknown	184	54	29
Total	43,443	16,885	39

[a] Fatalities in crash category that involve alcohol.

Figure 1
Fatalities in Alcohol-Related Motor Vehicle Crashes



2-4
Fatality Rates for Selected Modes



1-1
The Transportation Network: 2005

Mode	Components
Highway	**Public roads**
	46,873 miles of Interstate highway
	115,500 miles of other National Highway System roads
	3,849,259 miles of other roads
Air	***Public-use airports***
	5,270 airports
	Airports serving large certificated carriers
	26 large hub areas[a] (69 airports), 484 million enplaned passengers
	37 medium hub areas (60 airports), 141 million enplaned passengers
	66 small hub areas (82 airports), 53 million enplaned passengers
	930 nonhub areas (968 airports), 23 million enplaned passengers
Rail	***Miles of railroad operated***
	95,664 miles by Class I freight railroads in the United States[b]
	15,388 miles by regional freight railroads
	29,197 miles by local freight railroads
	23,000 miles by Amtrak (passenger)[c] (2004)
Urban transit (2004)	***Directional route-miles***[d]
	Bus: 165,854[e]
	Trolley bus: 425
	Commuter rail: 4,407
	Heavy rail: 1,596
	Light rail: 1,097
	Stations
	Commuter rail: 1,153
	Heavy rail: 1,023
	Light rail: 723
Water	***Navigable channels:*** *26,000 miles (2003)*
	Ferry routes[f]***:*** *623 directional route miles (2004)*
	Commercial waterway facilities[a] *(2004)*
	Great Lakes: 600 deep-draft
	154 shallow-draft
	Inland: 2,320 shallow-draft
	Ocean: 4,298 deep-draft
	1,761 shallow-draft
	Locks: 257
Pipeline	***Oil***
	Crude lines: 60,043 miles of pipe
	Product lines: 71,310 miles of pipe
	Gas (2004)
	Transmission: 298,900 miles of pipe
	Distribution: 1,139,800 miles of pipe

4-2
Number of Aircraft, Railcars, Vehicles, and Vessels

Mode	1980	1990	2000	2004
Air				
Air carrier	3,808	6,083	8,055	8,186
General aviation	211,045	198,000	217,533	219,426
Highway				
Automobiles	121,600,843	133,700,496	133,621,420	136,430,651
Other 2-axle, 4-tire vehicles[a]	27,875,934	48,274,555	79,084,979	91,845,327
Buses (municipally owned transit and commercial, federal, and school buses)	528,789	626,987	746,125	795,274
Motorcycles	5,693,940	4,259,462	4,346,068	5,780,870
Trucks				
Single-unit	4,373,784	4,486,981	5,926,030	6,161,028
Combination	1,416,869	1,708,895	2,096,619	2,010,335
Rail—Passenger				
Amtrak—Cars	2,128	1,863	1,894	1,211
Amtrak Locomotives	419	318	378	276
Commuter railcars and locomotives	4,500	5,007	5,498	P6,228
Transit[b]	10,654	11,332	12,168	P12,480
Rail—freight:				
Class I–Freight cars	1,168,114	658,902	560,154	473,773
Class I–Locomotives	28,094	18,835	20,028	22,015
Other freight cars	542,713	553,359	820,642	814,147
Waterborne				
Nonself-propelled vessels (barges)[c,d]	31,662	31,209	33,152	31,296
Self-propelled vessels[c,d]	7,126	8,236	8,202	8,994
Oceangoing ships[d] (1,000 gross tons and over)	864	636	454	412
Recreational boats (numbered boats)	8,577,857	10,996,253	12,782,143	12,781,476

[a] Includes vans, pickup trucks, sport utility vehicles, and other 2-axle, 4-tire motor vehicles that are not passenger cars. [b] Includes light and heavy rail only. [c] See Glossary for definitions. [d] U.S.-flag vessels.
Key: P = preliminary.

