VEHICLE SOURCE BOOK

A Resource for

MILLENNIUM'S END

and all other Contemporary Roleplaying Games

by
Jakko Westerbeke

CHAMELEON ECLECTIC

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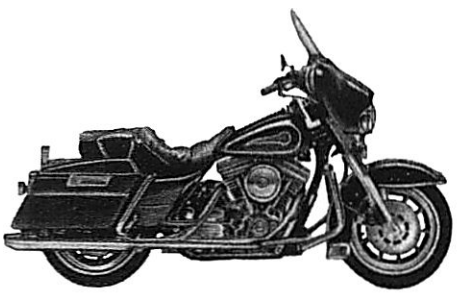

A Resource for *Millennium's End* and All Other Contemporary Roleplaying Games

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A Resource for *Millennium's End* and All Other Contemporary Roleplaying Games

Written by Jakko Westerbeke

To my parents, for their help and support, and to Zach Bush for some advice I really should have followed.

Edited by Michael J. Anderson, with additional editing by Charles Ryan

Illustrated by Rich Burlew, Ronald Chironna, Michael Connelly, Darryl Elliot, Robert Mansperger, Curt Shoultz, and George Vasilakos. Cover by Charles Ryan. No photographs appear in this book.

Art Coordination by Michael J. Anderson

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INTRODUCTION

Vehicles, just like firearms, are commonly used in role playing games, not to mention in popular fiction—nearly every action or detective movie involves a car chase at some point, and in roleplaying adventures the same element is often used to create tension and build action. Choosing a favorite vehicle for your character is also an excellent way to add a touch of realism to your game—after all, we use vehicles almost every single day of our lives.

Although the *Millennium's End* rulebook and *GM Screen & 1999 Datasource* include game statistics for a fairly large number of common vehicles, the information doesn't go into a lot of detail. This book fills that void, and presents players and GMs alike with a comprehensive guide to the most interesting and common vehicles available in 1999. The selection of vehicles ranges from motorcycles and jetskis to military helicopters and fighter planes.

A vehicle enthusiast could find this information on his or her own by doing a lot of research; however a large portion of the information to be found is bogged down with highly-detailed technical jargon. This book is not written for the mechanical expert, but rather is intended for the average roleplayer. The information you'll find here was selected to help you best utilize vehicles in your roleplaying game.

The vehicles covered in this book have been chosen to be a fair representation of what's available, both to civilians and to the military. Because our space is limited, and we've had to leave out many vehicles, we chose to keep those that player characters are most likely to encounter and use. Although the focus of this book centers on North America, most of the vehicles listed here can be encountered in other parts of the world as well.

Using This Book

The ten main chapters of this book cover a variety of vehicles, both civilian and military. In each chapter, a brief introduction discuses the history, basic mechanics, and quirks of the types of vehicles covered in that chapter. This information was chosen to help GMs and players make their games more interesting, and their vehicles more real. The rest of each chapter consists of a listing of and a brief discussion on each specific vehicle, including real life statistics such as top speed, engine size, weight, and carrying capacity. These short but fairly detailed descriptions of vehicles common in the mid- to late- 1990s focus mainly on the features that are important to the vehicle's users.

Although the statistics listed in the back of this book are for *Millennium's End*, the majority of this book is not specific to any game system. Instead, the information provided can be incorporated into any game that is set in the modern day, or in the near future.

Directly after this introduction follows the Features Index. This is a set of tables listing all the vehicles described in this book, indicating which features are present on which vehicle—allowing players to easily select a vehicle that suits their needs without having to read every vehicle's full description first. A vehicle that is good in a specific area is checked (✔) under the appropriate column. Those vehicles that are exceptional in a specific category have a cross (✚) listed under the appropriate column. The prices listed are based upon real-world data at the time of publication; For the *Millennium's End* world, multiply these prices by 2.5

The "Layout" column shows two numbers, the first is the number of wheels the vehicle has and the second is the number of wheels that are powered—a "4x2" car, for example, has 4 wheels, but only two of them are used to power the vehicle's movement.

The "Fuel" column indicates the type of fuel that the vehicle requires—usually gasoline or diesel fuel.

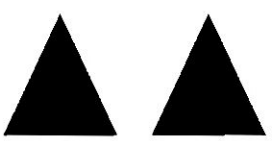
The "Transmission" column contains an "a" if the vehicle is available with an automatic transmission and an "m" if the vehicle is available with a manual transmission—the "m" will be followed by the number of gears the transmission has.

The number listed in the "Seating" column is the maximum number of passengers the vehicle can hold.

The "Land/TO" column will be marked with a V, S, St, or L. The letter on the right of the slash indicated the aircraft's landing capabilities. A "V" means that the craft is capable of Vertical Takeoff or Landing. An "S" indicates that the aircraft requires a short runway to take off or land. Aircraft marked with an "L" require a long runway to takeoff or land.

After selecting a vehicle that looks like it might suit your needs, you'll find a page reference that will send you directly to an entry that provides a more in-depth discussion.

The technical details of features found on vehicles have, for the most part, been left out. A basic discussion on technology has been included in this book, however, in order to provide the reader with some insight into how things work on a basic level. This knowledge is useful when deciding what features you're looking for in a vehicle, and how its real life statistics impact its performance within a roleplaying game.



Features Index

Civilian Automobiles

	Size	Layout	Fuel	Transmission	High speed	Economy	Seating	Safety	Luxury	Convertible	ABS	Common	Price	Page
BMW 318i	md	4x2	gas	a/m5	✔	✔	4	✔			✔		$26,500	22
BMW 320i	md	4x2	gas	a/m5	✔	✔	4	✔			✔		$33,000	22
BMW 323i	md	4x2	gas	a/m5	✔	✔	4	✔			✔		$35,500	22
BMW 325td	md	4x2	diesel	a/m5	✔	✔	4	✔			✔		$31,000	22
BMW 328i	md	4x2	gas	a/m5	✔	✔	4	✔			✔		$33,500	22
BMW 520i	lg	4x2	gas	a/m5	✔	✔	4	✔	✔		✔		$31,500	23
BMW 523i	lg	4x2	gas	a/m5	✔	✔	4	✙	✔		✔		$34,000	23
BMW 525tds	lg	4x2	diesel	a/m5	✔	✔	4	✙	✔		✔		$33,500	23
BMW 528i	lg	4x2	gas	a/m5	✔	✔	4	✙	✔		✔		$38,500	23
BMW 535i	lg	4x2	gas	a/m5	✙	✔	4	✙	✔		✔		$43,500	23
BMW 540i	lg	4x2	gas	a/m5	✙	✔	4	✙	✔		✔		$50,500	23
BMW 725tds	lg	4x2	diesel	a/m5	✔	✔	4	✙	✔		✔		$44,000	23
BMW 728i	lg	4x2	gas	a/m5	✔	✔	4	✙	✔		✔		$46,000	23
BMW 735i	lg	4x2	gas	a/m5	✔	✔	4	✙	✔		✔		$52,500	23
BMW 740i	lg	4x2	gas	a/m5	✙		4	✙	✔		✔		$61,000	23
BMW 750i	lg	4x2	gas	a	✙		4	✙	✔		✔		$94,000	23
BMW 840Ci	md	4x2	gas	m6	✙		4	✔	✔		✔		$76,000	24
BMW 850Ci	md	4x2	gas	a/m6	✙		4	✔	✔		✔		$95,000	24
BMW 850CSi	md	4x2	gas	m6	✙		4	✔	✔		✔		$100,000	24
BMW M3	md	4x2	gas	a/m6	✙	✔	4	✔	✔		✔		$40,000	22
Chevrolet Beretta 2.2L, 3.1L	md	4x2	gas	a/m5		✔	4	✔			✔	✔	$14,000	24
Chevrolet Beretta Z26	md	4x2	gas	m5		✔	4	✔			✔	✔	$17,000	24
Chevrolet Corsica et al	md	4x2	gas	a/m5		✔	4	✔			✔	✔	$15,000	25
Chevrolet Corvette	lg	4x2	gas	a/m6	✔		2	✔	✔		✔	✔	$38,000	26
Chrysler Cirrus LX	md	4x2	gas	m5	✔		4	✔	✔		✔	✔	$18,500	26
Chrysler Concorde LX	lg	4x2	gas	a	✔		4	✔	✔		✔	✔	$21,000	26
Chrysler Voyager et al	lg	4x2	gas	a/m5			7	✙	✔		✔	✔	$13,000	26
Ferrari F355	md	4x2	gas	m6	✙		2				✔		$100,000	26
Ford Escort Sedan	sm	4x2	gas	a/m5		✔	4	✔				✔	$11,500	28
Ford Escort LX Sedan	sm	4x2	gas	a/m5		✔	4	✔				✔	$12,000	28
Ford Escort LX Wagon	sm	4x2	gas	a/m5		✔	4	✔				✔	$13,000	28
Ford Probe	md	4x2	gas	m5	✔		4	✔			✔	✔	$14,500	28
Ford Probe GT	md	4x2	gas	m5	✔		4	✔	✔		✔	✔	$17,000	28
Ford Taurus G Sedan	lg	4x2	gas	a			4	✔	✔		✔	✔	$18,500	29
Ford Taurus GL Sedan	lg	4x2	gas	a			4	✔	✔		✔	✔	$19,500	29
Ford Taurus GL Wagon	lg	4x2	gas	a			4	✔	✔		✔	✔	$21,000	29
Ford Taurus LX Sedan	lg	4x2	gas	a			4	✔	✔		✔	✔	$22,000	29
Ford Taurus LX Wagon	lg	4x2	gas	a			4	✔	✔		✔	✔	$23,000	29
Ford Taurus SHO Sedan	lg	4x2	gas	a	✔		4	✔	✔		✔	✔	$27,000	29
Honda Accord DX	md	4x2	gas	a/m5	✔	✔	4	✔			✔	✔	$15,500	29
Honda Accord LX Coupe	md	4x2	gas	a/m5	✔	✔	4	✔			✔	✔	$18,500	29
Honda Accord LX Sedan	md	4x2	gas	a/m5	✔	✔	4	✔			✔	✔	$18,500	29

Features Index

Civilian Automobiles (cont.)

	Size	Layout	Fuel	Transmission	High speed	Economy	Seating	Safety	Luxury	Convertible	ABS	Common	Price	Page
Honda Accord LX Wagon	md	4x2	gas	a/m5	✔	✔	4	✔			✔	✔	$19,500	29
Honda Accord EX Coupe	md	4x2	gas	a/m5	✔	✔	4	✔			✔		$21,000	29
Honda Accord EX Sedan	md	4x2	gas	a/m5	✔	✔	4	✔			✔		$22,000	29
Honda Accord EX Wagon	md	4x2	gas	a/m5	✔	✔	4	✔			✔		$23,000	29
Honda Civic CX Hatchback	md	4x2	gas	a/m5		✔	4	✔				✔	$11,000	30
Honda Civic DX Coupe	md	4x2	gas	a/m5		✔	4	✔				✔	$12,500	30
Honda Civic DX Hatchback	md	4x2	gas	a/m5		✔	4	✔				✔	$12,000	30
Honda Civic DX Sedan	md	4x2	gas	a/m5		✔	4	✔				✔	$13,000	30
Honda Civic EX Coupe	md	4x2	gas	a/m5		✔	4	✔			✔	✔	$15,500	30
Honda Civic EX Sedan	md	4x2	gas	a/m5		✔	4	✔				✔	$17,000	30
Honda Civic HX Coupe	md	4x2	gas	a/m5		✔	4	✔				✔	$14,000	30
Honda Civic HX Coupe CVT	md	4x2	gas	a		✔	4	✔					$15,000	30
Honda Civic LX Sedan	md	4x2	gas	a/m5		✔	4	✔				✔	$15,000	30
Jaguar XJ6	lg	4x2	gas	a/m5	✔		4		+		✔		$55,000	31
Jaguar XJ6 LWB	lg	4x2	gas	a/m5	✔		4		+		✔		$60,000	31
Jaguar XJR	lg	4x2	gas	a/m5	+		4		+		✔		$68,000	31
Jaguar XJ12	lg	4x2	gas	a	+		4		+		✔		$80,000	31
Lamborghini Diablo	md	4x2	gas	m5	+		2		✔				$140,000	32
Lamborghini Diablo VT	md	4x4	gas	m5	+		2		✔				$175,000	32
Lamborghini Diablo Roadster	md	4x4	gas	m5	+		2		✔		✔		$178,000	32
Lamborghini Diablo SV/SVR	md	4x2	gas	m5	+		2		✔				$185,000	32
Lincoln Continental	lg	4x2	gas	a			5	✔	✔		✔		$38,000	34
Lincoln Mark VIII	lg	4x2	gas	a			5	✔	+		✔		$38,000	34
Mazda 626 DX	md	4x2	gas	a/m5	✔	✔	4	✔					$16,000	35
Mazda 626 LX	md	4x2	gas	a/m5	✔	✔	4	✔			✔	✔	$19,000	35
Mazda 626 LX V6	md	4x2	gas	a/m5	✔	✔	4	✔			✔	✔	$21,000	35
Mazda 626 ES	md	4x2	gas	a/m5	✔	✔	4	✔			✔		$24,500	35
Mazda MX-5 Miata	sm	4x2	gas	m5	✔	✔	2			✔			$19,500	36
Mercedes-Benz C180	md	4x2	gas	a/m5		✔	4	✔			✔	✔	$23,500	36
Mercedes-Benz C200	md	4x2	gas	a/m5	✔	✔	4	✔			✔	✔	$27,500	36
Mercedes-Benz C220	md	4x2	gas	a/m5	✔	✔	4	✔			✔	✔	$30,500	36
Mercedes-Benz C220 Diesel	md	4x2	diesel	a/m5		✔	4	✔			✔		$27,500	36
Mercedes-Benz C230	md	4x2	gas	a/m5	✔	✔	4	✔			✔	✔	$31,000	36
Mercedes-Benz C250 TD	md	4x2	diesel	a/m5	✔	✔	4	✔			✔		$34,000	36
Mercedes-Benz C280	md	4x2	gas	a/m5	✔	✔	4	✔			✔		$36,000	36
Mercedes-Benz E200	md	4x2	gas	a/m5	✔	✔	4	✔	✔		✔		$30,500	37
Mercedes-Benz E220 Diesel	md	4x2	diesel	a/m5	✔	✔	4	✔	✔		✔		$30,500	37
Mercedes-Benz E230	md	4x2	gas	a/m5	✔	✔	4	✔	✔		✔		$33,500	37
Mercedes-Benz E280	md	4x2	gas	a/m5	✔		4	✔	✔		✔		$39,000	37
Mercedes-Benz E290 TD	md	4x2	diesel	m5	✔	+	4	✔	✔		✔		$34,500	37
Mercedes-Benz E320	md	4x2	gas	a	✔		4	✔	✔		✔		$45,500	37
Mercedes Benz E420	md	4x2	gas	a	✔		4	✔	✔		✔		$50,500	37

Civilian Automobiles (cont.)

	Size	Layout	Fuel	Transmission	High speed	Economy	Seating	Safety	Luxury	Convertible	ABS	Common	price	Page
Mercedes-Benz SLK	sm	4x2	gas	a/m5	✔	✔	2			✔	✔		$30,500	38
Mercury Sable G/GS Sedan	lg	4x2	gas	a			4	✔	✔				$19,000	38
Mercury Sable GS Wagon	lg	4x2	gas	a			4	✔	✔		✔		$20,000	38
Mercury Sable LS Sedan/Wagon	lg	4x2	gas	a			4	✔	✔		✔		$22,500	38
Nissan 200SX	md	4x2	gas	a/m5	✔	✔	4	✔				✔	$13,500	39
Nissan 200SX SE	md	4x2	gas	a/m5	✔	✔	4	✔			✔	✔	$16,000	39
Nissan 200SX SE-R	md	4x2	gas	a/m5	✔	✔	4	✔			✔		$17,000	39
Nissan Altima XE	md	4x2	gas	a/m5		✔	4	✔			✔	✔	$16,000	39
Nissan Altima GXE	md	4x2	gas	a/m5		✔	4	✔			✔	✔	$18,000	39
Nissan Altima SE	md	4x2	gas	a/m5		✔	4	✔	✔		✔		$20,000	39
Nissan Altima GLE	md	4x2	gas	a		✔	4	✔	✔		✔		$21,500	39
Pontiac Firebird	md	4x2	gas	a/m5	✔	✔	4	✔	✔	✔	✔		$17,000	40
Pontiac Firebird Trans Am	lg	4x2	gas	a/m	✔		4	✔	✔	✔	✔		$23,000	40
Porsche 911 Carrera 4 Cabriolet	md	4x4	gas	m6	✢		2	✔		✔	✔		$79,000	41
Porsche 911 Carrera 4 Coupe	md	4x4	gas	m6	✢		2	✔			✔		$70,000	41
Porsche 911 Carrera Cabriolet	md	4x2	gas	m6	✢		2	✔		✔	✔		$70,000	41
Porsche 911 Carrera Cabriolet	md	4x2	gas	a	✢		2	✔		✔	✔		$78,000	41
Porsche 911 Carrera Coupe	md	4x2	gas	m6	✢		2	✔			✔		$64,500	41
Porsche 911 Carrera Coupe	md	4x2	gas	a	✢		2	✔			✔		$68,500	41
Porsche 911 Turbo Coupe	md	4x4	gas	m6	✢		2	✔			✔		$106,000	41
Porsche Boxster	sm	4x2	gas	a/m5	✔	✔	2	✔		✔	✔		$35,000	41
Rolls-Royce Silver Spirit et al	lg	4x2	gas	a	✔		4	✔	✢		✔		$200,000	42
Saab 900 3-Door	lg	4x2	gas	a/m5	✔	✔	4	✔	✔				$21,000	43
Saab 900 5-Door	lg	4x2	gas	a/m5	✔	✔	4	✔	✔				$22,000	43
Saab 900 Convertible	lg	4x2	gas	a/m5	✔	✔	4	✔	✔				$30,500	43
Saab 900 S 3-Door	lg	4x2	gas	a/m5	✔	✔	4	✔	✔				$25,500	43
Saab 900 S 5-Door	lg	4x2	gas	a/m5	✔	✔	4	✔	✔				$26,500	43
Saab 900 S Convertible	lg	4x2	gas	a/m5	✔	✔	4	✔	✔				$35,500	43
Saab 900 SE Turbo 3-Door	lg	4x2	gas	a/m5	✔	✔	4	✔	✔				$30,500	43
Saab 900 SE Turbo 5-Door	lg	4x2	gas	a/m5	✔	✔	4	✔	✔				$31,500	43
Saab 900 SE Turbo Convertible	lg	4x2	gas	a/m5	✔	✔	4	✔	✔				$41,500	43
Saab 900 SE V6 3-Door	lg	4x2	gas	a/m5	✔	✔	4	✔	✔				$32,500	43
Saab 900 SE V6 5-Door	lg	4x2	gas	a/m5	✔	✔	4	✔	✔				$33,000	43
Saab 900 SE V6 Convertible	lg	4x2	gas	a/m5	✔	✔	4	✔	✔				$43,000	43
Saab 9000 CS Hatchback	lg	4x2	gas	a/m5	✔	✔	4	✔	✔				$32,000	43
Saab 9000 CSE T Hatchback	lg	4x2	gas	a/m5	✔	✔	4	✔	✔				$38,500	43
Saab 9000 CSE V6 Hatchback	lg	4x2	gas	a/m5	✔	✔	4	✔	✔				$41,000	43
Saab 9000 Aero Hatchback	lg	4x2	gas	a/m5	✔	✔	4	✔	✔				$42,000	43
Toyota Camry CE	lg	4x2	gas	a/m5			5	✔	✔		✔	✔	$17,000	44
Toyota Camry CE V6	lg	4x2	gas	a/m5	✔		5	✔	✔		✔	✔	$19,500	44
Toyota Camry LE	lg	4x2	gas	a			5	✔	✔		✔	✔	$20,500	44
Toyota Camry LE V6	lg	4x2	gas	a	✔		5	✔	✔		✔	✔	$22,500	44

Features Index

Civilian Automobiles (cont.)

	Size	Layout	Fuel	Transmission	High speed	Economy	Seating	Safety	Luxury	Convertible	ABS	Common	Price	Page
Toyota Camry XLE	lg	4x2	gas	a			5	✔	✔		✔	✔	$22,500	44
Toyota Camry XLE V6	lg	4x2	gas	a	✔		5	✔	✔		✔	✔	$24,500	44
Toyota Celica GT Liftback	md	4x2	gas	a/m5	✔		4	✔			✔		$20,500	45
Toyota Celica GT Convertible	md	4x2	gas	a/m5	✔		4	✔		✔	✔		$25,000	45
Toyota Celica ST Coupe	md	4x2	gas	a/m5	✔		4	✔			✔		$17,500	45
Toyota Celica ST Liftback	md	4x2	gas	a/m5	✔		4	✔			✔		$18,000	45
Toyota Paseo	md	4x2	gas	a/m5		✔	4	✔			✔		$13,500	45
Toyota Paseo Convertible	md	4x2	gas	a/m5		✔	4	✔		✔	✔		$17,000	45

Civilian Off-Road Vehicles

	Size	Layout	Fuel	Transmission	High speed	Economy	Seating	Safety	Luxury	Convertible	ABS	Common	Price	Page
AM General Hummer	lg	4x4	diesel	a			4	✔		✔			$45,000	22
Chevrolet Blazer	lg	4x4	gas	a/m5			4	✔	✔		✔		$28,000	25
Jeep Cherokee LE	lg	4x4	gas	a/m5			5	✔			✔	✔	$28,000	31
Jeep Cherokee SE	lg	4x4	gas	a/m5			5	✔			✔	✔	$17,500	31
Jeep Cherokee Sport	lg	4x4	gas	m5			5	✔			✔		$20,000	31
Jeep Cherokee TD Sport	lg	4x4	diesel	m5			5	✔			✔		$20,000	31
Jeep Wrangler	md	4x4	gas	a/m5			4	✔		✔		✔	$18,000	32
Land Rover Defender 110 County	lg	4x4	diesel	m5			5					✔	$34,500	33
Land Rover Discovery 300	lg	4x4	diesel	a/m5			7		✔				$28,000	34
Land Rover Discovery V8	lg	4x4	gas	a/m5			7		✔				$28,000	34
Mercedes-Benz G230 3-door	sm	4x4	gas	a/m5			4			✔			$44,000	37
Mercedes-Benz G230 5-door	md	4x4	gas	a/m5			4						$50,000	37
Mercedes-Benz G300 3-door	sm	4x4	gas	a/m5			4			✔			$45,000	37
Mercedes-Benz G300 5-door	md	4x4	gas	a/m5			4						$55,000	37
Mercedes-Benz G300TD 3-door	sm	4x4	diesel	a			4	✔		✔			$47,500	37
Mercedes-Benz G300TD 5-door	md	4x4	diesel	a			4	✔					$53,000	37
Mercedes-Benz G320 3-door	sm	4x4	gas	a			4	✔		✔			$49,000	37
Mercedes-Benz G320 5-door	md	4x4	gas	a			4	✔					$57,500	37
Nissan Patrol GR	md	4x4	diesel	m5			5		✔			✔	$35,000	40
Nissan Patrol GR Wagon	md	4x4	diesel	m5			7		✔				$39,000	40

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Civilian Motorcycles

	size	fuel	transmission	high speed	off-road	economy	seating	luxury	ABS	Common	price	Page
BMW R 1100 RS	md	gas	m5				2	✔			$15,000	51
BMW R 1100 RT	md	gas	m5				2	✔	✔		$16,000	51
Ducati M 600	md	gas	m5			✔	2				$6,500	51
Ducati 600 SS Caraneta et al	md	gas	m5			✔	2				$7,000	51
H-D FLHR Road King	md	gas	m5			✔	2				$14,500	52
H-D FLHT Electra Glide	md	gas	m5			✔	2			✔	$12,500	52
H-D FLHTC Electra Glide Classic	md	gas	m5			✔	2	✔			$15,000	52
H-D FLHTCU EG Ultra Classic	md	gas	m5			✔	2	✔			$16,500	52
H-D FXD Dyna Super Glide	md	gas	m5			✔	2			✔	$10,500	52
H-D FXDS Dyna Convertible	md	gas	m5			✔	2				$13,500	52
H-D FXDWG Dyna Wide Glide	md	gas	m5			✔	2				$14,000	52
H-D FXDL Dyna Low Rider	md	gas	m5			✔	2				$13,500	52
Honda CB 500	md	gas	m6			✔	2				$5,000	53
Honda CBR 1100 XX	md	gas	m6	✚			2			✔	$11,000	53
Honda GL 1500 SE Gold Wing	md	gas	m5	✔			2	✚			$18,500	54
Honda ST 1100 Pan European	md	gas	m5	✔			2	✔	✔		$14,500	55
Honda XR 600 R	md	gas	m5		✔	✔	2			✔	$5,000	55
Kawasaki Eliminator 600	md	gas	m6				2			✔	$6,000	56
Kawasaki GPZ 1100	md	gas	m6	✚			2		✔		$9,000	56
Kawasaki KLX 650 R	md	gas	m5		✔	✔	2			✔	$5,000	57
Suzuki RF 900 R	md	gas	m5	✚			2				$9,000	57
Suzuki VS 600 GLS Intruder	md	gas	m5			✔	2			✔	$6,000	57
Suzuki VS 800 GL Intruder	md	gas	m5			✔	2			✔	$7,000	57
Suzuki VS 1400 GLP Intruder	md	gas	m5				2				$9,500	57
Vespa Sfera 125	sm	gas	auto			✚	2				$2,500	58
Vespa Skipper 125	sm	gas	auto			✚	2				$2,000	58
Yamaha XJ 600 S Diversion	md	gas	m5	✔		✔	2				$5,000	58
Yamaha XJ 900 Diversion	md	gas	m5			✔	2				$7,500	58
Yamaha XV 125	sm	gas	m5			✚	2				$2,500	59
Yamaha XV 750	md	gas	m5			✔	2				$6,000	59
Yamaha XV 1100	md	gas	m5			✔	2				$7,000	59

Civilian Airplanes

	Size	Type	Land/TO speed	High speed	Long range	Long flight time	Seating	Safety	Common	Price	Page
ABC A-60 Plus Lightship	v.lg	blimp	V/V		✚	✚	5			$6,000,000	66
Air Tractor AT-300 et al	lg	prop	S/S				1			$200,000	66
Boeing 737-600	v.lg	jet	L/L		✔	✔	±135	✔	✔	$33,000,000	67
Boeing 737-700	v.lg	jet	L/L		✔	✔	±150	✔	✔	$33,000,000	67

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Civilian Airplanes (cont.)

	Size	Type	Land/TO speed	High speed	Long range	Long flight time	seating	safety	Common	Price	Page
Boeing 737-800	v.lg	jet	L/L		✔	✔	±190	✔	✔	$33,000,000	67
Cessna 172R Skyhawk	md	prop	S/S			✔	4		✚	$124,500	67
Cessna 182S Skylane	md	prop	S/S			✔	4		✔	$190,500	68
Embraer EMB-120 Brasilia	lg	prop	St/St				32			$5,000,000	68
Gulfstream IV	lg	jet	St/St	✔	✚	✚	21			$25,000,000	69
HOAC DV 20 Katana	md	prop	S/S				2			$50,000	69
Learjet Model 45	lg	jet	St/St	✔	✔	✔	10			$21,000,000	70
Piaggio P.180 Avante	lg	prop	St/St				9			$4,000,000	70
Piper Archer III	md	prop	S/S			✔	4		✔	$149,500	71
TKEF/AAC Angel	md	prop	S/S		✔		8			$585,000	71

Civilian Helicopters

	Size	Type	Seating	Common	Price	Page
AÈrospatiale AS 350B et al	md	rotor	6		$900,000	76
AÈrospatiale AS 355F2 et al	md	rotor	6		$1,000,000	76
Aérospatiale SA 365N Dauphin 2	md	rotor	13		$2,000,000	76
Bell Model 206 JetRanger, Model 406	sm	rotor	5	✚	$500,000	77
Bell Model 212, 412	md	rotor	15	✔	$1,500,000	77
MBB-Kawasaki BK 117	md	rotor	12		$1,600,000	78
MDD Model 500 et al	md	rotor	7	✔	$250,000	78
Sikorsky S-76B	md	rotor	14		$2,500,000	79

Civilian Watercraft

	Size	Type	Engine	High speed	Economy	Long range	Accomodation	Luxury	Common	Price	Page
Bombardier Sea-Doo SP	sm	jetski	✔	✚			2			$3,400	85
Bombardier Sea-Doo GS	sm	jetski	✔	✚			2			$4,900	85
Bombardier Sea-Doo GTX	sm	jetski	✔	✚			3			$6,000	85
Bombardier Sea-Doo GTX-RFI	sm	jetski	✔	✚			3			$6,300	85
Broom Ocean 34	lg	motor	✔				5			$750,000	85
Christensen VC	v.lg	motor	✔	✔		✔	12	✔		$890,000	86
Codecasa 49	v.lg	motor	✔			✚	22	✚		$950,000	87
Etap 30i	lg	sail	✔		✔	✚	6			$95,000	87
Kawasaki Jetfoil 929-117	v.lg	foil	✚	✚			±250		✔	$3,050,000	88
Kawasaki Jet Ski 750 STX	sm	jetski	✔	✚			3		✔	$6,000	88
Kawasaki Jet Ski 900 STX	sm	jetski	✔	✚			3		✔	$6,500	88
Kawasaki Jet Ski 1100 STX	sm	jetski	✔	✚			3		✔	$7,600	88
MacGregor 26	lg	sail		✔	✔	✚	5			$15,000	89
Najad Farr 60	lg	sail	✔		✔	✚	9			$130,000	89

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Civilian Watercraft (cont.)

	Size	Type	Engine	High speed	Economy	Long range	Accommodations	Luxury	Common	Price	Page
Panther 14	md	motor	✔	✚		✔	2			$10,000	90
Panther 16	md	motor	✔	✚		✔	5			$15,000	90
Panther 20	md	motor	✔	✔		✔	10			$20,000	90
Tempest 60	md	motor	✚	✚			7	✔		$22,000	91

Military Unarmored Vehicles

	Size	Layout	Engine	Transmission	Seating	Off-road	Convertible	Common	Price	Page
AM General M35A2 et al	v.lg	6x6	diesel	auto	3	✔	✔	✔	restricted	116
AM General M997, M998	lg	4x4	diesel	auto	10	✔		✔	restricted	116
AM General M1025, M1043	lg	4x4	diesel	auto	4	✔	✔	✔	restricted	116
Ford M151 MUTT et al	sm	4x4	gas	auto	4	✔	✔		restricted	117
Land Rover Defender 110	md	4x4	diesel	m5	4-8	✔	✔	✔	restricted	118
Oshkosh M977 HEMTT et al	v.lg	8x8	diesel	auto	2	✔			restricted	118

Military Armored Vehicles

	Size	Layout	Fuel	Transmission	High-speed	Seating	Off-road	Armor	Amphibious	Common	Price	Page
Daimler FV 701 Ferret et al	md	4x4	gas	man	✔	3	✔	✔			restricted	99
Daimler FV 701 Mk. 3, 4	md	4x4	gas	man	✔	3	✔	✔			restricted	99
DTA M60A1, A3	lg	track	diesel	auto		4		✚		✔	restricted	100
DTA M60A1+	lg	track	diesel	auto		4		✚	✔	✔	restricted	100
Engesa EE-9 Cascavel	md	4x4	diesel	auto	✔	3	✔	✔			restricted	101
FMC M3 Bradley CFV	lg	track	diesel	man		5	✔		✔		restricted	103
FMC M3A2 Bradley CFV	lg	track	diesel	man		5	✔	✔	✔	✔	restricted	103
FMC M2 Bradley IFV	lg	track	diesel	man		10	✔		✔		restricted	101
FMC M2A2 Bradley IFV	lg	track	diesel	man		9	✔	✔	✔	✔	restricted	101
FMC M113A2	md	track	diesel	man		13		✔	✔	✚	restricted	102
FMC M113A3	md	track	diesel	man		13		✔	✔	✚	restricted	102
GD M1A1 Abrams	v.lg	track	multi-f.	man		4	✔	✚	✚		restricted	104
GD M1A2 Abrams	v.lg	track	multi-f.	man		4	✔	✚	✚		restricted	104
GMC ASLAV-25	md	8x8	diesel	man	✔	9	✔		✚		restricted	105
GMC LAV-25(MC)	md	8x8	diesel	man	✔	9	✔		✚		restricted	105
MOWAG Piranha 4x4	md	4x4	diesel	man	✔	10	✔		✚		restricted	106
MOWAG Piranha 6x6	md	6x6	diesel	man	✔	14	✔		✚		restricted	106
MOWAG Piranha 8x8	md	8x8	diesel	man	✔	15	✔		✚		restricted	106
Panhard AML	md	4x4	gas	auto	✔	3		✔	✔		restricted	107
RSA BMP-2, BMP-2D	lg	track	diesel	auto		10	✚	✔	✚		restricted	107

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Military Armored Vehicles (cont.)

	Size	Layout	Fuel	Transmission	High-speed	Seating	Off-road	Armor	Amphibious	Common	Price	Page
RSA BRDM-2	md	4x4	gas	auto	✔	4	✚	✔		✔	restricted	108
RSA BTR-60P, BTR-60PA	lg	8x8	gas	auto		18	✔	✔		✚	restricted	108
RSA BTR-60PB	lg	8x8	gas	auto		16	✔	✔		✚	restricted	108
RSA T-55A et al	lg	track	diesel	auto		4	✔	✚		✚	restricted	109
RSA T-72M1, M84	lg	track	diesel	auto		3	✔	✚		✔	restricted	109
RSA T-72M1M, T-72S	lg	track	diesel	auto		3	✔	✚	✚	✔	restricted	109
RSA T-80B, T-80U	lg	track	multi	auto		3	✚	✚			restricted	110
RSA T-80BV, T-80UD	lg	track	multi	auto		3	✚	✚	✚		restricted	110
RSA ZSU-23-4M "shilka" et al	lg	track	diesel	auto		4		✔		✔	restricted	111

Military Airplanes

	Size	Type	Landing/TO	High speed	Long range	Long flight time	seating	Armed	Common	Price	Page
Lockheed AC-130H Specter	v.lg	prop	L/St		✔	✔	131	✚		restricted	124
Lockheed C-130 Hercules et al	v.lg	prop	L/St		✔	✔	131		✚	restricted	124
Lockheed F-117A Nighthawk	lg	jet	L/St	✔	✚	✚	1	✚		restricted	124
RSA Antonov AN-12 "Cub"	lg	prop	St/St				103	✔		restricted	125

Military Helicopters

	Size	Type	High speed	Seating	Safety	Armed	Common	Price	Page
Aérospatiale SA 365F Dauphin 2 et al	md	rotor		13				restricted	130
Bell-Boeing MV-22 Osprey	lg	tilt	✔	26				restricted	131
Bell OH-58A, OH-58 D	sm	rotor		5		✔	✔	restricted	131
Bell UH-1H Iroquois (Huey)	md	rotor		15			✔	restricted	132
MDD AH-64 Apache et al	lg	rotor	✔	2	✔	✚		restricted	132
MDD OH-6 Cayuse et al	sm	rotor		5-7		✔	✔	restricted	133
RSA Mil Mi-8 "Hip"	v.lg	rotor	✔	30			✔	restricted	134
RSA Mil Mi-8T "Hip"	v.lg	rotor	✔	30		✔		restricted	134
RSA Mil Mi-24 "Hind" et al	v.lg	rotor	✚	10		✚	✔	restricted	135
Sikorsky UH-60A Black Hawk	md	rotor	✔	14		✔	✔	restricted	136
Westland Lynx AH Mark 7, 9	lg	rotor	✚	12		✔	✔	restricted	136

Military Watercraft

	Size	Type	Engine	High speed	Long range	Accomodation	Common	Price	Page
Bollinger Island-Class	v.lg	motor	√	√	+	18	√	restricted	142
Halter Pegasus Class Mark V	v.lg	motor	4	4		21	4	restricted	142
Tempest 43ft Fast	lg	motor	√	+		7	√	restricted	143

CIVILIAN AUTOMOBILES

CHAPTER ONE

CIVILIAN AUTOMOBILES

There is a lot of debate over who actually invented or built the first car. A number people in the 19th century built self-powered vehicles, some as early as the mid-1860s, but the first practical cars were being built in the 1880s, mainly in Germany. Essentially, most were not much more than horse-drawn carriages with the horse removed and an engine installed, though the German Carl Benz designed a three-wheeled car more or less from the ground up. This vehicle is often taken to be the first true motorcar, and Benz himself has always pointed to September 12, 1885 as the motorcar's date of birth—on that day, his wife "stole" the vehicle and took it for a test-drive.

In the first few years, cars were viewed with suspicion by government officials, and indeed the population as a whole. For example, in most countries strict speed limits were enforced, and in England a motorcar was only allowed to drive through towns if someone carrying a flag walked a certain distance in front of it. Even some automotive pioneers questioned whether cars would have any practical use at all.

By the time the First World War started, this situation had changed somewhat. Cars were by no means common, but many militaries saw they were valuable for use in war—and as usually happens at such times, development and production accelerated. The most important factor that limited car production, though, was that they were essentially hand-built by skilled craftsmen, much like coaches were. Manual production techniques are labor-intensive, and therefore slow and costly; most Europeans and North Americans did not have the money to buy cars even if they wanted them.

In the 1920s, Henry Ford set up the first assembly line in the world, allowing him to hire unskilled people and build cars both faster and cheaper than anyone else. The new method of production was used to build the famous Model T by the thousands. At the same time, American consumers had more money to spend than ever before,

allowing them to buy these relatively cheap cars when only a few years earlier they had been out of their reach. Car races also did much to improve the popularity of the automobile.

These early cars were still reminiscent of coaches—most had simple lines, canvas roofs that could be folded down, and wooden-spoked wheels. This was due to change as manufacturers in the 1930s began to pay more attention to how cars looked, giving them lines that the public wanted and promoting good-looking cars as status symbols. This trend was followed in both North America and Europe, though there were notable differences between the cars produced on either side of the Atlantic. There was an interruption in car production for World War II, as most manufacturers were forced to switch over to military products, but after the war they picked up where they left off a few years earlier.

By the 1940s and '50s, European and American car manufacturers were increasingly moving in different directions. American cars were big and heavy, with powerful engines to keep up performance and all sorts of luxury accessories. European manufacturers on the other hand were still recovering from the devastation of the war, and had limited resources to work with. Their cars were much smaller and lighter, and devoid of many of the luxuries that came standard with American cars.

The first true four-wheel drive car for off-road use that gained general acceptance was the Willys MB, designed as a light truck for the U.S. Army in the early 1940s. It was a very simple but rugged car that was produced in huge numbers during the war, not just by Willys but by several other manufacturers as well. The Ford-produced MBs were known by the designation GP, for General Purpose, and it is commonly thought that this gave rise to the term "jeep" to describe these off-road vehicles. The Willys Jeep remained in use until the 1950s, but many can still be found, often restored to their original state by military vehicle enthusiasts. After the war, Willys made civilian variants of the Jeep, most of which did not gain much popularity.

By the 1960s, Japan had also set up a car industry, and started exporting vehicles to other countries. Japanese cars of the time were small and light, like European cars but with distinctly different looks. They were often regarded as inferior in other countries, though this was mostly unwarranted.

The 1970s saw problems for American car manufacturers, for most of which they had only themselves to blame. Because foreign cars didn't sell well in the U.S., the American car industry had become lax and assumed that people would buy whatever was offered. This attitude led to poor quality products, and even to American consumers protesting in various ways.

Another problem was the oil crisis—due to the 1973 Arab-Israeli war, the Arab oil-producing nations cut off the oil supply to Israel's supporters, leaving western Europe and North America with a shortage of gasoline. Car designers had not bothered with good fuel economy, as the general mood in the post-WWII period was one of "everything is possible." The oil crisis showed them the facts, and also underlined another factor: natural oil supplies were not unlimited,

and there would be a time when they would run out. To deal with this, newer engine and car designs became more economical. This trend still continues today.

By the late 1970s, civilian interest in off-road cars had increased, and several manufacturers started making four-wheel drives. Many of these were from the Far East, giving competition to the mainly American-made four-wheel drives that were most common until that time. Around this time, the public and manufacturers realized that off-road vehicles need not be just the rugged and practical machines they had been until then, but could be just as luxurious as normal cars. This trend continues today, and many sport-utility vehicles today have standard luxury features that would be high-priced add-ons in other cars.

In the '80s, manufacturers began using more electronics when making cars, to the point that the electronics in a car of the late 1980s or early '90s had more computing power than those in the Apollo moonlanders of twenty years earlier. These electronic systems served many functions, though among the most common were engine-management (to improve economy) and electrical performance of tasks that were previously done by hand, such as opening the windows, adjusting rearview mirrors, and so on. These latter features were already in use in the 1950s, but they became much more common in the 1980s.

Body styles of modern cars are most often described as two-, three-, four-, or five-door. A two-door car (also called a "coupe", or "coupÈ") only has two front doors, so passengers in the rear seats have to climb past the front seats to get into the car. Most sports cars are coupes, often because they have no rear seats at all.

Three-door cars are similar to coupes, but have larger rear windscreens that can be hinged up for access to the trunk. In normal cars this third "door" is often referred to as a hatchback, and it is not used for passengers. In vans, however, the hatchback is often used for loading and unloading people as well as cargo. Four-door cars are known as sedans, and have separate doors for the front and rear seats. Five-door cars (wagons or stationwagons) are like four-door models, but they have additional rear doors similar to those of three-door cars.

All modern cars have features designed to make them safe for their passengers, including seat belts and airbags. Rigid bars placed inside the doors are commonly found in most modern cars. Airbags are usually mounted in the center of the steering wheel or the dashboard (for the front-seat passenger), and in some cars the doors as well. These latter are known as side-bags. All airbags work by causing a small explosion to quickly generate a large amount of gas, which is channeled into a plastic bag. The bag inflates and cushions the passenger's impact against the steering wheel or dashboard, after which it quickly deflates to prevent suffocation. All this takes place in a fraction of a second. They are designed to prevent injury to the passengers in case of a side collision, as do steel bars in the doors.

Accident prevention is also a considerable factor in choosing what features to include in a car. A car that is easy to control and doesn't make unexpected maneuvers when forced to take extreme course corrections has a much lower accident risk factor than a car

that does not meet these standards. Several of the most common safety features include power steering, power-assisted brakes, and anti-lock brakes.

Power steering makes the steering wheel much easier to turn by augmenting the normal mechanical linkage between the steering wheel and the front wheels with a hydraulic system that handles a large percentage of the force required to actually turn the wheels.

Power-assisted brakes work in a similar manner, allowing the driver to apply less force to the brakes than required by a purely mechanical linkage and get the same results. However, too much braking power can be dangerous because when the wheels are fully stopped, a moving car is nearly impossible to control. For this reason, anti-lock braking systems (also known as "ABS") are often used on modern cars. This system uses a sensor on the wheels to release the brakes automatically when the wheels almost stop spinning. Especially on slippery surfaces, such as wet or icy roads, an ABS drastically increases a car's controllability. Unless otherwise indicated, all cars in this book are equipped with airbags for the drivers and anti-lock brakes.

The engine is usually mounted at the front of the car, driving the front or rear wheels. Because of its simplicity, rear-wheel drive was very common in the past. With rear-wheel drive, the front wheels do the steering, and the rear wheels push the car forward. Front wheel drive requires a more complicated design, because the front wheels must be steerable and push the car forward at the same time. The design must also be more compact than a car with rear-wheel drive, because the whole drive system must be fitted underneath and around the engine. However, because the weight of the engine rests on the front wheels, vehicles with front-wheel drive have a better grip on the road than those that use rear-wheel drive. European and Japanese cars have used front-wheel drive for much longer than American ones.

Even though it is simpler to design, rear-wheel drive has some notable disadvantages. A drive shaft must run from the engine to the rear wheels. This shaft takes up room that could be used to increase the car's interior space. Cars that use rear-wheel drive also tend to have poorer handling and performance in bad weather and on rough roads.

Four-wheel drive vehicles are essentially identical in construction to other civilian cars, except that all four wheels are driven by the engine instead of only the front or rear pair. This makes them perform very well on rough terrain. In most cases the four-wheel drive can be switched off when it isn't required, since the increased traction it provides is at the expense of top speed and fuel economy—having four-wheel drive engaged when driving on a road is usually unnecessary. The change can normally be made only when the vehicles is stationary, with the transmission in neutral gear, though the engine may be running.

The engines used in cars, motorcycles, and most other vehicles are known as internal combustion engines or piston engines. One or more pistons move up and down in enclosed chambers known as cylinders; to make the engine operate, a mixture of fuel and air is fed into each cylinder, above the piston. The fuel is ignited by means of a spark plug, and the resulting explosion drives down the piston. As the piston is connected to an axle called the crankshaft, the piston's

movement causes the crankshaft to rotate. This turning motion is then transferred, through numerous gears and axles, to the car's wheels.

A number of different engine layouts are commonly used, which refer to the way the cylinders are arranged. "In-line" means very simply that all cylinders are in a straight row behind, or next to, each other. When there are a large number of cylinders, the engine gets very long, so "V"-engines were developed. In these, the cylinders are placed in two rows that angle up and away from each other; when looked at from the front, each pair of cylinders forms a V, giving the engine its name. All the cylinders are on the same crankshaft, but because the cylinders are arranged in pairs, the total engine length is reduced. The engine's width is increased, though. A "horizontally-opposed" engine is a variation on the V-engine in which the cylinders are laid out flat instead of in a V. "Radial" engines are a type common in propeller aircraft, and used in a few models of automobiles. A radial engine has a very short crankshaft to which all pistons are connected at almost the same point.

