전자제어 샤시시스템 II
Steering is the term applied to the collection of components, linkages, etc. which will allow a vessel (ship, boat) or vehicle (car, motorcycle, bicycle) to follow the desired course.

http://www.ford-capri.ch/technics/technical-data/steering-system.html


http://en.wikipedia.org/wiki/Steering

http://www.ford-capri.ch/technics/technical-data/steering-system.html

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Steering is the term applied to the collection of components, linkages, etc. which will allow a vessel (ship, boat) or vehicle (car, motorcycle, bicycle) to follow the desired course.

Collapsible steering column

http://www.ford-capri.ch/technics/technical-data/steering-system.html

조향시스템 [2][4]


http://www.therangerstation.com/tech_library/WheelTravel.html

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조향시스템 [2][4]

3d animation, car front wheel drive, steering and suspension
http://www.youtube.com/watch?v=g0yxpgf0a5k
Ackermann Steering Geometry

Ackermann steering geometry is a geometric arrangement of linkages in the steering of a car or other vehicle designed to solve the problem of wheels on the inside and outside of a turn needing to trace out circles of different radii.

The intention of Ackermann geometry is to avoid the need for tyres to slip sideways when following the path around a curve. **The geometrical solution to this is for all wheels to have their axles arranged as radii of a circle with a common centre point.** As the rear wheels are fixed, this centre point must be on a line extended from the rear axle. Intersecting the axes of the front wheels on this line as well requires that the inside front wheel is turned, when steering, through a greater angle than the outside wheel.

http://en.wikipedia.org/wiki/Ackermann_steering_geometry

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Power Steering

The term **power steering** is usually used to describe a system that provides mechanical steering assistance to the driver of a land vehicle, for example, a car or truck.

- (Hydraulic) Power Steering
- EHPS: Electro-Hydraulic Power Steering
- HPHS: Electrically Powered Hydraulic Steering
- ECPS: Electronically Controlled Power Steering
- EPS: Electric Power Steering
  - CEPS: Column type
  - REPS: Rack type

http://en.wikipedia.org/wiki/Power_steering

Hydraulic Power Steering

The hydraulic pressure is usually provided by a gerotor or rotary vane pump driven by the vehicle's engine. A double-acting hydraulic cylinder applies a force to the steering gear, which in turn applies a torque to the steering axis of the roadwheels.

http://en.wikipedia.org/wiki/Power_steering

http://en.wikipedia.org/wiki/Gerotor

WRC Technical - Power Steering
http://www.youtube.com/watch?v=B869YPZSLqw
Hydraulic Power Steering

The flow to the cylinder is controlled by valves operated by the steering wheel; the more torque the driver applies to the steering wheel and the shaft it is attached to, the more fluid the valves allow through to the cylinder, and so the more force is applied to steer the wheels in the appropriate direction.

One design for measuring the torque applied to the steering wheel is to fix a torsion bar to the end of the steering shaft. As the steering wheel rotates, so does the attached steering shaft, and so does the top end of the attached torsion bar. Since the torsion bar is relatively thin and flexible and the bottom end is not completely free to rotate, the bar will soak up some of the torque; the bottom end will not rotate as far as the top end. The difference in rotation between the top and bottom ends of the torsion bar can be used to control the valve that allows fluid to flow to the cylinder which provides steering assistance; the greater the "twist" of the torsion bar, the more steering assistance will be provided.

http://en.wikipedia.org/wiki/Power_steering
조향시스템: Power Steering [2][4]

Hydraulic Power Steering


EHPS: Electro-Hydraulic Power Steering

Electro-hydraulic power steering systems, sometimes abbreviated EHPS, and also sometimes called "hybrid" systems, use the same hydraulic assist technology as standard systems, but the hydraulic pressure is provided by a pump driven by an electric motor instead of being belt-driven by the engine.