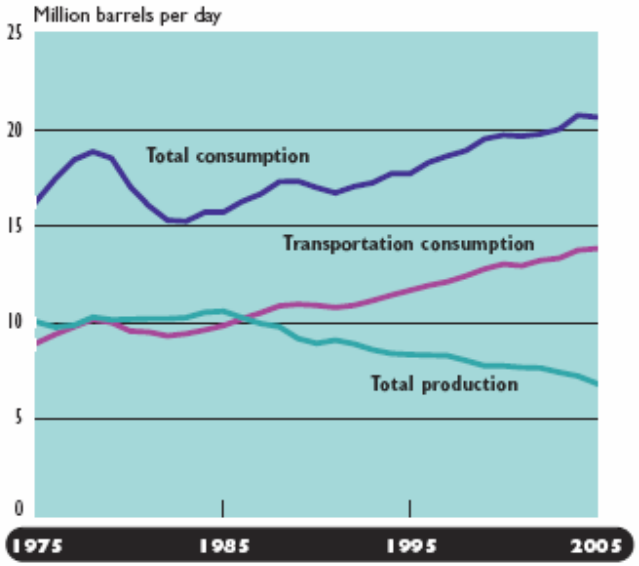
4-3
Vehicle-Miles
(Millions)

Mode	1970	1980	1990	2000	2004
Air					
Air carrier	2,068	2,523	3,963	5,664	6,552
General aviation	3,207	5,204	4,548	[a]N	[a]N
Highway					
Passenger cars	916,700	1,111,596	1,408,266	1,600,287	1,704,982
Other 2-axle, 4-tire vehicles[b]	123,286	290,935	574,571	923,059	1,014,342
Motorcycles	2,979	10,214	9,557	10,469	10,048
Buses[c]	4,544	6,059	5,726	7,590	6,637
Trucks:					
Single-unit	27,081	39,813	51,901	70,500	81,107
Combination	35,134	68,678	94,341	135,020	145,398
Rail[d]:					
Transit[e]	441	403	561	648	P710
Commuter	N	179	213	271	P295
Intercity/Amtrak[f]	690	235	301	368	308
Class I freight	29,890	29,277	26,159	34,590	37,071
Other transit[g]	N	15	324	833	P986

[a] The Federal Aviation Administration has estimated vehicle-miles for general aviation aircraft through 1997, relying in part on hours-flown survey data. Vehicle-miles estimates for subsequent years are not yet available.
[b] Includes vans, pickup trucks, sport utility vehicles, and other 2-axle, 4-tire motor vehicles that are not passenger cars.
[c] Includes municipally owned transit and commercial, federal, and school buses.
[d] Car-miles.
[e] Includes light and heavy rail only.
[f] Fiscal year data. Amtrak began operations in 1971.
[g] Includes demand response, ferryboat, and other transit not specified; 1980 data include "other transit" only.