There are two basic means to get the mixture of fuel and air into the cylinders. The first, and most common, is to mix them in a carburetor, which draws air from outside and fuel from the fuel tank. Each cylinder has valves that are opened and shut by the camshaft to allow the mixture to flow into the cylinder at a specific point in the piston's movement cycle. A separate set of valves is used to remove the waste gases, resulting from the burning of the fuel, from the cylinder. In the past, most engines had two valves per cylinder: one to remove the exhaust gases and one to fill the cylinder with the fuel-air mixture again. Over the last twenty years or so, the number of valves has steadily increased. Most engines nowadays have four valves per cylinder, which allows quicker filling and emptying of the cylinder.

The valves on the cylinders are opened and closed by camshafts—shafts with ridges that press open the valves when the shaft rotates. The position and number of the camshafts is frequently indicated in an engine designation, by such abbreviations as SOHC and DOHC, standing for Single and Double Over-Head Camshaft respectively. The over-head part means the camshaft is at the top of the engine, above the cylinders, while the single or double indicates the number of camshafts present. In engines with a single camshaft, the shaft operates both the "in" and "out" valves, while with double camshafts, there is one for the "in" and one for the "out" valves. Engines with single camshafts are easier to manufacture, but double camshafts give an engine better performance because the opening of the "in" and "out" valves can be timed separately, which isn't possible with only a single camshaft. Note that V-engines with double cams actually have four camshafts, two for each row of cylinders.

The second method of getting fuel into the cylinders is by injection. The engine has no carburetor, and instead only air is led to the cylinder. Just in front of the inlet valves, a precisely measured amount of fuel is injected straight into the air streaming into the cylinder. The main advantage of fuel injection is that the amount of fuel can be regulated much more accurately than in a carburetor, which gives the engine more power. It is more expensive than a carburetor, though.

For more power and thus better performance, some engines—mainly in sports cars and trucks—are fitted with turbochargers. These compress the air that is led into the cylinders, so more fuel and air is in the cylinder when it is ignited. Turbochargers are operated by the exhaust gases from the engine, which drive a small turbine connected to the air compressor. Superchargers work similarly, but the compressor is powered by the engine's crankshaft instead of a turbine.

Engine size is expressed in liters (l) or cubic centimeters (cc or cm3; there are 1,000 cubic centimeters in a liter), although older American cars often used cubic inches (one cubic inch is about 16.4 cc). This volume indicates the displacement volume of the moving cylinders—for example, a cylinder whose piston has a diameter of 8.2 cm and moves up and down 7.0 cm, displaces 370 cc. An engine with four of these cylinders has a total displacement of 1,479 cc, and so would be termed a 1.5 liter engine (for fiscal reasons the listed engine size is always slightly larger than the actual displacement).

Engine power is measured in horsepower (hp). One horsepower is approximately 1.36 kilowatts, or 1 kW = 0.735 hp. One watt equals an energy of one joule per second, so a 100 hp (1360 kW) engine has an energy output of 1,360,000 joules every second. If that engine were to be switched on for a minute, its total output of energy would be 81,600,000 joules.

For practical purposes, consider the following: a typical light bulb is rated at sixty watts, which means the 100 hp engine could provide enough power to keep 1670 such bulbs burning brightly (assuming, of course, a perfect situation where no energy is lost to the generation of unwanted heat, vibrations, friction, and so on).

Engines are not perfect, however, and a lot of the energy that is put into the engine (in the form of fuel) is spent causing unwanted heat. Because of this, the engine must be cooled or it will overheat, stall, and possibly suffer permanent damage.

The two normal engine coolant systems are air- and water-cooling. In the first, air is blown past the engine by a fan (which is driven by the engine itself), the air heats up as is passes over the engine, taking the heat from the engine and dispersing it into the atmosphere.

With a water-cooling system, tubes of water flow past the engine and remove heat, similar to the air-cooled system. However, the water must then be cooled because, unlike the air in an air-cooled engine, it cannot just flow away into the atmosphere. The water flows into radiator, through which a fan blows air in order to cool the water. A water-cooling system is more efficient than an air-cooling one, but it has a drawback: the water level in the cooling system must not be allowed to drop too far (through evaporation and leaks) or the engine will not be sufficiently cooled.

AM General

American Motors General Division, LTV Aerospace and Defense Co., U.S.

Hummer

Capacity:	1+3 or 1 ton cargo
Weight:	2,800kg
Engine:	150hp D
Top speed:	125km/h
Range:	480km

The Hummer is the civilian version of the military HMMWV (see page 116). It is a four-seat vehicle with a cargo area in the back that has a carrying capability of around 1,000 kg. The engine is in the front, and all wheels are driven, providing good cross-country performance. The Hummer is a very wide vehicle, with the chassis running between the seats and not underneath them. This makes its silhouette lower, and also means it is less likely to roll over because its point of gravity is low. The area between the seats is solid enough to stand on.

The Hummer is available in hard-top and soft-top models, the latter having roll-bars. The hard-top model is not the same as the military hardtop model, as it has a different roof and doors, and also lacks the roof hatch found on the military vehicle. The Hummer is popular with off-road enthusiasts, science-fiction TV shows, and rap artists, but their high price tag and heavy fuel consumption reduce sales to the general public somewhat.

BMW

Bayerische Motoren Werke AG, Germany

3-Series 316i

***also* 318i, 320i,323i, 325td, 328i, M3**

Capacity:	1+3
Weight:	1,150kg
Engine:	102hp
Top speed:	195km/h
Range:	890km

The 3-series is the smallest type of BMW available, and consists of over twenty-five models. The current body style was introduced in late 1990, and is still in use with only a few minor modifications. The basic models of the 3-series are listed below, all of which are available as four-door sedans, two-door coupe variants and five-door station-wagon models; the exceptions are the 325 (not available as coupe), and the 316 and M3 (both not as five-door). Of the 318, 320, 328, and M3, two-door convertibles are also made.

The engine is located at the front, a four-cylinder in the 316 and 318, but six-cylinder in the others, all with fuel injection and four valves per cylinder. Only the least expensive models are not equipped with engine management systems for optimal efficiency. The 325td has a turbo-diesel engine, while the others use gasoline. The rear wheels are driven through either a five-speed manual or an automatic transmission; the M3 has a special kind of transmission that can be used either as a six-speed manual or an automatic at the driver's choice, allowing very rapid gearshifts in manual mode because no clutch has to be applied. The M3's top speed is electronically limited to 250 km/h.

All the 3-series cars come standard equipped with power steering. As most people expect from BMW, the interiors are luxurious, boasting all of the features common to modern cars. The two front

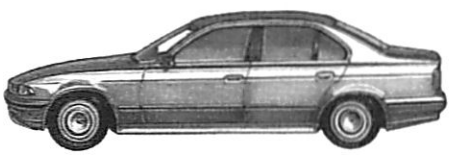
seats are adjustable, as is the height of the steering wheel, and safety belts are standard both for the front seats and the rear bench.

318i	320i	323i	325td	328i	M3
1+3	1+3	1+3	1+3	1+3	1+3
1,210kg	1,315kg	1,330kg	1,335kg	1,330kg	1,460kg
140hp	150hp	170hp	116hp D	193hp	321hp
200km/h	210km/h	225km/h	200km/h	235km/h	250km/h
815 km	785 km	815 km	955km	835km	890km

5-Series 520i

***also* 523i, 525tds, 528i, 535i, 540i**

Capacity:	1+3
Weight:	1,410kg
Engine:	149hp
Top speed:	220km/h
Range:	920km



BMW's current 5-series was introduced in September 1995, and in overall look and layout it is similar to the 3-series described above—though the 5-series is bigger, more powerful, more luxurious, and more expensive. All are available as four-door sedans, while the 520, 525, and 540 are also made in five-door station wagons.

Like the 3-series, the 5-series uses a 6-cylinder engine in most of its models, although the 535 and 540 feature a V-8 engine, filling the gap between BMW's traditional 6- and 12-cylinder engines. Drive is again to the rear wheels through a 5-speed manual transmission (6-speed in the 540i); an automatic is also available for all models, though there is no equivalent to the M3's combined transmission.

The interior is equipped with airbags for the driver and the front-seat passenger, and side-mounted airbags (side-bags) are standard from 1997 models onward. The side-bags are similar to normal airbags, but protect the passengers during collisions against the side of the car, instead of head-on collisions. One is mounted in each door to protect the torso, and one in the roof over each door to protect the head.

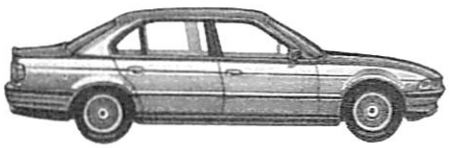
523i	525tds	528i	535i	540i
1+3	1+3	1+3	1+3	1+3
1,420kg	1,480kg	1,440kg	1,560kg	1,590kg
170hp	170hp D	193hp	235hp	286hp
230km/h	210km/h	235km/h	250km/h	250km/h
935km	1,030km	895km	770km	750 km

7-Series 725tds

***also* 728i, 735i, 740i, 750i**

Capacity:	1+3
Weight:	1,960kg
Engine:	143hp D
Top speed:	205km/h
Range:	1,180km

The 7-series is one of BMW's top notch cars. It resembles the 3- and 5-series, but is larger, more luxurious, and more powerful. The 725tds has a six-cylinder turbocharged diesel engine. The 728i has a six-cylinder gasoline engine with fuel injection, and both the 735i and 740i have a similar engine with eight cylinders instead of six. The 750i has a big twelve-cylinder engine, giving very good performance for a car its



size. All of the 7-series come equipped with an automatic transmission except for the 750i, which is equipped with a manual transmission instead.

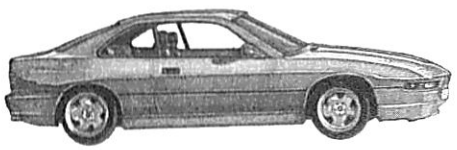
Except for the 725, all BMW 7-series models are also available in L versions (728iL, for example), which are 14 cm longer than the standard model, giving more leg room for passengers in the back seats.

728i	735i	740i	750i
1+3	1+3	1+3	1+3
1,670kg	1,765kg	1,815kg	1,960kg
193hp	235hp	286hp	327hp
225km/h	245km/h	250km/h	250km/h
1,025km	915km	895km	825km

850CI

also 840Ci, 850CSi

Capacity:	1+3
Weight:	1,855kg
Engine:	299hp
Top speed:	250km/h
Range:	890km



As close as a BMW gets to a true sportscar, the 850 is a high performance coupe introduced in late 1992. The basic model is the 850Ci, with a 5 liter V12 engine and an automatic transmission. The engine was upgraded to a 5.5 liter to produce the 850CSi. A manual six-speed transmission was installed into the 850CSi to make it more of a sportscar. Later, the 840Ci was introduced, with a 4.4 liter V8 replacing the V12. The 840 is available with either a manual six-speed or an automatic transmission.

840Ci	850CSi
1+3	1+3
1,795kg	1,865kg
286hp	381hp
250km/h	250km/h
965km	880km

CHEVROLET

General Motors Corporation, Chevrolet Division, U.S.

Beretta 2.2L

also Beretta 3.1L, Beretta Z26

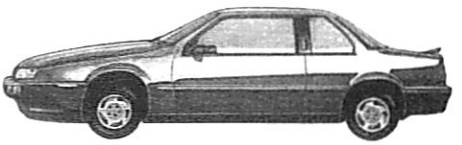
Capacity:	1+3
Weight:	1,300kg
Engine:	118hp
Top speed:	170km/h
Range:	765km

Although the medium-sized Beretta bears some resemblance to a high-performance sportscar, it's actually a two-door family car that shares a common chassis and engine with the Chevrolet Corsica.

The Beretta's interior is laid out in a standard fashion, with folding front seats to allow the rear passengers to get in and out. The doors are large enough to make this possible without having to crawl through the car. Some parts of the finish are not as good as they could have been. An airbag for the driver is standard.

The standard Baretta model comes with a 2.2 liter, four-cylinder engine and uses an automatic transmission (or an optional five-speed

manual transmission if desired). A 3.1 liter V6 engine can replace the 2.2 liter version to increases the car's performance noticeably—the V6, however, is only available with an automatic transmission. The 3.1 liter engine is standard on the Beretta Z26, which turns the basic Beretta into more of a sportscar. The Z26 also includes front and rear spoilers, aluminum wheels with wide tires, and side skirts for a more streamlined look. When seen up close though, it is apparent that these accessories were not part of the original design of the Beretta's bodywork.



3.1L	Z26
1+3	1+3
1,320kg	1,350kg
150hp	150hp
175km	175km
685km	685km

Blazer

***also* Blazer ZR2**

Capacity:	1+3
Weight:	1,915kg
Engine:	193hp
Top speed:	180km/h
Range:	580km

The Blazer is Chevrolet's entry in the luxury off-road category. It's a four-door car with enough room to comfortably carry four people long distances that is also capable of driving through rough terrain. As with many similar vehicles, there is a cargo area behind the rear seats, and to increase its size the rear seats can be folded down. This cargo area is accessed by a two-piece rear hatch, whose upper and lower parts can be opened separately.

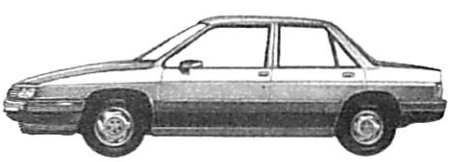
Standard features are an air conditioner, driver's airbag, electrical controls for all windows and rearview mirrors, and a choice of either an automatic or a five-speed manual transmission. The four-wheel drive can be switched off when it is not required, but only when the car is standing still. In two-wheel drive mode, only the rear wheels are driven. An ABS is installed, as are powered brakes and powered steering.

Corsica 2.2

***also* Corsica 3.1**

	2.2	3.1
Capacity:	1+3	1+3
Weight:	1,210 kg	1,250kg
Engine:	118hp	150hp
Top speed:	170km/h	175km/h
Range:	765km	685km

Chevrolet's Corsica is largely identical to the Beretta apart from the body. The Corsica has four doors, while the Beretta has two. This makes the two easily distinguishable in appearance, but performance-wise they are quite similar. Like the Beretta, the Corsica can be had with a 2.2 liter engine with either a five-speed or automatic transmission, or with a 3.1 liter V6 coupled to an automatic transmission.



Corvette Coupe

***also* Corvette 5.7-V8 Convertible**

Capacity:	1+1
Weight:	1,595kg
Engine:	282hp
Top speed:	255km/h
Range:	805km

The first model of the Corvette was introduced in 1953 and is still highly sought after by classic car enthusiasts. Almost forty-five years later, the Corvette has become what most people consider the only real high-end sportscar built in the U.S.

The Corvette has sleek lines, for low air resistance and a powerful engine to give it a high top speed and very good acceleration. Somewhat strange for a high-performance sportscar, the Corvette's engine is in the front, but it drives the rear wheels. A large cooling system prevents the 5.7 liter V8 engine from getting too hot. Oddly enough, for a sportscar, the Corvette uses an automatic transmission. A six-speed manual transmission is available, though, in a model Chevrolet calls the Grand Sport. Wide tires are fitted to provide excellent grip, and disc brakes are standard on all wheels. The Corvette also has power-assisted steering and brakes.

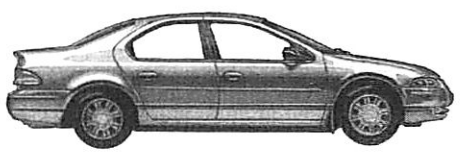
CHRYSLER

Chrysler Corporation, U.S.

Cirrus LX

***also* Cirrus 2.5-V6**

	LX	2.5-V6
Capacity:	1+3	1+3
Weight:	1,400kg	1,435kg
Engine:	150hp	161hp
Top speed:	210km/h	210km/h
Range:	750km	750km



The Cirrus is a compact, four-door sedan first introduced in 1994. Known as the Stratus in Europe, the Cirrus is available with either a four- or six-cylinder engine, though performance-wise the two are not very far apart. Both models have an automatic transmission, and oddly enough, a manual transmission is not available. The Cirrus does have a number of other standard features, such as driver and passenger airbags, powered windows and locks, and a stereo system. The independently-sprung wheels give good handling on the road, and despite its mass the Cirrus has good performance.

Also available is a convertible, which retains all four seats of the standard Cirrus, but has only two doors, and larger and wider tires. The soft top can be electrically opened and closed.

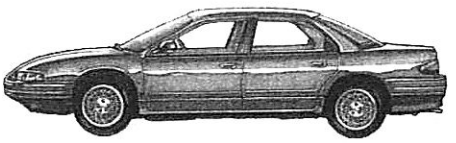
Concorde LX

Capacity:	1+3
Weight:	1,590kg
Engine:	211hp
Top speed:	210km/h
Range:	725km

Like the Cirrus (above), the Concorde follows Chrysler's "cab forward" design strategy, stretching the passenger compartment as far forward as possible to create more internal passenger space and trunk room than is normally found in similar cars. This four-door sedan has a large number of luxury features, such as cruise control, powered windows and locks, and electrically-adjustable rearview mirrors.

Both a driver's side and a passenger's side airbag has been installed and powered steering is a standard on all models.

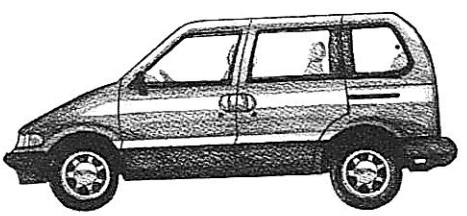
The only engine available for the Concorde (or Vision, in Europe) is a 3.5 liter V6, coupled to an automatic transmission that drives the front wheels.



Voyager 2.4i

also Voyager 3.3i V6, Grand Voyager 3.3i

Capacity:	1+6
Weight:	1680kg
Engine:	151hp
Top speed:	180km/h
Range:	650km



The Voyager is Chrysler's entry in the mini-van market, and is one of the most successful mini-vans around, both in the U.S. and Europe. As with all mini-vans, the Voyager holds the middle between a van and a normal car, and has a luxurious interior that can be transformed into a cargo bay with little difficulty. The rear area has two benches, allowing the voyager to seat a total of seven people. The benches are removable, but not as easily as in most other mini-vans. As an option, one or both benches can be replaced with individual seats.

Although not a small vehicle, the Voyager is not particularly large on the inside: tall people have some problems finding leg- or headroom. Interior noise levels are low, however, and luxury items such as cup holders, arm rests on the seats, and electrically adjustable rearview mirrors make it a comfortable passenger vehicle. Available options include extra sound insulation, cruise control, ABS, and electrically-operated side windows.

The suspension is somewhat old-fashioned, with leaf springs instead of coil springs, but it gives the Voyager good handling characteristics, especially when taking corners. The 2.4-liter engine is enhanced with a fuel injection system. Although it is equipped with a five-speed transmission, acceleration in the higher gears is poor compared to other cars in this class.

The Voyager 3.3i V6 has a larger engine, but in performance it is very hard to distinguish from the 2.4 liter model. The Grand Voyager is more luxurious than the other models. Four-wheel drive variants are also available for all of these models.

FERRARI

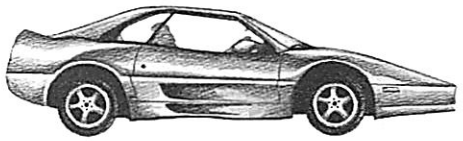
Ferrari S.p.A. Fabbriche Automobili e Corse, Italy

F355

also F355 GTS

Capacity:	1+1
Weight:	1,350kg
Engine:	381hp
Top speed:	295km/h
Range:	600km

The F355, which is the follow-up to the well-known and no longer produced 348, was introduced in 1994. Like its predecessor, it is a two-seater with a low profile. The 3.5 liter V8 engine and six-speed transmission insure that this vehicle can achieve high levels of performance. Its suspension is independent, with stabilizers and electrically-controlled shock absorbers to enhance the ride on less-than-smooth roads, while all wheels have disc brakes and wide tires



for optimal performance. Powered steering is also included, but there are no airbags. Like all Ferraris, the engine is mounted behind the passenger area and drives the rear wheels.

Although the standard model has a hard roof, the GTS version is a convertible. Ferraris are difficult to come by, as production is very limited; a two-year waiting period is not unusual.

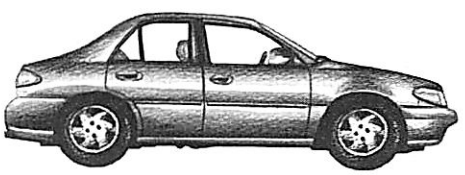
FORD

Ford Motor Company, U.S. (also Ford Werke, AG, Germany)

Escort

***also* Escort LX**

Capacity:	1+3
Weight:	1,145 kg
Engine:	110hp
Top speed:	190km/h
Range:	730km



The Escort is Ford's entry-level car for consumers on a budget. It has long suffered from a number of detractions that set it apart from similar cars, such as bad handling on rough roads, low power, and somewhat unrefined looks. For the latest Escorts, Ford has improved all these points: better construction of the body coupled to stabilizers in the suspension reduce the car's tendency to wobble on uneven surfaces; an upgraded engine has been fitted for better performance; and more attention to the interior and exterior styling have improved the car's appearance.

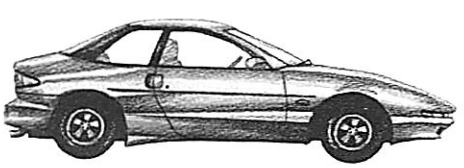
The Escort is available in a number of different models, including four-door sedan and stationwagon. Each of these models can seat four people, though the rear seats are somewhat small. As can be expected from an inexpensive car, the standard features are limited, but many accessories are available for those wanting them, including air conditioning, anti-lock brakes, powered locks, mirrors and windows, and more. Driver and front passenger airbags are included.

The baseline engine in the U.S. is a two-liter model, though Ford Werke in Germany manufactures more variants for the European market, including many with smaller engine sizes, down to 1.3 liters. A five-speed transmission is standard, but an automatic is available as an option. Ford also offers a four-speed manual transmission as an option.

Probe

***also* Probe GT**

	Probe	Probe GT
Capacity:	1+3	1+3
Weight:	1,220kg	1,280kg
Engine:	116hp	162hp
Top speed:	205km/h	220km/h
Range:	740km	590km



The Ford Probe is a three-door hatchback that isn't quite a true sportscar, but comes close. It has streamlined looks and good (but not exceptional) performance. It's also large enough to carry four people, although the rear seats are somewhat small and difficult to get into and out of.

The base version of the Probe has a two liter, four-cylinder engine and a five-speed transmission. The front wheels are driven and all of the wheels have independent suspension and power brakes, giving the car good handling qualities. Powered steering is also standard, and two airbags are fitted for the passengers' safety, but an ABS is optional.

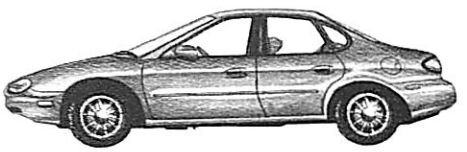
The GT model is similar, but it has a 2.5 liter, six-cylinder engine, standard anti-lock brakes, and more elaborate fittings.

The Probe is not a "true" Ford, being based on the Mazda MX-6—Ford owns about 50% of the Japanese Mazda company, and the Probe is built in a plant that Mazda set up in the U.S.

Taurus G

also Taurus GL, Taurus LX, Taurus SHO

Capacity:	1+3
Weight:	1,480kg
Engine:	203hp
Top speed:	180km/h
Range:	750km



The Ford Taurus and Mercury Sable are virtually identical, coming from the same factory and differing mainly in the manufacturer's logos. In the U.S., the Taurus was the best-selling car from 1994 to 1996. The Taurus and Sable are both available in four-door sedan and five-door stationwagon models, except for the Taurus SHO which is only offered in a four-door model. These models are easily recognized by their aerodynamic body shapes. Although not everyone likes the way these cars look, there is a lot of room inside and an excellent field of view for the driver and passengers. Two airbags are installed to protect the driver and front seat passenger.

The main difference between Taurus and Sable is that the Sable has leather upholstery. The various versions of the Taurus differ mainly in luxury details and very slight performance differences, though all have the same mechanical components: a three-liter, six-cylinder engine, automatic transmission, independent suspension, and powered disc brakes. An ABS is optional, while powered steering is standard.

The SHO is the only model that really stands out, primarily because its 3.4 liter, eight-cylinder engine noticeably improves the car's performance. It also has a standard ABS, and is not available as a stationwagon.

GL	LX	SHO
1+3	1+3	1+3
1,480kg	1,480kg	1,510kg
203hp	203hp	224hp
180km/h	180km/h	200km/h
750km	750km	670km

HONDA

Honda Motor Co. Ltd., Japan

Accord DX

also Accord LX, Accord EX

	LX/DX	EX
Capacity:	1+3	1+3
Weight:	1,240kg	1,275kg
Engine:	131hp	150hp
Top speed:	200km/h	210km/h
Range:	755km	755km

The Accord is one of Honda's most important cars, and probably the most popular car in North America. Its base model is a four-door sedan available with a number of different engines, and either automatic or five-speed manual transmission. Two- and five-door models are also produced, all in three basic styles: DX, LX, and EX. The DX is the baseline Accord, with an airbag for the driver and front passenger, and power steering. The LX adds cruise control, powered door locks,

powered windows, and anti-lock brakes (in the sedan model only). The most expensive model is the EX, which is like the LX but also has a deluxe stereo, a standard ABS, and a different engine. Optional in the EX is a leather interior.

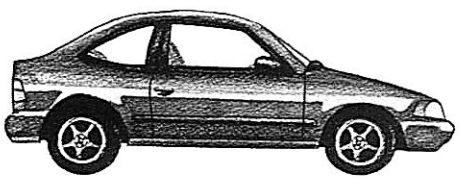
The engine is basically the same in all models, although the EX is more powerful and is equipped with a fuel-saving device Honda calls VTEC, which stands for Variable Valve Timing and Lift Electronic Control. This device regulates both the flow of fuel into the engine and the moment of ignition, reducing fuel consumption noticeably when compared to engines without it.

In the Accord, the VTEC system doesn't increase the range of the vehicle, but instead gives the engine more power and increases its overall performance. The transmission is a five-speed manual or an automatic, and drives the front wheels.

Civic CX

also Civic DX, Civic EX, Civic HX, Civic LX

Capacity:	1+3
Weight:	1,000kg
Engine:	106hp
Top speed:	180km/h
Range:	640km



The Civic can be seen as Honda's multi-national car. Versions of it are in production in Japan, Canada, the U.K., and the U.S., and it is sold all over the world. A large number of variants are made: coupes (DX, EX, and HX), three-door hatchbacks (CX and DX), and four-door sedans (DX, EX, and LX).

The Civic is a medium-sized family car that seats four people. The interior is not very large, however, and its layout is very basic and conventional, with two front seats and a rear bench. In the two- and three-door models, the front seats can be folded forward to allow the rear passengers to get in, but when the seats are folded back they have to be completely readjusted, which can be bothersome for the driver and/or front-seat passenger. In the four-door Civics, this is obviously not a problem.

The engine is in the front and it drives the front wheels. The transmission is either automatic or a manual five-speed in most models, though the Civic HX is also available with a continually variable transmission (CVT): a special kind of automatic transmission that allows an infinite range of gears through the use of convex discs and a chain instead of sprockets. The engines of the EX and HX models are equipped with Honda's VTEC system described in the entry for the Accord, above. An ABS is only available on one version of the EX, with automatic transmission.

DX	EX	HX	LX
1+3	1+3	1+3	1+3
1,000kg	1,000kg	1,000kg	1,000kg
106hp	127hp	114hp	106hp
180km/h	215km/h	190km/h	180km/h
640km	760km	725km	640km

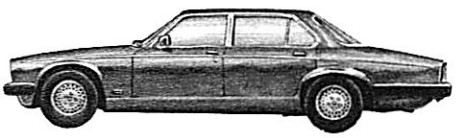
JAGUAR

Jaguar Cars Limited, UK

XJ6

***also* XJR, XJ12**

Capacity:	1+3
Weight:	1,800kg
Engine:	219hp
Top speed:	225km/h
Range:	935km



Jaguar is famous for its luxury, high-performance cars. All XJ-series cars are "saloon" models (Jaguar's term for four-door sedans) with seating for four people, though the rear passengers are a little bit cramped. Part of the upholstery is leather, making the seating very comfortable, and the front seats are fully adjustable. Long wheel base models are made that have 12 cm more leg room for the rear passengers, and as an option in these models two rear seats are available instead of a single bench.

The XJ6 is the baseline model in the XJ-series, and is available in a number of versions that differ slightly from each other. They all have a six-cylinder engine with fuel injection. The rear wheels are driven, either through a five-speed or an automatic transmission. Powered steering is a standard feature on all models.

The XJR is similar to the XJ6, but has a larger, more powerful engine to increase performance at the expense of economy, while the XJ12 replaces the six-cylinder engine by a twelve-cylinder model. The XJ12 is only available with an automatic transmission.

XJR	XJ12
1+3	1+3
1,875kg	1,975kg
327hp	318hp
250km/h	250km/h
865km	670km

JEEP

Jeep-Eagle Division, Chrysler Corporation, U.S.

Cherokee Sport

***also* Cherokee LE, Cherokee SE, Cherokee TD Sport**

Capacity:	1+4
Weight:	1,670kg
Engine:	264hp
Top speed:	215km/h
Range:	560km

The Cherokee is a luxury off-road car introduced in 1984 as a response to an increased market for such vehicles in the United States. Up until that time, off-road vehicles tended to be rather bare and functional rather than comfortable. The Cherokee is a five-door hardtop with high ground clearance, a powerful engine, and four-wheel drive. Seating is sufficient for five people, though more could be squeezed in if necessary. Behind the rear seats there is room for cargo, and on the roof are rails to which more can be fastened if required.

The standard engine in the Sport is a 2.5 liter, four-cylinder model. Both the LE and the SE have a 4 liter, six-cylinder engine. The TD Sport, on the other hand, boasts a 2.5 liter diesel. The normal transmission is a five-speed manual, though the both LE and SE can be equipped with an automatic instead. All have selectable rear-wheel or four-wheel drive at the flick of a switch, and due to the Command-Trac system the change can be made while driving. Four-wheel drive is useful off the road, but on-road it reduces performance somewhat. The Cherokee LE has standard ABS, the other models do not.

LE	SE	TD
1+4	1+4	1+4
1505kg	1505kg	1490kg
185hp	185hp	116hp D
180km/h	180km/h	165km/h
530km	530km	730km

Wrangler

Capacity:	1+3
Weight:	1,395kg
Engine:	177hp
Top speed:	170km/h
Range:	445km

The Wrangler can trace its lineage back to the first jeep, the Willys MB that was taken into service by the U.S. Army in 1941, and is styled to resemble the MB while appearing modern at the same time. The Wrangler is available with both hard and soft tops, seating four people in either configuration, and is primarily designed for off-road driving. The soft top version has two half-doors at the front, while the hardtop has a three-door body.

Underneath, the Wrangler has a strong chassis onto which the whole car is built, using two rigid axles braced with coil springs and shock absorbers for good cross-country performance. Either a five-speed manual or an automatic transmission is fitted, and the driver can choose between rear-wheel drive or four-wheel drive; this selection must be made when the car is standing still, however. The engine has six-cylinders in-line and fuel injection, providing the power necessary for driving through rough terrain.

LAMBORGHINI

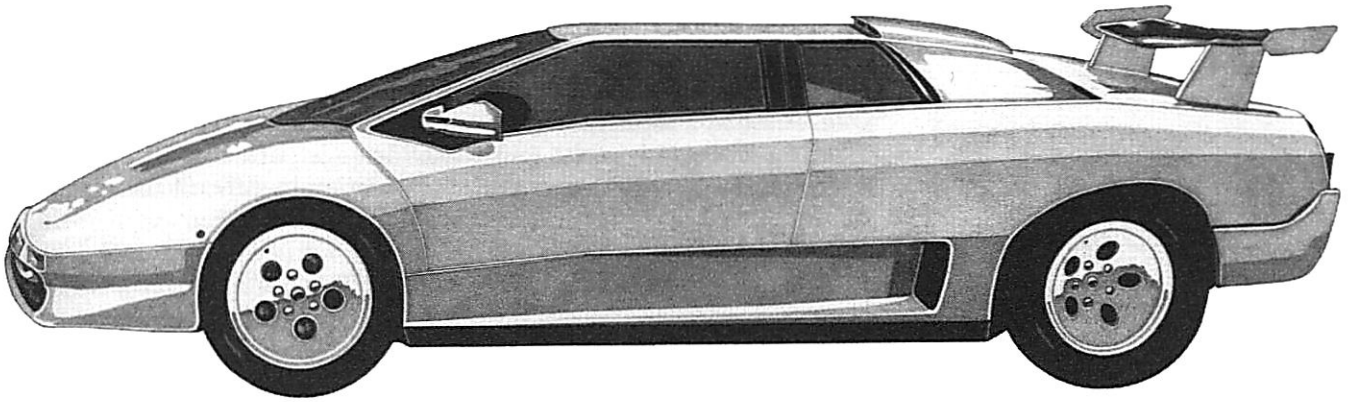
Nuova Automobili Ferruccio Lamborghini S.p.A., Italy

Diablo

also **Diablo VT, Diablo Roadster VT, Diablo SV/SVR**

Capacity:	1+1
Weight:	1,575kg
Engine:	493hp
Top speed:	325km/h
Range:	650km

The only car produced by the Italian Lamborghini company, the Diablo is a high-performance sportscar available in a number of versions. The basic model is a two-seater with a 12-cylinder engine behind the passengers, coupled to a 5-speed manual transmission driving the rear wheels, to give a top speed of around 325 km/h. The high power gives excellent acceleration, especially for a car as heavy as the Diablo, and 0 to 100 km/h is possible in 4.1 seconds according to the manufacturer's data. The SV/SVR model, which is lighter and has a slightly more powerful engine, does the same in less than 4 seconds.



All wheels have independent suspension, disc brakes, and shock absorbers; double shock absorbers are standard for the rear wheels, but an ABS is not installed. The VT and Roadster VT models have permanent four-wheel drive, which increases the weight somewhat but improves handling.

As with its predecessor, the Countach, the Diablo has doors that hinge upward at the front, rather than conventional doors that open sideways. Diablos manufactured during and after 1996 have a hydraulic system that allows the driver to raise the car 4.5 cm above its normal height, increasing ground clearance for driving across obstacles such as curbs and garage entrances. When the car's speed exceeds 70 km/h, it automatically goes back down to normal height.

The Roadster VT is a convertible, with a removable hard roof panel and a different bumper, engine cover, and wheels. The roof plate, when removed, can either be left off the car completely, or stowed above the engine deck. The Roadster's side windows automatically go down about two centimeters when the door is opened.

VT	Roadster VT	SV/SVR
1+1	1+1	1+1
1,620kg	1,625kg	1,475kg
493hp	493hp	493hp
325km/h	325km/h	325km/h
650km	650km	650km

Land Rover

Land Rover Limited, U.K.

Defender 110 County

Capacity:	1+4
Weight:	1,920kg
Engine:	113hp D
Top speed:	135km/h
Range:	375km

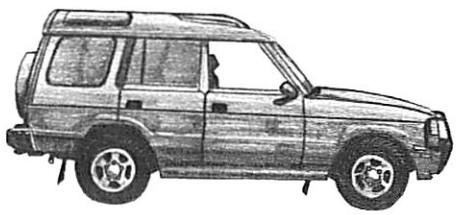
The Defender is a direct descendant of the first Land Rover produced in 1948. Almost fifty years later, the lines of the original are still recognizable, even though in essence the Defender 110 is a totally new vehicle. The only civilian model is a five-door, five-seater with a cargo area behind the rear seats. There are two front seats, and a rear bench that can seat three. The back of the bench can be folded down to increase the cargo space.

Under the hood sits a 2.5 liter diesel engine and a five-speed manual transmission; in older models, changing gears was somewhat difficult, but in recent models this has been made much easier by a newly-designed transmission. An automatic transmission is not available. The suspension has rigid front and rear axles, thus it is not fully independent; however the four-wheel drive is permanently enabled which certainly helps to provide good traction in difficult terrain.

Discovery 300

also Discovery V8

	300	V8
Capacity:	1+6	1+6
Weight:	2,065kg	1,975kg
Engine:	113hp D	182hp
Top speed:	145km/h	170km/h
Range:	815km	590km



This is a luxury four-wheel drive that is more intended to be a van than a true off-road vehicle. The Discovery comes in two basic models, the 300 and the V8, both available in either Leisure, Estate, or ES models. The Leisure version has either three or five doors, while the others are only available with a five-door body. The upholstery is leather in all models, and seats five people in comfort. Two additional passengers can be carried in the very back, on small folding seats not really suited for long distances.

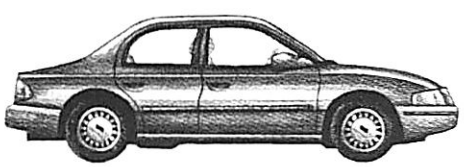
The Discovery 300 has a 2.5 liter diesel engine, the same as that fitted to the Defender 110, while the V8 uses a 4 liter gasoline engine with much higher power output. Both are available with a five-speed manual transmission, while an automatic transmission is also made for the V8. Permanent four-wheel drive is standard, but ground clearance is too low for real off-road driving.

LINCOLN

Ford Motor Co., Lincoln-Mercury Division, U.S.

Continental

Capacity:	1+4
Weight:	1,670kg
Engine:	264hp
Top speed:	215km/h
Range:	560km



Though the first Lincoln Continental was made in 1938, the current Continental model was introduced in 1995. This is a large car with many luxury features and lots of internal space. Even rear passengers have plenty of leg room, though head room is somewhat limited for tall passengers.

Electronics abound, including an automatic air conditioner, heated seats, cruise control, and an on-board computer giving driving advice and problem notifications. Airbags are installed for both the driver and the front-seat passenger. The rearview mirrors automatically change position when the car is put into reverse, giving the driver a better view of the area immediately behind the car.

Only available with an automatic transmission, the Continental has a 4.6-liter V8 engine with advanced engine management systems and electronically-controlled throttle. It has front wheel drive, and the suspension is pneumatic and adjustable in rigidity. The standard powered steering is likewise adjustable, and combined with the traction control it makes this heavy car easy to handle.

Mark VIII

Capacity:	1+4
Weight:	1,625kg
Engine:	284hp
Top speed:	215km/h
Range:	680km

The Mark VIII is a large car with spacious seating for five people. The front seats can be folded forward for easy access to the back seats, which is also made easier by the large doors. The seats automatically return to their starting positions when folded back. They can be programmed with up to three positions for different drivers. Two airbags are included as a standard feature.

The large 4.6-liter engine drives the rear wheels using an automatic transmission. The standard features include cruise control, powered steering, and powered brakes. The suspension is pneumatic, allowing the car to remain level despite bumps in the road, and also lowering the whole car slightly when speed goes over 70 km/h to improve handling at higher speeds. Top speed is electronically limited to 215 km/h.

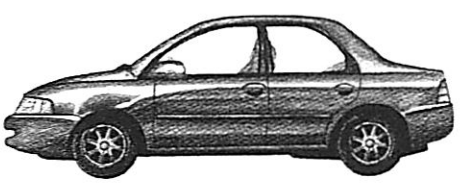
MAZDA

Mazda Motor Corporation, Japan

626 DX

***also* 626 LX, 626 LX V6, 626 ES**

Capacity:	1+3
Weight:	1,150kg
Engine:	117hp
Top speed:	200km/h
Range:	750km



Although a Japanese car, the Mazda 626 is built in the U.S. in the same plant that produces the Ford Probe (see page 28). It is a midsize car available in sedan and five-door hatchback models, each with a choice of two engines. With the rear seats folded down quite a large amount of luggage can be carried, especially in the hatchback.

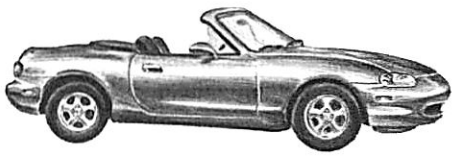
One of the plus-points of the 626 is its safety in crashes. There are airbags for the driver and the front-seat passenger, and crash test results have shown that passengers in the 626 are well-protected. However, an ABS is not available on the DX, while it is optional on both LX models and standard on the ES. The interior is comfortable and roomy for all of the passengers.

The standard engine is a four-cylinder, two liter model, while the LX V6 and ES models have a Ford-developed V6 engine that is much more powerful and increases performance markedly. Either engine drives the front wheels through an automatic or five-speed manual transmission, the latter being the standard type fitted. Powered steering and brakes are standard.

626 LX	626 LX V6	626 ES
1+3	1+3	1+3
1,150kg	1,250kg	1,250kg
117hp	167hp	167hp
200km/h	220km/h	220km/h
750km	700km	700km

MX-5 Miata

Capacity:	1+1
Weight:	990kg
Engine:	131hp
Top speed:	200km/h
Range:	640km



Introduced in 1990, but obviously inspired by the British "roadsters" of the 1950s, the MX-5 re-opened the market for small, light, open-topped sportscars. It quickly became very popular with sportscar enthusiasts, and an improved model was introduced after 280,000 were built in about five years.

The MX-5 only seats two people, and does not provide all that much room inside, but most people find this part of the charm of these types of cars. The interior is functional with little decoration, but it isn't Spartan either. The standard model is a convertible, although a hard top is available. The soft top is easily folded in or out in very little time, so the car doesn't get flooded while the driver tries desperately to get the roof on when it starts to rain. The trunk is in the back, and though large in capacity, it is not very deep, so bulky items are hard to carry.

Mechanically, the MX-5 uses a 1.8-liter engine derived from the 1.6-liter used in the earlier model Miata. Coupled to a five-speed transmission this engine gives good acceleration and a top speed in the order of 200 km/h. That is not outstanding compared to other sportscars, but the good cornering abilities compensate for this. With rear wheel drive and the engine in the front of the car, the MX-5 handles much like the famous MG of the 1950s.

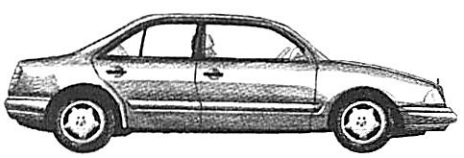
MERCEDES-BENZ

Mercedes-Benz AG, Germany

C-Class

***also* C200, C220, C220D, C230, C250TD, C280**

Capacity:	1+3
Weight:	1,280 kg
Engine:	122hp
Top speed:	195km/h
Range:	765km



The C-class was introduced by Mercedes in mid-1993 to replace the old model 190 and was intended to provide more comfort and useful space, be more environmentally-friendly, and have better safety-measures than its predecessors. The class consists of seven basic models, all of which are four-door, four-seat types with a hard top, front-mounted engine, and front-wheel drive. The 180, 200, 220 Diesel, 230, and 250 Turbodiesel are also available in a "Combi" version—that is, a five-door stationwagon. Standard equipment for all includes side-impact protection bars in the doors, powered steering, and choice of a five-speed manual or automatic transmission.

With all Mercedes cars, the number indicates the engine volume—the C 250 has a 2.5 liter engine, for example. The 220 is available in both gasoline and diesel engine models, while the 250 is only made with a turbocharged diesel engine, giving it performance rivaling that of gasoline-powered cars but with the low fuel consumption of a diesel.

Each model in the C-class comes in four versions: Classic, Esprit, Elegance, and Sport. The differences between these are minor, but are intended to give the car a style of its own: Classic as the basic model; Esprit for a youthful character; Elegance for a more formal, business-like look; and Sport for those wanting a more dynamic car.

C200	C220	C220D	C230	C250TD	C280
1+3	1+3	1+3	1+3	1+3	1+3
1,295kg	1,340kg	1,330kg	1,410kg	1,410kg	1,490kg
136hp	150hp	95hp D	150hp	150hp D	193hp
200km/h	210km/h	175km/h	210km/h	205km/h	230km/h
775km	765km	900km	765km	860km	650km

E-Class

***also* E220D, E230, E280, E290, E320TD, E420**

Capacity:	1+3
Weight:	1,440kg
Engine:	136hp
Top speed:	205km/h
Range:	960km

The E-class is a step bigger than the C-class. The most easily recognizable styling difference between the C- and E-classes is in the headlights: after years of rectangular headlights for all cars, Mercedes gave the E-class round headlights in 1995.

The E-class has more room and more standard features than its little brother, and comes with a more powerful engine. Features such as double airbags and door-mounted airbags for protection against collisions from the sides are standard. A sensor is fitted which automatically switches on the windscreen wipers when it starts to rain.

All E-models are made in Classic, Elegance, and Avantgarde variants. The normal body style is a four-door sedan, though the 200, 230, 290TD, and 420 are also available as 5-door Combis. The 320 and 420 are only available with an automatic transmission, the 290TD is only available with a five-speed manual transmission, and all other E-class cars are available with either an automatic or a five-speed manual transmission.

E220 D	E230	E280	E290 TD	E320	E420
1+3	1+3	1+3	1+3	1+3	1+3
1,390kg	1,450kg	1,570kg	1,545kg	1,600kg	1,620kg
95hp D	150hp	193hp	130hp D	220hp	279hp
180 km/h	215km/h	230km/h	200km/h	235km/h	250km/h
1,125 km	975km	1,000km	1,175km	910km	930km

G-Class

***also* G230, G300, G300TD, G320**

Capacity:	1+3
Weight:	2,060kg
Engine:	127hp
Top speed:	145km/h
Range:	590km

As with luxury cars, Mercedes manufacturers a whole series of off-road vehicles known as the G-class (for Gelnde, German for "terrain"). The four basic models are all made in three- and five-door body styles with hard roofs. The three-door models are also available as convertibles with roll bars over the passenger compartment. The data below is for the three-door types; the five-door variant is approximately 6% heavier, and is also 40 cm longer.

All models seat four people, as most of the extra length of the five-door model is used to create luggage space behind the rear seats. The layout is conventional, with the engine at the front and the passenger compartment taking up the rest of the body. Outside, the G-class appears simple, square, and somewhat old-fashioned. Internally, however, it is a very advanced design using the latest technology to give it a good performance both on and off the road, much like other Mercedes cars.

