Active & passive safety systems on Hyundai vehicles;
Development & strategy

Road Safety conference, Belgrade
April 27th – 29th 2011
Hyundai Auto Beograd, Since 2002
1997 ~ 1967

1996  Completion of the Namyang new Research & Development Center

1994  Annual production exceeds 1 Million;

1967  Founding of the
       Hyundai Motor Company
2005 ~ 1998

2005  Hyundai Motor Company enters the Top 100 Global Brands list
2003  HMC first automaker to announced the global environmental management
2002  Official Partner of the 2002 FIFA World Cup Games;
2000  1st fuel cell electric vehicle;
1998  Acquisition of Kia
2010 ~

Hyundai Motor Company is in Global Top 5
Distributers (and Dealers) around Globe
What shall we speak about in this reminder

- Active systems of safety
- Passive systems of safety
- Developments and strategy
A brake is a device which inhibits motion.
Tire forces and brake forces

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Deceleration</td>
</tr>
<tr>
<td>V</td>
<td>Speed</td>
</tr>
<tr>
<td>FS</td>
<td>Apply pressure</td>
</tr>
<tr>
<td>FF</td>
<td>Friction Force</td>
</tr>
</tbody>
</table>
**FRICTION & slip**

**Turning**

**Acceleration**

**Deceleration**

Forces

- Slip angle
- Direction tire is facing
- Direction tire is travelling

**Figure #1**

![Brake slip graph](image)

- ABS control ranges
- 1. Radial tires on dry concrete
- 2. Bias-ply winter tires on wet asphalt
- 3. Radial tires on snow
- 4. Radial tires on ice

**Figure #2**

![Forces graph](image)

- ABS control ranges
- Braking force coefficient
- Lateral force coefficient
- $\alpha = 2^\circ$
- $\alpha = 10^\circ$
Phase 1: Emergency Situation, Panic braking (Maximum vehicle deceleration)
Phase 2: Reduced braking requirement (Deceleration proportional to pedal force)
ACTIVE SAFETY

EBD
Electronic Brake force Distribution

pressure rear wheel
pressure front wheel
speed front wheel
speed rear wheel
0.25g

pressure hold
pressure decrease
hold or decrease
pressure hold

EBD-control
ABS-control

def. max difference

speed km/h
pressure bar

H Y U N D A I
Braking control on low traction surfaces

Vehicle speed
Reference speed
Slip switching threshold
Peripheral wheel speed
Thresholds of peripheral wheel acceleration
Thresholds of peripheral wheel deceleration

Phase 1 2 3 4 5 6 7 8

Brake pressure

Brake pressure decrease
Advantages of ABS

Vehicle without ABS

Vehicle with ABS
Wheel speed

Wheel acceleration/deceleration

Phase

Valve Signal

Brake pressure

Wheel spin
Vehicle speed

Time

Traction Control on low traction surfaces

System
General TCS function

Speed Difference (km/h) vs. Vehicle speed (km/h)
- Brake intervention
- Torque reduction
ESP (Electronic Stability Program)

ESP is a high-tech system that achieves driving safety by actively controlling the engine torque and braking. It senses the wheel speed, vehicle turning rate, the angle of the steering wheel, and the driver's pedal input when the driver cannot control the car well during the sudden braking or maneuvers.

Optimum brake-force distribution under the critical situation.
Relationship between cornering force and centrifugal force during turns
Wheel speed sensor → CAN-bus → ESPCU → ESP → ESP-Operating Light

Vehicle weight → Wheel speed sensor → CAN-bus → Yaw rate / lateral G sensor

Steering position sensor → ESP switch

Roll over protection (ROP)
**Hill start Assist Control**

- **Wheel speed sensor**
- **Yaw rate / 2G sensor**
- **Stop lamp switch**
- **Clutch switch (MT)**
- **D/R range (AT)**
- **Accelerator pedal**

- **Slope 8% (4.5°)**
- **0km/h**
- **Slope min. 8%**
- **ON OFF**
- **Gear Engaged**
- **Gear Engaged Neutral control**

**Hill start Assist Control**

- **Brake engaged**
- **Brake released**

**Torque**

- **Brake torque**
- **Engine torque**

*Diesel AT only*
Enable condition ESS

Speed above 55km/h
Deceleration 7m/s²

Disable condition for ESS

Deceleration below 2.5m/s²

Emergency Stop Signal

ESS deactivation 2.5 m/s²
Additional feature operation (only if speed is below 30km/h at this point)
Additional feature deactivated (CASE-2)
Additional feature deactivated (CASE-3)
System layout

Electronic Parking Brake

EPB Switch

Signal input to control module

Pulling force

EPB Control module & Actuator

Pulling force
PASSIVE SAFETY

Air bags

Vehicle with Airbag

Vehicle without Airbag
Airbag system classification, layout

Supplemental restraint system control module (SRSCM)