http://en.wikipedia.org/wiki/Power_steering

1. Electronic speedometer in the vehicle
2. Electronic control unit (ECU)
3. Electro-hydraulic transducer
4. Rack and pinion power steering gear
5. **Steering pump**
6. Oil reservoir with fine filter
7. Anti-vibration expansible hose
8. Manually adjustable steering column

http://www.zf.com/brands/content/en/zf_parts/products_zfparts/steering_system_function_zfparts/steering_system_function_ZFParts.html
Torque Sensor

Bosch torque sensor

Two concentric rings enclosing the torsion bar measure the twisting angle. One ring uses multipolar permanent magnets to generate static magnetic fields, which strike Hall sensors through “windows” in the second ring. The measured quantity is the magnetic flux reaching the two Hall sensors.

http://www.bosch-presse.de/presseforum/details.htm?txtID=4332&locale=en

Technical data – Bosch TSS steering torque sensor

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC supply voltage</td>
<td>5 to 9 volts</td>
</tr>
<tr>
<td>Measurement range (twisting angle)</td>
<td>±4°</td>
</tr>
<tr>
<td>Resolution (angle resolution)</td>
<td>0.002°</td>
</tr>
<tr>
<td>Permissible temperature</td>
<td>−40 °C to +120 °C</td>
</tr>
<tr>
<td>Data interfaces</td>
<td>PAS4/PSI5 or PWM; other interfaces on request</td>
</tr>
</tbody>
</table>
ECPS: Electronically Controlled Power Steering

(1) steering wheel
(2) steering shaft
(3) intermediate shaft
(4) steering gear assembly
(5) pressure hose
(6) return hose
(7) oil pump
(8) solenoid valve
(9) ECU
(10) reserve tank
(11) steering angle sensor
(12) check connector.

조향시스템: CEPS [2][4]

ZF electric power steering
http://www.youtube.com/watch?v=BX4y6ItzSII
• The EPS system requires no hydraulic pump, hoses or fluid.

• The assist power is applied directly to the rack with a belt and ball-nut mechanism. Power assist is applied directly to the rack allowing for a responsive, low-inertia, low-friction steering system with a direct-steering feel.

• In addition, the energy consumption of an EPS system is just 10% of a conventional hydraulic power steering (HPS) system as power assist engages only when needed, helping to improve fuel economy of an EPS-equipped vehicle.

TRW Automotive REPS, Belt Driven Type
조향시스템: AFS [2][4]

ZF Active Steering

- 1 ZF Servotronic 2 (basic unit)
- 2 Servotronic 2 rotary valve
- 3 Electric motor
- 4 Superposition gear system
- 5 Electronic control unit
- 6 Motor angle sensor
- 7 Electromagnetic locking unit
- 8 Pinion angle sensor
- 9 Steering pump with ECO
- 10 Oil reservoir with fine filter
- 11 Hoses, anti-vibration hose
- 12 Cables to power supply, CAN, ignition, vehicle sensors

The special feature of the ZF Active Steering is the superposition gear system (4) with two input shafts and one output shaft which is integrated between the Servotronic 2 rotary valve (2) and the basic unit (1). This gear system transmits to the pinion both the steering torque input, which comes from the steering wheel via the steering column and the Servotronic 2 rotary valve, and the additional motor angle (superposition angle) generated by the electric motor (3). This means that using the superposition gear system a steering angle can be generated by both the driver and the electric motor – independently of each other.
Active Front Steering (AFS)

Conventional rack and pinion gear

BMW Active steering
http://www.youtube.com/watch?v=unL8HpMeVTA
Active Front Steering (AFS): Planetary Gear

Epicyclic gearing or planetary gearing is a gear system consisting of one or more outer gears, or planet gears, revolving about a central, or sun gear. Typically, the planet gears are mounted on a movable arm or carrier which itself may rotate relative to the sun gear. Epicyclic gearing systems also incorporate the use of an outer ring gear or annulus, which meshes with the planet gears.

http://appauto.wordpress.com/2008/01/02/that-amazing-planetary-gear-set/

Active Front Steering (AFS): Planetary Gear

In many epicyclic gearing systems, one of these three basic components is held stationary; one of the two remaining components is an input, providing power to the system, while the last component is an output, receiving power from the system. The ratio of input rotation to output rotation is dependent upon the number of teeth in each gear, and upon which component is held stationary.