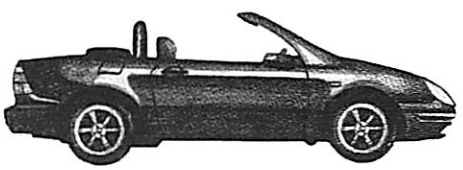
All four wheels are permanently driven, using a manual five-speed transmission in the 230 and 300. The 300 Turbodiesel and 320 are only available with an automatic transmission, which is optional on the other models.

G300	G300 TD	G320
1+3	1+3	1+3
2085kg	2145kg	2145kg
170hp	177hp D	211hp
165km/h	165km/h	175km/h
540km	500km	550km

SLK 200

also SLK 230 Kompressor

	200	230K
Capacity:	1+1	1+1
Weight:	1,270kg	1,325kg
Engine:	136hp	193hp
Top speed:	210km/h	230km/h
Range:	630km	655km



Standing for "Sportlich, Leicht, Kurz," meaning Sporty, Light, Short, the SLK is a modern light sportscar, a "roadster." Technically it is a derivative of the C-class, but it's about half a meter shorter. The rear seats have been deleted because of this, creating a two-seater, convertible coupe. The roof is of novel construction, being all-steel and hydraulically operated at the push of a button. It opens or closes in about twenty-five seconds and transforms the car into a hard-top; when folded in, the roof rests in the trunk, drastically reducing the available cargo space.

The SLK comes with either a 2- or 2.3-liter engine, the latter with a compressor to boost engine power. Either can be had with an automatic or five-speed manual transmission, and comes with an ABS; the 230 adds traction control.

The SLK does not come with a spare tire, instead there is a can with foam that is to be sprayed into a punctured tire as a temporary repair until the car can be brought into a garage.

MERCURY

Ford Motor Co., Lincoln-Mercury Division, U.S.

Sable

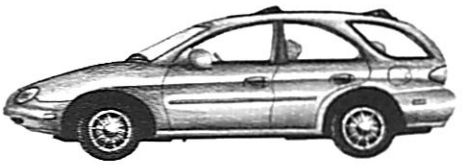
also See Ford Tarus

Capacity:	1+3
Weight:	1,480kg
Engine:	203hp
Top speed:	180km/h
Range:	750km

The Mercury Sable is virtually identical to the Ford Taurus (see page 29). They are made in the same factory and the primary difference between them is the manufacturers' logos. The Sable is available in four-door sedan and five-door stationwagon models. These models are easily recognized by their aerodynamic body shapes. There is a lot of room inside and an excellent field of view for the driver and passen-

gers. Two airbags are installed to protect the driver and front seat passenger.

The Sable has leather upholstery, a three-liter, six-cylinder engine, automatic transmission, independent suspension, and powered disc brakes. An ABS is optional, while powered steering is standard.



NISSAN

Nissan Motor Co., Japan

200SX

***also* 200SX SE, 200SX SE-R**

Capacity:	1+3
Weight:	1,060kg
Engine:	116hp
Top speed:	235km/h
Range:	740km

The 200SX is a medium-sized sporty coupe. It seats four people, though as with all coupes the rear passengers will have to climb past the front seats (which fold forward) to get in. Airbags are fitted for both front seats, and the doors have steel bars that protect the passengers in case of a collision from the side.

The engine is at the front of the car, and its weight makes the car somewhat nose-heavy. In taking corners at higher speeds, this requires the driver to pay careful attention. Two engine models are available for the 200SX, both with four cylinders; the base 200SX and the SE have a 1.6-liter engine, while the SE-R has a more powerful 2-liter engine. Both engines feature fuel injection. All three models come with either a five-speed manual transmission or an automatic. Antilock brakes are optional on the SE and SE-R, but are not available on the standard model. Power steering and powered brakes are standard.

200SX SE	200SX SE-R
1+3	1+3
1,065kg	1,135kg
116hp	140hp
235km/h	235km/h
740km	740km

Altima XE

***also* Altima GLE, Altima GXE, Altima SE**

Capacity:	1+3
Weight:	1,295kg
Engine:	150hp
Top speed:	235km/h
Range:	770km

The Altima is a compact car that's popular in the U.S. because it is a sporty family car. This four-door sedan is large and comfortable enough to carry four people for longer periods of time, but has exterior styling somewhat similar to many sportscars. Airbags for the driver and the front passenger are standard equipment in all Altimas, as are steel impact bars in the doors. Powered windows and powered locks are fitted to all except the XE, and the SE and GLE further have air conditioning and partly-leather upholstery.

The engine is the same in all models, a 2.4-liter four-cylinder mounted at the front of the car. The GLE is only available with an automatic transmission. On all models an ABS is optional, but powered steering is standard. Cruise control is standard on the GLE, GXE, and SE models, but not available for the XE.

GLE	GXE	SE
1+3	1+3	1+3
1,380kg	1,320kg	1,310kg
150hp	150hp	150hp
235km/h	245km/h	255km/h
770km	770km	770km

Patrol GR

also Patrol GR Wagon

	GR	Wagon
Capacity:	1+4	1+6
Weight:	1,920kg	1,960kg
Engine:	116hp D	116hpD
Top speed:	150km/h	150km/h
Range:	705km	670km

The Nissan Patrol GR (Grand Raid) is a four-wheel drive that is at home both in rough terrain and on the road. The three-door model, as it is about 60 cm shorter, has a much shorter wheel base than the five-door Wagon, which makes it less likely to get stuck off the road. The Wagon model can handle itself away from the road, but is also suitable for moving people for longer distances, as it has much more internal room. The Wagon can seat up to seven people if all seats are installed, while the three-door model only seats five.

The engine in the Patrol is a 2.8 liter, turbocharged diesel with six cylinders in line, and the transmission is a five-speed manual; it is not available with a gasoline engine or an automatic transmission. The engine can drive either the rear wheels only, or all four wheels when more traction is required. As with most four-wheel drives that have this option, the change between two- and four-wheel drive must be made when the car is standing still.

PONTIAC

Pontiac Motor Division, General Motors Corporation, U.S.

Firebird

also Firebird Trans Am

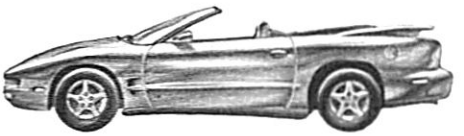
	Firebird	Trans Am
Capacity:	1+3	1+3
Weight:	1,655kg	1,710kg
Engine:	182hp	269hp
Top speed:	200km/h	240km/h
Range:	695km	615km

The Firebird is a legendary American sportscar, dating back to the late 1960s. A modernized version of the Firebird is still in production.

The Firebird is a four-seat sportscar, though as is often the case with such cars the rear seats are small and difficult to get into or out of. The standard model is a hardtop coupe with either a five-speed manual or an automatic transmission. It is also available as a convertible. Leather upholstery is available for either car, and a somewhat unusual option is a 500-watt stereo system with ten speakers. Airbags are installed for both the driver and the front-seat passenger, and air conditioning is fitted to all models.

The engine in the Firebird is a 3.8-liter V6. It is mounted in the front of the car, but it drives the rear wheels. Powered brakes and powered steering are installed as standard features.

Although the two are similar in appearance, the Trans Am is almost half a meter longer than the baseline Firebird, and has a much more powerful engine—a 5.7-liter V8. It can be had with the standard five-speed or automatic transmission, and a six-speed is also available at no increase in price.



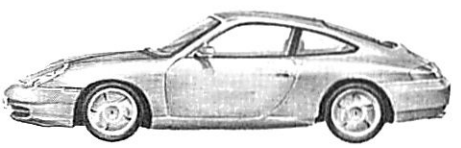
PORSCHE

Dr. Ing. H.C.F. Porsche AG, Germany

911 Carrera

***also* 911 Carrera 4, 911 Turbo**

Capacity:	1+3
Weight:	1,370kg
Engine:	286hp
Top speed:	270km/h
Range:	815km



For many, the 911 is the only real Porsche. In production for over thirty years, this sportscar has long been considered one of the most prestigious and trend-setting cars available. As most people expect, the 911's performance is outstanding, even when compared to other sportscars.

Although nominally a four-seater, the rear seats are so cramped that the only way to sit in the back is sideways, and this is made worse by the lack of rear doors; for most intents and purposes, the 911 is a two-seater. The interior is luxurious—the 911 Turbo has full leather upholstery. While the Carrera and Carrera 4 are available in either hardtop or convertible models, the Turbo is only available as a hardtop.

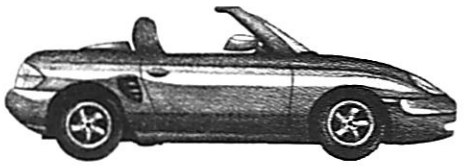
The six-cylinder, horizontally-opposed, air-cooled engine is installed in the rear. The Carrera has rear-wheel drive, while the Carrera 4 and the Turbo are both permanently in four-wheel drive, noticeably improving their performance on difficult roads. All of the wheels are independently sprung and have powered disc brakes; steering is also powered, and a six-speed manual transmission is the standard. The Carrera is also available with an automatic transmission which Porsche calls Tiptronic.

Carrerra	Turbo
1+3	1+3
1,420kg	1,500kg
286hp	408hp
270km/h	290km/h
805km	710km

Boxster

Capacity:	1+1
Weight:	1,250kg
Engine:	204hp
Top speed:	240km/h
Range:	915km

The Boxter is a brand-new Porsche, introduced in 1996 as a follow-up to the old 924, 928, 944, and 968. The Boxster is aimed at a younger market than the 911 (above), and has been carefully styled to look and sound like a Porsche—one of the common complaints about models like the 924 was that they weren't "real" Porsches.



The Boxster is a two-seat convertible with a 2.5-liter engine, available with a five-speed transmission or Porsche's "Tiptronic" automatic transmission. The roof is raised and lowered electronically, and though a hardtop is produced, the convertible is the standard model. Airbags for driver and passenger are standard.

The engine is a completely new water-cooled design, a six-cylinder with fuel injection. It is mounted in the middle of the car, driving the rear wheels. This allows the Boxster to have two trunks: a large one at the front and a small one behind the engine.

Handling is good due to the anti-lock brakes, independent suspension, and power steering. An interesting feature is the automatic spoiler—normally retracted between the trunk and rear bumper, this comes up as the car reaches 120 km/h.

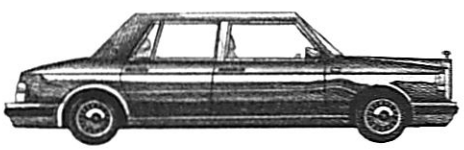
ROLLS-ROYCE

Bentley Motors Limited, UK

Silver Spirit

***also* Park Ward, Silver Dawn, Silver Spur**

Capacity:	1+3
Weight:	2,380kg
Engine:	259hp
Top speed:	215km/h
Range:	625km



Rolls-Royce is well known for its expensive luxury cars, and the Silver Spirit is no exception. It's a very large and heavy car with lots of internal space and many luxury features.

All Rolls-Royces can be outfitted to meet the customer's wishes straight from the factory, though standard features include top-quality leather upholstery, electrically-adjustable seats with memory for four different drivers, an entertainment system, air conditioner, and air bags for both front seats.

Under the hood, the Silver Spirit has a V8 engine with fuel injection, 6.75 liters in size and linked to an automatic transmission, while the suspension has an electronic dampening system for comfortable driving.

The Silver Dawn and Silver Spur are internally and externally almost identical to the Silver Spirit, but are some ten centimeters longer to create more room for the passengers. The Silver Spur has a turbocharged engine that increases both its acceleration and top speed. It has become the standard model, while the Silver Spirit is only produced on demand. The Park Dawn, formerly known as the Limousine, is similar to the Silver Spirit, but seventy centimeters longer.

Park Ward	Silver Dawn	Silver Spur
1+3	1+3	1+3
2,640kg	2,380kg	2,380kg
259hp	259hp	299hp
200km/h	215km/h	225km/h
575km	625km	615km

SAAB

Saab Automobile AB, Sweden

900

***also* 900 S, 900 SE, 900 SE Turbo, 900 V6 SE**

Capacity:	1+3
Weight:	1,290kg
Engine:	131hp
Top speed:	200km/h
Range:	800km

Saab's 900 is a medium-sized car in a somewhat higher price range than most of its equivalents. All 900-series Saabs are available as either three- or five-door hatchbacks, or as two-door convertibles. Saab further offers four accessory packages for each model: Driving (cruise control and car computer), Comfort (air conditioner), Sport (lightweight wheels, mist headlights, leather steering wheel, and rear spoiler), and Luxury (full leather upholstery and wooden dashboard panels).

The normal engine is a 2-liter model, though the SE has the volume increased to 2.3 liters to add more power. The 900 Turbo has the base 2-liter engine but adds a turbocharger—which Saab has long been known for—to increase its power output. It also has a different transmission, a five-speed manual with automatic clutch: the driver only needs to shift the gear stick to change gears, without having to press a clutch pedal. Gears can be changed faster this way, which complements the higher acceleration already provided by the turbo-charged engine.

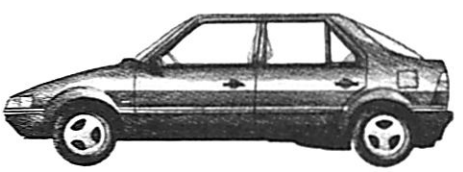
All 900s have an ABS and a system called EBD (Electronic Brake-force Distribution) that divides the braking forces as evenly as possible to all four wheels.

900 S	900 SE	900 SE Turbo	900 V6 SE
1+3	1+3	1+3	1+3
1,290kg	1,290kg	1,425kg	1,290kg
131hp	150hp	185hp	170hp
200km/h	210km/h	230km/h	225km/h
800km	885km	800km	810km

9000 CS

***also* 9000 CD, 9000 CDE, 9000 CSE, 9000 Aero**

Capacity:	1+3
Weight:	1,500kg
Engine:	131hp
Top speed:	200km/h
Range:	820km



Though it resembles the Saab 900, the 9000 is a slightly larger car and is made in more variants. These variants take two directions: the CD, CS, CDE, and CSE models differ in the accessories they are equipped with, while each is available with a choice of four different engines. The 9000 Aero is a slightly more streamlined version of the 2.3 Turbo-engine model. Furthermore, each is made in four- and five-door models, and the accessory packages mentioned for the 900-series (above) are also available in the 9000-series.

Three of the four engines in the 9000-series are equipped with turbochargers, which has long been one of Saab's hallmarks. The LPT versions have a low-pressure turbo that performs better when the engine is operating at a low number of revolutions per minute, which

improves acceleration rather than boosting overall engine power. The normal turbo fitted to the 2.3-liter engine is intended for maximum power, though.

All Saab 9000s have traction control and a car computer. The CSE adds cruise control, and the Aero also has an airbag on the passenger's side.

To celebrate fifty years of car manufacture, Saab has brought out a special Anniversary model of the 9000 CSE that was only for sale during 1997. The differences between this special edition car and the standard 9000-series are minimal, however.

2.0 LPT	2.3 LPT	2.3 Turbo	9000 Areo
1+3	1+3	1+3	1+3
1,500kg	1,500kg	1,500kg	1,500kg
150hp	170hp	200hp	224hp
210km/h	220km/h	235km/h	240km/h
850km	860km	840km	885km

TOYOTA

Toyota Motor Company Ltd., Japan

Camry CE

also Camry LE, Camry LE V6, Camry XLE, Camry XLE V6

Capacity:	1+4
Weight:	1,350kg
Engine:	136hp
Top speed:	195km/h
Range:	825km

The Camry is a large sedan, and has been one of the best-selling cars in the U.S. for some years. It has a spacious interior, large enough to comfortably carry five adults, and is well-equipped. The CE is the simplest model, the others add accessories to make the car more comfortable or luxurious. The LE comes with air conditioning, cruise control, powered door locks, powered windows, and electrically-adjustable rearview mirrors. The XLE adds an anti-theft system and some leather trim to the LE, and can be had with leather-covered seats.

Two engines are available, a four- and a six-cylinder, both driving the front wheels. In the CE model a five-speed manual or an automatic transmission can be fitted, while all others have a standard automatic transmission. The V6-engine variants of the Camry are only made with an automatic transmission, and have traction control available as an option. Powered steering and powered brakes are fitted to all models. An ABS is optional on the CE.

LE	LE V6	XLE	XLE V6
1+4	1+4	1+4	1+4
1,400kg	1,460kg	1,410kg	1,470kg
136hp	195hp	136hp	195hp
195km/h	220km/h	195km/h	220km/h
825km	775km	825km	775km

Celica ST

***also* Celica GT**

	ST	GT
Capacity:	1+3	1+3
Weight:	1,100kg	1,180kg
Engine:	116hp	135hp
Top speed:	200km/h	225km/h
Range:	810km	730km

Toyota's sportscar, the Celica, has long had a futuristic styling, some years ahead of most similar cars. The current model was introduced in 1994, though the first Celica dates from 1970.

The Celica is made in an ST and a GT model, which differ in their engines: a 1.8-liter in the ST, and a 2.2-liter for the GT. The ST is available as a coupe or a three-door hatchback. The GT is built as either a three-door hatchback or a two-door convertible. As with most sportscars, the rear bench is too small for adults, though it is large enough for most children.

All Celica models—engines and body styles—are made with either a five-speed manual or an automatic transmission, that drives the front wheels. An ABS is optional while power steering is a standard feature. The GT has powered locks and powered windows as well. In the GT Convertible, the folding roof is power-operated. Options include an air conditioner and cruise control.

Paseo

Capacity:	1+3
Weight:	895kg
Engine:	90hp
Top speed:	185km/h
Range:	650km

The Paseo is a compact coupe with a low profile that makes it look much like a high-performance sportscar; its actual performance, however, is only average. The interior is simple and uncluttered. It is equipped with two airbags for safety. Like the Celica (above), there is a rear bench but the rear passengers have very little room; it is large enough for children but not for adults. The front seats have more space, but they are not spacious.

The engine is a simple four-cylinder with a volume of 1.5 liters. A five-speed transmission is standard, while an automatic is available as an option. Further options include anti-lock brakes, cruise control, and air conditioning, though for some reason it is not possible for a Paseo to have both an ABS and cruise control. In addition to the normal body style with a hard roof, a convertible version is made.

In Japan, this car is known as the Cynos.

CIVILIAN MOTORCYCLES

CHAPTER TWO

CIVILIAN MOTORCYCLES

Motorcycles have been around for about as long as cars, but while they were initially seen as a cheaper alternative to a motorcar (due to their smaller size), they quickly attracted a following of enthusiasts who enjoy the sense of freedom a motorcycle gives to the rider: a motorcycle is open, unlike most cars, and much smaller so it can go places a car cannot. Furthermore, or perhaps because of these factors, society tends to think of motorcyclists as outsiders, somewhat wild and different from "normal" people.

The construction of a motorcycle is fairly similar for all manufacturers. A frame of welded metal tubes and cast parts forms the basic structure onto which the other components are installed; steel is still often used, but aluminum has replaced it in high-performance bikes. The engine is placed at the front of the frame, normally with part of the frame going under and in front of the engine. Some motorcycles use the engine as part of the frame, removing the need for several tubes and thus lightening the motorcycle. In these bikes, however, the engine as a whole cannot be removed from the frame. If the engine is water-cooled, a radiator is installed at the front or sides of the frame; an air-cooled engine has no radiator.

The rear suspension is attached to the rear of the frame, behind the engine. Its normally U-shaped, with the wheel in the open end of the U, and hinges in the frame at one point, with one or two springs to keep the rear wheel pressed firmly onto the ground. Shock absorbers are often fitted inside the springs.

The transmission is attached to the rear of the engine block, and it drives the rear wheel via a chain or a shaft. Chain drive is lighter and has less power loss than shaft drive, but it requires more maintenance because a chain stretches with use. A chain-driven motorcycle will

have to have its chain tensioned regularly to prevent it from running off the sprockets. There is a noticable difference in performance between a chain- and shaft-driven motorcycle. While a chain tends to pull the motorcycle up and forward, a shaft driven vehicle tends to have more force applied to the rear tire, pressing it down onto the pavement with more force than that of a chain-driven morotcycle.

The front suspension is attached to the upper front of the frame, in such a way that it can turn from left to right. It normally consists of two bars (together called the front fork) going down to the front wheel; each bar consists of two tubes—the upper one slides inside the lower and a spring inside the lower tube absorbs shock. A shock absorbing system using oil or air to cushion the shocks is often also fitted into the tubes. The handlebar is attached directly to the top of the front fork.

The fuel tank is usually installed above the engine, making a fuel pump unnecessary—gravity causes the fuel to flow to the engine. A seat for the rider, and usually one passenger as well, is behind the fuel tank.

Today, the wheels are often cast of a light metal such as aluminum, and have a small number of wide spokes. Motorcycles with a traditional look, as well as nearly all off-road bikes, have wheels with many thin, wire spokes. This latter method is advantageous because several spokes can be lost and the wheel will retain its strength. With a small number of large spokes, losing one would be disastrous. They're much stronger though, and breaking one is highly unlikely.

A brake is fitted to each wheel; the front wheel nearly always has a disc brake, in powerful motorcycles usually two, while the rear wheel uses a drum brake in the hub of the wheel, or a single disc brake (there is rarely enough room to install two disc brakes on a rear wheel).

These are all of the essential components—anything else is there to dress up the bike and make it more attractive or increase its performance. The most common features are cowlings of various kinds—plastic body panels covering the engine, the area around the headlights, and other parts of the frame, often in aerodynamic shapes. These cowlings serve to streamline the motorcycle; a well-designed cowling can have a serious effect on the bike's top speed, and to a lesser extent on acceleration. One problem caused by fitting a cowling is that less air flows directly over the engine, so most motorcycles with cowlings have water-cooled engines.

The controls of a motorcycle differ from those of a car somewhat. Everything is placed so that, in the natural riding position, the rider's hands and feet rest on the major controls such as steering bar, accelerator, clutch, gear shift lever, and brakes. All the main controls of a motorcycle can be operated without the rider having to move his or her hands or feet very far, unlike in a car. For this reason, motorcyclists can often react a little bit faster than car drivers to changing situations on the road.

The right handgrip of the steering bar is used to accelerate the motorcycle. By twisting it, the flow of fuel to the engine is increased. When released, the handgrip rotates back into the closed position. One of the brakes on a motorcycle is on the right-hand side of the handlebar, the other by the right foot. The foot pedal operates the rear brake, while the hand brake is for the front wheel.

On the left-hand side of the handlebar is another lever that looks like a brake lever, but is actually the clutch. Shifting gears is done with the left foot, by moving small lever up or down. The exact layout of the gears depends on the manufacturer; for example in some the neutral position is at the bottom, while others place it above first gear and below second—in that case, to go from neutral to first gear, the rider has to push the lever down once; from first to second is done by pushing up twice, second to third is up once more, etc.

On many motorcycles, the lights turn on when the ignition switch is connected. There is usually a switch to toggle between normal and bright lights, but there is no off switch. The other controls—the horn for example—are similar to those of cars, and their locations vary with the manufacturer and motorcycle type.

Motorcycles have some disadvantages when compared to cars. The most obvious one is that they, and their riders, are much more vulnerable: whereas a car driver can be protected by airbags, safety belts, and the overall construction of the car, there is nothing to cushion the impact of another vehicle against a motorcycle, or protect the rider from harm except for protective clothing—often leather—and a helmet.

A less severe drawback, though one experienced a lot more often, is that motorcycles are basically clear-weather vehicles. Naturally, it is possible to ride one through rain, snow, or low temperatures, but this is not very comfortable even when wearing a rain suit or insulated clothing.

While cars are safer and have more cargo space than motorcycles, there are some advantages to having a motorcycle. Motorcycle engines are similar to those used in cars, but most of the time they are slightly smaller. However, because these engines only have to move a fraction of the weight that a car engine does, motorcycles have a much faster rate of acceleration and deceleration than cars. In addition to the increased acceleration, motorcycles can also manuver through smaller areas and require less road space than cars do.

BMW

Bayerische Motoren Werke AG, Germany

R 1100 RS

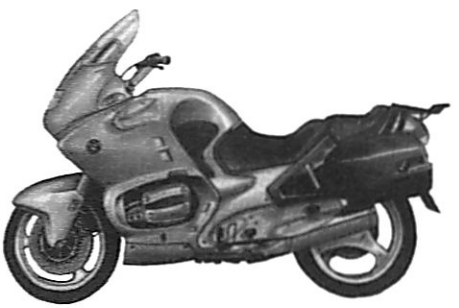
***also* R 1100 RT**

	R 1100 RS	R 1100 RT
Capacity:	1+1	1+1
Weight:	240kg	260kg
Engine:	90hp	90hp
Top speed:	215km/h	195km/h
Range:	370km	440km

The R1100 RS uses a horizontally-opposed two-cylinder, air-cooled engine and a five-speed transmission. The transmission can be noisy at times, though overall handling is excellent. The rear suspension consists of a single arm, on the right-hand side, while the front suspension is more traditional and has a normal front fork. Both front and rear wheels have disc brakes.

The engine of the RS is more powerful, and it has cowlings for better aerodynamics, as it is intended to be a sports bike with a high level of performance.

The RT adds even more cowlings and luxury extras to create a touring bike, including room to install a radio. Anti-lock brakes are also added.



DUCATI

Ducati, Italy

M 600

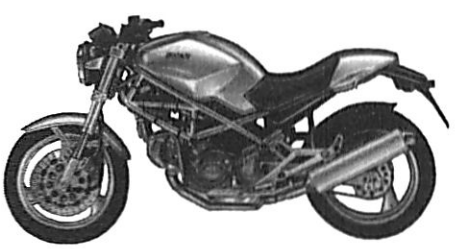
***also* 600 SS Caraneta, 600 SS Caraneta Nuda**

	M 600	600 SS
Capacity:	1+1	1+1
Weight:	175kg	170kg
Engine:	53hp	53hp
Top speed:	175km/h	190km/h
Range:	325km	365km

The M 600 is the lightest motorcycle made by the renowned Italian firm of Ducati. The frame is made from welded tubing, the engine hanging underneath it. The tank is located in the conventional position at the top of the frame, and the rider's seat is behind this. Although two people can sit on the M 600, the seat is really only large enough for one person; the passenger will have to sit in part on the piece of the cowling behind it.

The power plant is a 600 cc V2 engine with a 5-speed transmission that operates very smoothly (a feature Ducati is known for), using a chain to drive the rear wheel. A perforated disc brake on each wheel provides adequate braking power.

The M 600 lacks efficient cowlings, but the 600 SS Caraneta has a large, streamlined cowling over the engine and headlight, and a true buddy seat. Other minor differences exist between the M 600 and 600 SS, though in essence the two bikes are almost the same. The middle road between these bikes is the Caraneta Nuda, which only has a cowling over the top of the engine and the headlight.



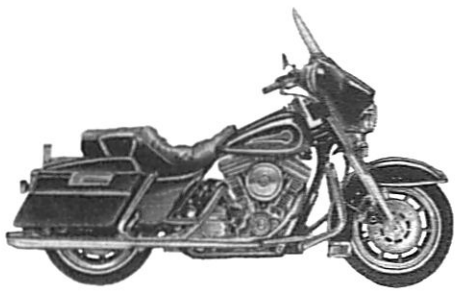
HARLEY-DAVIDSON

Harley-Davidson Motorcycles, U.S.

FLHT Electra Glide

***also* FLHR Road King, FLHTC Classic, FLHTCU Ultra Classic Electra Glide**

Capacity:	1+1
Weight:	320kg
Engine:	71hp
Top speed:	200km/h
Range:	360km



The Electra Glide is the motorcycle many people associate with Harley-Davidson. It is a heavy two-seater with a small cowling, a windscreen over the headlight, and a very large front fender. These add an aerodynamic look to the large motorcycle. A plastic baggage case on either side of the rear wheel is standard.

The whole Electra Glide series is powered by a 1,340 cc, air-cooled V2 engine with a five-speed manual transmission, that naturally drives the rear wheel. As an option, fuel injection is available, which presumably increases engine power and top speed. Good braking power is provided by two disc brakes on the front wheel and one on the rear wheel.

The Road King is very similar to the Electra Glide, but lacks the cowling over the headlight—it has a simple windscreen instead. Other differences are details, and the Road King can be considered similar to the Electra Glide for most purposes.

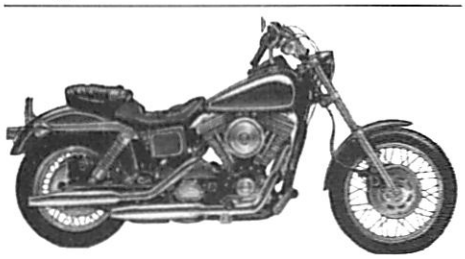
The Classic and Ultra Classic models add more accessories, mainly an extra baggage case behind the seat, but are otherwise similar to the standard Electra Glide.

FLHR	FLHTC	FLHTCU
1+1	1+1	1+1
315kg	345kg	345kg
71hp	71hp	71hp
200km/h	190km/h	190km/h
360km	360km	380km

FXD Dyna Super Glide

***also* FXDL Low Rider, FXDS Convertible, FXDWG Wide Glide**

Capacity:	1+1
Weight:	270kg
Engine:	71hp
Top speed:	200km/h
Range:	370km



The Dyna series is one of the classic-looking Harley-Davidson motorcycles, styled in a way many people feel is somewhat old-fashioned but greatly appreciated by Harley-Davidson enthusiasts.

Power comes from a 1,340 cc V2 engines, the same as used in the Electra Glide, mounted in the normal position at the front of the frame below the fuel tank. This engine makes a very recognizable sound, and Harley-Davidson strives to keep it exactly the same despite any modifications made to the engine—they have even gone so far as to trademark this sound. A five-speed manual transmission is fitted, driving the rear wheel through a chain. Unlike many modern bikes, the wheels have a large number of traditional, wire spokes; all brakes are perforated discs.

The differences between the different Dyna models are slight—at first sight they appear very similar. The Super Glide is the basic

model in the series with two front brakes, while the Low Rider is slightly longer and has only one front brake, reducing its braking power somewhat. The Wide Glide is also longer than the Super Glide, but not as long as the Low Rider. Its front fork makes a smaller angle to the ground than in the Super Glide, which makes it appear more streamlined, it has a backrest for the passenger, a different rear fender, and only a single front brake. The top-of-the-line model is the Dyna Convertible, with two front brakes, a seat with a backrest, and nylon with leather saddle bags beside the rear wheel. It also has a windscreen over the headlight.

FXDL	FXDX	FXDWG
1+1	1+1	1+1
270kg	280kg	270kg
71hp	71hp	71hp
200km/h	200km/h	200km/h
405km	350km	405km

HONDA

Honda Motor Co. Ltd., Japan

CB 500

Capacity:	1+1
Weight:	170kg
Engine:	59hp
Top speed:	190km/h
Range:	415km

The CB 500 is a simple motorcycle for everyday use. It is of conventional layout, with a buddy seat for the rider and one passenger, and the fuel tank above the engine. The cowlings on this model were designed for appearance, rather than utility, and provide little if any help against wind resistance.

The engine of the CB 500 is water-cooled, with a six-speed transmission to transfer its power to the rear wheel. Braking power is adequate for most situations, with a rear drum and a front disc brake.

Although not a particularly fast or outstanding motorcycle, the CB 500 is well-suited for day-to-day riding, such as commuting between home and work.

CBR 1100 XX SUPER Blackbird

Capacity:	1+1
Weight:	225kg
Engine:	165hp
Top speed:	300km/h
Range:	375km

Designed to be the fastest series-produced motorcycle ever, the Super Blackbird—named after the SR-71 Blackbird reconnaissance aircraft—is the first motorcycle that reaches 300 km/h straight from the factory. Honda claims that speed was not the only factor in the design, however; other goals included high acceleration, reliability, comfort, and stability on the road. Furthermore, there is enough room on the

buddy seat for the rider and a passenger, and luggage boxes can be mounted on the back.

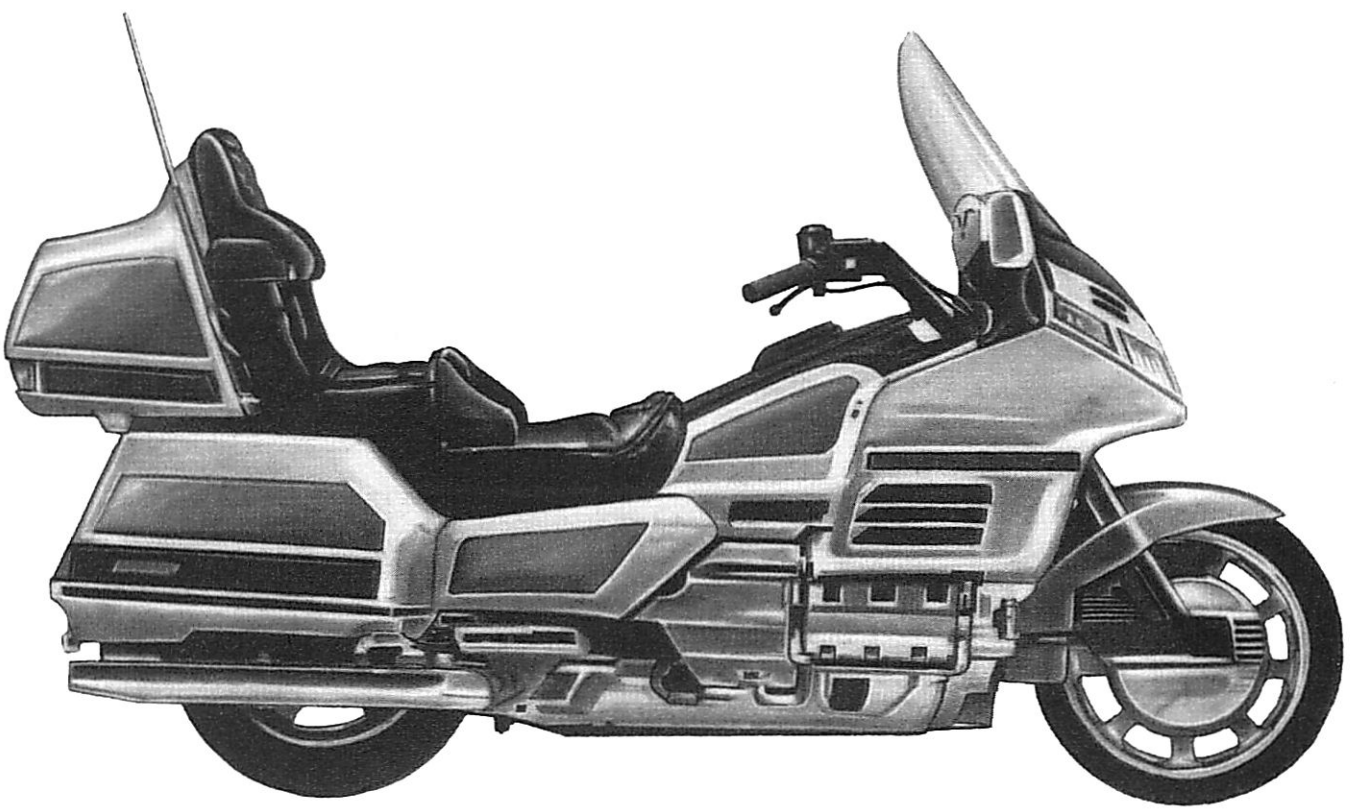
Honda has given the Super Blackbird a full cowling shaped to minimize air resistance, even going so far as to place the two headlights above each other instead of side-by-side. The four-cylinder, liquid-cooled engine was designed especially for this bike, and is hooked up to a six-speed transmission (though in practice the sixth gear is only needed if the rider wants to go to top speed). Both wheels are connected to fine-tuned disc brakes. Although not an ABS, these breaks are almost as effective. The brake pedal operates both rear and front brakes, rather than only the rear brake.

GL 1500 Gold Wing

Capacity:	1+1
Weight:	360kg
Engine:	101hp
Top speed:	200km/h
Range:	310km

Honda's flagship is the Gold Wing, a very large luxury motorcycle. The rider and passenger have individual leather seats instead of a buddy seat, with a small backrest for the rider and a large one for the passenger. Behind the seat is a luggage box, and two more boxes are fitted, one on either side of the rear wheel.

A complete set of cowlings cover most of the front, engine, and sides of the motorcycle for lower wind resistance, and includes a windscreen for the rider. Most Gold Wings are fitted with extensive electronics, including a riding computer and often a radio and an intercom system for communication between the rider and passenger, using helmet-mounted headsets and microphones.



Despite its large weight, the Gold Wing is reasonably fast, thanks to its six-cylinder engine and a five-speed manual transmission. Braking power is provided by two front and one rear disc brakes, contained in aerodynamic fairings. One interesting feature of the Gold Wing is a reverse gear, making it easy for the rider to back this very heavy bike into a garage or parking space. Speed is very low in reverse, mainly because the electric starting motor is used for it instead of the main engine.

ST 1100 Pan European

Capacity:	1+1
Weight:	287kg
Engine:	101hp
Top speed:	240km/h
Range:	475km

The Pan European is one of Honda's touring bikes, generally thought of to be easy to handle and comfortable to ride despite being a large machine. A cowling streamlines the bike to a large degree, and the seat is easily large enough for two people. However, the ST 1100 is not really built to accommodate tall riders, whose knees will press against the cowling. At the back are two storage boxes. The fuel tank is located under the seat instead of in front of it over the engine, as is more normal.

The engine is quite powerful, giving a high top speed and good acceleration, and the disc brakes (two front, one rear) give it equally good braking power. A further bonus is the long range due to the large fuel capacity and efficient fuel consumption. The standard ABS and a traction control system increase handling, especially on wet or otherwise slippery roads.

XR 600 R

Capacity:	1+1
Weight:	120kg
Engine:	45hp
Top speed:	140km/h
Range:	190km

The XR 600 R is an off-road bike that is somewhat large for its kind; most off-road bikes fall in the 125 to 500 cc bracket, and are correspondingly lighter. Apart from this, though, this bike is of fairly standard layout. It has a buddy seat for two people, though it is more suitable for a single person—there is not much for the passenger to hold onto—and has a high ground clearance with long suspension travel that makes it very suitable for riding through rough terrain. Off-road tires with a blocky profile are standard.

The engine has a single cylinder and is air-cooled, using a chain to drive the rear wheel. The transmission has five speeds. The bike gets its braking power from a front disc and a rear drum brake.

KAWASAKI

Kawasaki Heavy Industries Ltd., Japan

Eliminator 600

Capacity:	1+1
Weight:	200kg
Engine:	61hp
Top speed:	160km/h
Range:	220km

The Eliminator has a classic motorcycle look, with a teardrop-shaped fuel tank, a large engine visibly installed underneath it, and wire-spoked wheels. Behind the tank is the rider's seat, which incorporates a small backrest, and there is room for a passenger on the higher, rear part of the seat. A handhold is installed behind the seat for the passenger.

Performance is not outstanding, though a six-speed manual transmission is coupled to the medium-sized, four-cylinder engine. The rear wheel is not driven through a chain, but via an axle.

GPZ 1100

***also* GPZ 1100 ABS**

	1100	1100 ABS
Capacity:	1+1	1+1
Weight:	240kg	250kg
Engine:	131hp	131hp
Top speed:	275km/h	270km/h
Range:	350 km	350 km

A heavy sports bike, the GPZ 1100 has very high performance despite its somewhat high weight. As most similar bikes, there is room for two people on the buddy seat, the passenger having a small handhold behind the seat. A streamlined cowling is installed over the headlight and engine to reduce air resistance, and a small windscreen helps streamline the rider as well.

The engine of the GPZ 1100 is a four-cylinder with water cooling, installed in the conventional location at the front of the frame. Unlike most other motorcycles, a six-speed transmission is fitted. The GPZ 1100 ABS is exactly the same as the standard GPZ 1100, except for the addition of anti-lock brakes that add some ten kilograms of weight and reduce top speed by a fraction.

KLX 650 R

Capacity:	1
Weight:	125kg
Engine:	49hp
Top speed:	165km/h
Range:	145km

A heavy off-road motorcycle, the KLX 650 R is more intended for off-road racing than for leisure motorcycling. Though the buddy seat is large enough for two people, there are foot rests only for the rider, making it somewhat dangerous to carry a passenger.

Power comes from a single-cylinder, water-cooled engine, and is transmitted to the rear wheel through a five-speed transmission and a conventional chain. Range is very limited because of the KLX's small fuel tank, but for a racing bike this is not a major problem. The tires have a blocky profile for excellent grip in loose soil, and the suspension allows long wheel travel to absorb bumps. A single disc brake is fitted to each wheel.

SUZUKI

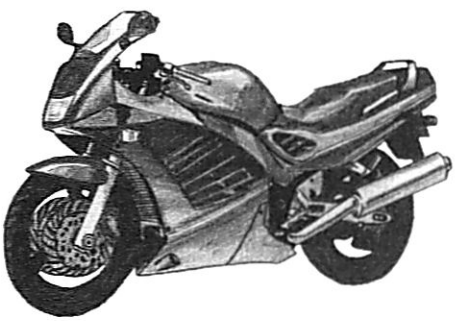
Suzuki Motor Co. Ltd., Japan

RF 900 R

Capacity:	1+1
Weight:	205kg
Engine:	135hp
Top speed:	265km/h
Range:	335km

The Suzuki RF 900 R is a high-performance sports and touring bike that can be comfortably ridden by two people for long periods of time. This motorcycle is streamlined with aerodynamic cowlings and a windscreen. A notable feature is the slits in the side of the cowling, which let the air coming past the radiator (the engine is water-cooled) escape; most motorcycles with cowlings like the RF 900 use only one opening on either side.

Hidden under the cowling, a four-cylinder engine and a five-speed transmission give the RF 900 a high level of performance for a reasonably heavy motorcycle. Adequate braking power comes from three disc brakes, two on the front and one on the rear wheel. To a degree, the suspension is adjustable in rigidity, allowing the rider to adapt the motorcycle to his or her preferences.



VS 600 GLS Intruder

***also* VS 800 GL Intruder, VS 1400 GLP Intruder**

Capacity:	1+1
Weight:	200kg
Engine:	45hp
Top speed:	150km/h
Range:	215km

The Intruder is a Japanese motorcycle with American-looking style, intended mainly to appeal to motorcyclists wanting the reliability of a Japanese manufacturer, but the type of bike normally produced in the U.S.. The Intruder has two seats, the rear one with a small backrest, while the front seat uses the rear seat for that purpose. The handlebar is mounted high and the brake and gear shift levers are far forward to allow the classic riding position common with bikes of this style.

The only real difference between the three Intruders is in their engine sizes, as they all look the same and are almost the same size. It is difficult to tell them apart from a distance. Each has a water-cooled V2 engine with a five-speed transmission, and a single disc brake on each wheel.

VS 800 GL	VS 1400 GLP
1+1	1+1
200kg	245kg
60hp	71hp
170km/h	190km/h
215km	215km

VESPA

Vespa, Italy

Skipper 125

***also* Sfera 125**

	Skipper	Sfera
Capacity:	1+1	1+1
Weight:	105kg	95kg
Engine:	14hp	12hp
Top speed:	100km/h	100km/h
Range:	200km	200km

Known generally as "Vespas," these two simple, lightweight scooters are both very similar. Each has a single-cylinder, 125 cc engine and an automatic transmission, so performance is limited, but comfort when riding is high. Two people are seated easily on the buddy seat, with the bike's front plate shielding the driver's legs. There is a small storage space in the front shield, large enough for a small bag, for example.

The differences between the Skipper and Sfera are mostly that the Sfera looks slightly more traditional—despite being the newer design—and has a different, more modern engine.

YAMAHA

Yamaha, Japan

XJ 600 S Diversion

***also* XJ 900 Diversion**

	600 S	900 D
Capacity:	1+1	1+1
Weight:	190kg	240kg
Engine:	61hp	83hp
Top speed:	170km/h	210km/h
Range:	305km	410km

Two motorcycles whose most obvious difference is in engine size, the XJ 600 S and XJ 900 are outwardly very similar. Both are multipurpose bikes, with sporty looks and good performance on the road, but still suitable for everyday use. There are minor differences in size between the two models, and the shape of the fairings differs slightly as well. Both have a buddy seat for the rider and one passenger, though there is little for the passenger to hold onto.

The 600 has a six-speed transmission, while the 900 has only five gears. Both bikes have an air-cooled four-cylinder engine. The 600 has a single disc brake on each wheel, the 900 has double front disc brakes to give it the extra braking power needed by a more powerful motorcycle.

XV 125

Capacity:	1+1
Weight:	140kg
Engine:	10hp
Top speed:	110km/h
Range:	230km

A light motorcycle styled as a custom, the XV 125 has a low-powered engine that makes it very suitable for beginning riders. In most respects the XV 125 is a standard motorcycle, with a two-cylinder engine under the teardrop-style fuel tank, and driving the rear wheel with a chain. The transmission has five speeds, and braking power is provided by a rear drum and one front disc brake. With the weak engine and the low top speed, this is adequate to stop the motorcycle.

For the rider a saddle is positioned directly behind the fuel tank, with a second, rectangular saddle directly behind it for the passenger. The passenger also has a handhold behind the saddle.

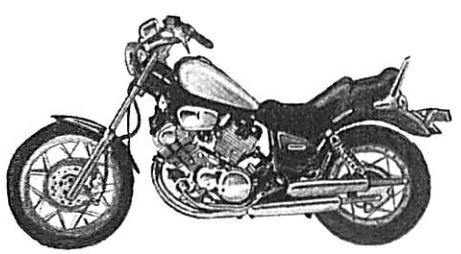
XV 750

also XV 1100

	750	XV 1100
Capacity:	1+1	1+1
Weight:	220kg	220kg
Engine:	54hp	61hp
Top speed:	170km/h	195km/h
Range:	290km	290km

Like the Suzuki Intruder (see page 57), the XV 750 and its big brother the XV 1100 are representative of the 1980s attempt by Japanese motorcycle manufacturers to enter the portion of the market dominated by brands like Harley-Davidson. As such, it has been styled to resemble American-built bikes, with a V2 engine, a teardrop-shaped fuel tank, wire-spoked wheels, and a riding position in which the riders sits with his or her feet forward. The leather-covered buddy seat is sized for two people, and comfortable enough for long journeys. The XV 1100 has a backrest for the passenger.