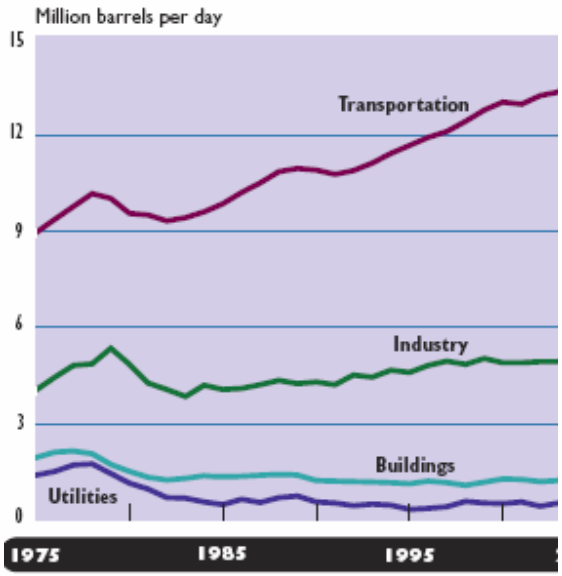
Petroleum Consumprion

3-3
U.S. Petroleum Production and Consumption: 1975–2005



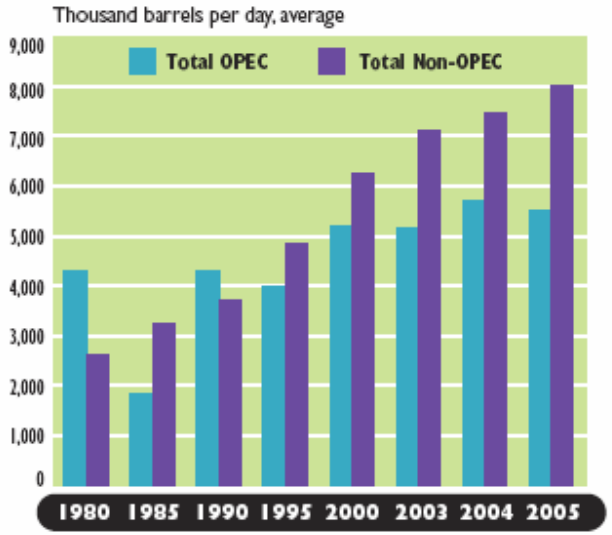
Note: 2005 data are preliminary.
Source: U.S. Department of Energy, Energy Information Administration, *Annual Energy Review 2005* (Washington, DC: July 2006), tables 5.1 and 5.13a-d.

3-4
Transportation's Share of U.S. Petroleum Use: 1975–2005

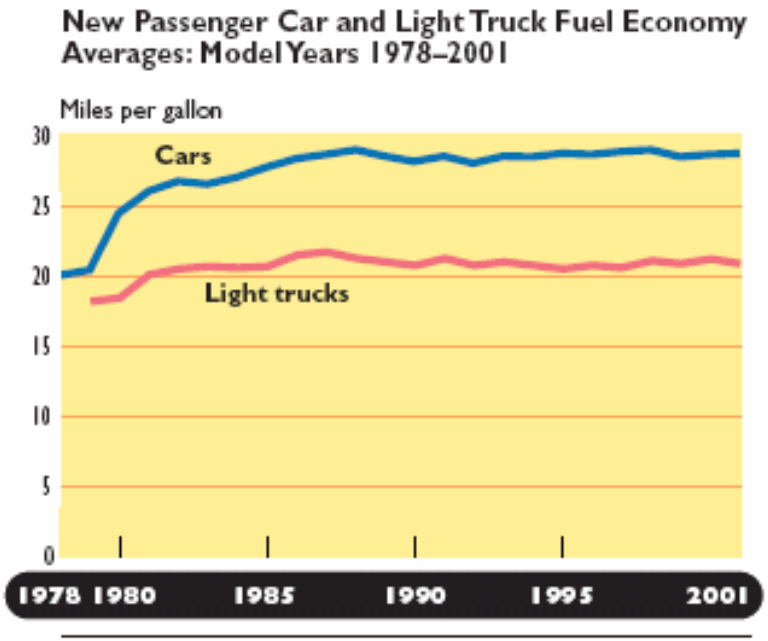


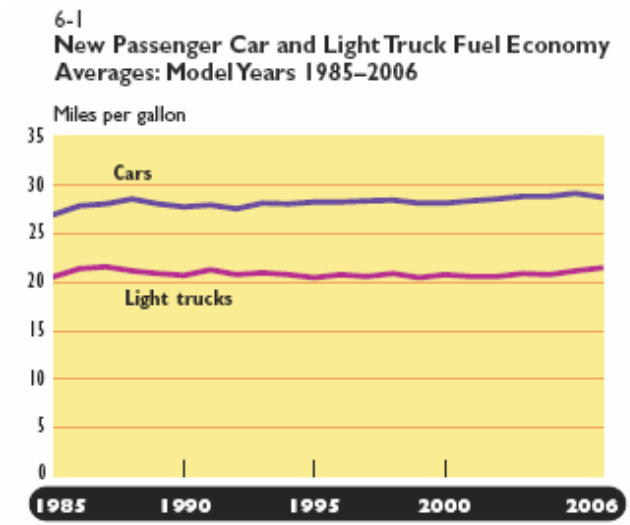
Note: 2005 data are preliminary.
Source: U.S. Department of Energy, Energy Information Administratio
Annual Energy Review 2005 (Washington, DC: July 2006), tables 5.13a-

