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**PRESS INFORMATION**
**September 2005**

# Motorcycle Airbag System

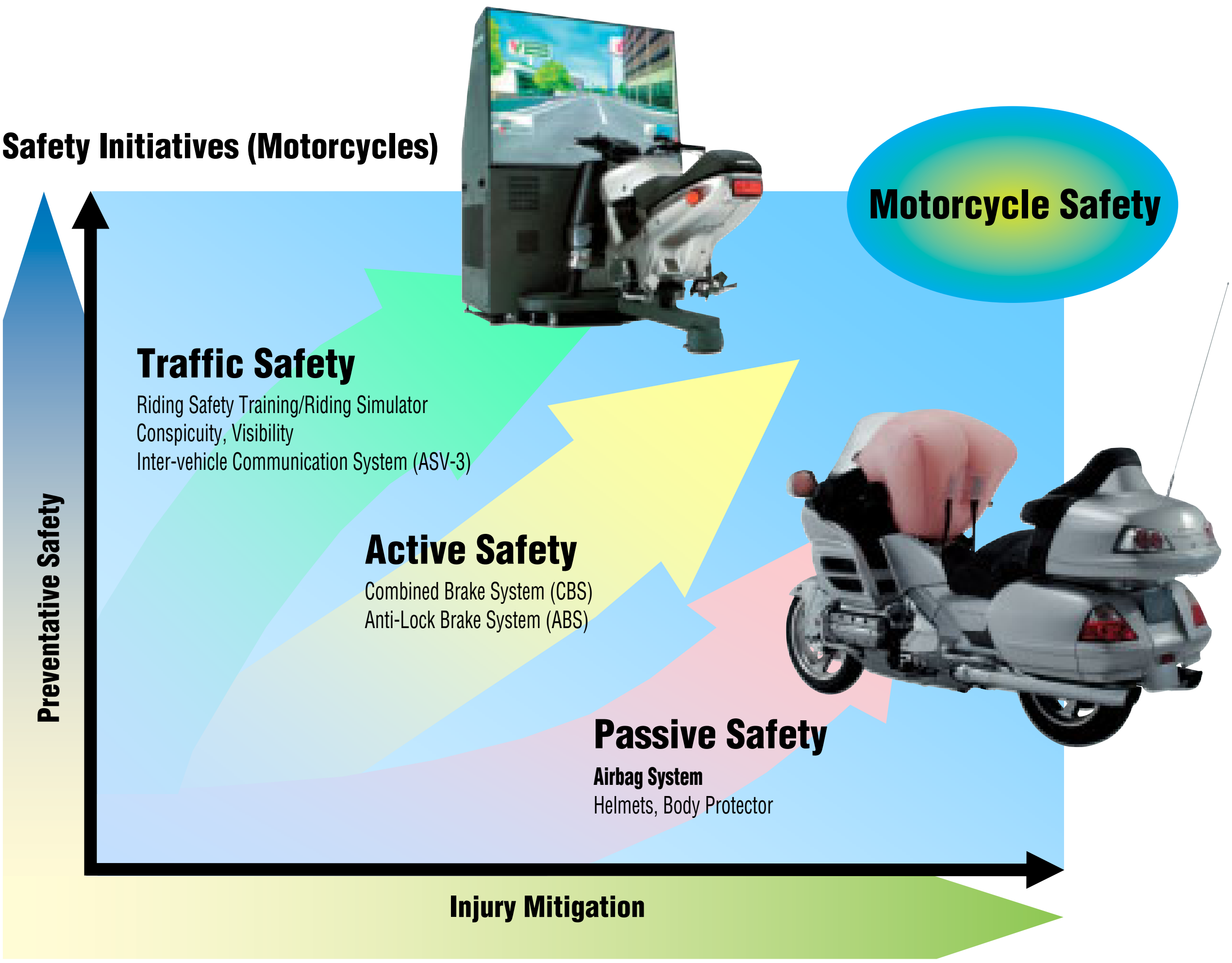
**Honda Motor Co., Ltd.**

# Introduction

Honda has been proactive in fostering driver and rider training as well as developing and implementing active safety technologies designed to prevent accidents and passive safety technologies designed to mitigate injuries in the event of an accident.