Mechanically, however, these motorcycles are Japanese machines and they're generally considered to be more reliable than their American counterparts. The engine is an air-cooled V2 in both models, the main difference between the two bikes is in its size. In both, a five-speed transmission transfers the engine power to the rear wheel through an axle.



CIVILIAN AIRPLANES

CHAPTER THREE

CIVILIAN AIRPLANES

Fixed-wing aircraft is a term that describes airplanes and other flying vehicles that do not have moveable wings, and is primarily used to distinguish them from helicop ters, whose wings do move, as explained in Chapter 4. The first successful fixed-wing aircraft was the Wright Flyer, built and flown in 1903 by the brothers Orville and Wilbur Wright.

An airplane has three main sections: the fuselage, the wings, and the tail. The fuselage is the main body, in which crew and passengers sit and cargo is carried; sometimes, the engine is also fitted into the fuselage. In most aircraft, the fuselage has a streamlined shape, to reduce air resistance (known as drag) as much as possible. The wings and tail are attached to the fuselage.

The wings are what makes an aircraft get off the ground. This is accomplished by the special shape a wing has, known as an airfoil. Looking at a wing from the side, it has a larger sloped surface on top and a flat, streamlined surface on the bottom. When wind blows past the wing, it is split: some goes over the wing, some underneath it. Because the top surface is curved while the lower surface is straight, the wind going over the wing has to travel a longer distance, and thus moves farther, creating a reduction in air pressure above the wing. If the wing is large enough, the pressure below the wing will become so high (relative to the pressure above the wing) that the wing will be pushed up against gravity—taking the aircraft off the ground. This is known as "lift."

Since it would be impractical to wait for a strong enough wind to come along to lift the aircraft, artificial wind can be made by moving the aircraft itself. This also creates an airflow over and under the wing, and lifts the aircraft into the air. The big drawback is that an airplane must keep moving forward all the time, or its airspeed will become too low, and the wing will not generate enough lift to keep the aircraft flying at all.

The amount of lift generated by a wing depends on many factors, though among the most important are the wing's cross-section and the angle it makes to the airflow, known as the angle of attack—an aircraft does not always fly straight forward; often times it will be pointing up somewhat from the actual direction of travel. The higher the angle of attack, the more lift a wing will provide, though at a certain angle (which again depends on the wing design) lift suddenly drops, and keeps dropping the greater the angle becomes. This is known as "stalling" or "stall"; too much stall and the lift will become so low that the aircraft will start to fall down. Pilots always have to be wary of pulling up too hard, or stalling may occur.

By fitting movable surfaces known as elevators at the rear edges of the wings, the lift can be increased when needed, allowing the aircraft to gain altitude while keeping its fuselage more or less horizontal. Additionally, similar moveable surfaces called ailerons allow the aircraft to roll, because they can be used increase lift on one wing and decrease it on the other. Some aircraft combine their elevators and ailerons together.

The tail is normally at the rear of the fuselage, and consists of a vertical and a horizontal part. The vertical tail—also called the tail fin—is used to keep the aircraft on a straight course, and to steer it left and right. The horizontal tail surfaces are small wings, but instead of lifting the aircraft up like the main wings, they push the tail down. This prevents the airplane from diving forward.

The horizontal tail is also used to steer the aircraft up and down, by varying the downward force it creates in much the same way the upward force of the wings can be adjusted: flaps at the back can be lowered or raised. Jet fighters use tails whose entire surfaces move, rather than just the rear edge. This is known as a "flying tail."

Because of the extra dimension of movement involved in flying, aircraft controls are more complicated than those of ground vehicles. The main controls of many aircraft are the throttle, the "stick," and the pedals. Most large aircraft have a steering wheel-type control, called a yoke, rather than a true stick.

The throttle governs the engine power, and can move forward and back: fully forward to close the throttle entirely, and all the way back for maximum power. Multi-engined aircraft usually have as many throttle levers as they have engines. The throttle is located on the left of the pilot, or between the pilot and copilot's seats (an aircraft pilot generally sits on the right-hand side, so the throttle is still operated by his or her left hand).

The stick is most often located in front of the pilot's seat, between the pilot's legs; some aircraft with computerized control systems locate it at the right-hand side of the cockpit, however. Yokes are usually mounted on an axle coming through the dashboard. The stick or yoke controls the direction the aircraft will move: if pulled back or pushed forward, the aircraft goes up or down; if pushed or turned to the side, the aircraft steers to that side. The pedals control the ailerons: the aircraft will roll to the opposite side of the pedal that is pressed.

These controls are used in combination—for example, when making a turn the stick is pushed to the side and the pedals are used to make the aircraft roll to that same side. This causes a loss in altitude because the wings' lift is not going straight up anymore, so the stick

must also be pulled back slightly to pull it up a bit. The way controls influence each other make aircraft difficult to fly, especially during take-off and landing.

The majority of aircraft have mechanical and hydraulic links between the pilot's controls and the various moving surfaces on the wings and tail. With mechanical links such as bars and cables, the stick is directly linked to the control surfaces, which is not a problem in small, light aircraft. Larger aircraft need hydraulic systems, in which the stick operates engine-driven hydraulic pumps and cylinders that in turn move the control surfaces; this takes the heavy work away from the pilot.

In the late 1970s, fly-by-wire was introduced to replace both mechanical and hydraulic systems. With this, the stick is connected to a computer, which interprets the movements of the stick and steers the control surfaces based on those movements. The two largest disadvantages are that the computer must be programmed for the exact type of aircraft it is to be installed in, and that loss of electric power could result in an uncontrollable aircraft. The first problem cannot be solved yet, while the second can be avoided by installing a backup mechanical/hydraulic system. A 1990s variant on fly-by-wire is fly-by-light, which replaces the electrical cables with much lighter fiber-optics.

It is important to remember that aircraft speeds are measured against the wind, not against the ground. For example, when an aircraft is flying at 300 km/h straight into a 50 km/h wind, it is actually only going 250 km/h relative to the ground. On the other hand, with this same wind in the back, it would be travelling around 350 km/h if measured from the ground. Either way, however, the aircraft's speed is still considered to be 300 km/h.

Like nearly every other motorized vehicle, up until the 1940s aircraft were powered by piston engines. The engine drove a propeller, which consists of two or more small wings that pull the aircraft forward because they are mounted on an axle driven by the engine.

In 1930s, a number of people had ideas for a radically different type of engine that would provide much greater power to aircraft than the established combination of a piston engine and a propeller: the jet engine. A jet engine has no pistons, no cylinders, no carburetors, or most other things engines usually have. It draws air in through a large opening at its front, compresses the air, and then injects fuel into that compressed air. The fuel is ignited in the back of the engine, producing expanding gases like in the cylinder of a normal engine. The rear end of the engine is open however, allowing the hot gases to escape. Because every action has an opposite and equal reaction, the engine is pushed forward by the blast of escaping gasses and it pulls the aircraft along with it.

To compress the air, a turbine is used; this can best be described as a fan with an incredible amount of blades. As the turbine spins, it moves air behind it, like a fan. By forcing the air through an ever-narrower tube in this way, the air is compressed. A single turbine is not enough to achieve the required compression, so a number of them are fitted onto the same shaft, behind one another. Each further compresses the air coming from the previous turbine, and at the end sufficient pressure has been created to allow the engine to work. Vaporized fuel is then sprayed into the compressed air, and ignited.

The burning gases get pushed out of the back of the engine to provide thrust, but on the way out they also pass a final turbine that is on the same shaft as the first ones. This last turbine turns because of the hot gases coming by, and in doing so it keeps the front turbines moving; the only way to switch off a jet engine is to cut off its fuel or air supplies, else the front turbines will keep drawing in more air, which continue to drive the last turbine, and so on.

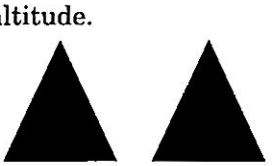
The amount of power that jet engines use to draw in air is enormous: an aircraft taking off from a wet runway will suck in water from the ground several meters below the engines. It's just as unwise to walk in front of a running jet engine as it is to walk behind one.

Due to the compression provided by the turbines, jet engines can operate at high altitudes in very thin air, where there is little oxygen. Piston engines might stop completely because of a lack of oxygen at high altitudes, and even if they didn't, the air at high altitudes is too thin for a propeller to pull the aircraft along. Jet engines do not have this drawback, allowing aircraft to be constructed that can fly to very high altitudes. However, compared to piston engines, jets require large amounts of fuel to keep going, reducing the aircraft's endurance. Their much greater thrust compensates for this, because the aircraft can weigh more, and so can also carry more fuel. On the whole, a high-performance aircraft is better off with a jet than with a piston engine.

To further increase thrust for short periods of time, afterburners can be installed in jet engines. An afterburner injects fuel directly into the exhaust (behind the final turbine), where it burns to provide additional power. Nearly all jet fighters have afterburners, but their fuel consumption is as enormous as the thrust they provide. A typical modern jet fighter can reach the speed of sound (± 340 m/s at sea level) without using its afterburner, and has enough fuel to fly for several hours at slightly lower speed. With both afterburner and throttle fully open, the same fighter may reach two and a half times the speed of sound, but will run out of fuel in about fifteen minutes. With good reason, afterburners are used only if the aircraft needs a sudden boost of speed, and are not continuously active. Civilian aircraft and military transports have no need for afterburners—the basic thrust of their engines is enough for the tasks they are used for.

The turboshaft, another type of engine, is similar to a jet engine in many ways, but does not rely on massive exhaust for its thrusting power. Instead, a turboshaft uses the axle on which the turbines are mounted to drive something else, usually an aircraft propeller (in which case the engine is known as a turboprop), the gearbox that drives a helicopter's rotor system, or the propeller of a ship. Turboshafts are most commonly found in helicopters.

Turbine engines get more efficient at higher altitudes, an added advantage for high-flying aircraft, but also one which caused some problems during early experiments with them: when the Kaman Corporation first put a turboshaft engine in a helicopter in the mid-1950s, at a certain point the test pilot had the throttle fully closed, but the machine kept gaining altitude! This has since been solved, and modern turboshafts can operate at nearly any altitude.



ABC

American Blimp Corporation, U.S.

A-60 Plus

Capacity:	1+4
Engine:	two 80hp
Top speed:	160km/h
Range:	4,000km

Widely used for advertising, blimps are so-called "non-rigid" airships. This means they do not have a metal framework—unlike the well-known zeppelins of the early part of the 20th century—but retain their shape in a similar way a balloon does, by the pressure of the gas inside. Modern airships are filled with helium, an inert gas lighter than air, to remain airborne. Since helium cannot burn, disasters like that with the German *Hindenburg* zeppelin in 1937 are impossible with a modern airship. The helium is sealed into many separate bags in the large balloon-like part of the ship, so that when one of the bags leaks, the whole ship will not plummet to the earth.

The A-60 Plus, or "Lightship" as ABC calls its blimps, is some 39 meters long, and its gondola has room for a pilot plus four passengers. It is equipped with modern avionics, making it as easily controllable as other modern aircraft. Its two engines give it a top speed that is lower than that of fixed-wing aircraft, but also very long endurance; the A-60 can remain in the air for twenty-four hours or more, if required.

The A-60 Plus has a semi-transparent outer skin, which allows two, 1,000 watt lights to illuminate the ship from the inside, making the advertisements on the sides highly visible, especially at night. It is also suitable—though somewhat expensive—for transporting passengers or cargo.

Air Tractor

Air Tractor Incorporated, U.S.

AT-301

***also* AT-301A**

Capacity:	1
Weight:	1,725kg
Engine:	600hp
Top speed:	270km/h
Range:	565km

This ungainly aircraft is a purpose-designed crop duster, with a spraying installation under and behind the wings, coupled to a 1,200-liter tank for the chemicals to be sprayed. The Air Tractor is powered by a radial engine driving a three-bladed propeller. Its performance is low, but for its intended role, high performance is not necessary. The pilot sits high in the center of the aircraft, under a rather unstreamlined cockpit canopy that does afford good visibility to all sides.

The AT-301A has an enlarged capacity chemical tank, to 1,325 liters. Other versions of the Air Tractor exist, but the 300-series is the most numerous. Many are used in the U.S. for spraying large patches of land, though outside the U.S. they are a lot less common.

BOEING

Boeing Commercial Aircraft Group, U.S.

737-700

***also* 737-600, 737-800**

Capacity:	2+149
Weight:	37,650kg
Engine:	Two 8,900kg TF
Top speed:	1,000km/h
Range:	3,000km

The 737-series is the most popular civilian jet airliner in the world, with over 3,000 having been ordered since the first 737 flew in 1967. The current production models are the -600, -700, and -800, but they are typical of other small and medium-sized airliners (though the 737 is smaller than most similar aircraft).

The three models differ mainly in fuselage length, the model 600 being shortest and the 800 longest; the extra length is achieved by lengthening the fuselage in front of and behind the wing to keep the aircraft balanced. The 737 has four doors: one on each side of the fuselage behind the cockpit, and one on each side at the back of the aircraft. There is also a small escape door above each wing.

The normal passenger cabin layout has rows of six seats along the length of the aircraft, with an aisle in the middle. In first-class, rows of four seats with an aisle in the middle may be installed at the front of the aircraft, separated from the rest of the passenger cabin by a bulkhead or a curtain. There are galleys (kitchens) and lavatories at the front and back of the passenger cabin.

The cockpit can be equipped in one of three ways: classic, for older 737s; or with one of two electronic display systems using liquid crystal display (LCDs). A heads-up display (HUD, similar to those used in jet fighters) for the pilots is optional, as is satellite communications equipment for contact with ground controllers anywhere in the world. The navigation system uses a global positioning system receiver to accurately indicate the aircraft's position at all times.

737-600	737-800
2+132	2+189
36375kg	41,400kg
Two 8,230kg TF	Two 10,675kg TF
1,000km/h	1,000km/h
2,800km	3,500km

CESSNA

Cessna Aircraft Company, U.S.

172R Skyhawk

Capacity:	1+ 3 or 400kg cargo
Weight:	730kg
Engine:	161hp
Top speed:	225km/h
Range:	1,260km

The Cessna 172 is a popular civilian plane that has been in production for many years, and can be found at nearly every airport in the western world. It is most often owned by individuals or small companies who use it for pleasure flying or small transportation work.

With its tricycle undercarriage (a nose wheel and two rear wheels) that cannot be retracted, the 172R is easy to control on the ground, and it is generally thought of as pleasant to fly as well. The

engine is at the front of the fuselage, driving a two-bladed propeller, and behind this is the passenger compartment that seats four people (including the pilot). Both front seats have a full set of controls. The rear of the fuselage is mostly empty, and can be used to store a small amount of cargo.

The wing is mounted above the passenger compartment. This allows easy access to the aircraft when it is parked on the ground. However, it restricts the upward vision of those looking out from within, especially to the sides. There is no autopilot, but an expanded avionics package that includes one is available as an option.

182S Skylane

Capacity:	1+ 3 or 600kg cargo
Weight:	920kg
Engine:	230hp
Top speed:	270km/h
Range:	1,525km

In most respects the Cessna 182S Skylane is a slightly larger version of Cessna's 172R Skyhawk (above), and both externally and in the cockpit the two are similar. The most important differences are in size—the 182S is longer and higher and has a wider cabin—and in performance, where the 182S is clearly superior to the 172R. The 182S also includes an autopilot as a standard feature, rather than it being an add-on as in the Skyhawk.

EMBRAER

Embraer, Brazil

EMB-120 Brasilia Advanced

Capacity:	2+30
Weight:	7,100kg
Engine:	two 1,800hp TP
Top speed:	610km/h
Range:	3,000km

The EMB-120 Brasilia is a regional transport used by several airlines around the world, as well as the Brazilian Air Force. It is of typical layout, with a streamlined fuselage, a low-set wing, and the horizontal tail at the top of the tail fin. A turboprop engine is installed in a nacelle in each wing.

Internally the Brasilia has a two-seat cockpit up front with a passenger cabin behind it. The normal seating layout is in ten rows of three seats, for a maximum of 30 passengers, although alternative layouts for between 24 and 30 passengers are available, as is a cargo layout which has no seats in the cabin at all. Access to the aircraft is by a door at the left front, and a small emergency escape hatch is located above the wing. There is also a separate cargo compartment, behind the main cabin, which is accessed by a door in the rear left-hand side of the fuselage.

GULFSTREAM

Gulfstream Aerospace, U.S.

Gulfstream IV

Capacity:	2+19 or 4,000kg cargo
Weight:	16,100kg
Engine:	two 6,300kg TF
Top speed:	945km/h
Range:	8,350km

The Gulfstream IV is small jet aircraft used mainly as a business jet, though it can be used for passenger or cargo transport if required. It has a cockpit for two pilots seated side-by-side, and a passenger cabin that can be fitted with a variety of seating arrangements depending on the customer's specifications. The maximum number of passenger seats is nineteen, but most aircraft have a smaller number to afford more space to the individual passengers. As with most business jets, the interior tends to be luxurious.

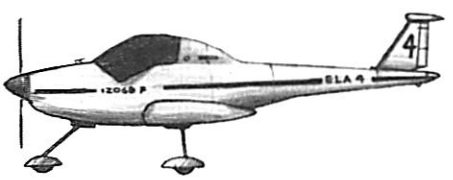
A notable feature of this aircraft are the winglets, small vertical fins at the tips of the wings to increase controllability of the aircraft. In overall design, though, the Gulfstream IV is typical of small jets. It has a T-shaped tail, the wings are set low, and the two turbofans are on the sides of the fuselage. The aircraft's performance is good, with its range being especially long.

HOAC

HOAC Austria, Asutria

DV 20 Katana

Capacity:	1+1
Weight:	505kg
Engine:	80hp
Top speed:	235km/h
Range:	765km



The DV 20 Katana is a small, light aircraft, fairly typical of privately owned, recreational aircraft and civilian flight trainers. It is constructed entirely of composite materials and plastics, using a simple four-cylinder engine to drive the two-bladed propeller mounted in the nose. The landing gear is non-retractable, but has aerodynamic fairings over the wheels.

The cockpit has room for two people seated side-by-side under the large canopy that provides excellent visibility in all directions. Both seats have a stick and pedals, with the rest of the controls being located between the seats where they are easily accessible to both pilots. Pilots find the aircraft easy to fly, despite the somewhat low top speed and maneuverability.

LEARJET

Bombardier Aerospace Group, Canada

Model 45

Capacity:	1+9
Weight:	8,900kg
Engine:	two 1,600kg TF
Top speed:	990km/h
Range:	4,000km

This latest Learjet model was first flown in late 1995, continuing Learjet's well-known line of business aircraft. It is a sleek-looking aircraft with a T-shaped tail, wings set far back on the fuselage, and vertical fins (winglets) on the wingtips. Power is provided by two Garrett turbofans, mounted on the fuselage sides just behind the wings.

The cockpit is almost completely electronic, with four main display screens and several smaller, auxiliary monitors. Flight controls are of the fly-by-wire type, and even though the cockpit seats two, the aircraft can be flown by one person just as easily. The passenger cabin has two rows of four comfortable leather seats equipped with fold-out tables, and there is a lavatory in the back of the fuselage. Other interior arrangements are available, including custom-designed layouts.

Although designed by Learjet (after it was bought out by the Canadian company Bombardier), parts of the Model 45 are built by all of Bombardier's subsidiaries: De Havilland-Canada builds the wings, Shorts Brothers in Northern Ireland builds the fuselage, and everything is assembled in the U.S. at Learjet's plant in Wichita, Kansas. The design of the Model 45 was done entirely on computers, and manufacture is also computer-controlled for a large part.

PIAGGIO

Industrie Aeronautiche e Meccaniche Rinaldo Piaggio S.P.A., Italy

P. 180 Avanti

Capacity:	1+8
Weight:	3,400kg
Engine:	two 865hp TP
Top speed:	730km/h
Range:	3,000km

This Italian aircraft has a somewhat unconventional wing layout, with the main wings set relatively far back on the fuselage, the aircraft remaining balanced by the use of small wings on either side of the nose, which also enhance its maneuverability. Power comes from two turboprops, one in each wing driving a propeller at the back. Even when one engine is inoperative, the Avanti remains relatively easy to control and still has adequate performance to often complete the flight safely. The very streamlined shape adds to the plane's top speed, as well as making the P.180 easily recognizable.

Intended as a business aircraft, the Avanti has not been a major commercial success, though its performance is very good compared to similar aircraft. The interior layout has a two-seat cockpit and a luxurious seven-seat passenger cabin, although different layouts for up to nine passengers are available directly from the manufacturer. The noise level inside the cabin is very low, and the aircraft is equipped with a pressurized cabin to allow a maximum flight altitude of some

12,500 meters. Visibility from the cockpit is generally excellent, though the angle at which the windscreen is set can cause distracting reflections. A door is located on the left-hand side, behind the cockpit.

PIPER

The New Piper Aircraft, Inc., U.S.

Archer III

Capacity:	1+3 or 410kg cargo
Weight:	1,155kg
Engine:	180hp
Top speed:	245km/h
Range:	925km

The Piper Archer III is typical of many privately-owned aircraft. It is a small aircraft with a low-mounted wing, a single engine in the nose, and a non-retractable, tricycle undercarriage. Its fuselage is streamlined to a large degree, and streamlined fairings for the wheels are standard.

The cabin has two front and two rear seats, with doors by the front seats. To reach the doors, the passengers have to climb onto the wing, however. Both front seats have a set of controls, allowing either front passenger to fly the aircraft. The cockpit windows are somewhat low, which may cause some discomfort to tall pilots. Also, because the cockpit is directly over the wing, the pilot's field of vision straight down is non-existent.

An autopilot is not normally fitted, though an avionics upgrade package includes one.

TKEF/ANGEL AIRCRAFT CO.

The King's Engineering Fellowship/Angel Aircraft Corporation, U.S.

Angel

Capacity:	2 + 6 or 800kg cargo
Weight:	1,760kg
Engine:	Two 300hp PP
Top speed:	945km/h
Range:	8,350km

The Angel is an unusual aircraft developed for an unusual task. First designed in the 1960s, it took about twenty-five years for the aircraft to come into production. It is intended for missionary work in remote areas away from airports, paved runways, and extensive maintenance facilities; to meet these requirements, the Angel is ruggedly built, can take off from dirt strips, has excellent short take-off and landing (STOL) capabilities, and is easy to maintain.

Although the aircraft resembles a business jet, it is driven by two push-propellers mounted behind the wings. This makes the aircraft safer to approach from the front and gives the pilot a much better view of the runway than from a plane with front-mounted propellers.

The cockpit and passenger compartment have side-by-side seating for up to eight people, though the seats in the passenger area can be easily removed to make room for cargo. A large cargo door in the right-hand side of the fuselage helps in loading and off-loading cargo.

In addition to missionary activities, the Angel is suitable for other tasks where landings and take-offs in difficult terrain are required, such as ambulance duties, border patrol, and forestry.

CIVILIAN HELICOPTERS

CHAPTER FOUR

CIVILIAN HELICOPTERS

Igor Sikorsky, the builder of the first true helicopter, was once asked when helicopters would be better than conventional aircraft. His reply was, "Never." Fixed-wing aircraft are better in everything than helicopters are, except for three things: helicopters can take off vertically, can hang still in the air, and can land vertically.

Helicopters fly by the same principle other aircraft use: air rushes over and under a wing, creating areas of low pressure above and high pressure below it. But where normal aircraft have their wings fixed to the fuselage and must move the whole aircraft forward to gain lift, a helicopter moves just the wings so the craft itself can stay at the same point in the air. This sounds simple, but it is not without problems.

The first problem that had to be dealt with was termed "counter-rotation": when the rotor (that is, the assembly consisting of the wings and the drive shaft they are mounted on) turns in one direction, the rest of the helicopter is pushed in the opposite direction, causing it to turn opposite the rotors. Newton's third law of motion is at work here: every action has an opposite but equal reaction. A number of systems have been developed to prevent counter-rotation, and the most widely-used solution is to add a small propeller at the rear of the helicopter. This propeller—known as a tail rotor—faces to the side, and either pushes or pulls the helicopter's fuselage back in line, working against its tendency to turn. A tail rotor's biggest drawback is its need for power, which must be taken from the main engine, thereby reducing the overall power available for the main rotor. Despite this, around nintey-five percent of all helicopters in use today have a tail rotor.

Another common way to counteract counter-rotation is to use two rotors that spin in opposite directions: since the sum of their movements is zero, the body of the helicopter will not spin. Most double-rotor helicopters have one rotor at each end of the fuselage, the rear one raised above the front one so their blades don't collide. Some helicopter designs have two rotors on the same axis, which is mechanically more complicated, though it makes the overall aircraft smaller.

Once the counter-rotation problem was solved, helicopters could take off and land without much trouble, but a new problem arose involving forward flight. When a helicopter hangs still in the sky, air

flows over all the rotorblades at the same speed, so each blade provides the same amount of lift. Once the helicopter moves forward, the airspeed over the blades starts to differ. The air passing over the blades that are moving forward (in the same direction that the helicopter is moving) equals the speed of the blades plus the speed of the helicopter, the air passing over the blades that are moving backwards (away from the direction the helicopter is moving) equals the speed of the blade minus the speed of the helicopter. A lower airspeed means the blade provides less lift. Depending upon which way the blades are spinning, the side of the helicopter on which the blades move backwards will tilt toward the ground instead of staying level. To compensate, during rotation the angle of each individual blade is automatically increased as it goes toward the back, which gives it more lift, and decreased when it goes forward again.

Gaining altitude can be accomplished in two ways: by increasing the angle of all the blades in the rotor, or by letting the rotor spin faster by opening the engine's throttle, which increases the airspeed over the blades, and so also increases lift—using both methods at once naturally gives the greatest lift. To go down, the reverse is done.

Helicopters generally have horizontal and vertical tails like fixed-wing aircraft, though the horizontal tail is comparatively much smaller in a helicopter. Some helicopters also have small wings (called stub wings) that add a bit of lift when the helicopter is flying forward. Military attack helicopters use these stub wings to carry weapons. By giving a wing cross-section to these weapon mounts they perform two functions at the same time.

Helicopters have two control sticks: the "cyclic," controlling the direction the helicopter flies, and the "collective," which controls the angle of the rotorblades. By pushing the cyclic stick, the rotor tilts in the direction the stick is pressed, and the helicopter will move there as well; the further the stick is pushed, the faster the helicopter will move. This results in a slight loss of altitude, because the rotor's power is not going straight up anymore, but also a bit to the side. The pilot must compensate for the altitude loss by increasing the throttle, which is controlled by a revolving grip on the collective stick, much like in a motorcycle.

Two pedals control the speed of the tail rotor. By increasing or decreasing the tail rotor's speed, helicopters can turn their fuselages to the left or right. This only works, however, if the helicopter is hanging still or flying at very low speeds. At higher speeds, a helicopter steers much like an aircraft: if the pilot presses the cyclic to the left, the helicopter makes a left-hand turn, for example.

If there is a malfunction while the helicopter is airborne, a technique called "auto-rotation" can be used to land safely. To do this, the pilot disengages the rotor from the engine, allowing it to turn freely, and then puts the helicopter into a dive. The air rushing past the rotor will keep it turning, thereby providing a certain amount of lift. Just before reaching the ground, the pilot reduces the rate of descent to zero, and touches down. This maneuver can only be performed if the helicopter is flying higher than approximately ten meters or faster than about fifty km/h when the emergency occurs.

AÉROSPATIALE

Aérospatiale, France

AS 350B Ecureuil

***also* AS 350D AStar, AS 355F2 Ecureuil 2, AS 355 TwinStar, HB 350 Esquilo, HB 355 Esquilo**

Capacity:	1+5
Weight:	1,120kg
Engine:	684hp TS
Top speed:	290km/h
Range:	655km

The Ecureuil (Squirrel) light utility helicopter was developed in France and license-produced in Brazil and the U.S. It is a medium-sized machine with a three-bladed main rotor driven by a single turboshaft engine located above the cabin. The AS 355 model differs in having two engines, which although lowering the aircraft's top speed, does increase range and cargo capacity. The cabin has the two-seat cockpit at the front, with a three- or four-seat passenger area behind it. Access to the cabin is by a large door on either side, and due to the large windows in the cockpit and doors, all-round vision is good.

The AS 350 and 355 are made in France by Aèrospatiale, while license production takes place in Brazil by Helibras, whose variants use the HB-designations, and in the U.S. The American-made AS 350D AStar model has a different engine, but is otherwise similar to the French version.

These helicopters are widely used by civilian companies, for transporting goods and people, accessing remote areas, carrying TV news crews, and so on. They are also in limited military use, being capable of carrying a variety of armaments.

AS 350D	AS 355F2	AS 355	HB 350	HB 355
1+5	1+5	1+5	1+5	1+5
1,120kg	1,305kg	1,120kg	1,120kg	1,120kg
684hp TS	two 420hp TS	684hp TS	684hp TS	684hp TS
290km/h	270km/h	290km/h	290km/h	290km/h
655km	705km	655km	655km	655km

SA 365N Dauphine 2

Capacity:	2+11
Weight:	2,160kg
Engine:	two 724hp TS
Top speed:	295km/h
Range:	850km

The Dauphin (Dolphin) 2 is a light, multipurpose helicopter built in France and first flown in 1979. It is used around the world by a number of civilian companies as well as governmental agencies. There are several military versions, described on page 130.

The Dauphin 2 has a streamlined fuselage with a combined cockpit/passenger cabin that seats two pilots side-by-side at the front. The rest of the cabin can be outfitted to meet the customer's requirements, but usually has seats or benches for six to ten people. There is a hinged door on either side of the cockpit, and a sliding door on each side of the passenger cabin.

The cockpit has two hinged side doors, while the passenger area has a large sliding door on each side. The interior of the cabin is better-equipped than the military version.

The aerodynamic qualities of this helicopter were a high priority in its design. The fuselage blends smoothly into the tail boom, and the landing gear is retractable.

The main rotor has three blades, and is driven by two turboshaft engines mounted above the cabin. There is no tail rotor in the traditional sense—instead it is housed in a circular opening in the vertical tail. This reduces drag while still being as efficient as a normal tail rotor, and it also reduces the danger to ground personnel who get close to the aircraft.

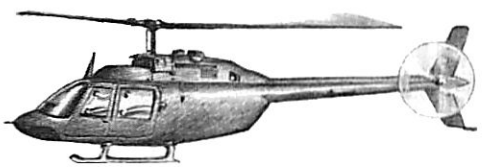
BELL

Bell Helicopter Textron, U.S.

Model 206 Jetranger

***also* Model 406 JetRanger**

Capacity:	1+4 or 500kg cargo
Weight:	1,030kg
Engine:	650hp TS
Top speed:	240km/h
Range:	400km



The JetRanger is a light utility helicopter developed in the 1960s to meet specific U.S. Army requirements. For obscure reasons, the McDonnell Douglas (then Hughes Aircraft Corporation) Model 500 (see page 78) was taken into service instead, and Bell decided to put their design on the civilian market as the Model 206 JetRanger. A few years later, the military purchased a version of the JetRanger anyway, calling it the OH-58 Kiowa. The Model 406 is an upgraded version of the 206.

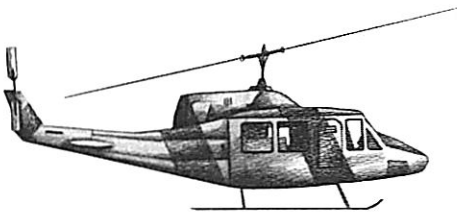
The JetRanger is a simple and durable helicopter that most pilots find pleasant to fly. It's reliable, and almost always does what it's supposed to without problems. Its layout is a basic, conventional design, with a cabin in front and the engine located above and behind it. The two-bladed rotor used in the JetRanger was once a feature of all Bell designs, but some Model 406 JetRangers are equipped with four-bladed rotors. A tail rotor is attached at the end of the tail boom. The undercarriage consists of two skids.

The cabin has two front seats, each with a full set of controls, and a three-seat bench in the back. Through the large front and side windows, the pilot and passengers have good vision in almost all directions, including up and down. The JetRanger is a very versatile helicopter, and is used for many different tasks.

Model 212

***also* Model 412**

	212	412
Capacity:	2+9	2+9
Weight:	2,520kg	2,945kg
Engine:	1250hp TS(2)	1400hp TS
Top speed:	240km/h	260km/h
Range:	400km	655km



The Model 212 is a civilian model of the UH-1N military helicopter, described on page 132, while the Model 412 is a further development of the same machine.

The Model 212 has a two-seat cockpit at the front of the fuselage and a 9-seat passenger area right behind it. The engines are behind and above the cabin, driving the main and tail rotors. Some Model 412s have a four-bladed main rotor that improves performance, though the majority of both 212 and 412 helicopters have Bell's two-bladed "door hinge" rotor (so named because of the resemblance between the hinges of the rotor blade and a door hinge).

MBB-Kawasaki

Messerschmitt-Blkow-Blohm GmbH, Germany
Kawasaki Heavy Industries Ltd., Japan

BK 117

Capacity:	1+11
Weight:	1,725kg
Engine:	two 590hp TS
Top speed:	280km/h
Range:	570km

The BK 117 aircraft was developed jointly by MBB of Germany and Kawasaki of Japan as a multi-purpose helicopter seating up to twelve people, although different seating layouts are possible for anything between seven and eleven passengers, plus a pilot. The BK 117 is a medium-sized, single-rotor helicopter of conventional layout, with the cockpit at the front of the cabin, behind a large windscreen to afford a good all-round view to the pilot. The rear part of the cabin is the passenger area, though it can also be used to carry cargo if some or all of the seats are removed. Entry to the cabin is through a hinged door on either side of the cockpit and a sliding door on either side of the passenger area.

As in many helicopters, the engines are located above the cabin and drive a four-bladed main rotor and a two-bladed tail rotor, located at the end of the tail boom. The landing gear consists of two skids.

Assembly of the BK 117 takes place in both Germany and Japan, each country building the components it designed and shipping them to the other. MBB Helicopters Canada and IPTN (in Indonesia) also build BK 117s, both being supplied with German and Japanese components to assemble the helicopters. The BK 117 has been in use around the world since 1981.

McDonnell Douglas

McDonnell Douglas Helicopter Corporation, U.S.

Model 500

***also* Model 500E, Model 530, 530MG**

Capacity:	1+4
Weight:	660kg
Engine:	256hp TS
Top speed:	260km/h
Range:	515km

The Model 500 was a competitor of the Bell JetRanger (above) in the U.S. Army's Light Observation Helicopter contest of the 1960s, and was the model eventually chosen and adopted as the OH-6A Cayuse, described on page 133. It is a very compact machine with a fuselage shaped like an egg laid on its side, a normal rotor system with a four-bladed main rotor and two-bladed tail rotor, and skids as landing gear. The cabin seats two people up front and up to three in the back, although two would be more comfortable. Later models of the 500 (from the 500E upward) have a different nose section—not rounded as in the original but more pointed—a new tail, T-shaped instead of V-shaped, and a five-bladed rotor.

There are few external differences between the 500 and 530—the two are virtually indistinguishable except for their performance.

The Model 500 is a very maneuverable machine, capable of an impressive level of performance for a helicopter its size. It is not really suitable for aerobatics flying, though. The large canopy and side windows allows a very good range of visibility from the cockpit.

500E	530	530MG
1+4	1+4	1+6 or 500kg
660kg	660kg	660kg
376hp TS	376hp TS	426hp TS
260km/h	260km/h	260km/h
515km	515km	515km

Sikorsky

Sikorsky, U.S.

S-76B

Capacity:	2+12
Weight:	2,970kg
Engine:	two 961hp TS
Top speed:	285km/h
Range:	580km

The S-76B is a light commercial transport helicopter designed in the late 1970s as the S-76A. The B model first flew in 1984, and is basically an improved version of the earlier A model, differing mainly in the useful payload it can carry due to the installation of more powerful engines.

The fuselage of the S-76B is highly streamlined, with a retractable undercarriage and very few protrusions that would add to the helicopter's air resistance. The cabin has seats for the pilot and copilot side-by-side at the front, and can carry a maximum of twelve passengers behind the flight crew. The cabin has two hinged doors on each side, one for access to the front seats and one for the passenger compartment. The engines are located above the cabin. They drive the three-bladed main rotor and a four-bladed tail rotor.

CIVILIAN WATERCRAFT

CHAPTER FIVE

CIVILIAN WATERCRAFT

Boats and ships have been used for thousands of years, and were most likely the first human-made vehicles. The earliest large ships, such as the triremes of the ancient Greeks, were constructed of wood, with oars as the main means of propulsion. Later, when it was better understood how the wind could be used to propel a ship, sails became more important, and by the late middle ages hardly any large ship used oars anymore. In the 16th and 17th centuries, Europeans used large sailing ships, often with three or even four masts, to explore the rest of the world. By the late 19th century, ships were being built with iron and steel plates bolted to the hull rather than wood planking.

Sailing ships have a major disadvantage because they are fully dependent on the wind; without wind, a sailing ship sits still in the water, and the ships built around the 17th century were too large to row even if they had the necessary equipment to do so. The invention of the steam engine in the late 18th century started a revolution in shipbuilding, as ships fitted with steam engines did not need to depend on the wind to build up speed. The first steam-engined ships were hybrids, having both sails and a steam engine, which shows that ship builders of the time did not fully trust the new means of propulsion, but soon the sails began to disappear and ships relied on the steam engine completely.

People talking about ships use a language all their own, with many terms that are not often applied to other vehicles. Some of the most common are "port" and "starboard", which indicate the left and right sides of the ship, respectively, when looking forward from the rear. The "bow" is the front (towards the "fore" of the vessel), and the "stern" is the back (towards the "aft"). The part of the ship that sits in the water is called the "hull". It gives a ship its ability to float. The "superstructure" is the building constructed on top of the hull. The "keel" is the lower edge of the hull, or a fin protruding from that lower edge. Large keels are used to keep a ship more stable in the water,

because their size makes it more difficult for the ship to sway from side to side. In sailboats, large keels are used to compensate for the wind blowing in the sails—without a keel, most sailboats would fall over onto their sides with even a slight sidewind; this is known as "capsizing" in nautical jargon.

A ship's displacement is a measure of its weight: any floating object moves (or displaces) a mass of water equal to its own mass. For example, a ship with a displacement of 100 tons moves 100 tons of water. Tonnage for commercial vessels is sometimes formulaic, and does not represent the actual amount of water the vessel displaces. Ship sizes are generally measured in tonnage, boats in length or LOA (length overall, as opposed to length at the waterline). Length is often included as part of a ship's model name (often in feet).

There are other terms that are unique to boats, such as "beam," "draft," and "freeboard". Beam is the width of the vessel at its widest point. A ship's freeboard is the amount of its hull that rises out of the water. The draft indicates how deep the ship lies in the water, and thus it determines how deep the water must be to keep the ship from running aground. A ship with a draft of two meters needs at least two meters of water to sit in, preferably more.

The speed of a watercraft is traditionally measured in "knots"—that is, nautical miles per hour (note that "knots per hour" is incorrect; technically, that would indicate acceleration rather than speed). One nautical mile is 1.852 kilometers, so a speed of one knot equals 1.852 km/h. For ease of reading, ship speeds have been given in kilometers per hour in this book.

Motor ships are driven by one or more engines, usually diesels but sometimes gas turbines, that operate one or more propellers at the rear of the hull. These propellers, used to push water away from the ship in order to propel it forward, are similar in shape to aircraft propellers. However, because of the high density of water, ship propellers do not need to spin as fast as aircraft propellers do. An alternative to the use of propellers is the waterjet, also known as a hydrojet. These have a number of propellers mounted inside a tube, and driven by the boat's engine. Water is sucked in through the front and pushed out the back at high speed, much like the air in an aircraft jet engine, with the obvious difference that fuel is not burned inside the waterjet. One of the main advantages of a waterjet is that the propellers are shielded, so they cannot get stuck behind plants or debris in shallow water, and they also can't cause injury to people swimming close to the boat. Waterjets are most often installed on small, light boats, though a number of high-speed ferries use them as well.

A ship is steered by the use of a rudder, a movable "fin" at the stern. In many large modern ships this is augmented by small, side-facing propellers in the bow (and sometimes at the rear as well) that can be used to push or pull the bow to the side. This is mostly useful when the ship is lying still in the water, because a rudder doesn't work in that situation. Waterjets often have steerable nozzles, eliminating the need for a rudder. Sailing ships also use their sails to steer: by changing the angle the sails make to the wind, the sails will turn the boat underneath them, changing its course.

Sailboats naturally need wind to move, but it does not need to blow straight from the back of the ship. In fact, most sailboats reach their greatest speed with the wind at an angle between 45° and 90° to

the side of the boat. It is even possible to sail up to about 45° into the wind, though not at very great speeds. The maximum speed reached by a sailboat depends not only on the wind, but also to a large degree on the combination of sails used. Nearly all sailboats have a back-up engine, to propel the ship when there is no wind.

The main controls of a motor vessel are a steering wheel and one or more throttle levers. The steering wheel operates the rudder and/or the nozzles of a waterjet, and works much like that of a car. Each throttle lever controls an engine, the further it is pushed forward the more power the engine provides. When the lever is pulled back, the engine is reversed so the ship can go backward. This arrangement allows most motor vessels to be operated by a single person.

Sailboats are a different matter, because their sails have to be adjusted to make optimum use of the available wind. To go faster, the vessel needs to increase the surface area and optimize the angle and tenion of its sails, so that it catches more wind. In gale winds, sails are taken down to prevent them from being ripped apart. On modern sailing vessels one or two people can quite easily put up or take down a sail in a short time through the use of a system of cables and pulleys attached to the mast, but it is still difficult to sail alone.

Among small boats (thirty meters or less), sailboats tend to draw much more water than powerboats—a fifteen meter powerboat might draw one meter of water, while a sailboat of the same length probably draws at least two meters of water, if not more. Also, sailboat hulls are much more rounded, thus space inside is more irregular and less efficient to live in. A powerboat can usually berth more people comfortably than a sailboat of the same size.

A relatively new type of watercraft is the jetski. Jetskis are small motorboats with a one- or two-person seat at the back, behind and above the engine and fuel tank. They are steered with a motorcycle-type handlebar, which in some models can be folded down when the jetski isn't used. Jetski's are driven by waterjets, which gives them their name, and most have a "dead man's switch"—a cord around the rider's wrist or hooked to his or her life jacket, which shuts off the engine should the rider fall off. This is a safety measure to prevent the jetski from going out of control, as people fall off jetskis relatively often. Jetskis are most commonly used for recreation, although they are not always appreciated by other people near or on the water due to their noise and speed.

A second modern type of boat is the jetfoil. This type of ship uses wings similar to those of an aircraft, but mounted on struts underneath the ship. The wings, or foils as they are called, glide through the water like an aircraft's wings through the air, and lift the rest of the boat out of the water. Because of the foils' small frontal area, the ship can achieve higher speeds than others of its size. The foils are much smaller than comparative aircraft wings, as the density of water allows them to generate more lift than is possible in air. However, the foils can only support the vessel when it is moving at high speed, so jetfoils have hulls like that of other boats for use at low speeds.

BOMBARDIER

Bombardier Motor Corporation of America Sea-Doo/Ski-Doo Division, U.S.

Sea-Doo SP

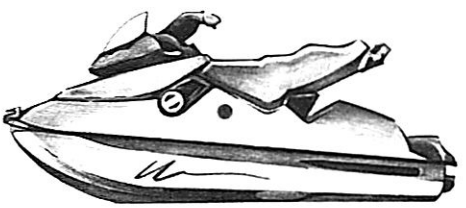
***also* Sea-Doo GS**

	SP	GS
Capacity:	1+1	1+1
Displacement:	175kg	215kg
Draft:	N/A	N/A
Engine:	60hp	85hp
Top speed:	65km/h	70km/h
Range:	95km	120km

The Sea-Doo is a popular series of jetski, available in a number of different models. The SP and GS have a somewhat plump look about them, especially when compared to some other jetskis. However, they have good performance, and have room for a rider and one passenger. No handholds are provided for the passenger, though. A storage space is provided for carrying small items on the craft.

These jetski's are constructed from fiberglass to make them as light as possible, and are equipped with a water-cooled, two-cylinder engine of 718 cc driving a waterjet for propulsion. The engine uses regular unleaded gasoline, so fuel availability should never be a real problem.

The GS is virtually identical to the SP except for an increase in engine power, even though the actual engine size remains unchanged.



Sea-Doo GTX

***also* Sea-Doo GTX-RFI**

	GTX	GTX-RFI
Capacity:	1+2	1+2
Displacement:	260kg	275kg
Draft:	N/A	N/A
Engine:	110hp	110hp
Top speed:	95 km/h	90km/h
Range:	120 km	115km

Not only is the Sea-Doo GTX larger and heavier than the SP and GS (above), but it also has a more powerful 782 cc engine, which increases the vessel's overall performance. Its layout is very similar to the SP, except that the buddy seat can hold up to three people. Even though the layouts are similar, the GTX has a much more streamlined look and its hull shape is designed for use on waves. The GTX RFI is a slightly heavier model with some extra features, but it is otherwise identical to the standard GTX for most purposes.

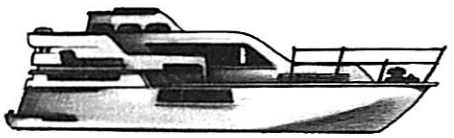
BROOM

Broom & Sons, U.K.