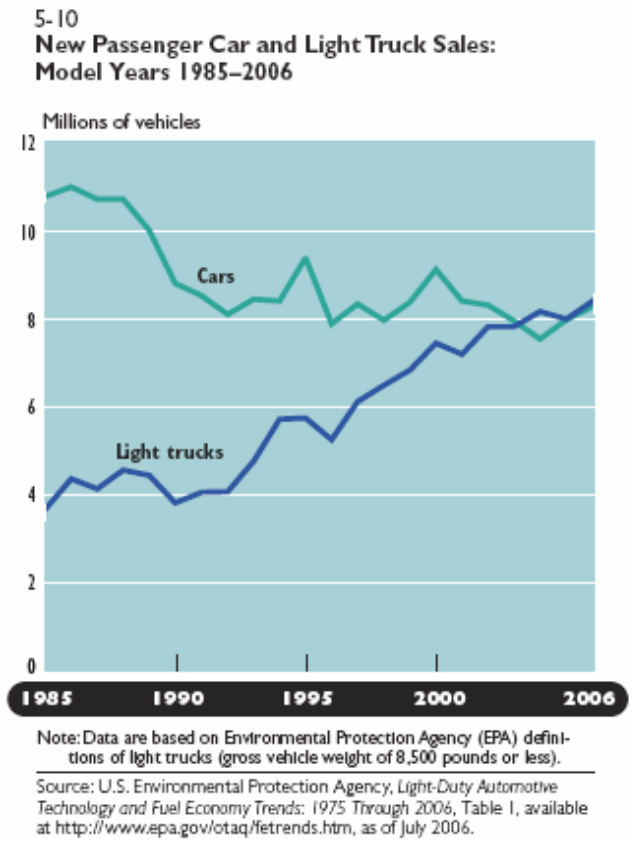
3-5
U.S. Oil Imports



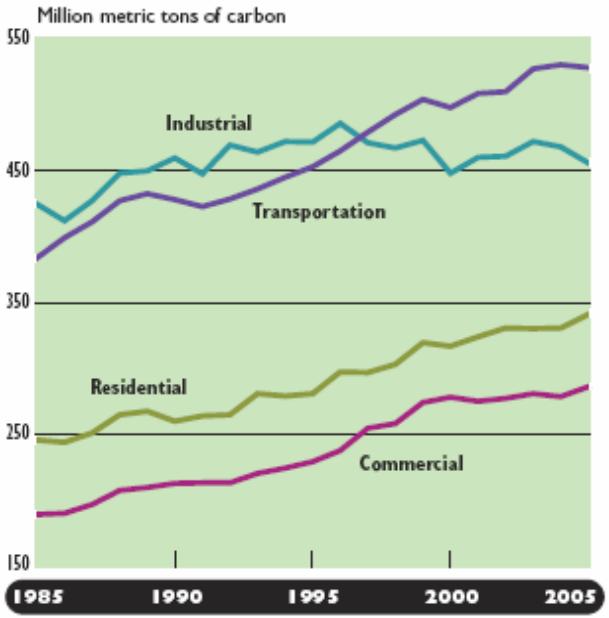
Notes: OPEC (Organization of Petroleum Exporting Countries) members are Algeria, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, the United Arab Emirates, and Venezuela. Former members Ecuador (until 1992) and Gabon (until 1994) are included in 1990 and prior years.


New Passenger Car and Light Truck Fuel Economy Averages: Model Years 1978–2001
Miles per gallon
30
25
20
15
10
5
0
Cars
Light trucks
1978 1980 1985 1990 1995 2001


6-1
New Passenger Car and Light Truck Fuel Economy Averages: Model Years 1985–2006
Miles per gallon
35
30
25
20
15
10
5
0
Cars
Light trucks
1985 1990 1995 2000 2006


5-10
New Passenger Car and Light Truck Sales: Model Years 1985–2006
Millions of vehicles
12
10
8
6
4
2
0
Cars
Light trucks
1985 1990 1995 2000 2006
Note: Data are based on Environmental Protection Agency (EPA) definitions of light trucks (gross vehicle weight of 8,500 pounds or less).
Source: U.S. Environmental Protection Agency, *Light-Duty Automotive Technology and Fuel Economy Trends: 1975 Through 2006*, Table 1, available at http://www.epa.gov/otaq/fetrends.htm, as of July 2006.