Honda has long been proactive in the development of traffic safety programs. In 1970, Honda established its Traffic Safety Promotion Division, which became the focus of the company's support for rider and driver training initiatives. Honda has also developed the Riding Simulator and other original training devices. In the area of active safety, Honda has developed the Combined Brake System and Anti-lock Brake System, applying these technologies in an expanding range of production motorcycle to help riders maintain fuller control over their vehicles. The effort to help prevent accidents involving motorcycles through the development and implementation of safety technologies has always been a top priority for Honda.

Passive safety measures, designed to help protect riders in the event of an accident, are an important part of Honda's approach to motorcycle safety and the company's ongoing research and development efforts. As a result of these efforts, Honda has now succeeded in creating the world's first production Motorcycle Airbag System.

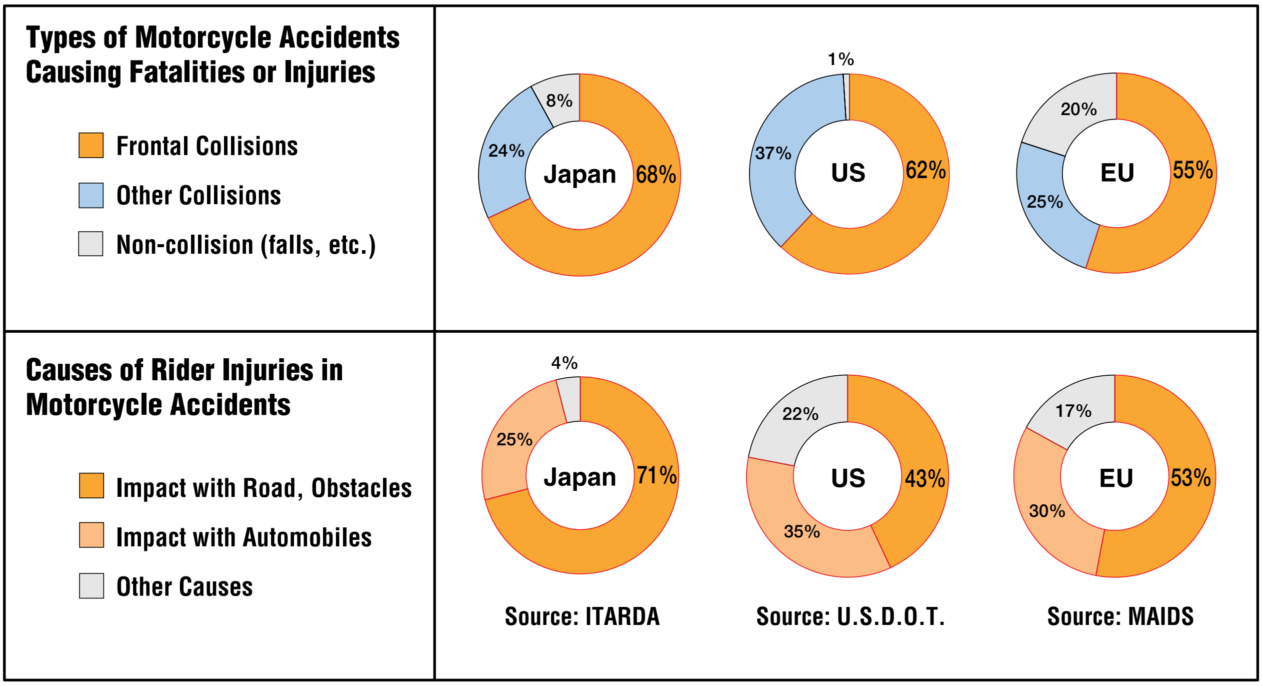


# Development Objective

One vital aspect of Honda's motorcycle safety research has been careful analysis of the key statistics concerning accidents. Data from Japan, the US and Europe all indicate that frontal collisions account for over half of all collisions. It also has been confirmed that many injuries result from the rider's impact with vehicles or the road surface. In view of these facts, Honda engineers sought to reduce the incidence and severity of injuries by absorbing the energy of an impact and reducing the rider's forward velocity.

To achieve this objective, Honda decided to develop a motorcycle airbag. In the event of a frontal collision, the airbag is designed to inflate and absorb some of the rider's kinetic energy.  As a result, the force of impact between the rider and the vehicle or the road may be reduced, mitigating injuries.