Ocean 34

Capacity:	1+4
Displacement:	7,500kg
Draft:	0.9m
Engine:	two 130hp D
Top speed:	25km/h
Range:	750km

The Ocean 34 is a 10.4 meter (34 foot) motor yacht with limited ocean-going capabilities. It is of polyester construction with an open bridge high on the back of the vessel, above the living quarters. The main deck has two bedrooms, a lounge, two bathrooms, and a kitchen area, with sleeping accommodations for up to five people if the couch in the lounge is used as a bed. The bridge is open, and there are no controls inside the boat's cabin.



Different engines are available; the data given here is for the most powerful option, but with the least powerful engine—a single 58 hp diesel—speed is only some 15 km/h. The engines drive a normal propeller at the rear of the hull, and a small propeller mounted transversely in the bow helps steer the boat when in port. Though not a particularly high-speed vessel, the Ocean 34 is typical of many small- to medium-sized motor yachts.

CHRISTENSEN

Christensen Motor Yacht Corporation, U.S.

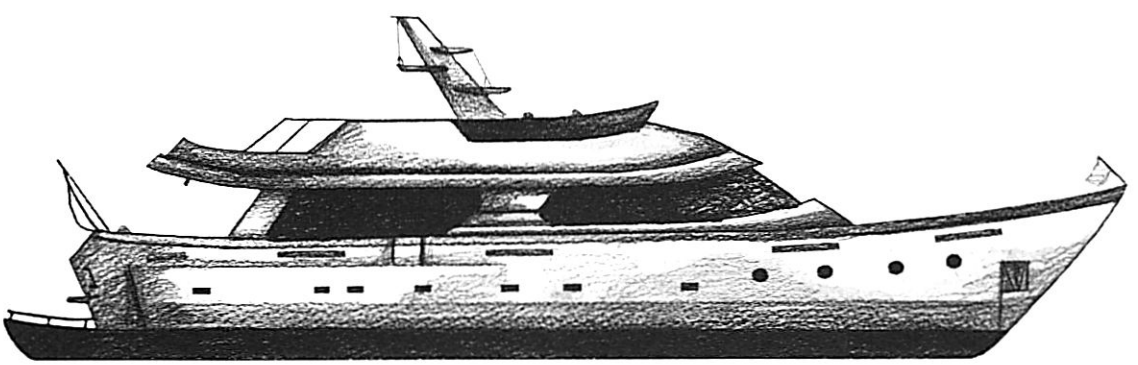
VC

Capacity:	2+10
Displacement:	77tons
Draft:	1.8m
Engine:	two 810hp D
Top speed:	55km/h
Range:	650 km

Christensen's VC is a 30-meter luxury motor yacht that is typical of its type. Since these boats are essentially custom-built, details can vary widely between similar yachts, but in general they are more or less as described here.

The VC has two decks inside, a main deck on top of the hull and a lower deck inside the hull. The main deck has a walkway all around the outside, with a bench set into the front of the superstructure and a lounge area at the port rear of the boat. Inside, the forward part of the superstructure is the pilot area, with the boat's controls and seating for passengers who want to be on the bridge. A large kitchen, a salon, and a dining area take up the remainder of the main deck. An open-topped recreational deck can be found above the main deck. A lifeboat is also carried here.

The lower deck features, going forward from the rear, the engine room with two engines and associated equipment; a master bedroom with a lounge and separate ladies' and mens' bathrooms; two guest staterooms with double-sized beds, toilet, and shower; on the port side another guest stateroom similar to the first, while on the starboard is a laundry room and a crew lounge. The two crew cabins are located at the front of this deck. They each contain a set of beds and a toilet/shower cabin.



Codecasa

Cantieri Navali Codecasa, Italy

Codecasa 49

Capacity:	8+14
Displacement:	350tons
Draft:	2.3m
Engine:	two 2,285hp D
Top speed:	35km/h
Range:	6,200km

This 49-meter motor yacht is designed as a luxury vessel capable of crossing the Atlantic ocean. The normal crew complement is eight, although it can be operated with only two or three people on board, as most functions are controlled from the bridge. There is only enough cabin space for twenty-two people to sleep on board comfortably.

There are four decks on this vessel. The lower deck has crew and passenger quarters, as well as the engine room and a boat garage. This garage is at the rear of the vessel and can hold two smaller boats and two jetskis, for recreation and going ashore in areas where the boat itself cannot get close to the shore. The main deck has the owner's bedroom, guest rooms, the galley (kitchen), a dining room, and a large lounge, while the bridge deck holds the ship's controls, plus a saloon complete with piano. Finally, the sun deck is on the roof of the bridge deck, and is not much more than a flat roof with low railings, open to the sky.

Etap

Etap Yachting NV, Belgium

30i

Capacity:	1+5
Displacement:	3.3tons
Draft:	1.7m
Engine:	18hp D
Top speed:	13km/h
Range:	unlimited

The Etap 30i is a standard sailboat approximately nine meters in length. It can be purchased with a short or a long keel, draft being either 1 or 1.7 meters, respectively. The longer keel makes the boat more stable in high winds.

The hull, made using a polyester construction, consists of an inner and outer shell with foam in between. This construction is so reliable that Etap claims the 30i is "unsinkable"; in any case, it should remain afloat even if seriously damaged. The cockpit is located at the back of the boat, with a door at its front giving access to the below-decks area. Below the deck, three bedrooms are set up to accommodate a total of six people, including a small kitchen and living area, and a bathroom. Storage lockers can be found all throughout the boat.

The controls are somewhat illogical to many sailors at first, employing a sort of steering wheel to control direction, however it must be moved the opposite of the desired direction—moving it to the left makes the boat steer right. It is also impossible to control the vessel from inside, which is not very handy in bad weather. Since the 30i is a sailboat, its speed is dependent on the wind speed and range is effectively unlimited. However, it is not very suitable for making long voyages because its hull shape and sail area make it difficult to handle at full sea.

KAWASAKI

Kawasaki Heavy Industries Ltd.

Jetfoil 929-117

Capacity:	2+350
Displacement:	119tons
Draft:	2.2m (4.9m w/foils)
Engine:	two 3800hp T
Top speed:	85km/h
Range:	600km

The Jetfoil series was originally designed and built by Boeing Aerospace, but Kawasaki received a license for manufacture of the Jetfoil 929-117 in 1987. Boeing itself stopped production of hydrofoil vessels in 1985. Most of the ships in the 929 series have been sold to Asian countries, although a few are used in Europe.

The Jetfoil 929-117 is a mid-size hydrofoil, using front and rear foils to lift itself out of the water, and is driven by twin Allison turbines of almost 2,800 kW each. The engines drive waterjets that propel the ship when riding on the foils, or conventional propellers when the foils are not in use.

Most Kawasaki-built Jetfoils are used as high-speed ferries by commercial companies. In this role, they have two decks seating a varying number of people—typically, around 250 passengers in addition to the crew. For maximum capacity, some 350 passenger seats can be installed. It only takes one person to pilot the ship, though it will operate better with a larger crew.

Jet Ski 900 STX

***also* 750 STX, 1100 STX**

Capacity:	1+2
Displacement:	300kg
Draft:	N/A
Engine:	100hp
Top speed:	85km/h
Range:	105km

These three jetskis are very similar in most respects, aside from their engine sizes and the corresponding differences in performance. They're all relatively small crafts, only about three meters from bow to stern, with buddy seats that can hold up to three people including the driver. Footrests are incorporated into the hull on either side of the seat, and there is a handgrip behind the seat for the rear passenger to hold onto.

The engine is water-cooled, equipped with an electric starter, and drives a waterjet that gives the craft good performance even in very shallow water. Although the larger engines are less fuel-efficient than the smaller models, they also have a larger fuel tank, so the overall ranges of these three jetskis are similar. It is notable that these jetskis all have a reverse mode for easier maneuvering in tight areas.

750 STX	1100 STX
1+2	1+2
275kg	280kg
N/A	N/A
83hp	120hp
70km/h	95km/h
105 km	105 km

MacGregor

MacGregor Yacht Corporation, U.S.

MacGregor 26

Capacity:	1+4
Displacement:	1ton
Draft:	2m
Engine:	outboard
Top speed:	wind-dependent
Range:	unlimited

This 8.1-meter (26 foot) sailboat is constructed from polyester strengthened with glass fibers, using a double-walled hull for added safety: in case the outer hull wall is breached, the inner wall can keep the ship afloat until repairs can be made. Because the hull walls are rather thin, this is not an unnecessary feature. The ship itself is pretty light and ballast tanks, sometimes filled with up to 550 liters of water, are used to make the ship sit in the water deep enough for it to operate correctly. The keel is removable for transport on roads, using the trailer that comes with the boat.

Overall, the MacGregor 26 is a simple vessel without many of the features that people generally expect to find on boats, such as safety rails, a bilge pump, or an installation to fold the mast. Such things are available as extras, though. The interior of the boat consists of one large cabin that is much too low for an adult to stand in, but the roof can be raised when necessary. There is sleeping room for up to five people in the main cabin, and also a small kitchen area. A small bathroom is contained in a separate area of the cabin.

Even though the boat itself is bare according to modern standards, it is fast. An engine is not built in, and while an outboard motor can be installed at the back of the boat, this should not be rated at more than 10 hp, with which it can reach a top speed of about 10 km/h.

Najad

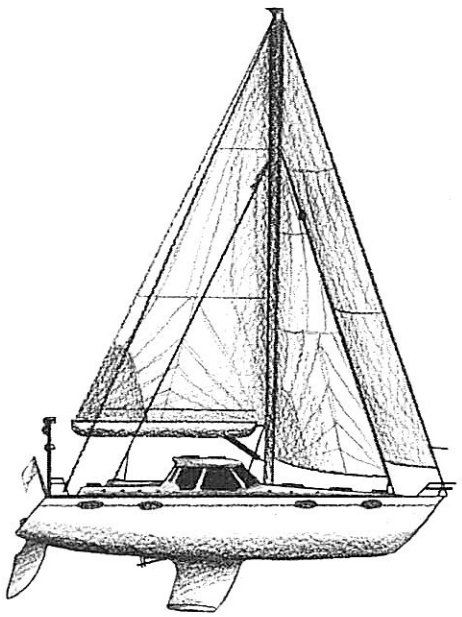
Najadvarvet AB, Sweden

Farr 60

Capacity:	2+7
Displacement:	22tons
Draft:	2.8m
Engine:	142hp D
Top speed:	18km/h or wind
Range:	unlimited

A large sail yacht built in Sweden, the Farr 60 is intended as a series of semi-custom-designed boats—meaning the basic boat designs will all be the same, but they're equipped according to the customer's specifications. This in contrast to standard boats, which are all identical, or complete custom-built ships.

The Farr 60 is 18.5 meters long overall, and 5.5 meters wide at its widest point. In layout, it is a conventional sailboat with a flat deck in the front, a raised roof with large windows over the middle section of the boat, and a deepened cockpit, without roof, at the rear. The cockpit area has benches all around, and the controls for the boat and engine in the center. The main lines for controlling the sails also extend to the rear of the cockpit. An autopilot is a part of the basic package.



Inside, there are four cabins that can hold a total of nine people, a saloon with a kitchen area, and three bathrooms. The navigation area in the saloon can be equipped with full controls, if required, so the boat can be steered from inside when the weather conditions are too bad for the crew to go outside.

PANTHER

Panther Air Boat Corporation, U.S.

Panther 16

***also* Panther 14, Panther 20**

Capacity:	1+4
Displacement:	1ton
Draft:	N/A
Engine:	220hp
Top speed:	75km/h
Range:	420km

An air boat is not much more than a shallow hull with a flat bottom and large propellers mounted at the back. The propeller is not in the water, but in the air and as such is similar to those fitted to propeller-driven aircraft. A metal wire cage around the propeller and engine protects the passengers. The driver has a seat high up on the boat, just in front of the engine, and uses a lever to steer the craft by means of rudders behind the propeller. In front of and below the pilot's position are more seats for passengers.

The Panther 16 is a typical airboat; many different models exist in various sizes, both offered by the manufacturer and built to order. The hull is constructed from aluminum, strong enough to withstand handgun rounds from a few meters range, and is some 5 meters (16 feet) in length. The Panther 14 is a smaller version, while the Panther 20 is larger; naturally, the larger the boat, the more passengers and cargo it can carry. A 220 hp or 300 hp General Motors engine is normally installed, though a different engine can be fitted as an option.

Air boats are common in the Florida Everglades and other marshy areas in the United States, but are seldom used in other countries. Their negligible draft makes them extremely suitable for use in shallow water, though the propeller and engine make quite a bit of noise which can attract attention or scare animals.

14	20
1+1	1+9
1ton	1ton
N/A	N/A
220hp (or 300hp)	220hp (or 300hp)
90km/h	60km/h
420km	420km

TEMPEST

Tempest Yachts, Inc., U.S,

Tempest 60

Capacity:	1+6
Displacement:	23tons
Draft:	1m
Engine:	two 1050hp D
Top speed:	90km/h
Range:	500km

The Tempest 60 is a high-speed motor yacht available in both commercial and recreational variants. It is 18 meters long with an open bridge, behind a large windscreen, in the middle of the boat. Passengers are seated behind the bridge, and there are living quarters below deck. Depending on how the boat is outfitted, these living quarters can be quite luxurious. Among the standard equipment are radar, an autopilot, and a fire extinguishing system.

These yachts are generally regarded as extremely seaworthy and safe, with a polyester hull to keep weight down. Power from two large diesel engines goes through Tempest's patented T-Torque Drive to propel the boat. The reasonably low draft allows the Tempest 60 to be operated in shallow waters.

MILITARY ARMORED VEHICLES

CHAPTER SIX

ARMORED VEHICLES

Armored Fighting Vehicles, often called AFVs, form a large part of the combat strength of any conventional modern military force. The first serious experiments with adding armor to ground vehicles were conducted in the early twentieth century, although as early as the fifteenth century, Leonardo daVinci had drawn plans for a fully-enclosed armored car. The first purpose-built armored vehicles in the 1910s consisted of civilian cars (which were quite new at the time) fitted with bodies made of armor plating and a few machineguns. Large numbers of these early armored cars were used in the opening months of World War I.

The first tanks were developed to overcome an inherent problem of trench warfare: crossing barbed wire. This led to the peculiar rhomboid shape of early tanks, a shape that was not maintained in future generations of armored vehicles.

During the wars since, armored vehicles have been employed not only in the tank's role of breaking through enemy lines, but also for other purposes such as transporting infantry on the battlefield. The German army, when it was re-arming in the 1930s, paid special attention to this factor, because a tank by itself is vulnerable, while a tank with infantry support is a very tough nut to crack. As a result, armored personnel carriers (APCs) were created so the infantry could keep up with the tanks' advance while being protected from enemy fire.

Before the Second World War there were two basic strategies used in the development of tanks and armored vehicles. The first divided tanks into two categories—cruiser tanks and infantry tanks—based upon what function the tank would be used for. Criuiser tanks were designed to make assaults on and break through enemy lines, using high speeds to exploit enemy weaknesses much like horsemounted calvary had done in the past. Infantry tanks supported

infantry attacks, and therefore had heavier armor and lower speeds than cruiser tanks. The second strategy in tank design dictated that a tank should be able to deal with anything it enountered while operating with continual infantry support—this was prefered by the Germans. The Russians used this strategy when they rebuilt their armies after the initial German attacks in 1941. The Americans sat somewhere in the middle, designing some vehicles for specialized roles while having others that could take on almost any enemy vehicle in the early years of the war.

During the Second World War, it became clear that combined arms operations were the way of the future, and from then on most AFVs were built for this kind of battle. The modern battlefield is populated not only by armored cars, tanks, and armored personnel carriers, but also by a great many other armored vehicle types that first saw the light of day in World War II. Nearly all follow certain common lines, however.

Military ground vehicles tend to be either wheeled or tracked. Wheeled vehicles are mechanically simpler (not to mention cheaper to build and maintain) than tracked vehicles, but they also have lower cross-country capabilities. It is also harder to build a very heavy wheeled vehicle, whereas tracked vehicles have less trouble with high weights. Wheeled vehicles are less noisy than tracked vehicles, though, making them better for fast and quiet manuvering on clear terrain.

Wheeled suspensions are generally similar to those used for civilian vehicles. Tracked suspensions, however, are a little more complex. A tracked vehicle has four kinds of wheels: road wheels are the ones the vehicle actually rides upon; sprocket wheels (or drive sprockets) transfer power from the engine to the track; idler wheels form the opposite "end" of the suspension to the drive sprockets; and return rollers are small wheels that support the top run of the track. Not all tracked vehicles have all of these wheels. If a vehicle has large roadwheels the tops of these sometimes function as return rollers. Some vehicles also use the last roadwheel as an idler, but very few vehicles do away with drive sprockets.

Modern AFVs can be divided into a number of broad groups: tanks, reconnaissance vehicles, APCs/MICVs (short for Mechanized Infantry Combat Vehicles), repair/recovery vehicles, self-propelled guns, tank destroyers, and support vehicles.

Tanks are now more often known as Main Battle Tanks, or MBTs, to distinguish them from light tanks (weighing up to about twenty-five tons) that are used mainly for reconnaissance. All MBTs are monsterous vehicles, weighing between forty-five and seventy tons fully loaded, and still reaching speeds of up to 70 km/h. MBTs are heavily armored, and equipped with very powerful main guns of 105 to 125 mm caliber—in western tanks coupled to fire control systems that virtually guarantee first-round hits at ranges up to three kilometers; effective ranges are about twice that figure. Western MBTs normally have four-person crews consisting of commander, driver, gunner, and loader, while Russian tanks do away with the loader in favor of an automatic loading mechanism. This keeps the silhouette of the tank down, but puts a slightly higher burden on the crew.

Reconnaissance vehicles are light and small, forming somewhat of a cross between MBTs and MICVs—they weigh some fifteen to thirty tons but carry only a small crew and have no room for passen-

gers. Their armament is similar to that of an MICV, and their armor is equally light. Speed is generally high, reaching up to 80 km/h or more. Some reconnaissance vehicles are modified APCs or MICVs, with only the interior and some minor external features setting the two apart.

The other types of AFVs are more specialized and, because of that, they have not been included in this book. For the most part, APC and MICVs are designed and constructed to carry and protect infantry units through dangerous territory. Self-propelled guns and tank destroyers tend to be heavily armored, and even though they are not as mobile as tanks, they make up for it in firepower. Repair and recovery vehicles are generally built with lighter armor so that they are more maneuverable and efficient at getting wounded men out of battle or damaged vehicles back in action.

With all these vehicle types, there are two common approaches to their design: the western and the eastern methods. The western method is to build vehicles that can accommodate the typical western male without being cramped, so any member of the population can be called upon to operate the vehicle. Because western soldiers receive extensive training, they are expensive and must be protected; as a result, western vehicles are heavily armored and place high emphasis on keeping the crew alive. Because of the size of the average, western male, these vehicles are large, requiring a lot of armor plating; this has a high weight, which in turn requires a powerful (and large and heavy) engine to give the vehicle good speed. All this costs money, and very quickly the design turns into a vicious circle of larger vehicle, larger weight, larger engine, and larger budget. Western AFVs are marvels of technology, incorporating almost every concievable design trick and device to enhance combat performance and survivability. The interior is large (as tanks go, that is) so the crew have enough room to sit and work without getting too tired to fight.

Eastern tank design (or, more specifically, Russian tank design) goes the other way round: Russia's large population means that only short people are selected for AFV duties; also the widespread use of automatic loaders makes for one less crewmember per vehicle. This keeps the vehicle's size down, and thereby the amount of armor needed to protect the crew. Russian tank crews receive only simple training compared to western crews, and the large population means replacements are easily available at low cost. This is coupled to the idea that tanks and their crews are somewhat expendable, which means the vehicles don't need so much armor plating anyway. In turn that allows the use of a lighter, smaller engine, and on the whole makes the vehicle cheaper to produce. Looking inside a Russian tank, it looks quite different from a western tank: first of all, the crew's seats are cramped and uncomfortable—in some tanks, the commander sits with his legs straight forward and has a vinyl-covered piece of wood as a backrest. To make matters worse, in these tanks the magazine for the automatic loading mechanism is directly below the commander's and gunner's seats, and the driver sits with his back almost against it. It is not difficult to imagine what would happen if it was hit...

The above may make it appear as if Russian-built AFVs are all cramped, uncomfortable, and major health hazards, while their western equivalents are roomy, nice, and safe. This is decidedly not the case: no matter where an AFV is produced, it has little interior space,

uncomfortable and cramped seating, and carries ammunition and fuel really too close to the occupants for comfort. The real difference is that western AFVs are generally designed with crew ergonomics as part of the design specification, whereas Russian ones seem to regard the crewmembers as pieces of equipment that need a place in the vehicle just like the engine and the main gun.

The inside of an AFV is normally painted white, to reflect as much light as possible so the crew can see what they are doing; an added psychological benefit is that the white paint makes the interior seem slightly larger than it actually is. Lights are placed at the crew stations for use when the hatches are closed, and the crewmembers can look out of the vehicle by means of periscopes. In most AFVs, the driver's periscopes cover the frontal arc only, the commander has a 360° field of view, the loader has a single periscope that is either fixed in one direction (usually to the front or side) or can be rotated through 360°, and the gunner can use the gun sight to look in the turret's forward arc. In MICVs, the passengers often also have periscopes or other vision devices so they can use their personal weapons from inside the vehicle. All these provide reasonable fields of vision, but certainly not as good as from an open hatch—most tank commanders and drivers only close their hatches when coming under enemy fire.

Hearing is another matter; the interior of a tank is incredibly noisy, with the roar of the engine coupled to the sounds of gunfire and movement over rough terrain, both from outside and from within the vehicle. Shouting is the only way to make oneself understood, and even then only with difficulty. The solution to this problem is to use an intercom system: headphones and a microphone for each crewmember, often built into a helmet (one of the primary rules of riding in an armored vehicle across country is that, as soon as you duck your head inside to look at something, the vehicle will hit a bump and you'll crack your skull against the roof). The intercom is coupled to a radio set to allow the crew to communicate with other units at the flick of a switch. A few intercom systems also exist to allow passengers in AFVs and MICVs to communicate, but these are not common.

The controls of AFVs are largely similar to those of civilian cars, although tracked vehicles have a few exceptions. Many modern tracked AFVs have steering wheels, but most older ones use two levers or sticks instead. Each lever controls one of the tracks, so that by pushing both forward the vehicle moves forward (the speed is usually determined by an accelerator pedal, like in a car), and by pulling both backward it brakes. If only one of the levers is pulled, the vehicle steers; for example, pulling the right-hand lever causes the AFV to make a right-hand turn—this is because by pulling the right-hand lever, the right track is braked or put into reverse. This maneuver is known as pivot-steering, and often allows the vehicle to stand in one place and still turn from side to side, something that is impossible with normal wheeled vehicles.

To ease the load on the driver, most AFVs have automatic or semi-automatic transmissions. The latter are manual transmissions that don't require the driver to apply a clutch, so gear shifts can be made faster and the driver can devote less attention to them.

Although tanks are common on the modern battlefield, they cannot work alone, because a tank without support is not able to hold ground. A tank can be used quite effectively to capture enemy territory,

but infantry is needed to actually control that territory, as well as to protect the tank from attacks by enemy infantry—even though a tank is a powerful weapon, a lone tank can be quite easily disabled by determined and well-trained infantry.

However, even as early as 1918, technology has insured that infantry needs protection to survive on a modern battlefield. Furthermore, they need to be able to keep up with the tanks they are supposed to protect. Armored personnel carriers, or APCs for short, perform both these functions. They carry troops onto and around the battlefield, and are armored to such a degree that they can withstand small arms fire and grenade fragments—though most cannot survive hits from automatic cannons, let alone from tank guns. An APC's speed is more or less equal to that of the MBTs with which it is to operate, allowing infantry to keep pace with those MBTs in a rapidly-moving battle.

APCs have a large part of their interior devoted to benches, seats, and equipment stowage, and have large hatches to allow the passengers to leave the vehicle quickly. Most have either large doors or a drop ramp at the rear of the vehicle for quick entry and exit. APCs weigh only about ten to fifteen tons.

Crews of APCs are often two people (commander and driver), and the vehicles are usually armed with only a machinegun mounted on the commander's hatch. The passengers can often use the roof hatches to stand up and fire their personal weapons, but they must expose themselves to enemy fire in order to do so.

Ultimately, an APC is not much more than a "battle taxi"—the soldiers can sit inside and are protected from enemy fire, but cannot actively participate in the battle until they dismount. MICVs were developed in the 1960s to overcome this drawback. They are usually equipped with firing ports so passengers can use their personal weapons from inside the vehicle. APCs normally do not have turrets, while MICVs are armed with turret-mounted automatic cannons almost without exception, and often an anti-tank missile launcher as well. MICVs are heavier than APCs, usually between 20 and 30 tons, and the crew includes a gunner in addition to the commander and driver.

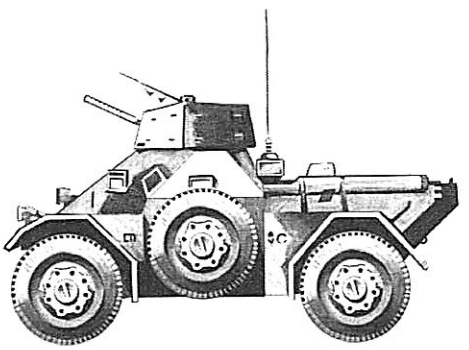
DAIMLER

Daimler Motors Ltd., U.K.

FV 701 Ferret Mark 2

***also* Mk. 1/1, Mk. 1/2, FV 711 Ferret Mk.3, Mk. 4**

Capacity:	3
Weight:	4,500kg
Engine:	130hp
Top speed:	95km/h
Range:	300km



The Ferret was designed after World War II to a requirement of the British Army for a small armored reconnaissance vehicle to replace similar vehicles used during the war. It is a fairly simple vehicle with room for up to three crewmembers in the forward part of the hull, the rear being the engine compartment. The Ferret has four-wheel drive for good cross-country capabilities and is sufficiently armored to protect the crew against small arms fire.

The driver sits centrally at the front of the hull and has a small hatch in the front plate, although this is not really intended as an entry point to the vehicle. The Mark 1/1 version of the Ferret had an open top and no turret, so crew could enter and leave the vehicle easily but were somewhat exposed to the weather. There is also a door in the right-hand side of the hull, between the front and rear wheels, but this is normally covered by a stowage locker. A spare wheel is carried on the corresponding left-hand side of the hull. A pintle mount for a machinegun is often fitted to the hull top. Many Ferret Mk. 1/1s are fitted with Plexiglas windscreens on top of the hull.

The Mark 1/2 added a small turret-like structure to the hull top, and although this could not revolve, it did fully enclose the crew compartment. A hatch in this turret provides access to the vehicle, and a machinegun pintle mount is located on top of the turret, firing to the front. The Mark 2 has a fully-revolving turret with an M1919A4 machinegun, again with a hatch for access. The Mark 3 is simply a Mark 1 with larger wheels and a floatation screen to make the vehicle amphibious, and the Mk. 4 is a Mk. 2 with these same modifications.

The Ferret can be found in service throughout the world, mainly in countries that have or have had close ties with Great Britain.

Mk. 1/1	Mk. 1/2	Mk. 3	Mk.4
3	3	3	3
4,500kg	4,500kg	5,500kg	5,500kg
130hp	130hp	130hp	130hp
95km/h	95km/h	95km/h	95km/h
300km	300km	300km	300km

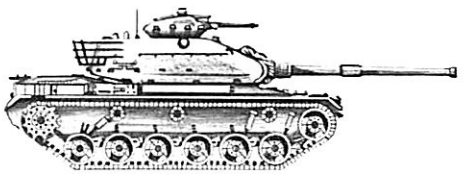
Detroit Tank Arsenal

Detroit Tank Arsenal (Chrysler Corporation), U.S.

M60A3 TTS

***also* M60A1, M60A1+**

Capacity:	4
Weight:	46,000kg
Engine:	750hp D
Top speed:	50km/h
Range:	480km



The M60-series of MBTs was designed in the 1950s to counter the threat of the (then) latest Soviet tanks. It has good armor protection, mobility, and firepower, though it has been superseded in all these areas by more modern tanks such as the M1 Abrams (page 104) and T-80 (page 110).

The driver is seated in the center of the hull, in front of the turret, and has a hatch to enter and exit the vehicle. The turret seats the commander and gunner on the right-hand side, while the loader sits or stands on the left. The commander has a hatch in his cupola, while the loader has a hatch in the turret roof.

The M60A3 is armed with a 105 mm rifled gun, a coaxial M73 7.62 mm machinegun, and an M85 .50 caliber machinegun in the commander's cupola. The cupola can revolve 360 degrees independently from the turret. The turret has two 6-barrel smoke grenade launchers of British design, firing forward. Above the gun barrel a powerful searchlight can be mounted, which can operate in both the visible and infrared parts of the spectrum; in the infrared mode, the light cannot be seen except by infrared and thermal viewers, which are carried by the tank.

The "TTS" in the designation indicates this model is equipped with a Tank Thermal Sight, to distinguish it from earlier M60A3s which did not have this feature. The thermal sight allows the gunner and commander to spot targets by the heat those targets emit, without the need to use the searchlight, which would give away the M60's position.

The M60A1 is an earlier model, of which the M60A3 is an improved model. The A1 version lacks the passive thermal sight, but is otherwise very similar to the A3 model. Some exported M60A1s also do not have the smoke dischargers fitted to American versions of the tank. The U.S. Army uses the M60A3 TTS, while the U.S. Marine Corps has the M60A1. USMC M60A1 tanks have smoke dischargers, a modified M60 machinegun in place of the M73 coaxial weapon, and can be fitted with explosive reactive armor (ERA) blocks. They are known as M60A1+.

ENGESA

Engesa Engenheiros Especializados SA, Brazil

EE-9 Cascavel

Capacity:	3
Weight:	10,750kg
Engine:	172hp D
Top speed:	100km/h
Range:	750km

This Brazilian armored car was first produced in 1973 and is a fairly typical example of a modern armored car. It uses many commercial vehicle components in its construction, which makes the vehicle cheaper to produce and also makes repairs easier. The EE-9 has all-wheel drive and an independent suspension designed for maximum traction in rough terrain.

The hull has three compartments: the driver sits at the front, the engine and transmission are at the back, and in the center is the fighting compartment which holds the turret. The hull is a double-shelled construction, with an inner and an outer layer of armor with an air gap in between to enhance the protection for the crew. An air conditioning system is fitted to regulate temperatures as well as filter out noxious fumes, gases, and smoke which may be employed to stop the vehicle.

The turret seats the commander and gunner, and is of French origin, the same as that used on the Panhard AML armored car (page 107), and equipped with a Belgian Cockerill EC 90-1 low-pressure gun of 90 mm caliber and a coaxial 7.62 mm MAG machinegun. Four smoke grenade launchers are fitted to the turret sides. The turret has roof hatches for both crewmembers.

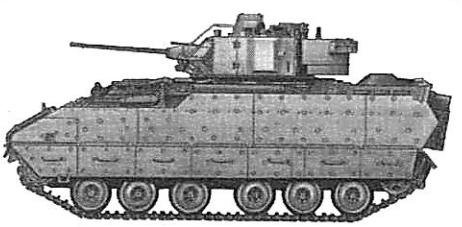
FMC

FMC Corporation, U.S.

M2 Bradley IFV

***also* M2A2 Bradley IFV**

	M2	M2A2
Capacity:	3+7	3+6
Weight:	22,600kg	29,900kg
Engine:	500hp D	600hp D
Top speed:	65km/h	60km/h
Range:	480km	400km



The M2 Bradley Infantry Fighting Vehicle (IFV) is the most capable MICV in the world, but also one of the most expensive. The Bradley series was named after U.S. Army five-star general Omar N. Bradley, a major figure of WW II.

The M2 is a large vehicle, almost the same size as a main battle tank, and it pushes the MICV concept to the limit. The passenger compartment has seven seats, which can carry a complete infantry squad. The passengers—the whole reason for its existence—are crammed into the rear third of the hull, with engine, turret, and driver's station taking up the rest of the internal space.

The M2 carries 600 25 mm rounds, 1540 7.62 mm rounds, and five TOW missiles. There are two firing ports in each side of the hull, and two more in the rear ramp; these ports will only accept the M231 firing port weapon, of which six are carried inside the M2.

The M2A2 has the extra armor and does not have the firing ports in the hull sides, though the ones in the rear ramp are retained. One of the passenger seats has been removed, reducing the passenger capacity from seven to six but freeing some room for carrying supplies.

The M2A2 is pictured here, while the M2 looks like the picture shown for the M3 Bradley CFV, shown below.

M113A2

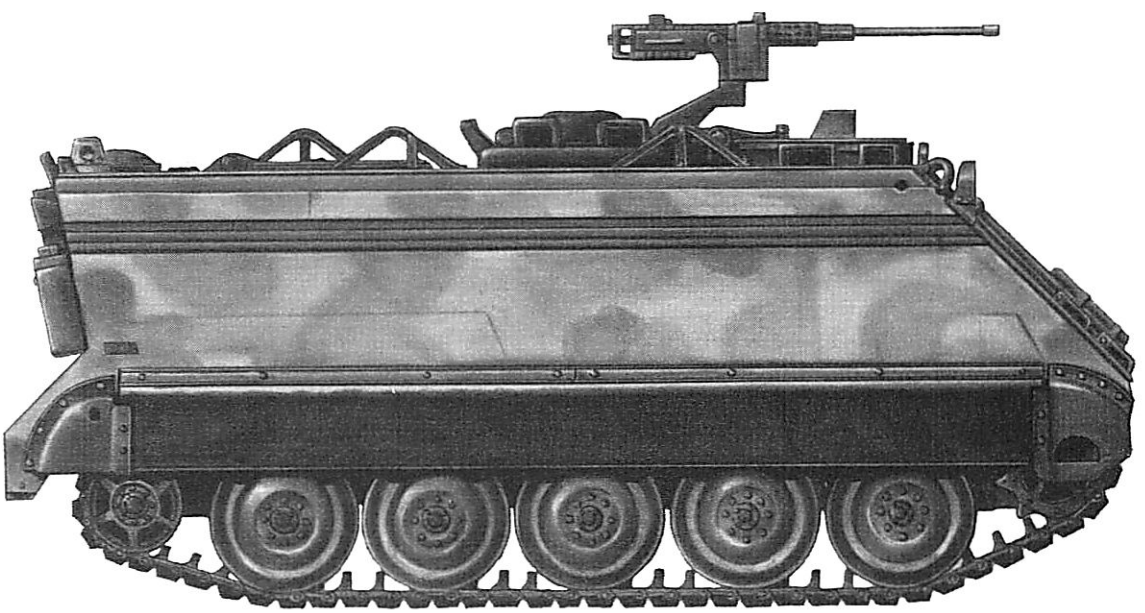
***also* M113A3**

	M113A2	M113A3
Capacity:	2+11	2+11
Weight:	11,300kg	12,000kg
Engine:	215hp D	275hp
Top speed:	65km/h	65km/h
Range:	480km	480km

The most widely-produced armored vehicle ever, the M113-series has had a production run of over 70,000 vehicles since the first rolled off the assembly line in 1960, and it will still be going strong in the 21st century; the M113A2 is just one of the more recent versions. Not much more than an aluminum box with vertical sides and a sloped front, the M113 can carry two crew and eleven passengers onto the battlefield. The M113 is amphibious, being propelled in the water by its tracks. It is armed with a single M2 HB machinegun mounted on the commander's station, with 105 ready rounds; additional ammunition is stored wherever convenient. Many U.S. Army M113s have a mount on the commander's hatch to which an M47 Dragon anti-tank missile can be clipped. Neither the M2 HB nor the M47 can be operated from inside the vehicle, though, and the commander's head and upper torso are exposed to enemy fire when the weapons are operated.

The M113A3 is an improved version that moves the fuel tanks to the outside of the vehicle (reducing the fire hazard for the people inside) with an upgraded engine and transmission for better performance. The control sticks are replaced by a steering wheel.

The M113 can achieve good cross-country speeds and carry a large load. The passenger area takes up most of the interior, with the only other compartment being for the engine, at the right front of the hull. Seating is typically military, in that it consists of two large



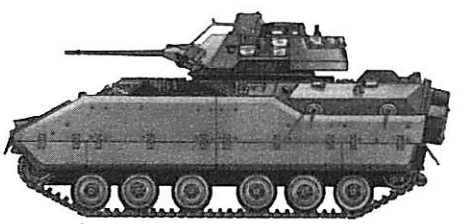
benches and a few individual seats of little comfort, but there is enough room inside for the passengers to ensure that they reach their destination in fighting condition. Access to the vehicle is good, with roof hatches for the commander and the driver, a large hatch over the passenger seats, and a large ramp in the rear of the hull.

In service in over fifty countries and in more than 150 variants, the M113 can be found all over the world in countries using western arms. Many of its users have made local modifications to the design in order to make it more compatible with their own specific needs. Some of the main variants include mortar carriers (with 60 mm, 81 mm, 107 mm, and 120 mm mortars), a command post with a raised roof, and a repair/recovery vehicle. The basic vehicle can also be quickly converted into an ambulance capable of carrying four litters.

M3 Bradley CFV

also M3A2 Bradley CFV

	M3	M3A2
Capacity:	5	5
Weight:	22,600kg	29,900kg
Engine:	500hp D	600hp D
Top speed:	65 km/h	60km/h
Range:	480km	400km



The Bradley Fighting Vehicle series was developed in the 1970s to meet U.S. Army requirements for both an infantry combat vehicle and a reconnaissance vehicle. The M3 Bradley CFV, apart from its internal layout and minor external features, is nearly identical to the M2 (above).

The M3 can carry a crew of three (driver, gunner, and commander) and two passengers. The driver sits in the hull front with the passengers on the left side and in the back, and the gunner and commander sit in the turret. The passenger area, behind the turret, can be accessed by a large drop ramp at the rear of the hull, through which the passengers can quickly dismount, and there is a large hatch in the roof over the passenger area. In the passenger area are two seats, and periscopes in the roof give the passengers a view of the battlefield. The rear ramp has two firing ports.

The turret is armed with an M242 chain gun with 300 ready rounds (150 APDS and 150 HE) and 1200 reloads. There is a coaxial MAG machinegun (800 rounds ready, plus 3740 reloads). Mounted on the left side of the turret is a twin TOW missile launcher, so the Bradley packs a hard punch against other armored vehicles. Ten TOW reloads are carried in the hull.

Cross-country capability is excellent despite the Bradley's large weight, due to the powerful engine and good suspension.

The most important difference between the M3 and M3A2 is that the latter has extra armor plating on the hull and turret, and can be further equipped with ERA blocks for increased protection. The extra armor adds a lot of weight, so the engine, transmission, and suspension were improved to keep performance at about the same level as that of the M3. Also, in the M3A2 the firing ports have been deleted. Both M3 and M3A2 can be made amphibious with the installation of a floatation screen, which takes five to ten minutes to erect.

General Dynamics

General Dynamics Land Systems Division, U.S.

M1A2 Abrams

***also* M1A1 Abrams, M1A1(HA) Abrams**

Capacity:	4
Weight:	59,000kg
Engine:	1500hp GT
Top speed:	70km/h
Range:	465km

The latest version of the U.S. Army's main battle tank for the 1980s and '90s, the M1A2 is one of the most capable tanks ever developed. Named after U.S. Army general Creighton W. Abrams, earlier versions proved themselves in combat during operation Desert Storm in 1991.

The main armament is a M256 tank gun of 120 mm caliber, with the coaxial weapon being a MAG machinegun (called M240 by the U.S. Army) with 220 ready rounds. Both these weapons are controlled by the gunner's fire control system, with the commander also having a set of controls. The system incorporates a thermographic night sight, and the commander has an independent thermal night sight that can be rotated 360 degrees independently of the turret. Anti-aircraft weaponry consists of a MAG machinegun mounted at the loader's hatch (220 ready rounds) and an M2 HB at the commander's cupola (105 ready rounds). In the M1A2, the commander's machinegun cannot be aimed and fired from inside the tank, but in the earlier M1A1 it can. The loader's weapon cannot be fired from inside in either model.

Forty rounds of main gun ammunition are carried in an explosion-proof stowage area in the rear of the turret—if the ammunition should explode, blow-out panels in the turret roof vent the force upward and the tank would be out of action. The crew would be badly shaken, but there is a good chance they would survive the ordeal (good compared to tanks not equipped with such panels, that is). The tank also carries 12,400 rounds of 7.62 mm and 1,000 rounds of .50in ammunition for the machineguns.

The M1A2's most important drawback is its high fuel consumption, which results from the use of a gas turbine instead of a more conventional diesel engine. The 1,500 horsepower engine does give the tank the power to reach 70 km/h on a level surface, and its quietness compared to other tank engines has earned the M1-series the nickname "whispering death." To conserve fuel, an auxiliary power unit (APU) can be fitted to the rear right hand side of the hull to power the vehicle's electronics, allowing the engine to be switched off when the tank is stationary.

There are not many differences between the M1A1 and M1A2. The most distinguishing feature is the different commander's cupolas. The M1A2 also has a thermal viewer on the turret roof, which the M1A1 lacks. The M1A1(HA) is a minor variant, HA standing for Heavy Armor and indicating the tank has depleted uranium armor on its turret front. The only way to tell an M1A1(HA) apart from a standard M1A1 is by the serial number welded into the turret sides, which ends with a "U" if uranium armor is installed. M1A2s have this improved armor as standard.

General Motors

General Motors of Canada Limited, Canada

LAV-25 (MC)

***also* ASLAV-25**

Capacity:	3+6
Weight:	12,900kg
Engine:	275hp D
Top speed:	100km/h
Range:	670km

General Motors of Canada built the Light Armored Vehicle (LAV) series to meet U.S. Marine Corps specifications, based on several similar vehicles used by the Canadian armed forces under the names Grizzly, Cougar, and Husky. In turn, these vehicles are based on the Swiss-designed MOWAG Piranha (see below). Where the Canadian models are six-wheeled vehicles, the LAV-series is eight-wheeled. A Light Armored Vehicle is quite large, though not as big as some Russian eight-wheeled armored cars.

In the LAV, all of the wheels are driven and independently sprung for good cross-country mobility. The front four wheels are steered, and all of them have shock absorbers and large pneumatic tires with an all-terrain tread. At the rear of the hull are two propellers and small steering vanes for amphibious operations. Before the LAV can enter the water, a splash plate must be erected at the front—this only takes a couple of minutes.

The driver is seated at the left front of the hull, with the engine compartment to his or her right, and is provided with an overhead hatch. The rest of the hull's layout differs with the exact model of LAV, as there are several. The LAV-25(MC) has a two-person turret armed with an M242 chain gun and a MAG machinegun as a coaxial weapon. Ammunition carried is 210 ready 25 mm rounds plus 420 spare, and 420 ready plus 1,200 stowed rounds of 7.62 mm ammunition. The turret has two hatches for the commander and gunner, and there is a pintle mount for an M60 or M2HB machinegun on the turret roof. The turret can be fitted with one or two single-shot TOW missile launchers, one on each side. These are not commonly used, however.

In the hull roof are two hatches behind the turret, and two doors are provided in the rear wall. Underneath the hatches are two benches for three persons each, facing outward. In each hull side are two vision blocks and each door also has one, but no firing ports are provided.

Several variants of the LAV-25(MC) have been produced, mostly turretless models such as supply carriers, recovery vehicles, command, control, communication and intelligence (C3I) centers, etc. The ASLAV-25 is an Australian variant of the LAV-25 that only has detail differences with the American version; most noticeable are the brush guards and smaller tires, and the gunner in the ASLAV-25 has a thermal sight which is not present in the LAV-25(MC).

It should be noted that the U.S. Marine Corps does not see the LAV-25(MC) as a troop carrier, even though six passengers can ride in it. Under current doctrine, troops are only attached to the vehicle for reconnaissance purposes, and they are to dismount on contact with the enemy. The U.S. Army's 82nd Airborne division also has a platoon of LAV-25s.

MOWAG

MOWAG Motorwagenfabrik AG, Switzerland

Piranha 8X8

***also* Piranha 4x4, Piranha 6x6**

Capacity:	1+14
Weight:	12,300kg
Engine:	300hp D
Top speed:	100km/h
Range:	780km

The Piranha series is a private venture by the Swiss company MOWAG, which was developed under license by General Motors of Canada into the Cougar, Grizzly, and Husky vehicles, and later into the LAV-25(MC) (see above). The three basic models offered are 4x4, 6x6, and 8x8. The 4x4 is the shortest, the 6x6 is much longer to accommodate the extra pair of wheels, while the 8x8 is only slightly longer than the 6x6, because it adds a pair of wheels in the space between the 6x6's first and second axles.

In all variants, all the wheels are driven and sprung independently of the others. In the 4x4 and 6x6, the front pair of wheels are steerable, while in the 8x8 the front two pairs are steered. All are amphibious, propelled by two propellers at the rear of the hull and steered by four small vanes. Before swimming, a splash plate must be extended on the hull front, taking a few minutes.

Because it is a private venture, the Piranha can be purchased in nearly any configuration desired; the capacity figures given are the maximum possible if the whole hull is used for high-density passenger seating. Installation of a turret or other weapon system would alter these figures drastically, as can be seen by comparing the 8x8 to the LAV-25. The vehicle, in various guises, is used mainly by African nations and Canada. Canadian Piranhas are of the 6x6 and 8x8 variants, and the turreted models are armed with a 25 mm M242 autocannon or a short-barreled 76 mm gun, while turretless variants armed with an M2HB or MAG machinegun are used as APCs capable of carrying eight troops.

The 8x8 Piranha looks similar to the LAV-25, above, while the 6x6 and 4x4 variants are also similar but shorter.