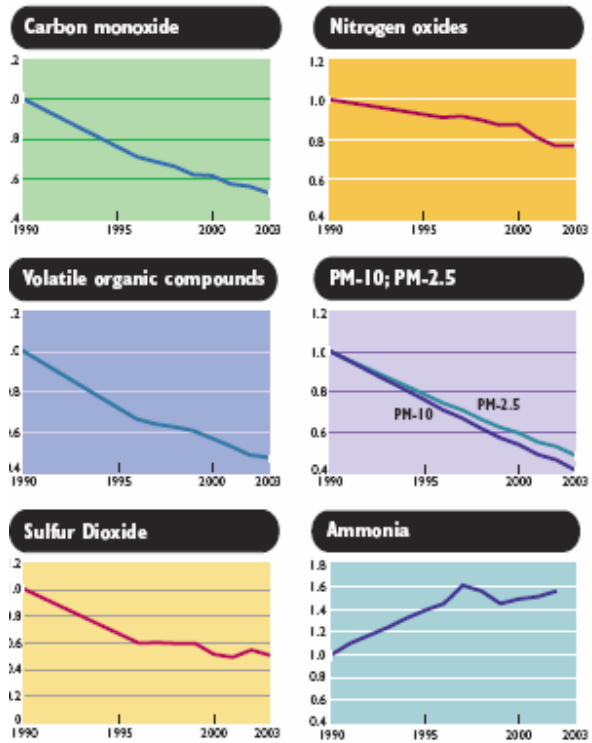
6-2
U.S. Carbon Dioxide Emissions from Energy Use: 1985–2005



Notes: 2005 data are preliminary.
One ton of carbon equals 3.667 tons of carbon dioxide gas. Electric utility emissions are distributed across sectors.

Sources: 1985–1989—U.S. Department of Energy (USDOE), Energy Information Administration (EIA), *Emissions of Greenhouse Gases in the United States*, Appendix E, available at http://www.eia.doe.gov, as of December 2005. 1990–2004—USDOE, EIA, U.S. Carbon Dioxide from Energy Sources 2005 Flash Estimate, available at http://www.eia.doe.gov/, as of June 2006.

6-4
Index of Key Air Pollutant Emissions from U.S. Transportation: 1990–2003
Index: 1990 = 1.0



Key: PM-10 and PM-2.5 = airborne particulates of less than 10 microns or 2.5 microns, respectively.

Government $$ in Transportation

Government Transportation Revenues by Mode and Level of Government
(Millions of current dollars)

	1980	1990	1995	1999	2000
Highway total	25,268	49,945	66,743	88,668	87,800
Federal:					
Highway Trust Fund—Highway Account[a]	7,647	13,453	19,377	33,823	30,347
State	16,287	32,644	42,415	48,784	P51,073
Local	1,334	3,848	4,952	6,061	P6,380
Transit total	2,397	7,193	9,352	13,186	12,674
Federal:					
Highway Trust Fund—Mass Transit Account	–	1,977	2,813	5,478	4,625
State	362	1,074	1,257	1,404	P1,524
Local	2,035	4,142	5,283	6,304	P6,525
Air total	4,100	10,119	13,954	21,079	21,627
Federal: Airport and Airway Trust Fund[b]	2,274	4,945	6,291	11,089	10,544
State	190	556	695	744	P852
Local	1,636	4,617	6,968	9,246	P10,231

Government Transportation Expenditures by Mode and Level of Government From Own Funds
(Millions of current dollars)

	1980	1990	1995	1999	2000
Highway total	34,553	62,563	79,309	95,494	103,838
Federal	11,706	15,452	20,078	23,589	27,657
State and local	22,847	47,112	59,232	71,905	P76,181
Transit total	8,949	19,261	26,162	29,027	31,827
Federal	3,307	3,832	4,474	4,265	5,337
State and local	5,642	15,429	21,688	24,762	P26,490
Rail total	2,497	541	1,043	565	781
Federal	2,474	534	1,034	546	755
State and local	23	7	9	19	P26
Air total	5,673	12,568	16,960	21,789	20,820
Federal	3,762	7,305	10,389	10,722	9,556
State and local	1,911	5,263	6,571	11,067	P11,264

Societal oversight on transportation.