Single sensor type
- Passenger airbag (PAB)
- Driver airbag (DAB)
- Belt pretensioners (BPT)
- Buckle switch (BS)

Single threshold

Multi sensor type
- Passenger airbag
- Supplemental restraint system control module (SRSCM)
- Front impact sensor
- Passenger presence detection (PPD)

Double threshold
- Side airbags (SAB)
- Curtain airbags (CAB)
- Belt pretensioners
- Buckle switch
- Side impact sensor

Advanced airbag system
System Layout

Basic Sensors & Systems
Inputs and outputs (I/O)

- Passenger airbag Deactivation switch
- Passenger presence detection
- Battery (+)
- Front impact sensor
- Side impact sensor
- Passive occupant detection system (PODS)
- Seat buckle switch

- Single threshold
- Double threshold

- Driver airbag
- Passenger airbag
- Side airbags
- Curtain airbags
- Belt pretensioner
- Buckle retractor pretensioner
- Airbag warning lamp
- Passenger airbag deactivation lamp
- Crash output to BCM/ETACS
- K-Line
Active head rest

Head remains stationary due to inertia

Seatback pushes torso forward
Belt pretensioner, buckle retractor, Isofix seat for kids

Ball chamber

Ball type

Gear
Shaft
Steel balls

Isofix child seat

Cylinder
Piston
Steel cable

Cylinder type
Buckle retractor pretensioner
Crumple zones

- Corner area
- Ring frame
- Cowl area
- C-pillar area

Material strength

Strength improved
NCAP Test & marks

**ADULT OCCUPANT PROTECTION**
We crash test 30 models a year to help you drive safely.

**CHILD OCCUPANT PROTECTION**
How seriously do you take your child’s protection?

**PEDESTRIAN PROTECTION**
Protecting pedestrians is a priority for Euro NCAP. Is it for you?

**SAFETY ASSIST**
How do the latest technologies really assist you on the road?

http://www.euroncap.com/home.aspx

New Car Assessment Program

⭐⭐⭐⭐⭐ = 10% or less poss. Heavy injuries
⭐⭐⭐⭐ = 11% to 20% ~
⭐⭐⭐⭐ = 21% to 35% ~
⭐⭐⭐ = 36% to 45% ~
⭐⭐ = 46% or higher ~
NHTSC tests & marks

- Buckles, seat belts
- Air bags
- All kind of accidents, roll over
- Tires
- Child safety

http://www.safercar.gov

National Highway Traffic Safety Administration

Government of the USA
We announced "Innovation for Customers" as our mid–to long–term vision with five core strategies: **global orientation, respect for human values, customer satisfaction, technology innovation, and cultural creation.** We desire to create an automobile culture of putting customer first via developing human–centered and environment–friendly technological innovation.
PHILOSOPHY

CULTURAL PHILOSOPHY

VISION

Global orientation

Respect for Human values

Cultural creation

Customer satisfaction

Technology innovation

Innovation For Humanity

VISION
Hyundai Design - Design Process

Designing the future of automobiles! Perfecting design with cutting-edge technology!
Hyundai Technology

Making smarter vehicles!
Expanded application of automotive electronics
Infotainment system
Advanced Safety Vehicle (ASV) system
New technologies for driver safety and convenience
Solar cell sunroof

Pre-crash headrest
Nano technology glass, wiper less
Honeycomb tire  Smart window
Hyundai Technology - Safety

Securing the highest safety ratings
Hyundai Technology – Pre crash Safety

Vehicle Stability Management
Hyundai Technology – Pre crash Safety

Lane Keeping Assist
Hyundai Technology – Pre crash Safety

Computer aided and simulations crashes
Hyundai Technology – Environmentally friendly

<table>
<thead>
<tr>
<th>Structure/Characteristics</th>
<th>HEV</th>
<th>Plug-in HEV</th>
<th>EV</th>
<th>FCEV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine+motor (secondary power source)</td>
<td>Structure/Characteristics</td>
<td>Engine+motor (can drive on motor)</td>
<td>Drives on motor alone</td>
<td>Creates electricity through hydrogen/oxygen</td>
</tr>
<tr>
<td>Battery 0.9~1.8 kwh</td>
<td>Battery 4~16 kwh</td>
<td>Battery 10~30 kwh</td>
<td>Battery 0.9~8 kwh</td>
<td></td>
</tr>
</tbody>
</table>

Development task:
- Minimize higher price markup compared to regular vehicles
- Build electric charging infrastructure and develop quick charging technology
- Improve battery performance (increase energy density, lower price)
- Build Hydrogen charging infrastructure
- Lower price of high-priced parts

Vehicle for the future - now
PHILOSOPHY

Thank you kindly

Yours Hyundai Auto Beograd
Miodrag B. Stojanovic