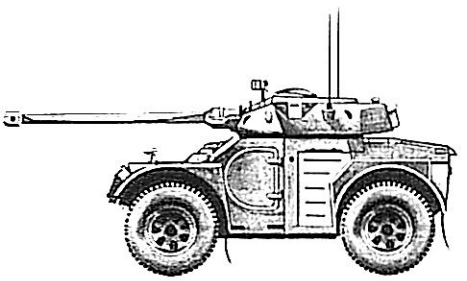
4x4	6x6
1+9	1+13
7,800kg	10,500kg
514hp D	514hp D
100km/h	100km/h
700km	600km

PANHARD

Société de Constructions Méchaniques Panhard et Levassor, France

AML

Capacity:	3
Weight:	5,500kg
Engine:	90hp
Top speed:	100km/h
Range:	600km



The AML is a successful model of armored car that has been sold to many countries the world over since 1960. It is popular in Asia and South America due to its mechanical simplicity and because it can be easily adapted to many different roles.

The hull of the AML has a crew compartment at the front and the engine compartment in the back. The crew compartment has a door in either side of the hull, and a small hatch with three vision blocks in the front plate. The crew consists of the driver who sits in the front of the hull, plus whatever crew is needed to operate the weapons in the turret. The turret is mounted on top of the crew compartment, and in the most common version has a 90 mm Cockerill EC 90-1 gun and a coaxial AA 7.62 machinegun. The turret crew consists of the gunner on the right and the commander on the left.

Alternative weapons fits are common, mainly two-person turrets armed with a 20 mm or 30 mm automatic cannon and a coaxial machinegun, and versions also exist to carry up to four French-designed SS-11 or SS-12 anti-tank missiles and their guidance system.

The AML can be made amphibious by installing a bow screen and bulky boxes filled with foam plastic, which takes some time. Speed is only some 3 km/h in this way, as the vehicle is propelled by its wheels. Propellers are also available as an add-on, which increases the speed in water to some 7 km/h.

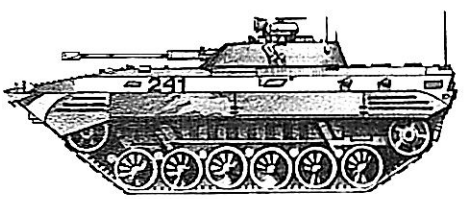
RUSSIAN STATE ARSENALS

State Arsenals of Russia and the former U.S.S.R.

BMP-2

***also* BMP-2D**

Capacity:	3+7
Weight:	14,000kg
Engine:	300hp D
Top speed:	65km/h
Range:	600km



The BMP-2 (Boevaya Mashina Pyekhota, meaning Infantry Combat Vehicle) is a development of the earlier BMP-1, which was one of the first MICVs in the world. It is a fully-tracked vehicle with a very low silhouette in order to make it a small target to enemy gunners, and has seating for seven infantry in addition to the three crewmembers. The BMP-2 is amphibious with very little preparation, and is propelled in the water by its tracks.

The driver sits at the left front of the hull, underneath a hatch in the hull deck. Behind the driver is a passenger seat with an overhead hatch and a firing port for a PK machinegun. The large turret seats the commander on the right and the gunner on the left, both with a hatch in the turret roof. Six more passengers are seated behind the turret, in two rows of three facing outward. Two roof hatches and two doors

in the rear of the hull give access to the passenger compartment. There are three firing ports in either side of the hull, the front-most being for a PK machinegun and the others for an AKM or AK-74 rifle, and the left-hand door also has a firing port for an AKM or AK-74 facing to the vehicle's rear.

Armament consists of a 2A42 cannon of 30 mm caliber in the turret with a coaxial PK machinegun; ready ammunition is 500 rounds for the cannon and 2,000 rounds for the machinegun. The turret has six smoke grenade launchers, and a 9M113 Konkurs (NATO name AT-5 "Spandrel") anti-tank missile launcher is often mounted on the turret roof. This can only be fired by the commander, who must open his hatch to do so. Three spare missiles are carried.

In service the BMP-2 has proven vulnerable to heavy machinegun fire, so the BMP-2D variant (often called BMP-2E in the west) had extra armor fitted for use in the Afghanistan war. Despite this modification, the BMP-2 remains less heavily armored than comparable western vehicles such as the M2 Bradley (page 101). It is also very cramped inside—although seven passengers can be carried, in most countries this number is reduced to only five or six.

BRDM-2

Capacity:	3+1
Weight:	7,000kg
Engine:	140hp
Top speed:	100km/h
Range:	750km

This Russian-designed armored scout car is in widespread military service in many non-Western countries. A number of versions were built over the years, but the basic BRDM-2 is the most common.

It is a simple, four-wheeled armored car with a small turret housing a KPV heavy machinegun with a coaxial PK general purpose machinegun, and carrying three crewmembers plus one passenger. Ammunition carried is 500 rounds of 14.5 mm R ammunition (100 ready) and 2,000 rounds 7.62x54 mm R (250 ready). Access is by means of two hatches over the front seats.

When compared to a tracked vehicle, the BRDM-2 has the rather low cross-country capability that can be expected of an armored car, but the designers have found an ingenious way of compensating for this somewhat: retractable belly wheels. During road travel, these wheels are stowed between the double side walls of the hull, and when needed, they can be lowered from inside the vehicle. The wheels are driven by means of chains, in effect turning the four-wheeled BRDM-2 into an eight-wheeler, and preventing it from getting stuck on rough ground. The wheels are much more susceptible to damage than the normal wheels, however.

BTR-60P

***also* BTR-60PA, BTR-60PB**

	60P/60PA	60PB
Capacity:	2+16	2+14
Weight:	10,000 kg	10,300
Engine:	two 90hp	two 90hp
Top speed:	80km/h	80km/h
Range:	500km	500km

This wheeled APC was developed in the Soviet Union in the late 1950s. It was adopted by the Russian armed forces, and modernized versions are still in active service in a large number of countries.

An impressive vehicle with eight large wheels, the BTR-60P has room for two crewmembers and sixteen passengers. The entire crew and passenger compartment is open-topped, and there are small doors in each side of the hull. It is easier for passengers to enter and exit the

vehicle over the sides, however. Each side also has three firing ports that can be used with nearly any standard issue weapon, allowing the passengers to fire at the enemy from within the vehicle. A pintle mount is also provided, usually equipped with a PK machinegun, but sometimes carrying a DShK heavy machinegun. The BTR-60P is amphibious, at a speed of 10 km/h.

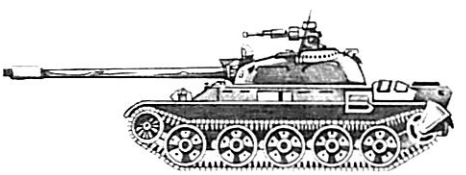
There are two main variants of the BTR-60P: the BTR-60PA and -60PB. The former has a roof over the hull, with two hatches in it, and the hull side doors are deleted. The firing ports are retained. The BTR-60PB is similar to the -60PA, but has a small turret with both a KPV and a PK machinegun, the same as that fitted to the BRDM-2 (above). In either side of the hull is a door, and the normal firing ports are also present. Twelve passengers can be carried in addition to the three-person crew, but common practice is to carry only eight.

The BTR-60 can be found in these three versions in most of Africa, Asia, Central America, Eastern Europe, and the Middle East.

T-55A

***also* T55A(M), Type 69**

Capacity:	4
Weight:	36,000kg
Engine:	580hp D
Top speed:	50km/h
Range:	500km



A Russian tank designed in the late 1950s as an improved version of the T-54, this tank was widely exported to many communist and non-aligned countries around the world. The T-54 and T-55 are very similar both externally and internally, to the extent that they are usually referred to as the "T-54/55 series."

The T-55A is armed with a 100 mm main gun, for which it carries forty-three rounds of ammunition. It has a coaxial PK machinegun, with 3,500 rounds of carried ammunition (250 ready), both of these weapons being tied into the gunner's fire control system. The T-55A(M) also has a DShK machinegun on the loader's hatch, with 500 rounds of ammunition (50 ready). Many T-55s currently in service have been retrofitted with laser rangefinders, improving their accuracy. On internal fuel, the T-55 has a maximum road range of 500 km, but it can be fitted with external fuel drums holding a total of 200 liters, to add 100 km extra range.

The T-55A and T-55A(M) can be encountered in many African, Asian, Central American, Eastern European and Middle Eastern countries. China has manufactured unlicensed copies of the T-55 under the designation Type 69, though the differences between this and the T-55 are very minor.

T-72M1

***also* M84, T-72M1M, T-72S**

Capacity:	3
Weight:	41,000kg
Engine:	780hp D
Top speed:	60km/h
Range:	450km

The T-72 is the result of the Soviet philosophy of designing two MBTs around the same time: one to equip elite units and one for the rest of the army and to export to other countries. The T-72 was intended for the lesser units, whereas the much more advanced T-64 equipped elite units from the 1960s through 1990s. The T-72M1 variant is the most common export model; due to the thick armor on the turret front compared to earlier T-72 variants, the M1 was nicknamed "Dolly Parton" by Western intelligence agencies.

In most respects, the T-72 is the archetypal modern Russian MBT: very low so as to present a small target, moderate armor protection, reasonably high speed, and an automatic loader for the main gun. The interior is very small, so that anyone over about 1.70 meters tall will find it impossible to sit up straight, and crew comfort was apparently last on the designers' list. The driver sits in the hull front behind the well-sloped front plate, and has a hatch for entering the vehicle. The commander sits on the right-hand side of the turret and has a cupola with several periscopes for all-round visibility. The gunner sits on the left-hand side of the turret and also has a hatch in the turret roof.

The main armament of the T-72 is a 125 mm D-81TM smoothbore gun with a very long barrel, which does not perform as well as Western guns even though it is of larger caliber. As mentioned, this gun is fed from an autoloader, whose 39-round magazine sits in the hull directly underneath the turret. Because the gun must be elevated to a specific angle before loading can begin, the rate of fire is slower than in tanks with a manually loaded main gun. Also, the position of the magazine means that almost any hit under the turret that penetrates the armor will set off a catastrophic explosion that will kill the whole crew, wreck the tank, and blow the turret several meters off the tank. Syrian T-72s in Lebanon and Iraqi T-72s in the Gulf War proved very vulnerable to such shots. As if all this isn't bad enough, if the gunner is not careful the autoloader may grab his sleeve and ram his arm into the gun breech. Secondary armament consists of a coaxial PK machinegun and an NSV heavy machinegun on the commander's hatch. Twelve smoke grenade launchers are mounted on the turret front.

The T-72 can ford through water up to 5.5 meters deep after a snorkel is placed on the gunner's hatch and the tank has been waterproofed, which takes up to half an hour to complete. The snorkel is carried on the tank, in a tube on the side of the turret. This kind of deep-fording is not without danger, though.

The T-72M1M (also called T-72M2 by some sources) has much thicker armor on the front turret, leading to the nickname "Super Dolly Parton," and anti-radiation mats on the turret roof. The T-72S is a T-72M1M which can be fitted with explosive reactive armor blocks to the hull front, turret front, and turret roof for extra protection against high-explosive anti-tank rounds. It is also capable of firing a guided missile designated 9K120 "Kvir" from its gun tube. This missile must be manually loaded into the gun by the turret crew.

Some former Warsaw Pact countries produce copies of the T-72, and some have developed improved variants. An example of this is the Yugoslavian M84, a number of which were supplied to Free Kuwaiti forces during the Gulf War. The main difference between the M84 and the T-72M1 is that the M84 has a wind sensor mounted on the turret.

T-80U

***also* T80BV, T80UD**

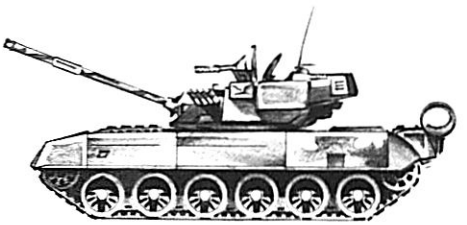
Capacity:	3
Weight:	46,000kg
Engine:	1,250hp
Top speed:	70km/h
Range:	335km

The Soviet T-64 MBT, developed in the late 1960s, proved too complex for most combat troops to maintain, so a new tank called the T-80 was built in the early 1980s. The interior is cramped and the driver sits in the hull behind the sloped front plate. The commander sits on the right hand side of the turret and has a cupola with several periscopes which provide a large field of visibility. The gunner sits on the left hand side

of the turret and also has a hatch in the turret roof. The T-80 is the first Russian MBT to use a gas turbine engine instead of a diesel one.

The primary gun—an improved 125 mm D-81TM smooth bore—has an autoloader magazine that holds forty rounds and can fire the 9K120 "Kvir" laser-guided anti-tank missile. Each missile comes in two parts, and replaces one round of ammunition; normally, up to eight missiles are carried. Coaxial to the main gun is a PK machinegun with 1,250 rounds of ammunition, while an NSV heavy machinegun is mounted on the commander's cupola. There are eight smoke grenade launchers on the turret front.

The T-80 can ford through water up to 5.5 meters deep after extensive preparations, including the placement of a snorkel on the gunner's hatch. The T-80B is an earlier model, which uses 9M119 "Refleks" laser-guided anti-tank missile (NATO name AT-11 "Sniper") instead of the 9K120. Either model can be fitted with explosive reactive armor (ERA) blocks on the hull and turret fronts, the T-80U using a newer type of ERA than the T-80B that gives the tank a markedly different appearance. The designations change as well: a T-80B with ERA is called T-80BV, while a T-80U with ERA is known as a T-80UD.



ZSU-23-4M "Shilka"

***also* ZSU-23-4V, ZSU-23-4V1**

Capacity:	4
Weight:	20,500kg
Engine:	280hp D
Top speed:	45km/h
Range:	260km

The "Zoo-23," as it is known to American troops, is a tracked vehicle with a large turret housing four AZP-23 automatic guns, 500 ready rounds of ammunition for each gun, a radar-based fire control system, and four crewmembers: the commander, driver, gunner, and radar operator. The driver is the only crewmember that sits within the hull, the others are all stationed in the turret. A hatch/door in the front plate of the hull allows the driver to enter or leave the driver's position. In the turret roof a large hatch is designed for the gunner and radar operator, and a cupola holds the commander.

Shilka means "awl" in Russian, while the letters ZSU stand for Zenitnaya Samokhodnaya Ustanovka (mechanized anti-aircraft gun), with 23 and 4 indicating the caliber and number of guns, respectively. The Shilka is outdated by modern countermeasures systems, but is still a deadly weapon system when employed against ground troops and air forces with less modern equipment.

The early version from 1962, known simply as ZSU-23-4, was not built in large numbers by the Soviet Union, while an improved model known as the ZSU-23-4V was mass-produced but only exported to Poland. More improvements lead to the V1 model, which was sold to many Middle Eastern and some Asian countries, and the ZSU-23-4M was the final model that also was widely exported.

The most important drawback of all variants of the ZSU-23-4 is that the fire control system uses 1960s technology (vacuum tubes and relays), which takes some time to get up to speed and generates a lot of heat when switched on. The radar has an effective range of 30 km, but during the final years of the war in Afghanistan it was often removed because it is only effective against aircraft. It was replaced by ammunition bins for an additional 2,000 rounds.

Crew stations are typically Russian: small, cramped, and uncomfortable to be in for long periods of time, and with the Shilka's electronics it gets hot inside the turret as well.

MILITARY UNARMORED VEHICLES

CHAPTER SEVEN

MILITARY UNARMORED VEHICLES

Unarmored military vehicles are just as important to an army as the heavy armored vehicles that are used on the front lines. They aren't designed to be in the thick of battle. Instead they are primarily used in rear areas to transport troops and supplies to and from the battlefield.

Two kinds of unarmored vehicles are used by military forces: adaptations of civilian vehicles, and vehicles specifically designed for military use. Each has its own advantages.

Adapted civilian vehicles are usually trucks, pick-ups, and four-wheel drives that have been strengthened to deal with cross-country driving conditions better than their civilian counterparts. A winch and other additional military equipment are typically installed on these vehicles. They're also repainted to meet standard military requirements. The Dodge pickups used by the U.S. Army in the 1970s and '80s are prime examples of this kind of vehicle. They're cheap to buy and spare parts are easy to find, but they are not suitable for all of the tasks military vehicles are required to perform.

The other type of unarmored vehicle, those that are built from the ground up for a specific purpose, tend to be more effective because they can be made to meet the military's specific requirements. As a result, however, they are more expensive and often more difficult to repair—requiring specialized parts that can be hard to find when supplies are limited—than modified civilian vehicles. However, these vehicles are much more capable of standing up to abuse and difficult driving conditions than civilian equivalents.

The body of these military vehicles is normally devoid of luxuries, instead focusing on practicality and ease of use without cluttering up

the vehicle with unnecessary gadgets. Many even lack a heater for the crew compartment, though one can usually be fitted as an add-on kit. The majority are also open-topped, providing a canvas roof for bad weather; most Jeep-like vehicles don't even provide doors with the canvas roof. Western designs of the 1980s and '90s steer away from this trend somewhat, in that hard roofs are now more or less standard, with soft tops being made as alternative versions of the same vehicle, rather than the other way around.

Mechanically, these military vehicles have strong chassis that support the engine and body of the vehicle, and use all-wheel drive for good cross-country mobility. Large tires with deep profiles are fitted to increase ground clearance and provide more grip in difficult terrain, making it harder for the vehicle to get stuck. In these respects, their design is similar to that of civilian four-wheel drives. Most of the engines used require diesel fuel. Gasoline engines were, however, common until the 1960s.

Most "soft-skin" (unarmored) military vehicles are used to transport people or goods to and from the battlefield. Occasionally, some are used on or near the battlefield for reconnaissance, or as combat vehicles. The most common kind of truck is the cargo carrier, with its capacity usually indicated in tons—for example a "two and a half ton truck" like the M35A2 on page 116 can carry 2.5 tons of cargo. On this baseline vehicle, many variants are often developed. Some of the most common are bulk tankers, with large tanks for carrying liquids replacing the load beds; wreckers, with cranes for recovering damaged vehicles; and tractors, to pull large trailers.

Although this chapter deals mostly with American-built vehicles, they represent a good sample of what is used by other nations. The U.S. military does not use many adapted civilian vehicles; western European armies tend to do so more often, especially in the case of heavy trucks.

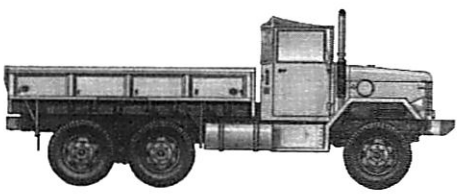
AM General

American Motors General Division, LTV Aerospace and Defense Co., U.S.

M35A2

***also* M35, M35A1, M49A1**

Capacity:	1+2 + 2,500kg cargo
Weight:	6,000kg
Engine:	140hp D
Top speed:	90km/h
Range:	525km



The M35 two-and-a-half ton truck (or "deuce-and-a-half") was first produced in 1950 to provide the U.S. Army with a modern truck to carry personnel and equipment, and to pull the M2A1 105 mm howitzer. An upgraded version known as the M35A1 appeared in 1960, and in 1970 a further upgrade produced the M35A2. The M49A1 is a bulk tanker used to keep fuel supplies available.

The M35A2 is a conventional military truck, with the engine located under the front hood; right behind the engine compartment is the crew compartment, where there is room for the driver (on the left) and two passengers. This area is open-topped and has no doors, though a canvas roof and doors are usually attached.

Without the canvas roof in place, the front windshield can be folded down to lay on the hood. The transmission is underneath the passenger area. It drives all three axles via drive shafts and a transfer case. The rear two axles are fitted with double wheels, and only the front wheels are steerable.

The rear of the truck carries a flat load bed capable of supporting up to two and a half tons of cargo; the sides of the load bed can be folded down or removed completely, and each side panel has an integral folding bench to carry around ten troops, making about twenty passenger seats in addition to the two in the cab. A canvas tilt is often placed over the load bed to shield the occupants or cargo from the weather. The M49A1 has a 2,500 liter capacity tank instead of the cargo bed.

M35 trucks can be found with or without a front-mounted winch, and a ring mount for an M2 HB machinegun can be fitted over the right side of the crew compartment as an anti-aircraft weapon. This machinegun mount is not fitted to all trucks.

The M35 and its derivatives are used in over forty countries world-wide, including the United States, Israel, Taiwan, and South Korea.

M998 HMMWV

***also* M997, M1025, M1026, M1038**

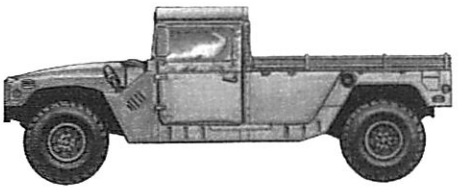
Capacity:	1+9
Weight:	2,800kg
Engine:	150hp D
Top speed:	125km/h
Range:	480km

Known as the Hum-Vee in the American military and as the Hummer to the general public, the M998 High Mobility Multipurpose Wheeled Vehicle has replaced the various Jeep-derivatives in American service (see M151 below), and is made in around twenty-five variants for the U.S. Army alone, from cargo vehicles to anti-tank missile carriers.

The basic HMMWV is the M998, which is a four-seat, soft-top vehicle with a cargo area in the back and carrying capability of around 1,000 kg. The engine is located in the front of the vehicle, and all of the wheels are driven—giving the HMMWV excellent cross-country per-

formance. The Hum-Vee is a very wide vehicle, with the chassis running between the seats and not underneath them. This makes its silhouette lower, and means it is less likely to roll over because its center of gravity is low. The area between the seats is solid enough to stand on. The rear two seats can be removed and their locations plated over with ease to create a two-seat pick-up truck with a larger cargo bed, which can also be used to carry six to eight people. The M1038 is identical to the M998, but has a front-mounted winch.

A hard-top variant is made under the designation M1025 (or M1026 if it has a winch). This has four seats and a roof hatch, normally used for a pintle-mounted M2 HB or M60 machinegun. The M997 is an ambulance with a large, hard-top body and room in the back for up to four stretchers and a medical attendant.



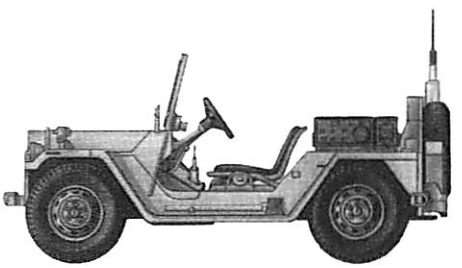
FORD

Ford Motor Company, U.S.

M151 MUTT

***also* M151A1, M151A2, M718, M825**

Capacity:	1+3
Weight:	1,000kg
Engine:	71hp
Top speed:	110km/h
Range:	480km



The M151 Military Utility Tactical Truck is typical of several small trucks designed for military use, more or less based on the Willys Jeep of World War II. The M151 is a 1960s variant, built by Ford and AM General.

The M151 was made in three main variants, but the differences between them are small. In dimensions and overall layout, the M151 is directly based on the Willys jeep, being a rugged, four-wheel-drive car with an open top, no doors, and a windscreen that can be folded down onto the hood. A canvas roof and rear "wall" can be fitted, but this lacks doors of any kind (they are available as an add-on kit, though, as is arctic equipment consisting of a hard roof, rear wall and doors, and a heater). A deep-wading add-on kit made up of air intake and engine exhaust extensions allows the M151 to be driven through water a meter and a half deep.

The MUTT was used by the American armed forces in the Vietnam War (where troops called it the "dog"), and into the 1980s as a general purpose, all-terrain vehicle. Normally it is unarmed, but a pintle mount for an M60 or M2 HB machinegun is easily fitted between the front seats. With the arctic conditions kit installed, it is impossible to arm the vehicle.

Two ambulance versions (M718 and M718A1) were made—these differ from the M151 in that rails for up to three litters can be installed in a few minutes' time (though these take up nearly all of the space in the vehicle except for the driver's seat). Other models carried a 106 mm recoilless rifle (M151A1C and M825) or a TOW anti-tank missile launcher (M151A2 with TOW).

Land Rover

Land Rover Limited, UK

Defender 110

Capacity:	1+1 and 750kg cargo
Weight:	1,920kg
Engine:	113hp D
Top speed:	135km/h
Range:	375km

The Defender is a direct descendant of the first Land Rover produced in 1948. Almost 50 years later, the lines of the original are still recognizable, even though in essence the Defender 110 is a totally new vehicle. The usual military models have a long wheel base and an open top. There are two front seats and the rear can be equipped in any number of ways. It is usually setup as a cargo bed, although seats or benches can be added without much hassle.

A 2.5 liter diesel engine and a five-speed manual transmission are located under the hood. In older models, changing gears required a good degree of force, but in recent models a new transmission has made it much easier. An automatic transmission is not available. The suspension has rigid front and rear axles and is not fully independent; however all wheels are permanently driven to provide good traction in difficult terrain, which is what the Land Rover was intended for after all.

One of the most famous users of this kind of Land Rover is the British SAS, which uses them for long-range reconnaissance and strike missions behind enemy lines. Their vehicles are equipped with extra fuel tanks, and carry armament consisting of MAG machine guns and/or MILAN anti-tank missile launchers.

Oskosh

Oshkosh Truck Corporation, U.S.

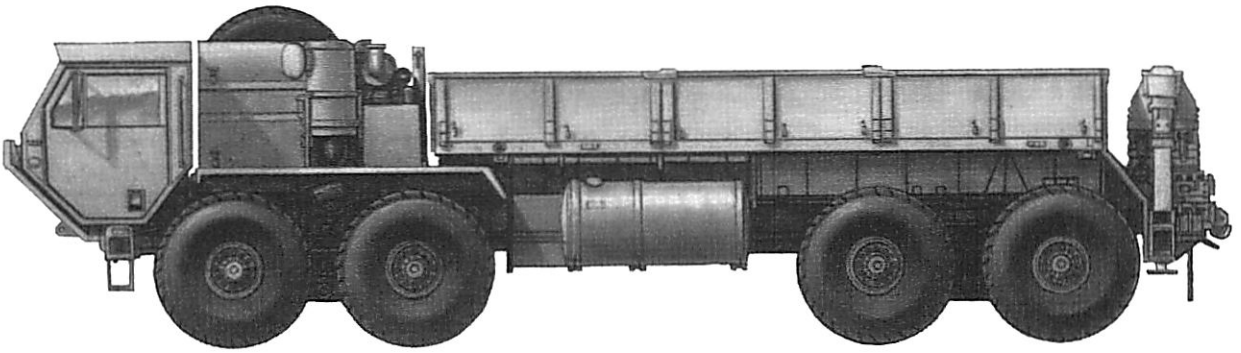
M977 HEMTT

***also* M978, M983, M984E1, M985**

Capacity:	1+1 and 10,000kg cargo
Weight:	28,125kg
Engine:	445hp D
Top speed:	90km/h
Range:	500km

An immense truck, the M977 Heavy Expanded Mobility Tactical Truck was designed as a heavy cargo carrier with good off-road capabilities. It was first used in 1985 by the U.S. Army. Civilian vehicle parts were used in its construction as much as possible to reduce production and repair costs.

The result is a massive truck, over 11 meters long and with 8-wheel drive from the front-mounted engine. Only the front four wheels are steered, and power is transferred from the engine to the wheels through a four-speed automatic transmission and a two-speed manual transfer case. The large cab at the front seats only the driver and one passenger. The engine sits in between them and can be accessed from panels located on both the driver's side and the passengers side. A small window is built into the floor so that the driver can see the ground directly ahead of the vehicle.



The M977 cargo truck is the standard version. It is capable of carrying a ten-ton load on its load bed; it has a hydraulic crane at the rear (behind the load area) to assist in loading and unloading cargo, but the crane is not big enough to reach all the way across to the front of the cargo area. The M985 is identical but also has a winch.

Other variants are the M978, a fluid carrier with a 9,500 liter tank replacing the load bed and crane, and the M983, which is a tractor intended to pull large trailers. The M984E1 is a specialized recovery model, with a reduced-size cargo area and extensive winches that allow it to tow other M977-series vehicles, as well as other vehicles of similar size and weight.

HEMTTs are used to supply front-line troops with ammunition, fuel, and supplies, as well as deliver missiles to MLRS, Patriot and Pershing-II missile units, and recover damaged or stranded vehicles after a battle.

MILITARY AIRPLANES

CHAPTER EIGHT

MILITARY AIRPLANES

Military aircraft are similar to civilian aircraft in layout and design, though many have features or qualities that are not found in civilian aircraft. In general principles, though, like the use of wings to lift them in the air, they are identical.

The controls of military aircraft differ little from those of civilian aircraft, though military cockpits tend to have more dials, switches, buttons, and other systems because they carry much more equipment necessary for their assigned missions. Modern cockpits attempt to minimize the numbers of these items, instead integrating them into computer displays, sometimes with touch-screens: buttons are displayed on-screen instead of being next to the monitor, and the pilot touches the screen to press the button.

Military combat aircraft make extensive use of Heads-Up Displays (HUDs), which consist of a glass plate installed in the front of the cockpit. A computer projects the most important flight and weapons data on the screen in such a way that the pilot can read it if his or her eyes are focused on the horizon, rather than on the HUD itself. This allows the pilot to look forward, out of the cockpit, and still get the information needed to fly the aircraft and fight the enemy. It does not work when the pilot is looking to the sides or up, however.

One other notable difference between military and civilian aircraft controls is very visible in those aircraft intended for combat: there are many more buttons on the control stick and throttle than in civilian aircraft. The HOTAS philosophy (Hands On Throttle And Stick) holds that fighter pilots need to keep hand movements to a minimum to save time. Nearly all the commonly-used buttons are placed on the stick or the throttle, allowing the pilot to keep his or hands in one place to access all major functions, including piloting the aircraft, operating the radio, aiming and firing weapons, using electronic counter-measures (ECM) and more.

Fighter aircraft are designed for speed and maneuverability, while carrying heavy weaponry. The most modern designs also incorporate "stealth" aspects into the overall design, though the first of this new generation to truly integrate stealth into conventional fighters

will not be in use until well after the turn of the century.

Speed is achieved by using one or two high-powered jet engines with afterburners (aircraft engines are discussed on page 64) in a streamlined fuselage. Speed is important for two purposes: a fast aircraft can outrun pursuers if it is the target, or catch up with targets if it is the pursuer. Speeds of two and a half times the speed of sound—also known as "Mach 2.5"—are not unusual when travelling at full throttle with afterburners active.

Maneuverability is also dependent on the shape of fuselage and wings, and especially the various flaps and tail surfaces. The latest innovation in maneuverability is movable engine nozzles that can bend the jet exhaust to give an additional steering force. This is called thrust vectoring, and only one current production aircraft uses it: the Russian Suchoi SU-27M "Flanker" as built for the Indian air force. In the west, it has only been fitted to experimental aircraft so far—the Harrier has vectored thrust for vertical or short take-offs, but doesn't fully implement it to affect maneuverability while in flight.

The amount of weapons a plane carries can often be a problem, because the more weapons that are equipped on the plane, the worse speed and maneuverability it has. Weapons are normally mounted externally on hardpoints or pylons under the wings or fuselage, where they cause extra air resistance and add weight to the aircraft. A pylon most often resembles a short, vertical fin under the wing; a weapon—or a rack with weapons—is attached to the pylon. The pilot is then able to release it from the cockpit; modern weapons such as missiles often have computer links to the cockpit that allow the pilot to program or reprogram the weapon in-flight.

Crews of fighter aircraft are limited to one or two people. In single-seat aircraft, the pilot performs all necessary functions: flying the aircraft, navigating to the target, watching out for enemy fighters, aiming and firing weapons, and so on. Two-seat aircraft divide these tasks over the crew, though exactly how this is done depends on the doctrines of the air force operating the aircraft. The pilot sits in the front seat, while the back seat is occupied by either a weapons operator or a navigator. In all cases, though, the second person provides an additional pair of eyes that can be very useful in combat, and in case of emergencies, either crewmember can perform the tasks of the other.

Transport aircraft are another common type of military aircraft. They're large without exception because they must have a lot of cargo space in order to transport troops and equipment. The fuselage often has large rear doors and a ramp, and sometimes the nose can open as well, allowing easy access to the cargo bay, which is as unobstructed as possible. The floor is flat, except for the many tie-down points, and has no obstacles like wheel wells or fixed seats. Transport aircraft are usually built so their cargo hold is wide and high enough to transport the common light armored fighting vehicles.

An important difference between military transport aircraft and civilian airliners is that airliners need paved runways to land and take off, while most military transports can make use of wide roads or even simple dirt strips. This is because of the difference in the way the undercarriage is constructed, as well as the higher strength of military aircraft.

LOCKHEED

Lockheed-Martin, U.S.

C-130H-30 Hercules

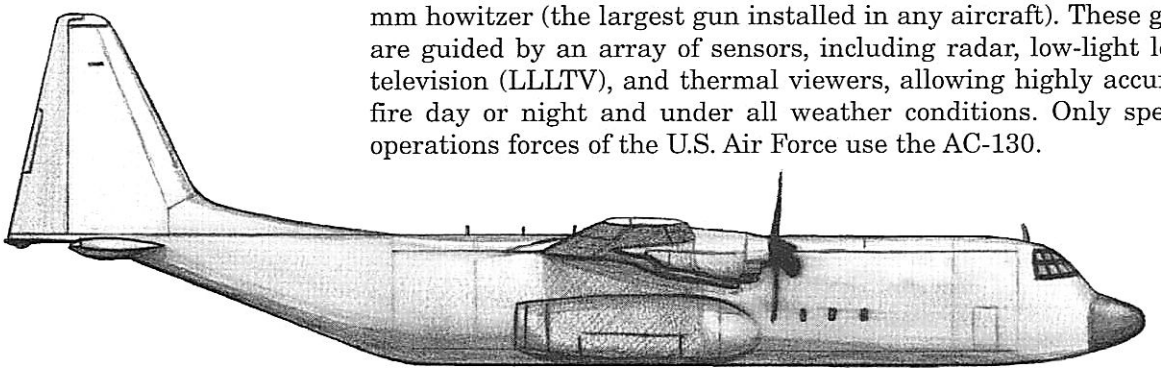
***also* AC-130H Specter, C-130J, KC-130R**

Capacity:	3+128
Weight:	35,250kg
Engine:	four 4510hp TP
Top speed:	570km/h
Range:	9,000km

Nicknamed the "Dollar-Thirty" or "Herky Bird," the Hercules was developed as a military transport in the 1950s, and with around 2,000 having been built it is still in production. The C-130H-30 is one of the latest variants, used by about a dozen air forces worldwide.

The C-130 is powered by four turboprops, two in each wing, driving four-bladed propellers. The wings are placed high to give good ground clearance for landing in rough terrain, and the undercarriage is also suitable for such landings. The fuselage has a flat load bed for most of its length, capable of carrying up to 23 tons of freight. It can also be fitted with bench seats for up to 128 passengers. The cockpit at the front of the plane carries three people, and affords good visibility all-round.

The C-130J is the latest upgraded model, while the AC-130H "Specter" is an aerial artillery platform: mounted on the left-hand side of the fuselage to fire downward are two M61A1 Gatling guns, two GAU-2B/A miniguns, a 40 mm Bofors automatic cannon, and a 105 mm howitzer (the largest gun installed in any aircraft). These guns are guided by an array of sensors, including radar, low-light level television (LLLTV), and thermal viewers, allowing highly accurate fire day or night and under all weather conditions. Only special operations forces of the U.S. Air Force use the AC-130.



F-117A Nighthawk

Capacity:	1
Weight:	23,800 kg
Engine:	two 4,900 kg TJ
Top speed:	1100km/h
Range:	Unlimited

The F-117A is probably the most famous aircraft in the world, after being kept top secret for years while it was fully operational. The F-117 Nighthawk was the first "stealth" aircraft able to remain undetected by enemy radar. The first production F-117 was delivered in 1981, but not until October 1988 was the aircraft's very existence officially acknowledged by the U.S. Air Force, which has approximately sixty of them in service.

The F-117 has a peculiar and easily recognizable shape, consisting entirely of flat surfaces. This shape was chosen to make the aircraft deflect incoming radar waves in such a way that almost nothing would be bounced straight back to the radar; only flat plates are used because computer technology at the time the Nighthawk was

designed, the mid-1970s, was not up to calculating the radar images presented by complex, curved surfaces. Because of this shape, the aircraft is about as aerodynamically stable as a brick, and needs computerized controls like no aircraft before it.

Everything on the F-117 is designed to make it hard to detect: the already-mentioned shape of the aircraft is only the beginning. The entire aircraft is coated in RAM (radar-absorbing material) to further reduce the radar signature presented, the air intakes are shielded with mesh so radar waves cannot reflect off the turbines (always a very good way to detect an aircraft), the exhausts are at the top of the fuselage so they cannot be seen from the ground, and the hot exhaust gases are mixed with cold air to make them less obvious to infrared imagers. Additionally, the tail planes are placed at such an angle as to cover the exhausts when viewed from above. As yet another measure to lower the chance of the F-117 being detected, the aircraft are painted black and fly combat missions only at night.

The armament of the Nighthawk is carried in the internal bomb bay, where two weapons can be installed. Normally, two 2,000 lbs. (900 kg) laser-guided bombs are carried but the F-117 can also carry nuclear weapons. The target designation equipment is permanently installed in the aircraft, and is based around two infrared systems looking forward and down.

The maximum speed and range of the F-117 are classified, but speed is known to be high-subsonic, which means approximately 1,000 to 1,200 km/h. No afterburners are fitted, as they would only increase the chance of the aircraft being detected. Range is theoretically unlimited, because the aircraft can be refueled in flight.

Russian State Arsenals

State Arsenals of Russia and the former U.S.S.R.

Antonov AN-12 "Cub"

Capacity:	3+100
Weight:	28,000kg
Engine:	four 4,000hp TP
Top speed:	780km/h
Range:	3,600km

This aircraft is in many ways similar to the American C-130 Hercules medium transport. Used all over the world since the early 1960s, it is a four-engined propeller aircraft with high-mounted wings and the capability to land on and take off from unpaved runways, while its streamlined shape gives it quite high performance despite its size. The main cabin has removable seats for up to 100 passengers or some 25 tons of cargo, and is accessed by a rear ramp that consists of left and right halves which can be opened independently of each other. Vehicles can be driven up the ramp into the cargo bay.

The aircraft is fully pressurized, allowing it to operate at high altitudes although the rear ramp shouldn't be opened there because this will result in loss of pressure, not to mention everything in the cargo area that's not tied down being blown outside. The An-12 can be used for dropping up to 100 parachutists in less than a minute when the rear ramps are opened in-flight.

A distinguishing feature of the An-12 is the small turret in the tail, containing two NR-23 automatic cannons of 23 mm caliber. This is remotely controlled from the cockpit as a self-defense weapon against aircraft trying to shoot down the An-12 from behind.

MILITARY HELICOPTERS

CHAPTER NINE

MILITARY HELICOPTERS

The differences between military and civilian helicopters are mostly the same as those between military and civilian fixed-wing aircraft: primarily performance, avionics, and weaponry. A small number features are peculiar to military helicopters, though. Specifically-designed military helicopters are much more resistant to abuse than civilian ones. The reason is obvious: they are much more likely to get shot at (and hit). Many naval helicopters have two engines, because if one fails while flying over water the other is usually enough to bring the helicopter to a place where a safe landing can be made. For land-based helicopters this is not really required, because they are almost always over relatively safe—if not secure—places to land in emergencies.

The helicopter's main strength in combat is its ability to get troops into areas that would normally require days of cross-country marching. Often, troops can be transported and a successful operation mounted before the enemy is aware of the presence of troops. Because helicopters are very expensive to operate and they don't have the long range that airplanes do, they are almost never used in bombings or air raids. Their agility and ability to hover and fly low, however, do make them ideal weapons platforms for certain types of air-to-ground combat, like anti-tank operations.

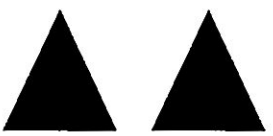
The complexity involved in helicopter operations keeps the crew quite occupied. On most military utility or transport helicopters, a crew chief flies along with the pilot and co-pilot. On the ground the crew chief is the head mechanic, but when flying serves to supervise the passengers and act as a liaison between them and the flight crew. The crew chief usually oversees boarding and offloading, and will often jump out of the aircraft (still tethered in by the long audio cable

that connects his or her headset to the helicopter's intercom) to direct boarders or keep an eye on obstructions in the landing zone that are outside of the pilots' fields of view. In the air, the crew chief may act as a gunner, but more commonly if aircraft is armed, additional personnel man the guns.

As in all aircraft, the pilot is in charge, and he or she usually puts the safety of the aircraft and the crew ahead of the passengers' objectives. The pilot decides who does and does not get into the helicopter, when to deploy troops, and where to land. On board, noise levels are often near-deafening, making it difficult for passengers to communicate short of shouting in each others' ears. The crew communicate via headsets in their helmets, and most military aircraft have one or two extra headsets for the passengers' use.

Military helicopter operations are organized into "lifts," "flights, and "chalks." A lift is a discrete air operation, which may involve many aircraft each flying many trips. A flight is a batch of aircraft flying together, and a chalk is a single aircraft making a single trip. Thus, a large lift might involve many flights, each of made up of several—even scores—of helicopters. Each flight by a single helicopter is a chalk. At the other extreme, a small operation may just be a single helicopter making a single trip—a lift made up of a single flight made up of a single chalk.

Some military helicopters have features designed to reduce the vehicles' noise levels. These features do reduce the volume of the noise somewhat, so that it doesn't travel as far as normal and may be difficult to track when the helicopter puts terrain or other barriers between it and the enemy. However, all helicopters are still very noisy, even when equipped of the most modern noise-damping design features. The "whisper mode" common to science-fiction aircraft is just that: science-fiction.



AÉROSPATIALE

Aérospatiale, France

SA 365F Dauphin 2

***also* HH-65A Dolphin, SA 365G, SA 365M**

Capacity:	2+11
Weight:	2,160kg
Engine:	two 724hp TS
Top speed:	295km/h
Range:	850km

The Dauphin (Dolphin) 2 is a light, multipurpose helicopter built in France and first flown in 1979. This is the military version; the civilian model is described on page 76.

The Dauphin 2 has a streamlined fuselage with a combined cockpit/passenger cabin that seats two pilots side-by-side. The rest of the cabin can be outfitted to the customer's requirements, but usually has seats or benches for six to ten people. There is a hinged door on either side of the cockpit, and a sliding door on each side of the passenger cabin.

The aerodynamic qualities of this helicopter were a high priority in its design. As a result, the fuselage blends smoothly into the tail boom, and the landing gear is retractable.

The main rotor has three blades, and is driven by two turboshaft engines mounted above the cabin. The non-traditional tail rotor is housed in a circular opening in the vertical tail. This reduces drag while still being as efficient as a normal tail rotor, and it also somewhat reduces the danger to ground personnel who get close to the aircraft.

The SA 365F is used by Saudi Arabia as an anti-ship helicopter, equipped with radar and four anti-ship missiles. Its rotor blades can be folded for easy storage aboard a ship, where hangar space is always limited. The 365G is used by the U.S. Coast Guard as the HH-65A Dolphin, which differs from the 365F in that it has American engines of somewhat less power than the French engines on other Dauphins. The HH-65A is used for search-and-rescue (SAR) duties, and is equipped with a winch next to the right-hand cabin door, that is used to pick up accident survivors from the water.

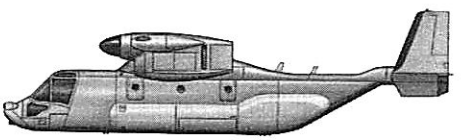
Another military model, the 365M (known as Panther rather than Dolphin), is a ground-based military version that can be fitted with a roof-mounted sight and a variety of weapons. Both the HH-65A and the SA 365G have 683 hp turboshaft engines instead of the standard 742 hp ones.

BELL

Bell Helicopter Textron, U.S.

MV-22 Osprey

Capacity:	2+24
Weight:	14,000kg
Engine:	two 6155hp TS
Top speed:	510km/h
Range:	3400km



The MV-22 Osprey is actually a joint venture by Bell and Boeing, and is a cross between a dual-rotor helicopter and a multi-propeller conventional aircraft. It has more or less the layout of a small cargo aircraft, with a hull of square cross-section and an aircraft-style tail and wings. The wings are short and wide, and have the engines mounted at the tips. The engines drive very large propellers, and are contained in pods that can be rotated from horizontal to vertical. With the engines vertical, the propellers function as rotors, allowing the Osprey to hang still in the air and land or take off vertically like a helicopter. Although capable of vertical take-off, a short take-off, with the rotors/propellers tilted to about halfway between horizontal and vertical, is more common for sake of fuel efficiency.

What makes the Osprey attractive is that it combines an conventional aircraft's range and speed with a helicopter's ability to go anywhere. Helicopters have always been slower and have had less flight range than fixed-wing aircraft, and the Osprey is one of the first true crossbreeds with its high speed and long range.

OH-58A Kiowa

***also* OH-58D**

Capacity:	1+4 or 500kg cargo
Weight:	1,030kg
Engine:	650hp TS
Top speed:	240km/h
Range:	400km

The Kiowa is a light utility helicopter developed in the 1960s to meet U.S. Army requirements. For a number of rather obscure reasons, the Hughes Aircraft Corporation (now McDonnell Douglas) Model 500 (see page 78) was taken into service instead, and Bell decided to put the design on the civilian market as the Model 206 JetRanger (page 77). A few years later, the military purchased a version of the JetRanger anyway, calling it the OH-58 Kiowa.

The Kiowa is a simple and durable helicopter that most pilots find pleasant to fly. It is of conventional layout, with a cabin at the front and the engine above and behind that. The rotor is of the two-bladed type that used to be a feature of all Bell designs, and there is a tail rotor at the end of the tail boom. The undercarriage consists of two skids, another feature Bell uses quite often.

The cabin has two front seats, each with a full set of controls, and a removable, three-seat bench in the back. Through the large front and side windows, the pilot and passengers have good vision in almost all directions, including up and down. The Kiowa is used mainly as a light transport and reconnaissance helicopter.