## Motorcycle Accident Data Analysis



# Development History

Honda began research and development on the motorcycle airbag in 1990. For the first few years the focus was on basic issues such as the appropriate size and shape for the airbag, and the means of securing it to the motorcycle. In 1996, an airbag system including sensors was installed on the Gold Wing touring bike (1500cc) and a program of crash tests designed to assess the efficacy of motorcycle airbags was initiated. Further testing was performed on a large scooter with a view to refining airbag technology. A motorcycle rider crash test dummy was introduced to help in the evaluation of the airbag, and Honda engineers reproduced a broad range of real world accidents, generating highly precise assessments of injury levels using Honda developed computer simulation technology.

Seeking to share information with researchers worldwide, Honda began at an early stage to present the results of its work on motorcycle airbags at international symposia and in other forums.

Thanks to this program of research and development, Honda is now ready to introduce a motorcycle airbag system for production vehicles.

## Research and Development History

1990

**Fundamental Research**
- Airbag size, shape and securing method
- Deflation vent size, energy absorption characteristics
- Computer simulation development (Multi-body type software)

1996

1997

**Operational Vehicle/ Full System Research**
(based on Gold Wing touring bike (1500cc))
- Collision/non-collision differentiation methods
- Airbag effectiveness in various types of collision
- Computer simulation development (Finite element analysis software)

- **16th International Technical Conference on the Enhanced Safety of Vehicles**
  Presentation: *Exploratory Study of an Airbag Concept for Large Touring Motorcycles*

1998

- **The Society of Automotive Engineers of Japan Spring Meeting**
  Presentation: *Fundamental Research into Airbag Systems for Large Motorcycles*

1999

- **Advanced Safety Vehicle 2 - Smart Cruise Demo 2000**
  Presentation: *Airbag System for Large Motorcycles*

2000

2001

**Research with Other Models**
(large scooter)

- **17th International Technical Conference on the Enhanced Safety of Vehicles**
  Presentation: *Exploratory Study of an Airbag Concept for Large Touring Motorcycles: Further Research*

2002

- **SETC 2003 (US)**
  Presentation: *A Computer Simulation for Motorcycle Rider-Motion in Collision*

2003

**Completion of Airbag System for 1800cc Gold Wing**

- **IFZ 2004 (Germany)**
  Presentation: *Exploratory Study of an Airbag for a Large Scooter-Type Motorcycle*

2004

- **19th International Technical Conference on the Enhanced Safety of Vehicles**
  Presentation: *Exploratory Study of an Airbag Concept for Large Touring Motorcycle : Feasibility Verification*

2005

# Research and Development Methodology

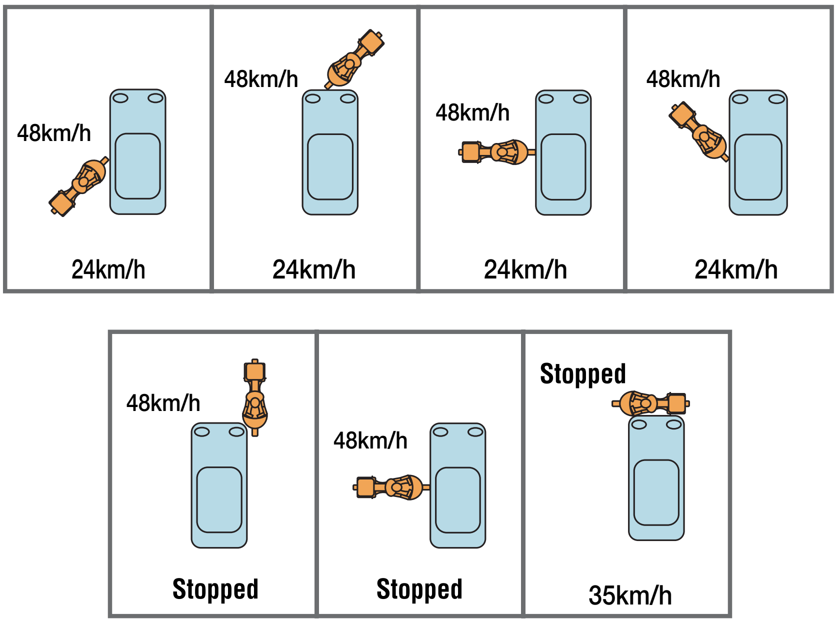
## Crash Tests

Due to the complexity of the dynamics in a motorcycle accident, the interaction between the airbag and the rider can be affected by different types of crash motion, including yawing, pitching, and rolling. In evaluating the effectiveness of its motorcycle airbag system, Honda analyzed a series of crash tests and computer simulations devised to simulate real world accident configurations.