In other systems, such as hybrid vehicle transmissions, two of the components are used as inputs with the third providing output relative to the two inputs.

 조향시스템: AFS [2][4]

Differential Angle Unit
1 Rack
2 Servotronic 2 rotary valve
3 Electric motor
4 Worm
5 Planet carrier
6 Motor angle sensor
7 Electromagnetic locking unit
8 Worm gear
9 Stepped planet gear
10 Pinion
11 Sun gear (shaft)

ZF Active Steering
조향시스템: AFS [2][4]

**Differential Angle Unit**

4 Worm
5 Planet carrier
6 Motor angle sensor
8 Worm gear ➔ Input 2 (from motor)
9 Stepped planet gear ➔ Output (to pinion)
11 Sun gear (shaft) ➔ Input 1 (from steering wheel)

The stepped planet gears establish the mechanical connection between the upper sun gear (11, shaft of the Servotronic 2 rotary valve) and the lower sun gear. The lower sun gear and the pinion (10) are of an integral design. This ensures straight through drive from the Servotronic 2 rotary valve (2) to the teeth of the rack (1) – and also in the reverse direction.

**ZF Active Steering**

Active Front Steering (AFS): Planetary Gear

Steering wheel 조작 없이 motor 만 구동된 경우

Steering wheel은 조작되었으나, motor는 구동되지 않은 경우

⇒ Steering wheel의 조작이 그대로 전달됨

Steering wheel이 조작되고 motor가 동시에 구동된 경우

⇒ 모터를 구동하여 pinion의 회전량을 변경할 수 있다.

Planetary Gear Set
http://www.youtube.com/watch?v=ECljAo1q1RQ

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VGRS (Variable Gear Ratio Steering)
At slow speed, a low steering ratio makes parking maneuvers and negotiating sharp turns easier. The car appears more direct, more active and easier to handle. At high speeds, the electric motor intervenes in a direction which is opposite to the movement of the steering wheel, thus slightly reducing the steering motion.

ZF Active Steering
조향시스템: AFS [2][4]

Active Front Steering (AFS)

Variable steering ratio
Improved vehicle dynamics
Yaw rate control
Yaw torque compensation
Authentic steering feedback

BMW Active steering
http://www.youtube.com/watch?v=unL8HpMeVTA
조향시스템: AFS [2][4]

Active Front Steering (AFS)

Demo
http://www.youtube.com/watch?v=gVzV0YXO4j4
Suspension is the term given to the system of springs, shock absorbers and linkages that connects a vehicle to its wheels.

Suspension systems serve a dual purpose
1) contributing to the car's roadholding/handling and braking for good active safety and driving pleasure
2) keeping vehicle occupants comfortable and reasonably well isolated from road noise, bumps, and vibrations, etc.

http://en.wikipedia.org/wiki/Suspension_(vehicle)
The shock absorber and coil spring mount to the wishbones to control vertical movement.

- Red section: Steering knuckle or hub carrier
- Blue section: Lower control arm or track control arm
- Light blue section: Steering gear tie rod
- Lower purple section: Radius rod
- Upper purple section: Coil spring
- Yellow section: Tubular housing containing shock absorber or damper
Shock Absorber

A shock absorber is a mechanical device designed to smooth out or damp shock impulse, and dissipate kinetic energy.

Pneumatic and hydraulic shock absorbers commonly take the form of a cylinder with a sliding piston inside. The cylinder is filled with a fluid (such as hydraulic fluid) or air. This fluid-filled piston/cylinder combination is a dashpot. Shock absorbers include cushions and springs.