- Government Involvement / Influence:
- ***Why***?
  - Transportation is an industry that impacts public interests; a "business affected with the public interest"
  - To create or replace the attributes of: *competition* and *free markets*
    - Transportation is a derived good
    - Products are justified only by the willingness of people to produce them and buy them
    - People are Utility maximizers (do things that make them better off)
    - Product should not be sold at price less than marginal cost of last unit.
  - Issues of Equity, Economies of Scale
  - Should it be nationalize?

- ***What?***
  - Maintain competition (Courts enforce anti-trust)
  - Substitute regulation for competition
  - Invest, assume ownership
  - Control extenalities
  - Regulation has involved: Regulation of entry and exit (Granting of charters); Pricing (filed rate doctrine), Employee relations, Operations, Safety
- ***How?***

- Controlled by the legal system based on Common law (judicial precedent; principles of law developed in from former court decisions) augmented by Statutory law enacted by legislative bodies.
  - Concept of "business affected with the public interest"
  - Concept of **common carriage**: serve all shippers on a similar basis, at reasonable rates and without discrimination.
- Who's involved:
  - Legislature, courts, administrative bodies
    - Started with states, moved to the federal Gov in 1887 with the ICC,
    - ICC was an administrative layer that provides continuity to regulation that the legislature and the judiciary don't provide. (Surface Transportation Board replaced ICC)
  - added "executive decisions" to legislative and judicial actions.

- **Evolution of Regulation:**
  - Granger laws: problem- high rates where competition didn't exist
  - Wabash case 1886: Supreme court ruled that states could not control rates on interstate commerce.
  - ICC 1887 regulate interstate commerce (RR): promulgate common carriage concepts
  - 1935 Motor Carrier Act:
    - Control of Entry
  - CAB Act 1938; purpose:
    - **promote** aviation by establishing and establishing an airport airways system
    - **safety** (regulate entry)
  - Transport Act 1940 national policy statement
    - Regulation of all modes of transportation
    - Need a unified perspective
  - Reed - Bulwinkle Act of 1948: Joint rate-making anti-trust protection.
  - 1956 ND & IH Act
  - 1966 Creation of Exec branch Department of Transportation
  - 3R, 4R, '78 Air Dereg. Act, Motor carrier Dereg. Act, Staggers,
  - 1994 Sunset of ICC, Transportation Board
- **Current Federal Laws:** U.S. Code
  - Title 23 Highways; Title 45 Railroads; Title 49 Transportation

Overview/Modes

The Transportation Network: 2001

Mode	Components
Highway	***Public roads***
	46,717 miles of Interstate highway
	114,700 miles of other National Highway System roads
	3,801,849 miles of other roads
Air	***Public-use airports***
	5,315 airports
	Airports serving large certificated carriers
	29 large hub areas (72 airports), 445 million enplaned passengers (see Glossary for "hub" definition)
	31 medium hub areas (52 airports), 95 million enplaned passengers
	55 small hub areas (72 airports), 36 million enplaned passengers
	598 nonhub areas (622 airports), 16 million enplaned passengers
Rail	***Miles of railroad operated***[a]
	97,631 miles by Class I freight railroads in the United States[b]
	17,439 miles by regional freight railroads
	27,563 miles by local freight railroads
	22,741 miles by Amtrak (passenger) (2000)
Urban transit	***Directional route-miles***[c]
	Bus: 160,506 (2000)
	Trolley bus: 471
	Commuter rail: 5,209
	Heavy rail: 1,572
	Light rail: 892
	Stations
	Commuter rail: 1,155
	Heavy rail: 1,019
	Light rail: 628
Water *(2000)*	26,000 miles of navigable waterways
	Ferry routes: 487
	Commercial waterway facilities[d]
	Great Lakes: 611 deep-draft
	143 shallow-draft
	Inland: 2,367 shallow-draft
	Ocean: 4,079 deep-draft
	2,109 shallow-draft
	Locks: 276
Pipeline	***Oil***
	Crude lines: 76,658 miles of pipe
	Product lines: 87,123 miles of pipe
	Gas (2000)
	Transmission: 250,000 miles of pipe
	Distribution: 1,110,000 miles of pipe