All OH-58s can be fitted with a forward-firing M134 minigun controlled by the pilot, and many have other armaments installed as well. Some are used as light and cheap tank killers, but the main role of the OH-58 is observation. The latest military version is the OH-58D, which has a four-bladed rotor and a mast-mounted sight (i.e. the sight

sits on top of the rotor but doesn't spin with it) that allows it to look over obstacles such as trees and buildings while the helicopter hides behind them. It can carry a weapons mount on either side of the fuselage; normal armament is a 7-shot pod for 70 mm rockets on one side and two Stinger anti-aircraft missiles on the other. During the Gulf War, many OH-58Ds carried AGM-114 Hellfire missiles in place of the Stingers, turning them into effective anti-tank machines.

UH-1H Iroquois a.k.a. "Huey"

***also* UH-1N**

	UH-1H	UH-1N
Capacity:	2+9	2+9
Weight:	2,115kg	2520kg
Engine:	1100hp TS	1250hp TS
Top speed:	240km/h	240km/h
Range:	400km	400km

The UH-1H is one of the later versions of the ubiquitous UH-1 series of helicopters, the first of which flew in the late 1950s, with its descendants still in use today. The U.S. Navy and Marine Corps variant is the UH-1N, which has twin-engines whereas the UH-1H has only a single engine.

The UH-1N has a two-seat cockpit at the front of the fuselage and a 13-seat passenger area right behind it. The cockpit seats are armored, while the passenger seats consist of simple metal tubing frames with canvas seats and backs; they are often removed entirely, so the passengers have to sit on the floor. The engines are behind and above the cabin, driving the two-bladed main and tail rotors. The cockpit has two hinged side doors, while the passenger area has a large sliding door on each side that allows troops to quickly board or leave the helicopter. During the Vietnam War, many Hueys were equipped with an M60 machinegun in each door opening, firing to the side, for self protection. These are still used on some UH-1s today, mainly those that are expected to be flown in combat zones; in the U.S. Army the Huey has almost completely been replaced by the Sikorsky UH-60 Black Hawk (page 136).

The unofficial nickname "Huey" came from the original HU-1 designation of the aircraft in the early 1960s; hardly anyone in the American military (or outside of it, for that matter) calls the UH-1 by its official nickname of Iroquois.

McDonnell Douglas

McDonnell Douglas Helicopter Corporation, U.S.

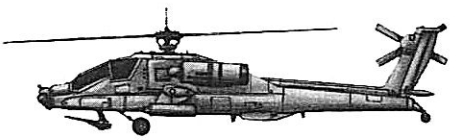
AH-64D Apache

***also* AH-64A, AH-64D Longbow Apache**

Capacity:	2
Weight:	4,900kg
Engine:	two 1695hp TS
Top speed:	360km/h
Range:	480km

Even though the AH-64A was first deployed by the U.S. Army in the early 1980s, it is still quite probably the most capable attack helicopter in the world. The entire machine was built for one purpose: hunting and destroying enemy armored vehicles. The AH-64 is a very large and heavy helicopter, weighing in at around six and a half tons when combat-loaded, but despite this heavy weight it can make loops and rolls with little difficulty.

The cockpit seats the gunner up front with the pilot behind and above, to give both a good view of the outside world; it is armored against 23 mm armor-piercing rounds. The engines are mounted in pods on the outside of the fuselage, and drive the four-bladed main and tail rotors. The main rotor has swept tips to reduce the noise produced, and is of extremely rugged construction: it will survive direct hits by 23 mm cannons, and will continue working for up to an hour after the lubrication system runs out of oil—as a comparison, a car engine without oil will break down after only a few minutes.



The AH-64's sensor array is located in the nose, with a turret for the gunner and one for the pilot; the gunner's turret has a direct optical viewer with 13x magnification, an infrared viewer, a low-light television camera, and a combined laser target designator/range finder, while the pilot's turret has only an infrared viewer. These systems give the crew the ability to fly the Apache and attack targets at any time of the day or night, in any weather condition. The clusters can be slaved to the pilot or gunner's helmet and they always point where the helmet-wearer is looking. The gunner's turret can also follow a selected target automatically. In emergencies, each crewmember can use the other's turret.

On each side of the fuselage is a stub wing for carrying weapons, and under the fuselage is a rotating mounting (up to 110° either side of the centerline) carrying an M230 chain gun with 1,200 rounds of ammunition. This gun can be set to follow the gunner's (or pilot's, if required) helmet movements, in effect aiming wherever the gunner is looking. There are three pylons on each wing: each outer pylon can carry two Stinger anti-aircraft missiles, while the inner two can be used for a variety of weapons. U.S. Army AH-64s normally carry either four AGM-114 Hellfire anti-tank missiles, or a nineteen-round 70 mm rocket pod on each pylon. A typical combat mix is two rocket pods and two Hellfire racks, making thirty-eight rockets and eight missiles. External fuel tanks can also be carried to extend the helicopter's range.

The differences between the AH-64A and AH-64D are mostly internal: the D model has more up-to-date avionics, and inside the cockpit computer monitors have replaced most of the clocks and dials of the A. The D can also be outfitted as a Longbow Apache, which means it has a Longbow radar mounted on the rotor mast. This radar gives it even better all-weather capabilities—it is used to detect ground targets, although it has anti-aircraft capabilities too—but is employed only by a limited number of helicopters. One or two AH-64's in a combat flight carry it to find targets for the whole flight.

OH-6 CAYUSE

***also* AH-6F, AH-6G, MH-6E, MH-6F, Model 530MG**

Capacity:	1+4 or 500kg cargo
Weight:	660kg
Engine:	256hp TS
Top speed:	260km/h
Range:	515km

The OH-6 was a competitor of the Bell JetRanger in the U.S. Army's Light Observation Helicopter contest of the 1960s, and was the model eventually chosen and adopted. It is a very compact machine with a fuselage shaped like an egg laid on its side, a normal rotor system with a four-bladed main rotor and two-bladed tail rotor, and skids for landing gear. The cabin seats two people up front and up to three in the back, although two would be more comfortable. The civilian Model 500 and the military OH-6 Cayuse are virtually identical except for more

comfortable seats in the civilian version, and the OH-6's ability to carry a forward-firing M134 minigun with 2,000 rounds on the left side of the fuselage. Later models of the OH-6-series differ from the earlier versions in having a different nose section, not rounded as in the original but more pointed, a new tail (T-shaped instead of V-shaped), and a five-bladed rotor.

The Model 530MG is a military variant that can carry more passengers (pilot plus two passengers in the front, four passengers in the back) although the seats for them are cramped. It can also be armed with a variety of weapons on its two hardpoints, including anti-tank missiles. The AH-6F and G are the U.S. Army versions of the 530MG, and are normally armed with a twin TOW anti-tank missile launcher on each side of the fuselage.

The MH-6E and F models are specially modified machines with exhaust suppressors and silencers, for night missions where stealth is important. They are armed with the twin TOW launchers of the AH-6F or other weapons to suit the mission, and are used mainly by American Special Forces units for clandestine operations.

The OH-6 is a very maneuverable machine, and gives impressive performance for a helicopter its size. It is not really suitable for aerobatics flying, though. The large canopy and side windows provide excellent visibility for the pilots and passengers.

AH-6F	AH-6G	MH-6E	530MG
1+4 or 500kg	1+4 or 500kg	1+4 or 500kg	1+6 or 500kg
660 kg	660 kg	660 kg	660 kg
256hp TS	256hp TS	376hp TS	426hp TS
260 km/h	260 km/h	280 km/h	285 km/h
515 km	515 km	515 km	515 km

Russian State Arsenals

State Arsenals of Russia and the former U.S.S.R.

MIL MI-8 "Hip"

***also* MI-8T**

Capacity:	2+28
Weight:	6,800kg
Engine:	two 1,500hp TS
Top speed:	260km/h
Range:	500km

This heavy transport helicopter has been in use since the 1960s, having been upgraded several times. The Mi-8, or "Hip" as it is known to NATO, is a single-rotor helicopter with a five-bladed main rotor and a three-bladed tail rotor, driven by two turboshafts mounted at the top of the fuselage. The cockpit seats the pilot and copilot, while the main cabin behind the cockpit has removable bench seats for up to 28 passengers. Access to the cockpit is by a large sliding window on either side; the main cabin has a sliding door on the left-hand side behind the cockpit, and two very large "clamshell" doors at the rear of the fuselage. The cabin is large enough to hold a small armored car, such as the BRDM-2 (page 108) when the benches have been removed. Rows of seven circular windows on either side give the passengers a view outside.

The sides of the fuselage have brackets for carrying external fuel tanks, which are always installed. The Mi-8T is a utility version with racks on either side of the fuselage to carry up to eight weapon pods; most commonly these are 57 mm rocket pods holding thirty-two rockets each, gun pods, or anti-tank missiles of various types. The Mi-8T can also be equipped with a hoist located at the front door and a pintle mount for a machinegun or grenade launcher in this same door. To use this weapon, the door must be opened.

MIL MI-24 "Hind-D"

***also* MI-24 "Hind-E", MI-24 "Hind-F", MI-25**

Capacity:	2+8
Weight:	8,500kg
Engine:	two 2,200hp TS
Top speed:	325km/h
Range:	310km

This very large helicopter forms a hybrid between an armed utility helicopter and a true attack helicopter. It has an eight-seat passenger area behind the two cockpits at the front, and has large wings able to carry a variety of armaments. The front-most cockpit seats the gunner, and has a hatch on the left-hand side of the canopy. The pilot's cockpit is above and behind the gunner's, and has a door on the right-hand side of the fuselage. The passenger cabin has a two-piece door in the left-hand side of the fuselage that opens upward and downward, the lower part having steps for easier access. There are four windows on either side of the cabin, which can be opened so the passengers can use their personal weapons; the window frames incorporate rifle rests for this purpose. The seats can be easily folded up to make room for cargo, extra ammunition, or stretchers.

The large and powerful engines and the transmission are mounted above the passenger cabin, the engines having shields to prevent debris from being sucked in. The main rotor has five blades, and a three-bladed tail rotor is mounted high on the tail fin.

The only fixed armament is a four-barrel, 12.7 mm R gatling machinegun with 2,000 rounds in a turret under the nose, firing into the frontal arc and operated by the gunner. Around the turret are numerous "blisters" containing a variety of sensors, such as passive infrared sensors, low-light television, and missile guidance systems. A laser target designator/range finder is mounted on the left wing tip. Each wing has three pylons; the outer one normally carries two AT-2 "Swatter" anti-tank missiles, while the inner two have 57 mm rocket pods holding thirty-two rockets each. However, the Mi-24 can carry many other types of weapons, and is one of the few helicopters to regularly carry unguided bombs.

Experiences in Afghanistan showed the need for protection against heat-seeking missiles. Thus, the Mi-24 carries flare and chaff launchers, an infrared strobe light—designed to distract missiles—and thermal baffles to reduce the helicopter's heat signature.

The version of the Mi-24 described above has been widely exported under the name Mi-25. NATO calls it the "Hind-D" meaning it is the fourth variant of the single-rotor helicopter code-named "Hind".

The main differences between the D and E models are that the E has had the nose sensors rearranged, and that it can carry two AT-6 "Spiral" anti-tank missiles on the outer wing pylons instead of AT-2s. The Hind-F is an upgraded version of the Hind-E in which the nose-mounted machinegun is replaced by a 23 mm GSh-23L two-barrel cannon on the right-hand side of the fuselage, firing forward.

SIKORSKY

Sikorsky, U.S.

UH-60A Black Hawk

Capacity:	2+14
Weight:	5,100kg
Engine:	two 1560hp TS
Top speed:	300km/h
Range:	600km

Designed to replace the aging UH-1 in U.S. Army service, the Black Hawk is a utility helicopter that can fill a variety of roles: it can carry twelve troop seats (plus two gunner positions), four stretchers, or an equivalent load of cargo. In addition, stub wings can be fitted to allow the UH-60 to function as an armed helicopter.

Behind the Black Hawk's cockpit is a cargo bay that can be equipped to hold up to twelve people. There is a door on either side of the cockpit, and a large, sliding door on either side of the fuselage. On each side, between the cockpit and main doors, is a window with a pintle mount for an M60 or M2HB machinegun; M60s are most common.

Stub wings can be installed while in the field (taking thirty minutes per wing). They have two pylons per wing and each pylon can support a rack of four Hellfire anti-tank missiles, a fuel tank, one or two 19-round pods of 70 mm rockets. When the wings are in place, the pintle-mounted machineguns can still be used.

WESTLAND

Westland Helicopters, UK

Lynx AH Mark 9

***also* AH Mark 7**

Capacity:	2+10
Weight:	4,700kg
Engine:	two 850hp TS
Top speed:	330km/h
Range:	885km

The Lynx Attack Helicopter (AH) forms the mainstay of the British Army's combat helicopter fleet. The Mark 9 is the latest model and has been in service since 1995. Some earlier models, mainly Mark 7, are still in service.

The cockpit has a door on either side, while the passenger cabin is accessed by two large sliding doors. Over the cabin are the engines and transmission, driving the four-bladed main and tail rotors. The landing gear consists of two skids, though naval versions of the Lynx have a non-retractable, wheeled undercarriage. Lynx is a very maneu-

verable and fast helicopter—a modified version set the world helicopter speed record at 401 km/h—with its streamlined shape giving good aerodynamics.

In the anti-tank role, Lynx carries two launchers for four TOW-2 anti-tank missiles and can carry reloads in the passenger cabin. The gunner sits on the left-hand side of the cockpit, with the sight unit for the TOW system mounted on the roof over his or her seat. In the tank-killer role, the Lynx usually carries two anti-tank teams that consist of three soldiers. Each of these teams is equipped with one Milan anti-tank missile launcher and multiple reloads.

MILITARY WATERCRAFT

CHAPTER TEN

MILITARY WATERCRAFT

Military watercraft are similar to civilian vessels, although they are usually outfitted to perform very different tasks. In general terms, military ships are more practical, and have less space devoted to the crew's needs than similarly-sized civilian ships—the primary purpose of military ships is combat, not pleasure.

The features and equipment usually installed on military ships is commonly the same sorts of equipment used on civilian counterparts, with a few minor alterations or additions made. Often, military vessels are faster, tougher and weigh more than civilian ships. Some accessories that are generally unnecessary on civilian ships—such as extensive fire- and damage-control systems, and advanced detection and communication capabilities—are common on military vessels, but most of these have little direct effect on the vessel's performance.

Perhaps the largest difference between military and civilian ships is weaponry. Almost all military ships are equipped with at least one, if not more, fixed armament of some kind—usually cannons and/or missile launchers. Machineguns are not used on larger ships, because these vessels are rarely close enough to the enemy to use them effectively. They are, however, common on smaller vessels, like those used for coastline patrol and contraband interdiction.

The construction of a military ship is very similar to that of civilian ships. Small vessels are built with polyester hulls, while the larger ones are constructed of steel. Large minesweepers, ships designed to detect and remove enemy mines, are an interesting exception—they are made from polyester, or even wood, despite the fact that they are commonly very large ships. Wood or polyester construction reduces the ship's susceptibility to magnetically-detonated mines, making the vessel less likely to detonate a mine while

disarming and extracting it. Apart from these ships, however, steel is used for the construction of almost everything from patrol boats to aircraft carriers.

Aside from the benefits of such construction, most modern naval vessels are not heavily armored. Some designs intend for close combat with shore positions (such as riverine patrol boats) may have armored sections to protect the crew from small arms fire and light explosives, but heavier armor is very uncommon.

A ship's commander is king. As with the pilot of an aircraft, the commander is in charge of the vessel and everyone aboard, and will make decisions on movement and deployment according to his or her priorities (which generally place the safety of the ship and its crew over the mission priorities of passengers). A naval commander is due a special degree of respect, and even the commander of a small patrol boat outranks senior officers who are passengers.

BOLLINGER

Bollinger Machine Shop & Shipyard Inc., U.S.

Island-Class

Capacity:	18
Displacement:	168 tons
Draft:	2m
Engine:	two 2990hp D
Top speed:	50km/h
Range:	7,275km

The *Island*-class was built in the late 1980s for the U.S. Coast Guard, forty-nine vessels having been delivered by the early 1990s. The ships are used as patrol boats to guard the territorial waters of the United States.

As with all larger ships, there are some minor differences between each ship in the class. The *Island*-class is based on a hull designed by Vosper Thornycraft Ltd. from the U.K., and is made from steel with an aluminum superstructure. Two engines drive conventional propellers mounted at the rear of the hull.

The overall length of the ship is 33.5 meters. Set in the middle of the deck is the superstructure, which has two levels. The fully-enclosed bridge is at the upper level, while storage and crew compartments are on the lower level and in the hull. In front of the superstructure is a pintle mount for a 20 mm cannon with 270° traverse and high enough elevation to be used against airborne targets. Two M60 machineguns are also provided for self-defense, which can be fitted to various pintle mounts on the ship.

HALTER

Halter Marine Equitable Shipyard, U.S.

Pegasus Class Mark V

Capacity:	5+16
Displacement:	57,000kg
Draft:	1m
Engine:	two 4,500hp D
Top speed:	85km/h
Range:	1,020km

The *Pegasus*-class is designed to deliver and pick up U.S. Navy special forces troops, mainly SEAL teams. It is a 25-meter boat with a streamlined aluminum hull, the bridge being located amidships. The vessel has very high speed and good all-round performance, necessary to both remain undetected by enemy forces, and if detected, to evade them. Defensive armament consists of one Mark 19 automatic grenade launcher and up to five machineguns, either M60 or M2HB. The crew consists of five people, and up to sixteen fully-equipped troops can be carried.

Pegasus-class craft can be carried inside the U.S. Air Force's C-5 Galaxy transport aircraft, allowing them to be delivered to areas where they are needed all over the world. Eight boats were in service by mid-1997, with twelve more being delivered over the next two years. The U.S. Navy has an option for a further fourteen vessels.

TEMPEST

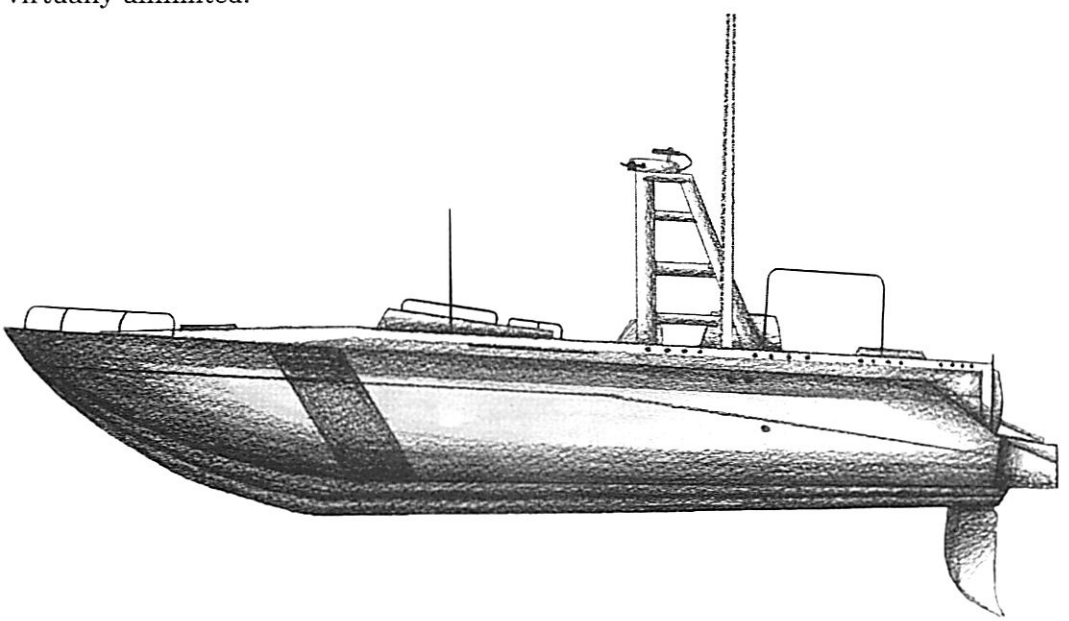
Tempest Yachts, Inc., U.S.

Tempest 43ft Fast Coastal Interceptor

Capacity:	1+6
Displacement:	8 tons
Draft:	0.1m
Engine:	two 431hp D
Top speed:	85km/h
Range:	240km

The Tempest 43ft FCI is a mono-hulled boat used by the U.S. Coast Guard for tasks such as rescue, intelligence gathering, assaulting and boarding ships, patrolling and police duties. In design it resembles high-speed racing boats, with its 13.5 meters length and very shallow draft. The boat is open-topped, with the crew sitting in the middle of the hull under a roll-bar-like structure that supports a radar antenna. There are five seats in the crew area, plus two folding seats on the rear deck, although more than seven people can be carried when required.

The 43ft FCI is capable of operating at rough seas, in strong winds, on the open sea, and on inland waters such as rivers or lakes. Its small size, and especially its low profile, make it hard to spot using radar or visual observation, and because it can be refueled at sea its operating range is virtually unlimited.



TABLES

APPENDICES

GLOSSARY

ABS Anti-lock Braking System—a system that prevents the wheels from stopping completely when the brakes are applied, keeping the vehicle more controllable, especially on slippery surfaces.

AFV Armored Fighting Vehicle—any vehicle intended for combat use that has armor plating to protect the crew and the vehicle itself from enemy fire. AFVs are usually armed as well as armored.

Airbag An inflatable cushion in the steering wheel, dashboard, or door of a car, designed to protect the vehicle's occupants in a collision.

APC Armored Personnel Carrier—an armored vehicle used to carry soldiers across a battlefield.

Avionics Electronic equipment installed in an aircraft; the term is a combination of "aviation" and "electronics."

Body The outer shell of a car, usually made of thin steel plating.

Bonnet British term for the part of a car's body that is over the engine.

Boot British term for the stowage area of a car.

Bow The front of a boat.

Cabriolet European term for "convertible."

Carburetor A device that mixes air with fuel, which is then fed into the cylinders of an engine.

Chassis The framework on which a car is built. Many modern cars only have a partial chassis, the body having enough built-in strength to take over the chassis' function in many areas.

Chopper A motorcycle that has had its front fork extended.

Convertible A car with a roof that can be folded down or removed from the car entirely. Some convertibles have a hard roof similar to that of non-convertibles, but most use waterproofed fabric.

Coupe A two-door car, often applied to two-door models of cars that are also available as four-door sedans. Also spelled Coupé.

Cupola

In an armored vehicle, a hatch with periscopes around its rim, usually for use by the vehicle commander. It gives a 360° field of vision even with the hatch closed, and often has a pintle mount for a machinegun.

Cylinder

An assembly of one piston and all valves and all other items associated with it. An engine can have a single cylinder, though most have more.

Diesel

A type of fuel, and also a name for engines using that fuel. Diesel has a higher ignition point than gasoline, and so cannot be used in gasoline engines, but diesel engines are more fuel-efficient.

ERA

Stands for Explosive Reactive Armor—tiles made up of two steel plates with a layer of explosives in between. When struck by an exploding round (not small arms fire or grenade shrapnel), the tile explodes, sending the steel plates flying to disrupt the armor-penetrating force of the round.

Fuel injection

A system which injects fuel directly into an engine's air intake, rather than mixing it with air in a carburetor. Diesel engines always have fuel injection.

Fly-by-wire

A system that uses electrical signals and motors to steer aircraft, instead of mechanical and hydraulic linkages. This has only become possible with the advent of microcomputers in the 1970s; a more recent innovation is "fly-by-light" in which fiber-optics take the place of electrical cables, saving much weight.

Hood

American term for the part of a car's body that is over the engine.

hp

Horsepower—a measure of engine power, representing how many horses would be necessary to give the same power as the engine. 1 horsepower equals 0.735 kilowatts (kW).

i

Often used in car designations to indicate the car's engine has fuel injection.

Keel

The bottom edge of the hull of a ship, or a large fin protruding from that edge.

kW

Kilowatt—a measure for the rate at which energy is released or absorbed, one kilowatt being equal to 1,000 joules per second. Used as a measure for engine power, 1 kW equals 1.36 horsepower.

MBT

Main Battle Tank—the principle combat vehicle of an army. Today's MBTs are heavily armed and armored, and highly mobile even in rough terrain.

MPV

Multi-Purpose Vehicle—a small van with a luxurious interior and a large cargo capacity if the seats are removed. Also called a mini-van.

Off-road

This indicates rough terrain, not on a road or other prepared surface. Also, a vehicle intended for such cross-country driving.

Periscope A vision device that uses mirrors or prisms to allow people inside a vehicle to look outside. Used in submarines and (less well-known) nearly all armored fighting vehicles.

Pintle mount A simple, flexible mount for a machinegun.

Port The left-hand side of a boat, when looking forward.

Propeller Small wings on a shaft that is driven by the engine. The propeller pulls itself through the air (or pushes itself through water, in case of a ship) and pulls the aircraft along with it.

PWC Personal Watercraft—a small, light boat usually powered by a waterjet.

Rotor system Basically, the wings of a helicopter. They are arranged around a central shaft known as the mast, and when the mast is spun by the engine, the wings move through the air so the helicopter can stay in the air. The tail rotor is also a part of the rotor system.

Rudder A fin that can be moved from side to side to steer a boat or an aircraft.

Sedan A four-door car with a fixed roof that cannot be folded down or removed.

Sidebag An airbag in a car's door, to protect against collisions from the side.

Stability An aircraft is stable if it automatically returns to its previous attitude after being steered away from it. Conversely, an unstable aircraft will move further away from its original attitude, while a "neutrally stable" aircraft holds the middle, and will remain at its new attitude. Until the advent of fly-by-wire systems, aircraft almost had to be at least neutrally stable; many modern fighters are not, since a computer can make necessary corrections automatically and much faster than a human pilot can.

Starboard The right-hand side of a boat, when looking forward.

Stern The rear of a boat.

Suspension The part of a vehicle that forms the connection between a wheel and the rest of the vehicle. It keeps the wheels firmly on the ground and absorbs shocks.

Tail rotor A propeller at the side of a helicopter's boom, to stop the helicopter from spinning its fuselage.

Targa A term sometimes used to refer to a convertible car with a hard roof.

Thrust Any force applied to an aircraft, that makes it go forward. Usually provided by the engine.

Transmission A system of gears and axles that transmits the power from the engine to the wheels or propellers of the vehicle. By using different combinations of gears, the engine can operate at more or less maximum

efficiency regardless of the vehicle's speed. With a manual transmission, the driver can select the gear, while an automatic transmission does so itself.

Trunk

American term for the stowage area of a car.

Waterjet

A propulsion system for boats that draws in water and pumps it out at high pressure. Also called a hydrojet.

VEHICLE RULES

These rules cover ground movement, aircraft movement, and vehicle design. The section on ground movement is an addition to the basic vehicle rules found on pages 72 through 77 of the *Millennium's End v2.0* rulebook. The aircraft rules are new, and explain the process involved in having a character pilot an airplane or helicopter. Because we could not include every vehicle in this book, we've chosen to also include a set of rules that will allow players and GMs to create their own vehicles.

Ground Vehicle Movement

Nearly everything about the movement of a vehicle can be kept as-is from the basic rules. Only a few additions need to be made for motorcycles and tracked vehicles.

Motorcycles

The normal rules for driving a car apply equally to riding a motorcycle, except as noted below. The main differences are that motorcycles have much higher acceleration ratings due to their lighter weight than cars, and crashes are more dangerous.

In a crash, a motorcycle is handled somewhat differently than a car. This is because motorcycles often fall over, in a crash, sliding along the road while the rider is thrown off. When a motorcycle takes damage the rider makes a Drive/Motorcycle skill roll to keep it from falling over with a negative modifier equal to the total damage suffered by the bike.

Should the roll fail, the motorcycle falls on its side, throwing the rider against the street. Both slide or roll on for some distance, and the rider may be injured. The motorcycle takes damage as normal from the crash (p. 77, *Millennium's End*) and, chances are, it'll need a new paint job sometime soon. The rider also suffers damage from the crash, equal to half that suffered by the motorcycle; treat this as Burn damage (because of the large areas of skin lacerated in motorcycle crashes—it is not actually burned, though). Distribute the damage as if it were falling damage (*Millennium's End* page 113).

Motorcycle helmets, leathers, and even heavy jackets may act as armor—use the Armor Values and Conversion Numbers listed on the Armor Table on page 195 of *Millennium's End v2.0*.

Tamara gets shot at as she's trying to get away from a crime scene; one of the shots hits her bike, causing TL18 damage. She has to roll her Drive/Motorcycle subskill of 58, with a -18 modifier, for a required roll of 40, to keep it on its wheels. She rolls 64, and the bike slides along the street. She was traveling at 50 km/h at the time, so the bike takes TL30 damage, putting it at a total of TL48.

Tamara takes half this crash damage (TL15) distributed as falling damage. Luckily she's wearing a crash helmet, but no other protective clothing. The damage is distributed as follows: Body Zone 1 (head), 6 damage; Body Zone 13 (leading forearm), 9 damage.

The helmet's AV of 6 stops the damage to her head, while her forearm takes 9 x 0.8 = 7 Burn damage.

Tracked Vehicles

These vehicles are much more mobile across terrain than wheeled vehicles are, at the expense of speed and acceleration.

All tracked vehicles can "pivot-steer," which is accomplished by braking one track while the other keeps turning; for tight turns in most modern vehicles, the track on the inside of the turn may even be turning the other way. Many military tracked vehicles can remain in one spot while turning through 360 degrees, although they can only do this when they are at full stop. Pivot-steering while moving at speed can lead to the track on the inside of the turn running off the wheels, immobilizing the vehicle and bringing it to an immediate stop; it can still turn, though, because the second track is still there.

Rules-wise, tracked vehicles generally have a lower Cornering number (indicating poorer cornering ability) than wheeled vehicles, but they can turn on a dime when they need to. The vehicle must come to a full stop before attempting this, however. The rate at which the vehicle can change its direction in this way is about 45 degrees per second, or 90 degrees per combat turn.

Aircraft Movement

Aircraft have a slight problem when it comes to applying vehicle rules to them, namely that they can move in three directions, while ground vehicles generally have only two available to them. To account for this, aircraft have more game stats than ground vehicles: Climbing Threshold, Ceiling, and Landing/Take-Off have been added. Also, the uses of one of the existing limitations (Cornering) are different for aircraft than they are for ground vehicles.

Keep in mind that real aircraft are complex to control, and the game rules in this chapter are not intended to be a 100% faithful representation of their behavior, but try to give a system that allows aircraft to be easily integrated into *Millennium's End* assignments.

Speed

For fixed-wing aircraft, the listed speed is divided into two parts. The first is the minimum speed the aircraft must maintain, else it will stall (lose lift) and might crash as a result, while the second is the maximum airspeed. Both are in kilometers per hour.

Acceleration and Braking

These are used just as for ground vehicles. The numbers indicate how much the aircraft can add to, or remove from, its speed every turn. As per the standard rules, the threshold is the maximum rate without making a skill roll, while the limitation is the absolute maximum.

Cornering

The Cornering limitation shows how much force an aircraft can handle—in other words how tight a circle it can fly. To understand how this works, consider that anyone in an aircraft making a turn experiences a higher gravity force than normal. 1 G is the "standard" pull of gravity on someone standing on the earth, 2 G is twice that (it causes someone's weight to double), 3 G is three times the normal, and so on. To a much smaller extent, this is also experienced in a car that drives

Aircraft Cornering Table

Speed (km/h)	Gs pulled 2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0
150	100	65	50	-	-	-	-	-
200	185	115	80	65	-	-	-	-
250	285	180	130	105	-	-	-	-
300	410	250	180	150	-	-	-	-
350	560	340	250	200	165	-	-	-
400	730	445	325	265	215	-	-	-
450	925	565	415	330	270	-	-	-
500	1,140	700	510	410	330	290	-	-
550	1,380	840	615	495	400	350	-	-
650	1,930	1,180	860	690	560	490	420	-
800	2,900	1,780	1,300	1,040	850	745	635	565
950	4,200	2,580	1,880	1,500	1,230	1,080	915	815
1,100	5,625	3,450	2,520	2,020	1,650	1,440	1,230	1,090
1,250	7,275	4,460	3,260	2,610	2,130	1,860	1,590	1,410
1,500	10,200	6,275	4,580	3,660	2,990	2,610	2,240	1,990
1,750	12,800	7,850	5,725	4,590	3,740	3,270	2,800	2,490
2,000	14,600	8,975	6,550	5,250	4,280	3,740	3,200	2,840
2,500	18,300	11,200	8,175	6,550	5,350	4,670	4,000	3,550

around a corner: the passengers feel like they are pushed to the outside of the corner. In aircraft making tight turns, this is much more pronounced than in cars driving around on public roads.

A pilot attempting a radical turn in an aircraft is restricted by the G-force the aircraft can withstand, as defined by its cornering limitation. Looking at the Aircraft Cornering Table, cross-reference the aircraft's current speed with the G-force the pilot is willing to take. The number read off is the radius of the circle the aircraft will fly, in meters. As can be seen, if the aircraft goes faster, the turn radius becomes larger for a given G-force, while if the number of Gs increases but the aircraft maintains a constant speed, the turn radius goes down.

The Cornering threshold of an aircraft is the number of Gs that can be pulled without the need to make a Pilot roll, while the Cornering limitation indicates the absolute G force maximum the aircraft can handle. Going over the limitation causes a crash (or worse) as the aircraft simply cannot handle the forces imposed on it.

The table does not have entries for all G forces at all speeds, because it is just not possible to make tight turns if the aircraft is going too slow. For example, no aircraft can make a 5 G turn at 150 km/h.

The Turning Table is valid for turns in all dimensions—that is, for loops and banking turns as well as flat turns.

Effects On The Pilot and Passengers

When an aircraft is pulling Gs, anyone on board is also subject to those G-forces. Their blood is drawn downward because of the additional gravity caused by the aircraft's movements. If the turn rate remains

low, this is not a problem, but when higher G-forces are pulled, so much blood is built up in the legs and lower body that the brain gets too little oxygen. At very high G-forces, people simply pass out because their brain does not get enough oxygen to keep the higher functions working. This is known as "Gravity-induced Loss of Consciousness"—G-LOC—or simply as "blacking out." This is mainly a problem for military jet fighter pilots and acrobatics flyers, since normal civilian aircraft rarely, if ever, perform maneuvers that can lead to blackout.

Characters on board an aircraft making sharp turns might be subject to G-LOC. No roll is required for turns of 3 Gs or less. For turns of 4 Gs or more, require a Constitution roll modified by four times the G-force of the turn. Requre this roll only at the beginning of the turn for turns of 6 Gs or less, but for turns of 7 Gs or more, require the roll every round.

Each unconscious character may make a Constitution roll at the end of each turn after blacking out to see if he or she regains consiousness; this roll is modified as stated above. Characters automatically wake up after spending three turns at 1 G.

Climbing

This rating indicates how fast the aircraft can gain altitude, in meters per turn. The first value is the threshold, the second the limitation. As before, a successful Pilot roll is needed to make the aircraft climb at rates over its climbing threshold, and no roll is needed below this rate.

Descending can safely take place at the same rate, although of course it is always possible to simply fly more or less straight down. In such a case, the aircraft's speed should be used to find the rate of descent, not its climbing threshold or limitation.

Ceiling

This is the maximum altitude above sea level that the aircraft can reach, in meters. No rolls are needed to get to this altitude, just time spent climbing.

Landing/Take-Off

This is also not a threshold/limitation rating, instead it shows the shortest possible landing and take-off that can be made by the aircraft. For simplicity, these are divided into four categories:

Vertical (V): The aircraft may take-off or land vertically. In theory, all that's needed is an area large enough to contain the whole aircraft, although generally an area twice the length by twice the width of the aircraft is the minimum required. For helicopters, that is usually twice the rotor diameter.

Short (S): The aircraft needs a short runway to take off, a few hundred meters being sufficient, or take-off may be performed from a ramp. For landing roughly 100 meters of runway is required.

Standard (St): The aircraft needs a sizable length of runway to take off or land: around a kilometer for take-off, about 500 meters for landing.

Long (L): The aircraft needs two or three kilometers of runway to take off and about half this to land.

Terry, with a Constitution of 53, is subject to 6 G. He will black out unless he succeeds at a roll of 24 (53 - (6 x 4)). Terry's player rolls the dice, and scores 07—Terry can remain conscious until the G force changes. Halfway through the turn, the pilot starts pulling even more Gs, which forces Terry to make another roll or black out immediately. Since the aircraft now pulls 7G, the required roll is 25 (53 - (7 x 4)). With 89, Terry fails (rather poorly, too) and everything before his eyes goes black.

David needs a 43 to land his aircraft correctly; its Landing rating is Standard, which the GM decides is 600 meters in this case. David rolls 98. That's a miss by nearly 60 points, so his GM determines that David's landing will require a lot more room than 600 meters—more like twice that. Since the runway is only 1000 meters long, David will have to make a roll to recover. This time, he rolls a 41—barely succeeding. His GM says he aborts the landing just in time, barely clearing the trees at the far end of the runway. He'll have to circle around to make another attempt.

Any aircraft can land and take off at higher "levels" of runway requirement, although generally there is not much point in doing so except for fixed-wing, vertical take-off aircraft: most of these can have a higher take-off weight if they use a short take-off instead of a vertical take-off. Helicopters can only really use vertical take-off and landing, anything else would be flying at an extremely low level over the runway.

The rating is given for take-off first, landing second, so "St/S" means the aircraft needs a standard runway to take off, but only a short runway to land. How much runway is actually needed varies with the aircraft, its acceleration, and the wind speed, but the lengths given above are reasonable guidelines. Runways are normally clear, flat terrain and on level ground, although some people have managed to take off from airstrips high up in the mountains that were actually too short for the aircraft they were flying at the time.

Landing is one of the most difficult aspects of flying an aircraft—to represent this, require a Pilot skill roll whenever a player character attempts to land an aircraft. If the required roll is missed, the landing distance is longer than normal—perhaps even longer than the runway. If it is missed by more than 30, some sort of mishap results. Require a second Piloting roll to see how badly the landing was botched. If the player fails this roll, then the plane has crashed (perhaps catastrophically, or perhaps just taking minor damage). If the operative suceeds in making the second roll, he or she manages to save the plane.

Helicopters

Although helicopters follow the rules for other aircraft given above, some special rules apply to them as well.

Hovering and Flying Backward

A helicopter has no minimum airspeed, and so can stay in one position without moving; this is known as hovering. In addition to only going forward, a helicopter can fly backward and to the sides. For simplicity, assume the maximum speed that can be reached in these directions is equal to one-quarter the normal maximum speed. When going forward, the top speed can be attained.

Before the direction of movement can be changed, the helicopter must first go into a hover.

Descending

When going down, the G force experienced by persons in an aircraft goes down as well. Helicopters may not generate negative G forces, because in most helicopters these cause loss of control. This is not true for all helicopters, but nearly all in those commonly used the 1990s suffer from this drawback. Again for simplicity, no helicopter may go down at a rate of more than ten meters per combat turn; this rate of descent causes people onboard to experience a force of 1/2 G.

Vehicle Design

Use this set of tables to determine the various stats used for vehicles in *Millennium's End*. These tables are optimized for the kind of data typically provided in reviews by American car magazines, although they can also be used with data given by European car magazines.

Acceleration

In the first table, find the time it takes the vehicle to go from 0 to 60 mph or from 0 to 100 km/h, and read off the Acceleration Threshold and Limitation, by looking in the column appropriate to the vehicle's transmission. Add 1 to the Threshold if the vehicle has traction control.

Acceleration Thresholds

Time from 0-60 mph (seconds)	Time from 0-100 km/h (seconds)	Threshold/Limitation Manual	Automatic
4.70 to 4.95	4.87 to 5.13	15/20	18/20
4.96 to 5.21	5.14 to 5.40	14/19	17/19
5.22 to 5.51	5.41 to 5.71	13/18	16/18
5.52 to 5.85	5.72 to 6.06	13/17	15/17
5.86 to 6.22	6.07 to 6.44	12/16	14/16
6.23 to 6.66	6.45 to 6.90	11/15	13/15
6.67 to 7.15	6.91 to 7.41	10/14	12/14
7.16 to 7.72	7.42 to 8.00	10/13	12/13
7.73 to 8.39	8.01 to 8.69	9/12	11/12
8.40 to 9.19	8.70 to 9.52	8/11	10/11
9.20 to 10.16	9.53 to 10.52	7/10	9/10
10.17 to 11.35	10.53 to 11.76	7/9	8/9
11.36 to 12.87	11.77 to 13.33	6/8	7/8
12.88 to 14.85	13.34 to 15.38	5/7	6/7
14.86 to 17.55	15.39 to 18.18	4/6	5/6
17.56 or greater	18.19 or greater	4/5	4/5

Braking

First determine if the vehicle has standard or anti-lock brakes. Then look up the distance it requires to get to a full stop from 60 mph or 100 km/h, and read off the Threshold and Limitation from the appropriate column.

Cornering

Note that the cornering threshold table in particular is based on subjective input—this is usually given in depth in sportscar magazines—and there's also a conversion table based on ratings from Consumer Reports reviews. European magazines do not normally give cornering data, which makes this a tricky area.

Top Speed and Range

A vehicle's top speed in kilometers per hour is normally given in European car reviews. American magazines give it in miles per hour, and to calculate the top speed for *Millennium's End*, multiply that by 1.609. Round top speeds off to the nearest 5 km/h.

The range in kilometers depends on the size of the fuel tank in liters or gallons, and the fuel consumption rate. Use one of the following formulas to calculate the approximate range, and round it off to the nearest 5 km.

- miles per gallon x fuel capacity (gallons) x 1.609
- fuel capacity (liters) x fuel consumption (per 100 km) x 100
- kilometers per liter x fuel capacity (liters)

Braking Thresholds

60-0 mph (feet)	100-0 km/h (meters)	Threshold/Limitation Standard	ABS
0 to 111	0 to 35	4/3	2/3
112 to 142	36 to 45	6/4	3/4
143 to 174	46 to 55	7/5	4/5
175 to 205	56 to 65	8/6	5/6
206 to 237	66 to 75	10/7	6/7
238+	76+	11/8	7/8

Armor Values

Only calculate these for military or other armored vehicles, as most civilian vehicles are assumed to have Armor Values of 0. The data you will need is the thickness of the armor plate on these six locations: hull front, hull sides, hull rear, turret front, turret sides, and turret rear;

also the angle each side makes to the vertical. Armed with this data and a (preferably scientific) calculator, the armor rating is easy to compute.

Cornering Table			
G's	Limitation	Rating	Threshold
0 to 0.64	1	C	20%
0.65 to 0.69	2	C+	25%
0.70 to 0.74	3	B-	30%
0.75 to 0.79	4	B	40%
0.80 to 0.84	5	B+	50%
0.85 to 0.89	6	A-	60%
0.90 to 0.94	7	A	70%
0.95 or greater	8	A+	75%

First of all, establish the effective armor thickness by taking into account the angle the armor makes to the vertical: take the cosine (COS on the calculator) of this angle, and divide the thickness of the armor by the result; then multiply the number you get by 24. This assumes you have the thickness in centimeters; if in millimeters, multiply by 2.4, while if it is in inches, multiply by 0.96.

In case the armor is made of aluminum and not of steel, divide the Armor Value by 2.5. Finally, round fractions off: if below 50, round to the nearest whole number. Up to 500, round to the nearest 5, and over 500 round to the nearest 10.

Many vehicles have different armor thicknesses and angles on a single side, in which case you can best take the average of the thicknesses and angles. If you want to be really accurate you should figure out the percentages of the armor at each angle and thickness, but being that thorough is not quite necessary.

An alternative way of deciding armor values is to find which rounds will be stopped by the vehicle's armor, and find their Damage Value in the Millennium's End rules (page 193) or Ultramodern Firearms (last two pages), then use that as a general indication of the Armor Value. For example, if a vehicle is quoted as stopping 7.62 mm armor-piercing rounds, its AV is about 38: the DD of 7.62 mm armor-piercing rounds is 19, so the AV necessary to stop them is 38.

FCS Ratings

Most fire control systems are optical devices, and get a base +11 to the weapon's Inherent Accuracy. Further modifiers to the IA depend on the specifics of the system, as can be seen on the table below. All are cumulative.

FCS Ratings	
FCS is equipped with	IA
Barrel temperature meter	+1
Computerized FCS	+5
Electrical turret drive	+1
Laser rangefinder	+6
Muzzle reference system	+3
Normal rangefinder	+2
Stereoscopic sight/rangefinder	+3
Vehicle tilt meter	+2
Wind sensor	+1

Second Hand Vehicles

Not all vehicles bought (or otherwise obtained) by *Millennium's End* characters will be new and in a straight-from-the-showroom condition. Vehicles of all types suffer from wear, though in how much is dependent on many different factors, such as preventive maintenance, frequency of use, and how the vehicle is used. To reflect this, the GM may sometimes want to select an entry from this list for the vehicles that characters obtain in one way or another. By adding these quirks, vehicles become more unique and memorable to the players—one Ford Escort is pretty much like the next one, but if the one bought from the Colombian garage has a much higher fuel consumption than normal, a faulty speedometer, and is dented all over you can bet the player will pay more attention to it.