Shock absorber with internal reservoir. The components are:
A - rod,
B - the piston with seals,
C - the cylinder,
D - oil reservoir,
E - floating piston,
F - air chamber.

현가시스템 [2][5]

Shock Absorber

그림 1. 속 업소버의 작용
현가시스템 [2][5]

Shock Absorber

![Shock Absorber Diagram]

그림 3. 속 업소버의 작동 (통형)

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Shock Absorber

Mono-tube

Twin-tube

This control system continuously monitors all influences on the driving situation such as loads, driver actions, and vehicle movements – and adjusts for the **optimum damping force**. All of this is made possible thanks to electronically controlled **proportional valves** which minimize oil through-flow in the shock-absorber tube within split seconds (for hard damping characteristics) or will expand the diameter once again (for soft suspension). **Continuously variable valve adjustment and rapid adaptation of the damping forces enable variable regulation of the damping rate.**

Damping forces for each wheel are individually controlled for the directional movements of wheel and body. Thus they always provide the best possible compensation for vehicle body movement relative to a stationary center position. The skyhook principle keeps the vehicle body as stable as possible, independent of driving and road conditions. The control strategy seeks to calm vehicle body movement, as if the moving vehicle were connected to a hook fixed on the sky. As a result, the body moves along like a sedan chair parallel to the sky.

Intelligent Suspension Control System
Benefits
- High level of driving safety
- Optimum driving comfort
- Protection of the intervertebral disks
- Increased dynamics
- More economical

ZF CDC Damping System
http://www.youtube.com/watch?v=80PI8d1dXdo
Continuous Damping Control (CDC)
http://www.youtube.com/watch?v=XGTef6BGQsM
Magneto-rheological fluids (MRF)

Operating principle

- Suspension of magnetically polarizable particles in a carrier fluid
- Alignment of the polarized particles along the lines of magnetic flux due to interaction of the dipoles
- Reversible solidification in only a few milliseconds.

http://www.cesma.de/440.html?&L=1
http://www.cesma.de/fileadmin/FILES/Files_CESMA/MRF/CeSMa_Switching_between_liquid_and_solid_MRF.pdf
Active or adaptive suspension is an automotive technology that controls the vertical movement of the wheels via an onboard system rather than the movement being determined entirely by the surface on which the car is driving. The system therefore virtually eliminates body roll and pitch variation in many driving situations including cornering, accelerating, and braking.

Damping Control (Semi-Active Suspension)
Height adjustable suspension ➔ Spring 特性 변화
  • Pneumatic
  • Hydraulic
  • Electromagnetic

http://en.wikipedia.org/wiki/Active_suspension
현가시스템: Active Suspension [2][5]

Bose active suspension

http://www.youtube.com/watch?v=eSi6J-QK1lw
통합 모듈: eCorner

Siemens VDO eCorner Project
http://www.youtube.com/watch?v=8tLQ2-yKT4Y

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통합 모듈: eCorner

Siemens VDO eCorner Project

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통합 모듈: Michelin’s Active Wheel

By integrating a **motor**, **suspension** system, **brakes** and **tire** into a standalone wheel package, Michelin’s paradigm-changing **“Active Wheel”** technology is an innovation that could make electric cars truly affordable and practical, as well as fundamentally change the way we approach car design.

http://gas2.org/2008/12/05/revolutionary-wheel-for-electric-cars-puts-guts-inside-wheel/
통합 모듈: Michelin’s Active Wheel

Nothing under the hood...

Michelin Active Wheel:
- An electric motor
- An electric suspension system
- A compact braking system
- An Energy Saver Michelin tire

Michelin Active Wheel
http://www.youtube.com/watch?v=-4ygUCbHjTc

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통합 모듈: Michelin’s Active Wheel

Michelin Hy-Light Active Wheel Motor EV concept Car
http://www.youtube.com/watch?v=i1uTR-8KarE
참고자료