- ❑ Bullet holes in the body, broken windows, etc.
- ❑ Engine cooling system is broken: engine will start to overheat after 3d10 minutes of use.
- ❑ Engine has been finely tuned: add 1 to Accelera tion threshold and limitation, and d10 percent to top speed.
- ❑ Engine is worn-out: subtract 1 from Acceleration threshold and limitation, and d10 percent from top speed.
- ❑ Faulty brakes: add 1 to Braking threshold and limitation.
- ❑ Fuel tank is nearly empty: roll a d10 for the number of miles before the vehicle runs our of gas (only for vehicles that are "found some where").
- ❑ Gear changes make much noise (a badly-maintained or damaged transmission?).
- ❑ Headlights, taillights, and/or turn signals are broken.
- ❑ Heater or air conditioner is broken; either it does not work at all, or is continuously on and cannot be switched off.
- ❑ High fuel consumption: decrease range by d10 percent.
- ❑ Hubcaps have been stolen or are otherwise missing.
- ❑ Instruments are faulty, giving slightly (or totally) wrong readings, or might not work at all.
- ❑ One of the tires is flat.
- ❑ One or more engines are out of operation (in multi-engined vehicles only).
- ❑ Police are looking for the vehicle, or one of its type, in connection with a crime or a wanted felon, or the vehicle has been reported stolen.
- ❑ Radio has been stolen (probably one of the side windows is broken as well).
- ❑ Seats are stuck in an awkward position and can not be moved.
- ❑ Seat belt warning beep doesn't turn off until seat belts are fastened.
- ❑ Starting takes much longer than usual, especially with a cold engine.
- ❑ Tools, spare tire, bulbs, and/or fuses are missing.
- ❑ Trunk won't open because the locking mechanism is broken and whatever is in there smells real bad.
- ❑ Various parts of the vehicle's body have been repainted or replaced by parts of different colors.
- ❑ Vehicle has large and obvious dents.
- ❑ Vehicle is damaged: apply 3d10+10 TL in damage to the Crash Results Table.
- ❑ Vehicle under-steers: add 1 to Cornering Thresh old and Limitation.
- ❑ Windscreen wipers don't work.

Millennium's End Game Stats

Civilian Automobiles

		Thresholds Acceleration	Braking	Cornering	Top speed	Range	Fuel
BMW 361i	2- or 4-door, 4-pass, auto	6/8	4/5	4/6	195	890	G
BMW 318i	2- or 4-door, 4-pass, auto	7/9	4/5	4/6	200	815	G
BMW 320i	2- or 4-door, 4-pass, auto	7/10	4/5	4/6	210	785	G
BMW 323i	2- or 4-door, 4-pass, auto	9/12	4/5	4/6	225	815	G
BMW 325td	2- or 4-door, 4-pass, auto	6/8	4/5	4/6	200	955	D
BMW 328i	2- or 4-door, 4-pass, auto	10/14	4/5	4/6	235	835	G
BMW 520i	2- or 4-door, 4-pass, auto	7/9	4/5	4/6	220	920	G
BMW 523i	2- or 4-door, 4-pass, auto	7/10	4/5	4/6	230	935	G
BMW 525tds	2- or 4-door, 4-pass, auto	7/9	4/5	4/6	210	1030	D
BMW 528i	2- or 4-door, 4-pass, auto	8/11	4/5	4/6	235	895	G
BMW 535i	2- or 4-door, 4-pass, auto	10/13	4/5	4/6	250	770	G
BMW 540i	2- or 4-door, 4-pass, auto	12/16	4/5	4/6	250	750	G
BMW 725tds	2- or 4-door, 4-pass, auto	7/9	4/5	5/7	205	1180	D
BMW 728i	2- or 4-door, 4-pass, auto	7/10	4/5	5/7	225	1025	G
BMW 735i	2- or 4-door, 4-pass, auto	10/13	4/5	5/7	245	915	G
BMW 740i	2- or 4-door, 4-pass, auto	10/14	4/5	5/7	250	895	G
BMW 750i	2- or 4-door, 4-pass, auto	11/15	4/5	5/7	250	825	G
BMW 850Ci	2- or 4-door, 4-pass, auto	12/16	4/5	5/7	250	890	G
BMW 840Ci	2- or 4-door, 4-pass, auto	12/16	4/5	5/7	250	965	G
BMW 850CSi	2- or 4-door, 4-pass, auto	13/17	4/5	5/7	250	880	G
BMW M3	2- or 4-door, 4-pass, both	13/18	4/5	4/6	250	890	G
Chevrolet Beretta 2.2L	2-door, 4-pass., 5-speed	7/9	7/5	2/5	170	765	G
Chevrolet Beretta 2.2L	2-door, 4-pass., auto.	8/9	7/5	2/5	170	685	G
Chevrolet Beretta 3.1L	2-door, 4-pass., auto.	8/9	7/5	2/5	175	685	G
Chevrolet Beretta Z26	2-door, 4-pass., auto.	8/9	7/5	2/5	175	685	G
Chevrolet Corsica 2.2	4-door, 4-pass., 5-speed	7/9	7/5	2/5	170	765	G
Chevrolet Corsica 2.2	4-door, 4-pass., auto.	8/9	7/5	2/5	170	685	G
Chevrolet Corsica 3.1	4-door, 4-pass., auto.	8/9	7/5	2/5	175	685	G
Chevrolet Corvette	2-door, 2-pass., 6-speed	13/17	5/4	3/7	245	800	G
Chevrolet Corvette	2-door, 2-pass., auto.	15/17	5/4	3/7	245	800	G
Chevrolet Corvette ZR-1	2-door, 2-pass., 6-speed	15/20	5/4	6/8	280	680	G
Chrysler Cirrus LX et al	4-door, 4-pass., auto.	9/10	3/4	2/4	210	745	G
Chrysler Concorde	4-door, 4-pass., auto.	10/11	3/4	2/4	210	725	G
Chrysler Voyager et al	5-door, 7-pass., 5-speed	6/8	7/5	4/6	180	650	G
Chrysler Voyager et al	5-door, 7-pass., auto.	7/8	7/5	4/6	180	650	G
Ferrari F355 et al	2-door, 2-pass., 5-speed	14/19	7/5	3/6	280	1000	G
Ford Escort Sedan	4-door, 4-pass., 4- or 5-speed	7/9	7/5	2/3	190	730	G
Ford Escort Sedan	4-door, 4-pass., auto.	8/9	7/5	2/3	190	650	G
Ford Escort Sedan (ABS)	4-door, 4-pass., 4- or 5-speed	7/9	4/5	2/3	190	730	G
Ford Escort Sedan (ABS)	4-door, 4-pass., auto.	8/9	4/5	2/3	190	650	G
Ford Escort LX Sedan	4-door, 4-pass., 4- or 5-speed	7/9	7/5	2/3	190	730	G
Ford Escort LX Sedan	4-door, 4-pass., auto.	8/9	7/5	2/3	190	650	G
Ford Escort LX Sedan (ABS)	4-door, 4-pass., 4- or 5-speed	7/9	4/5	2/3	190	730	G
Ford Escort LX Sedan (ABS)	4-door, 4-pass., auto.	8/9	4/5	2/3	190	650	G
Ford Escort LX Wagon	5-door, 4-pass., 4- or 5-speed	5/7	7/5	2/3	190	730	G

Millennium's End Game Stats

Civilian Automobiles (cont.)

		Thresholds					
		Acceleration	Braking	Cornering	Top speed	Range	Fuel
Ford Escort LX Wagon	5-door, 4-pass., auto.	6/7	7/5	2/3	190	650	G
Ford Escort LX Wagon (ABS)	5-door, 4-pass., 4- or 5-speed	5/7	4/5	2/3	190	730	G
Ford Escort LX Wagon (ABS)	5-door, 4-pass., auto.	6/7	4/5	2/3	190	650	G
Ford Probe	3-door, 4-pass., 5-speed	7/10	6/4	3/5	205	740	G
Ford Probe (ABS)	3-door, 4-pass., 5-speed	7/10	3/4	3/5	205	740	G
Ford Probe GT	3-door, 4-pass., 5-speed	9/12	3/4	4/6	220	590	G
Ford Taurus Sedan et al	4-door, 4-pass., auto.	10/11	6/4	3/4	180	750	G
Ford Taurus Sedan (ABS) et al	4-door, 4-pass., auto.	10/11	3/4	3/4	180	750	G
Ford Taurus Wagon et al	5-door, 4-pass., auto.	10/11	6/4	3/4	180	700	G
Ford Taurus Wagon (ABS) et al	5-door, 4-pass., auto.	10/11	3/4	3/4	180	700	G
Ford Taurus SHO	4-door, 4-pass., auto.	11/15	3/4	3/5	200	670	G
Honda Accord DX, LX	4- or 5-door, 4-pass., 5-speed	7/10	7/5	2/4	200	755	G
Honda Accord DX, LX	2-, 4- or 5-door, 4-pass., auto.	9/10	7/5	2/4	200	755	G
Honda Accord LX (ABS)	4-door, 4-pass., 5-speed	7/10	4/5	2/4	200	755	G
Honda Accord LX (ABS)	4-door, 4-pass., auto.	9/10	4/5	2/4	200	755	G
Honda Accord EX	4- or 5-door, 4-pass., 5-speed	8/11	3/4	2/4	210	755	G
Honda Accord EX	2-, 4- or 5-door, 4-pass., auto.	10/11	3/4	2/4	210	755	G
Honda Civic CX, DX, HX	2- or 5-door, 4-pass., 5-speed	7/10	7/5	3/5	180	640	G
Honda Civic CX, DX, HX	2- or 3- door, 4-pass., auto.	8/9	7/5	3/5	180	640	G
Honda Civic EX, LX	2- or 3-door, 4-pass., 5-speed	8/11	7/5	3/5	215	760	G
Honda Civic EX, LX	2-, 3- or 5-door, 4-pass., auto.	9/10	7/5	3/5	215	760	G
Honda Civic EX (ABS)	2-, 3- or 5-door, 4-pass., auto.	9/10	4/5	3/5	215	760	G
Honda Civic HX	2-, 3- or 5-door, 4-pass., CVT	10/11	7/5	3/5	215	760	G
Jaguar XJ6	4-door, 4-pass., auto	9/12	5/6	3/6	225	935	G
Jaguar XJR	4-door, 4-pass., auto	12/16	5/6	3/6	250	865	G
Jaguar XJ12	4-door, 4-pass., auto	12/16	5/6	3/6	250	670	G
Lamborghini Diablo et al	2-door, 2-pass., 5-speed	16/21	7/5	3/6	325	650	G
Lamborghini Diablo SV/SVR	2-door, 2-pass., 5-speed	17/22	7/5	3/6	325	650	G
Lincoln Continental	4-door, 5-pass., auto.	10/11	4/5	2/5	215	560	G
Lincoln Mark VIII	2-door, 5-pass., auto.	10/11	4/5	2/5	215	680	G
Mazda 626 DX, LX	4-door, 4-pass., 5-speed	7/9	6/4	3/4	200	750	G
Mazda 626 DX, LX	4-door, 4-pass., auto.	6/8	6/4	3/4	185	740	G
Mazda 626 ES, LX V6 (ABS)	4-door, 4-pass., 5-speed	9/12	4/5	3/4	220	700	G
Mazda 626 ES, LX V6 (ABS)	4-door, 4-pass., auto.	7/10	4/5	3/4	205	645	G
Mazda 626 LX (ABS)	4-door, 4-pass., 5-speed	7/9	3/4	3/4	200	750	G
Mazda 626 LX (ABS)	4-door, 4-pass., auto	6/8	3/4	3/4	185	740	G
Mazda 626 LX V6	4-door, 4-pass., 5-speed	9/12	7/5	3/4	220	700	G
Mazda 626 LX V6	4-door, 4-pass., auto	7/10	7/5	3/4	205	645	G
Mazda MX-5 Miata	2-door, 2-pass., 5-speed	8/11	7/5	4/7	200	640	G
Mercedes C 180	4-door, 4-pass., 5-speed	6/8	4/5	4/6	190	765	G
Mercedes C 180	4-door, 4-pass., auto	7/8	4/5	4/6	190	730	G
Mercedes C 200	4-door, 4-pass., 5-speed	7/9	4/5	4/6	200	775	G
Mercedes C 200	4-door, 4-pass., auto	8/9	4/5	4/6	200	730	G
Mercedes C 200 Diesel	4-door, 4-pass., 5-speed	4/5	4/5	4/6	160	755	D
Mercedes C 200 Diesel	4-door, 4-pass., auto	4/5	4/5	4/6	160	850	D

Millennium's End Game Stats

Civilian Automobiles (cont.)

		Thresholds			Top		
		Acceleration	Braking	Cornering	speed	Range	Fuel
Mercedes C 220	4-door, 4-pass., 5-speed	7/10	4/5	4/6	210	765	G
Mercedes C 220	4-door, 4-pass., auto	9/10	4/5	4/6	210	730	G
Mercedes C 220 Diesel	4-door, 4-pass., 5-speed	4/6	4/5	4/6	175	900	D
Mercedes C 220 Diesel	4-door, 4-pass., auto	5/6	4/5	4/6	175	825	D
Mercedes C 250 Diesel	4-door, 4-pass., 5-speed	5/7	4/5	4/6	190	900	D
Mercedes C 250 Diesel	4-door, 4-pass., auto	5/6	4/5	4/6	190	825	D
Mercedes C 280	4-door, 4-pass., 5-speed	8/11	4/5	4/6	230	640	G
Mercedes C 280	4-door, 4-pass., auto	11/12	4/5	4/6	230	630	G
Mercedes E 200	4-door, 4-pass., 5-speed	7/9	4/5	4/6	205	960	G
Mercedes E 200	4-door, 4-pass., auto	8/9	4/5	4/6	205	960	G
Mercedes E 220D	4-door, 4-pass, auto	8/9	4/5	4/6	180	1125	G
Mercedes E 220D	4-door, 4-pass, 5-speed	7/9	4/5	4/6	180	1105	G
Mercedes E 230	4-door, 4-pass, 5-speed	7/9	4/5	4/6	220	955	G
Mercedes E 280	4-doot, 4-pass, auto	7/9	4/5	4/6	215	975	G
Mercedes E 290 TD	4-door, 4-pass., 5-speed	8/11	4/5	4/6	210	1155	G
Mercedes E 320	4-door, 4-pass, auto	8/10	4/5	4/6	235	910	G
Mercedes E 420	4-door, 4-pass. auto	9/10	4/5	4/6	250	930	G
Mercedes SLK 200	2-door, 2-pass, auto	9/10	7/5	3/6	210	630	G
Mercedes SLK 200	2-door, 2-pass, 5-speed	9/12	7/5	3/6	210	610	G
Mercedes SLK 230 K	2-door, 2-pass, auto	10/11	7/5	3/6	230	655	G
Mercedes SLK 230 K	2-door, 2-pass, 5-speed	8/12	7/5	3/6	230	655	G
Mercury Sable Sedan et al	4-door, 4-pass., auto.	10/11	6/4	3/4	180	750	G
Mercury Sable Wagon et al	5-door, 4-pass., auto.	10/11	6/4	3/4	180	700	G
Nissan 200SX, 200SX SE	2-door, 4-pass., 5-speed	8/11	7/5	2/4	235	740	G
Nissan 200SX, 200SX SE	2-door, 4-pass., auto	10/11	7/5	2/4	225	730	G
Nissan 200SX SE (ABS)	2-door, 4-pass., 5-speed	8/11	4/5	2/4	235	740	G
Nissan 200SX SE (ABS)	2-door, 4-pass., auto	10/11	4/5	2/4	225	730	G
Nissan 200SX SE-R	2-door, 4-pass., 5-speed	9/12	7/5	3/6	235	740	G
Nissan 200SX SE-R	2-door, 4-pass., auto	10/11	7/5	3/6	225	730	G
Nissan 200SX SE-R (ABS)	2-door, 4-pass., 5-speed	9/12	4/5	3/6	235	740	G
Nissan 200SX SE-R (ABS)	2-door, 4-pass., auto	10/11	4/5	3/6	225	730	G
Nissan Altima et al	4-door, 4-pass., 5-speed	9/12	6/4	2/4	235	770	G
Nissan Altima et al	4-door, 4-pass., auto.	9/10	6/4	2/4	235	740	G
Nissan Altima et al (ABS)	4-door, 4-pass., 5-speed	9/12	3/4	2/4	235	770	G
Nissan Altima et al (ABS)	4-door, 4-pass., auto.	9/10	3/4	2/4	235	740	G
Pontiac Firebird	2-door, 4-pass., 5-speed	10/13	3/4	3/5	200	695	G
Pontiac Firebird	2-door, 4-pass., auto.	12/13	3/4	3/5	200	695	G
Pontiac Firebird Trans Am	2-door, 4-pass., 5- or 6-speed	12/16	3/4	3/5	240	615	G
Pontiac Firebird Trans Am	2-door, 4-pass., auto.	14/16	3/4	3/5	240	615	G
Porsche 911 Carrera Cabroilet	2-doot, 4-pass, 5-speed	13/18	4/5	4/6	270	815	G
Porsche 911 Carrera Coupe	2-doot, 4-pass, 5-speed	13/18	4/5	4/6	270	815	G
Porsche 911 Carrera 4 et al	2-doot, 4-pass, 5-speed	13/18	4/5	4/6	270	805	G
Porsche 911 Turbo Coupe	2-doot, 4-pass, 5-speed	16/21	4/5	4/6	290	710	G
Porsche Boxster	2-doot, 4-pass, 5-speed	11/15	3/4	4/5	240	915	G
Rolls-Royce Silver Spirit et al	2-doot, 4-pass, 5-speed	7/10	5/6	3/5	215	625	G

Millennium's End Game Stats

Civilian Automobiles (cont.)

		Thresholds					
		Acceleration	Braking	Cornering	Top speed	Range	Fuel
Saab 900, S	3- or 5-door, 4-pass., 5-speed	6/8	3/4	3/4	200	800	G
Saab 900, S	3- or 5-door, 4-pass., auto	7/8	3/4	3/4	190	800	G
Saab 900 SE	3- or 5-door, 4-pass., 5-speed	6/8	3/4	3/4	210	885	G
Saab 900 SE	3- or 5-door, 4-pass., auto	7/8	3/4	3/4	195	885	G
Saab 900 SE Turbo	3- or 5-door, 4-pass., 5-speed	9/12	3/4	3/4	230	800	G
Saab 900 SE Turbo	3- or 5-door, 4-pass., auto	11/12	3/4	3/4	230	800	G
Saab 900 SE V6	3- or 5-door, 4-pass., 5-speed	8/11	3/4	3/4	225	810	G
Saab 900 SE V6	3- or 5-door, 4-pass., auto	10/11	3/4	3/4	225	810	G
Saab 9000 2.0 et al	4- or 5-door, 4-pass., 5-speed	8/9	4/5	3/4	200	820	G
Saab 9000 2.0 et al	4- or 5-door, 4-pass., auto.	9/9	4/5	3/4	200	820	G
Saab 9000 2.0 LPT et al	4- or 5-door, 4-pass., 5-speed	9/11	4/5	3/4	210	850	G
Saab 9000 2.0 LPT et al	4- or 5-door, 4-pass., auto.	9/9	4/5	3/4	210	850	G
Saab 9000 2.3 LPT et al	4- or 5-door, 4-pass., 5-speed	10/12	4/5	3/4	220	860	G
Saab 9000 2.3 LPT et al	4- or 5-door, 4-pass., auto.	11/11	4/5	3/4	220	860	G
Saab 9000 2.3 Turbo et al	4- or 5-door, 4-pass., 5-speed	11/13	4/5	3/4	235	840	G
Saab 9000 2.3 Turbo et al	4- or 5-door, 4-pass., auto.	12/12	4/5	3/4	235	840	G
Saab 9000 Aero et al	4- or 5-door, 4-pass., 5-speed	12/15	4/5	3/4	240	885	G
Saab 9000 Aero et al	4- or 5-door, 4-pass., auto.	14/15	4/5	3/4	240	885	G
Toyota Camry CE	4-door, 5-pass., 5-speed	7/10	6/4	3/4	205	825	G
Toyota Camry CE	4-door, 5-pass., auto	8/9	6/4	3/4	205	825	G
Toyota Camry CE (ABS)	4-door, 5-pass., 5-speed	7/10	3/4	3/4	205	825	G
Toyota Camry CE (ABS), LE, XLE	4-door, 5-pass., auto	8/9	3/4	3/4	205	825	G
Toyota Camry CE V6	4-door, 5-pass., 5-speed	10/13	3/4	3/4	220	775	G
Toyota Camry LE V6, XLE V6	4-door, 5-pass., auto.	11/12	3/4	3/4	220	775	G
Toyota Celica GT Convertible	2-door, 4-pass., 5-speed	8/11	6/4	4/6	215	730	G
Toyota Celica GT Convertible	2-door, 4-pass., auto.	10/11	6/4	4/6	215	730	G
Toyota Celica GT Liftback	2-door, 4-pass., 5-speed	9/12	6/4	4/6	225	730	G
Toyota Celica GT Liftback	2-door, 4-pass., auto.	11/12	6/4	4/6	225	730	G
Toyota Celica GT Liftback (ABS)	2-door, 4-pass., 5-speed	9/12	3/4	4/6	225	730	G
Toyota Celica GT Liftback (ABS)	2-door, 4-pass., auto.	11/12	3/4	4/6	225	730	G
Toyota Celica ST et al	2-door, 4-pass., 5-speed	7/10	7/5	4/6	200	810	G
Toyota Celica ST et al	2-door, 4-pass., auto.	9/10	7/5	4/6	200	810	G
Toyota Celica ST et al (ABS)	2-door, 4-pass., 5-speed	7/10	4/5	4/6	200	810	G
Toyota Celica ST et al (ABS)	2-door, 4-pass., auto.	9/10	4/5	4/6	200	810	G
Toyota Paseo	2-door, 4-pass.,5-speed	7/10	6/4	2/5	185	650	G
Toyota Paseo (ABS)	2-door, 4-pass.,5-speed	7/10	3/4	2/5	185	650	G

Millennium's End Game Stats

Civilian Off-Road Vehicles

		Thresholds			Top		
		Acceleration	Braking	Cornering	speed	Range	Fuel
AM General Hummer	4-door, 4-pass., auto.	8/9	7/5	2/5	125	480	D
AM General Hummer	open-top, 4-pass., auto.	8/9	7/5	2/5	125	480	D
Chevrolet Blazer	4-door, 4-pass., 5-speed	7/9	7/5	2/3	180	580	G
Chevrolet Blazer	4-door, 4-pass., auto.	8/9	7/5	1/3	180	580	G
Chevrolet Blazer ZR2	2-door, 4-pass., 5-speed	7/9	7/5	1/3	180	580	G
Chevrolet Blazer ZR2	2-door, 4-pass., auto.	8/9	7/5	1/3	180	580	G
Jeep Cherokee Sport	5-door, 5-pass., 5-speed	6/8	3/4	1/5	165	555	G
Jeep Cherokee Sport LE, SE	5-door, 5-pass., 5-speed	8/11	3/4	1/5	180	530	G
Jeep Cherokee Sport LE, SE	5-door, 5-pass., auto.	10/11	3/4	1/5	180	530	G
Jeep Cherokee TD Sport	5-door, 5-pass., 5-speed	6/8	3/4	1/5	165	730	D
Jeep Wrangler	2-door, 4-pass., 5-speed	8/11	6/4	1/3	170	445	G
Jeep Wrangler	2-door, 4-pass., auto.	9/10	6/4	1/3	170	400	G
Land Rover Defender 110 County	5-door, 5-pass., 5-speed	4/5	6/4	2/4	135	375	D
Land Rover Discovery 300	3- or 5-door, 7-pass., 5-speed	4/6	6/4	2/4	145	815	D
Land Rover Discovery 300	3- or 5-door, 7-pass., auto.	5/6	6/4	2/4	145	815	D
Land Rover Discovery V8	3- or 5-door, 7-pass., 5-speed	7/9	6/4	2/4	170	590	G
Land Rover Discovery V8	3- or 5-door, 7-pass., auto.	7/8	6/4	2/4	170	585	G
Mercedes G 230	3- or 5-door, 4-pass., 5-speed	4/6	7/5	2/3	145	590	G
Mercedes G 230	3- or 5-door, 4-pass., auto.	4/5	7/5	2/3	145	550	G
Mercedes G 300	3- or 5-door, 4-pass., 5-speed	5/7	7/5	2/3	165	540	G
Mercedes G 300	3- or 5-door, 4-pass., auto.	6/7	7/5	2/3	165	500	G
Mercedes G 300 Turbodiesel	3- or 5-door, 4-pass., auto.	6/7	7/5	2/3	165	500	G
Mercedes G 320	3- or 5-door, 4-pass., auto.	7/8	7/5	2/3	175	550	G
Nissan Patrol GR	3-door, 5-pass., 5-speed	4/6	6/4	1/3	150	705	D
Nissan Patrol GR Wagon	5-door, 7-pass., 5-speed	4/6	6/4	1/3	150	670	D

Civilian Motorcycles

		Thresholds			Top		
		Acceleration	Braking	Cornering	speed	Range	Fuel
BMW R 850 R	2-pass., 5-speed	11/15	6/4	4/6	185	400	G
BMW R 850 R (ABS)	2-pass., 5-speed	11/15	3/4	4/6	185	400	G
BMW R 1100 RS	2-pass., 5-speed	12/16	6/4	3/6	215	370	G
BMW R 1100 RS (ABS)	2-pass., 5-speed	12/16	3/4	3/6	215	370	G
BMW R 1100 RT	2-pass., 5-speed	12/16	6/4	3/6	195	440	G
BMW R 1100 RT (ABS)	2-pass., 5-speed	12/16	3/4	3/6	195	440	G
Ducati 600 SS Caraneta et al	2-pass., 5-speed	13/18	6/4	4/7	190	365	G
Ducati M 600	2-pass., 5-speed	13/17	6/4	4/7	175	325	G
H-D FLHT Electra Glide et al	2-pass., 5-speed	11/15	7/5	3/4	200	360	G
H-D FLHTC Electra Glide Classic	2-pass., 5-speed	11/15	7/5	3/4	200	380	G
H-D Dyna Super Glide	2-pass., 5-speed	12/16	7/5	3/5	200	370	G
H-D Dyna Low Rider, Wide Glide	2-pass., 5-speed	12/16	7/5	3/5	200	405	G
H-D Dyna Convertible	2-pass., 5-speed	12/16	7/5	3/5	200	350	G
Honda CB 500	2-pass., 5-speed	13/17	6/4	3/5	190	415	G
Honda CBR 1100 XX	2-pass., 6-speed	15/20	5/4	5/7	300	375	G

Millennium's End Game Stats

Civilian Motorcycles (cont.)

		Thresholds			Top		
		Acceleration	Braking	Cornering	speed	Range	Fuel
Honda GL 1500 SE Gold Wing	2-pass., 5-speed	10/14	7/5	3/6	200	310	G
Honda ST 1100 Pan European	2-pass., 5-speed	14/17	4/5	5/6	240	475	G
Honda XR 600 R	2-pass., 5-speed	10/13	8/6	2/4	140	190	G
Kawasaki Eliminator 600	2-pass., 6-speed	12/16	6/4	4/6	160	220	G
Kawasaki GPZ 1100	2-pass., 6-speed	13/18	6/4	3/6	275	350	G
Kawasaki GPZ 1100 ABS	2-pass., 6-speed	13/18	3/4	3/6	270	350	G
Kawasaki KLX 650 R	1-pass., 5-speed	11/15	7/5	2/5	165	145	G
Suzuki RF 900 R	2-pass., 5-speed	14/19	6/4	4/6	265	335	G
Suzuki VS 600 GLS Intruder	2-pass., 5-speed	12/16	7/5	3/5	150	215	G
Suzuki VS 800 GL Intruder	2-pass., 5-speed	13/17	8/6	3/5	170	215	G
Suzuki VS 1400 GLP Intruder	2-pass., 5-speed	13/18	8/6	3/5	190	215	G
Vespa Sfera 125	2-pass., auto.	11/12	6/4	1/4	100	200	G
Vespa Skipper 125	2-pass., auto.	11/12	6/4	2/4	100	200	G
Yamaha XJ 600 S Diversion	2-pass., 5-speed	13/17	7/5	4/5	170	305	G
Yamaha XJ 900 Diversion	2-pass., 5-speed	14/19	8/6	4/5	210	410	G
Yamaha XV 125	2-pass., 5-speed	10/13	7/5	2/5	110	230	G
Yamaha XV 750	2-pass., 5-speed	12/16	7/5	3/5	170	290	G
Yamaha XV 1100	2-pass., 5-speed	13/18	8/6	3/5	195	290	G

Civilian Airplanes

		Thresholds				Top			Land/	
		Acceleration	Braking	Cornering	Climbing	speed	Ceiling	Range	TO	Fuel
ABC A-60 Plus Lightship	1-door, 5-pass., blimp	3/4	14/12	2/2	6/12	160	3500	4000+	V/V	A
Air Tractor AT-300 et al	1-door, 1-pass., SE prop	6/8	10/8	2/4	8/16	270	4000	565	S/S	A
Boeing 737-600	8-door, 134-pass., ME jet	15/24	13/10	2/3	12/24	1000	12500	2800	L/L	A
Boeing 737-700	8-door, 151-pass., ME jet	15/24	13/10	2/3	12/24	1000	12500	3000	L/L	A
Boeing 737-800	8-door, 191-pass., ME jet	15/24	13/10	2/3	12/24	1000	12500	3500	L/L	A
Cessna 172R Skyhawk	2-door, 4-pass., SE prop.	8/12	10/8	3/6	4/8	225	4100	1260	S/S	A
Cessna 182S Skylane	2-door, 4-pass., SE prop.	8/12	10/8	3/6	4/8	270	4500	1525	S/S	A
Embraer EMB-120 Brasilia	1-door, 32-pass., ME prop	9/13	11/9	3/6	12/22	610	9,100	3,000	St/St	A
Gulfstream IV	1-door, 21-pass., ME jet	22/29	13/10	4/7	20/40	945	15500	8350	St/St	A
HOAC DV 20	canopy, 2-pass., SE prop	7/9	12/10	3/4	4/8	235	4,000	765	S/S	A
Learjet 45	2-door, 10-pass., ME jet	17/23	11/9	4/7	14/28	990	15000	4000	St/St	A
Piaggio P.180 Avante	1-door, 9-pass., ME prop	10/14	11/9	4/7	16/30	730	12,500	3000	St/St	A
Piper Archer III	2-door, 4-pass., SE prop	8/13	11/9	3/6	6/12	245	4000	925	S/S	A
TKEF/AAC Angel	3-door, 8-pass.,ME prop	7/11	11/9	3/6	8/14	945	6000	8350	S/S	A

Millennium's End Game Stats

Civilian Helicopters

		Thresholds				Top			Land/	
		Accelerate	Brake	Corner	Climb	Speed	Ceiling	Range	TO	Fuel
AÈrospatiale AS 350B et al	2-door, 6-pass., helicopter	7/11	4/3	3/5	5/9	290	900	655	V/V	A
AÈrospatiale AS 355F2 et al	2-door, 6-pass., helicopter	6/10	4/3	3/5	4/7	270	2000	705	V/V	A
Aérospatiale SA365N Dauphine 2	4-door, 13-pass., helicopter	8/12	4/2	2/3	3/7	295	2100	850	V/V	A
Bell 206 JetRanger, 406 JetRanger	4-door, 5-pass., helicopter	7/11	4/2	2/3	5/9	240	5200	400	V/V	A
Bell 212, 412SP	4-door, 11-pass., helicopter	6/10	5/2	2/3	3/7	230	4500	655	V/V	A
MBB-Kawasaki BK 117	4-door, 12-pass., helicopter	6/10	3/2	3/5	5/10	280	2900	570	V/V	A
MDD Model 500	4-door, 4-pass., helicopter	7/11	3/2	2/4	5/10	260	2600	515	V/V	A
MDD Model 530, 530MG	4-door, 4-pass., helicopter	7/12	3/2	2/4	5/11	240	5000	375	V/V	A
Sikorsky S-76B	4-door, 14-pass., helicopter	8/12	5/3	2/5	4/8	285	2500	580	V/V	A

Civilian Watercraft

		Thresholds			Top		
		Accelerate	Brake	Corner	Speed	Range	Fuel
Bombardier Sea-Doo et al	2-pass, Jetski	8/10	8/5	3/4	65	95	G
Bombardier Sea-Doo GTX et al	2-pass, Jetski	8/10	8/5	3/4	70	120	G
Broom Ocean 34	5-pass., SE-motorboat	1/2	9/6	2/3	15	750	D
Broom Ocean 34	5-pass., ME-motorboat	2/3	9/6	2/3	25	750	D
Christensen VC	12-pass, ME-motorboat	3/4	10/7	1/3	55	650	D
Codecasa 49	22-pass, ME-motorboat	2/3	12/8	1/2	65	3200	D
Etap 30i	6-pass., sailboat	1/2	7/5	1/3	13[1]	unltd	D
Kawasaki Jetfoil 929-117	350-pass., hydrofoil	4/6	12/8	1/3	85	600	G
Kawasaki Jet Ski 750 STX	3-pass., jetski	8/10	8/5	3/4	70	105	G
Kawasaki Jet Ski 900 STX	3-pass., jetski	9/11	8/5	3/4	85	105	G
Kawasaki Jet Ski 1100 STX	3-pass., jetski	10/13	8/5	3/4	95	105	G
MacGregor 26	5-pass., sailboat	1/2	10/7	1/3	[2]	unltd	-
Najad Farr 60	9-pass., sailboat	1/2	8/5	1/2	18[2]	unltd	D
Panther 14	2-pass., SE-motorboat	5/7	8/5	2/3	90	420	G
Panther 16	5-pass., SE-motorboat	4/6	8/5	2/3	75	420	G
Panther 20	10-pass., SE-motorboat	3/4	9/6	1/3	60	420	G
Tempest 60	7-pass., ME-motorboat	3/5	4/2	2/4	90	500	D

[1] When using sails, top speed is approx. 1/4 wind speed.

[2] When using sails, top speed is approx. 1/2 wind speed.

Millennium's End Game Stats

Military Armored Vehicles

		Thresholds			Top		
		Accelerate	Brake	Corner	Speed	Range	Fuel
Daimler FV 701 Ferret Mk. 1, 3	open top, 3-pass., 4-speed	6/8	7/5	2/4	95	300	G
Daimler FV 701 Ferret Mk. 2, 4	1-hatch, 3-pass., 4-speed	6/8	7/5	2/4	95	300	G
Detroit Tank Arsenal M60A3 et al	3-hatch, 4-pass., 4-speed	4/6	8/5	2/3	50	480	D
Engesa EE-9 Cascavel	3-hatch, 3-pass., 4-speed	6/8	7/5	2/4	100	750	D
FMC M2 Bradley	4-hatch+rear ramp, 10-pass., auto.	7/8	7/5	1/2	65	480	D
FMC M2A2 Bradley	4-hatch+rear ramp, 9-pass., auto.	7/8	7/5	1/2	65	480	D
FMC M3, M3A2 Bradley	4-hatch+rear ramp, 5-pass., auto.	7/8	7/5	1/2	65	480	D
FMC M113A3 et al	3-hatch+rear ramp, 13-pass., auto	2/5	7/5	1/1	65	480	D
GD M1A2 Abrams et al	3-hatch, 4-pass., auto.	5/5	4/5	3/5	70	465	ADG
GMC LAV-25	3-hatch+2 rear doors, 9-pass., 5-spd.	9/10	10/7	1/4	100	670	D
MOWAG Piranha 4x4	1-hatch+2 rear doors, 10-pass., 5-spd.	9/10	10/7	1/4	100	700	D
MOWAG Piranha 6x6	1-hatch+2 rear doors, 14-pass., 5-spd.	9/10	10/7	1/4	100	600	D
MOWAG Piranha 8x8	1-hatch+2 rear doors, 15-pass., 5-spd.	9/10	10/7	1/4	100	780	D
Panhard AML	2-hatch+2-door, 3-pass., 4-speed	4/6	8/5	2/4	100	600	G
RSA BMP-2 et al	6-hatch+2-door, 10-pass., 5-spd	5/7	7/5	1/3	65	600	D
RSA BRDM-2	2-hatch, 4-pass., 4-spd	7/10	7/5	3/5	100	750	G
RSA BTR-60P	2-hatch+2-door+open top, 18-pass., 4-spd	4/6	4/3	2/3	80	500	G
RSA BTR-60PA	4-hatch, 16-pass., 4-spd	4/6	4/3	2/3	80	500	G
RSA BTR-60PB	4-hatch+2-door, 14-pass., 4-spd	4/6	4/3	2/3	80	500	G
RSA T-55A et al	3-hatch, 4-pass., 5-spd	4/5	8/6	2/4	50	500	D
RSA T-72M1 et al	3-hatch, 3-pass., auto	4/5	8/5	2/4	60	450	D
RSA T-80U et al	3-hatch, 3-pass., auto	4/6	8/5	2/4	70	450	ADG
RSA ZSU-23-4 et al	1-door+2-hatch, 4-pass., auto.	2/4	6/4	1/2	45	260	D

Additional Armored Fighting Vehicle Data

			Hull Armor			Turret Armor		
	Armament	FCS	front	sides	rear	front	sides	rear
Daimler FV 701 Ferret Mk. 1, 3	M1919A4	-	40	35	35	-	-	-
Daimler FV 701 Ferret Mk. 2, 4	M1919A4	-	40	35	35	40	35	35
Detroit Tank Arsenal M60A1	105 mm gun, M73, M85	+14	900	410	145	1000	125	120
Detroit Tank Arsenal M60A1+	105 mm gun, M73, M85	+14	900[5]	410	145	1000[5]	125[5]	120
Detroit Tank Arsenal M60A3	105 mm gun, M73, M85	+21	900	410	145	1000	125	120
Engesa EE-9 Cascavel	90 mm gun, MAG	+13	60	40	30	28	28	20
FMC M2 Bradley	M242, MAG	+17/x12	60	50	50	60	50	60
FMC M2A2 Bradley	M242, MAG	+17/x12	80	80	50	70	50[1]	60
FMC M3 Bradley	M242, MAG	+17/x12	60	50	50	60	50	60
FMC M3A2 Bradley	M242, MAG	+17/x12	80	80	50	70	50[1]	60
FMC M113A2, M113A3	M1HB2	-	110	80	60	-	-	-
GD M1A1 Abrams	120 mm gun, MAG/2, M1HB2	+30/x10	1550	750	200	1800	320	300
GD M1A1(HA), M1A2 Abrams	120 mm gun, MAG/2, M1HB2	+30/x10	1650	750	200	1950	320	300
General Motors LAV-25	M242, MAG, M60/M2HB2	+13/x6	50	40	40	40	40	40
MOWAG Piranha et al	varies	varies	50	40	40	-varies-	-	-
Panhard AML	90 mm gun, 2x AA 7.62	+13	35	28	20	28	28	20
RSA BMP-2	30 mm gun, PK	+14	70	38	45	80	55	55
RSA BMP-2D	30 mm gun, PK	+14	70	75	45	80	55	55
RSA BRDM-2	KPV, PK	+11	31	17	17	23	21	21

Millennium's End Game Stats

Military Armored Vehicles (cont.)

			Hull Armor			Turret Armor		
	Armament	FCS	front	sides	rear	front	sides	rear
RSA BTR-60P, BTR-60PA	PK or DShK	-	50	18	17	-	-	-
RSA BTR-60PB	KPV, PK	+11	50	18	17	23	21	21
RSA T-55A	100 mm gun, PK	+11/x7[4]	430	120	110	495	365	155
RSA T-55A(M)	100 mm gun, PK, DShK	+11/x7[4]	430	120	110	495	365	155
RSA T-72M1, M84	125 mm gun, PK, NSV	+11/x7	1050	500	125	900	250	250
RSA T-72M1M	125 mm gun, PK, NSV	+17/x7	1050	500	125	850	250	250
RSA T-72S	125 mm gun, PK, NSV	+17/x7	1050[5]	500[5]	125	850[5]	250	250
RSA T-80B, BV	125 mm gun, PK, NSV	+18/x7	1000[5]	400[5]	150	1200[5]	465	450
RSA T-80U, UD	125 mm gun, PK, NSV	+18/x7	1350[5]	600[5]	180	1200[5]	465	450
RSA ZSU-23-4 et al	4x AZP-23	+11/x13	30	30	20	35	25	25

[1] AV is 60 on right-hand side of turret.
[2] Pintle-mounted, and therefore not linked to FCS.
[3] +25/x1 against aircraft if the radar is turned on.
[4] +17/x7 with laser rangefinder.
[5] When ERA blocks are fitted, double this Armor Value against explosive weapons, but not against non-explosive ones.

Military Unarmored Vehicles

		Thresholds			Top		
		Accelerate	Brake	Corner	Speed	Range	Fuel
AM General M35 et al	open top, 3-pass.[1], 4-speed	3/5	8/6	1/1	125	870	D
AM General M49A1	open top, 3-pass., 4-speed	3/5	8/6	1/1	125	870	D
AM General M997 HMMWV	2-door+2 rear doors, 6-pass., auto.	8/9	7/5	2/5	125	480	D
AM General M998,M1025 HMMWV	open-top, 4-6-pass., auto.	8/9	7/5	2/5	125	480	D
AM General M1043 HMMWV	4-door, 4-pass., auto.	8/9	7/5	2/5	125	480	D
Ford M151 MUTT et al	open-top, 4-pass., 4-speed	8/9	7/5	1/3	110	480	G
Land Rover Defender 110	5-door, 5-pass., 5-speed	4/5	6/4	2/4	135	375	D
Land Rover Defender 110	open top, 5-pass., 5-speed	4/5	6/4	2/4	135	375	D
Oshkosh M977, M985 HEMMT	2-door, 3-pass.[2], 2-speed+auto	4/5	11/8	1/2	125	360	D
Oshkosh M978, M983 HEMMT	2-door, 3-pass., 2-speed+auto	4/5	11/8	1/2	125	360	D
Oshkosh M984E1 HEMMT	2-door, 3-pass.2, 2-speed+auto	4/5	11/8	1/2	125	360	D

[1] plus up to 20 seated passengers in the cargo area, more if they stand up.
[2] plus up to 10 seated passengers in the cargo area, more if they stand up.

Millennium's End Game Stats

Military Airplanes

		Thresholds				Top			Land/	
		Acceleration	Braking	Cornering	Climbing	speed	Ceiling	Range	TO	Fuel
Lockheed C-130 Hercules	1-door+ramp, 100-pass., ME prop.	5/9	12/9	2/3	10/20	620	10000	4000	L/St	A
Lockheed F-117A Nighthawk	1-canopy, 1-pass., ME jet	17/27	14/10	4/8	10/20	1100	10500	5000[1]	L/St	A
RSA Antonov AN-12 "Cub"	1 ramp,103-pass.,ME propeller	6/10	13/10	2/4	10/20	780	10000	3600	St/St	A

[1] Official data is classified. Effectively unlimited with air-to-air refuelling.

Military Helicopters

		Thresholds				Top			Land/	
		Acceleration	Braking	Cornering	Climbing	speed	Ceiling	Range	TO	Fuel
Aérospatiale SA365N Dauphine 2	4-door, 13-pass.	8/12	4/2	2/3	4/7	295	2100	850	V/V	A
Bell-Boeing MV-22 Osprey1	1-door+ramp, 26-pass.	4/7	5/3	2/4	6/12	185	5500	3900	V/V	A
Bell-Boeing MV-22 Osprey2	1-door+ramp, 26-pass.	9/13	10/8	4/7	7/14	510	7000	3900	S/S	A
Bell OH-58	4-door, 5-pass.	7/11	4/2	2/3	3/6	240	6000	400	V/V	A
MDD AH-64 Apache et al[1]	4-door, 2-pass.	6/10	4/2	3/4	3/5[1]	360	4600	480	V/V	A
MDD OH-6A Cayuse et al	4-door, 4-pass.	7/11	3/2	2/4	5/10	240	2600	610	V/V	A
RSA Mil Mi-8 "Hip" et al	3-door+ramp, 30-pass.	3/5	4/2	2/3	5/9	260	4500	500	V/V	A
RSA Mil Mi-24 "Hind" et al	3-door, 10-pass.	4/7	4/2	2/4	5/8	325	4500	310	V/V	A
Sikorsky UH-60A Black Hawk	4-door, 16-pass.	8/12	4/3	2/3	6/11	295	2900	600	V/V	A
Westland Lynx AH Mark 7 et al	4-door, 12-pass., helicopter	6/10	3/2	3/4	5/9	260	3200	540	V/V	A
Westland Lynx AH Mark 9 et al	4-door, 12-pass., helicopter	7/11	3/2	3/4	5/10	330	3200	885	V/V	A

[1] The AH-64 can go down to -.5 G, which means it may descend at 15 m/s (30 m/turn) instead of the normal maximum of 5 m/s.

Military Watercraft

		Thresholds			Top		
		Accelerate	Brake	Corner	Speed	Range	Fuel
Bollinger Island-class	18-pass., ME motorboat	2/4	4/2	1/3	50	7275	D
Halter Pegasus Class Mk. V	21-pass., ME motorboat	4/7	4/2	2/4	85	1,020	D
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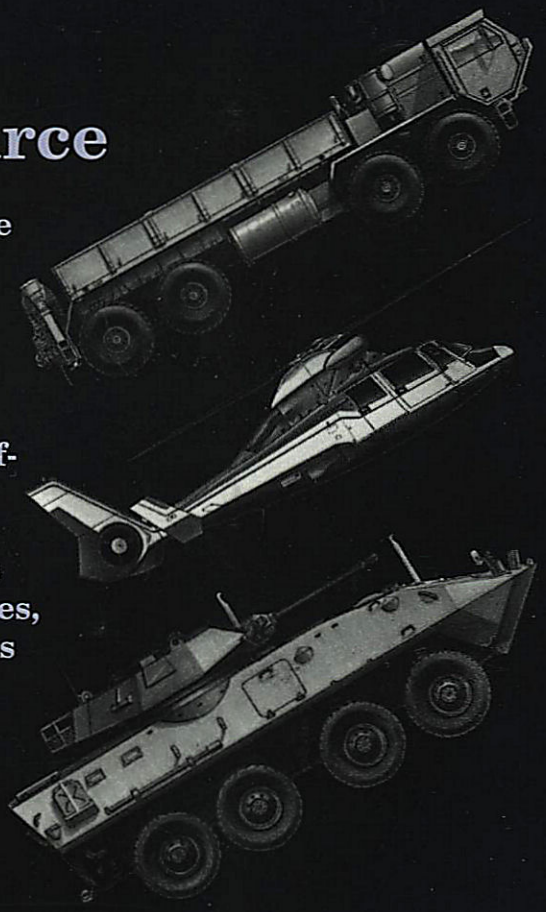

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