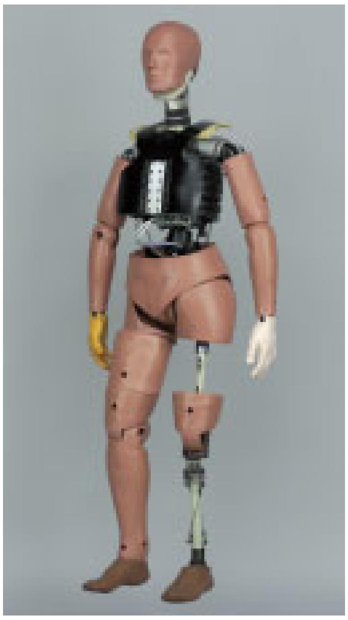
In addition to tests designed in accordance with ISO 13232-mandated configurations, Honda devised a series of crash tests based on its own analysis of motorcycle accident data to simulate an array of accident configurations, taking into account such factors as the type of the other vehicle, rider mass and riding position. The tests, including those in which both vehicles were in motion, were conducted at Honda's advanced indoor omni-directional Real World Crash Test Facility.

Honda's commitment to motorcycle safety is also demonstrated by its early introduction of ISO 13232-certified crash-test dummies specifically designed for motorcycle testing.  Unlike automobile crash test dummies, motorcycle crash test dummies contain embedded sensors that record crash text data without the need for external wires, which can interfere with dummy movement.  Sensors embedded in the head, neck, chest, stomach, and limbs make is possible to measure the extent of injuries over virtually the entire body.

**ISO 13232 Crash Test Configurations**




**ISO 13232 Motorcycle Crash Test Dummy**



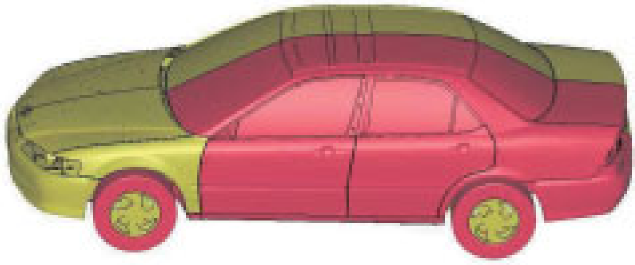
Note: ISO 13232 contains standards for testing and analyzing the effectiveness of rider protection devices in motorcycle accidents.

# Research and Development Methodology

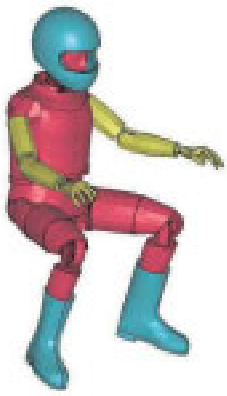
## Computer Simulation Technology

ISO 13232 includes standards for assessing the effectiveness of rider protection devices using computer simulations. These standards cover what happens during the approximately 0.5-seconds between the beginning of impact and the moment the rider collides with the other vehicle. Going beyond these parameters, Honda devised original simulations to extend the analysis to cover what happens after the rider collides with the other vehicle and comes in contact with the road surface. This allowed for a more thorough analysis of the dynamics of vehicle behavior and rider injury. The computer simulations developed by Honda allow for a highly precise analysis of the impact on the airbag-equipped motorcycle, the automobile involved in the accident, and the dummy for the relatively long period of one second, from the beginning of impact to the moment the rider falls to the ground.

**Airbag Model**



**Automobile Model**



**Dummy Model**

**Example Computer Simulatio**

**Motorcycle Model**

## System Composition and Functionality

The Motorcycle Airbag System is made up of the following main components:

- The airbag module, containing the airbag and inflator, positioned in front of the rider
- The airbag ECU, positioned on the right side of the airbag module, which analyzes impacts and determines whether or not to inflate the airbag
- Four crash sensors, attached on both sides of the front fork to detect changes in acceleration caused by frontal impacts

**Inflated Airbag**

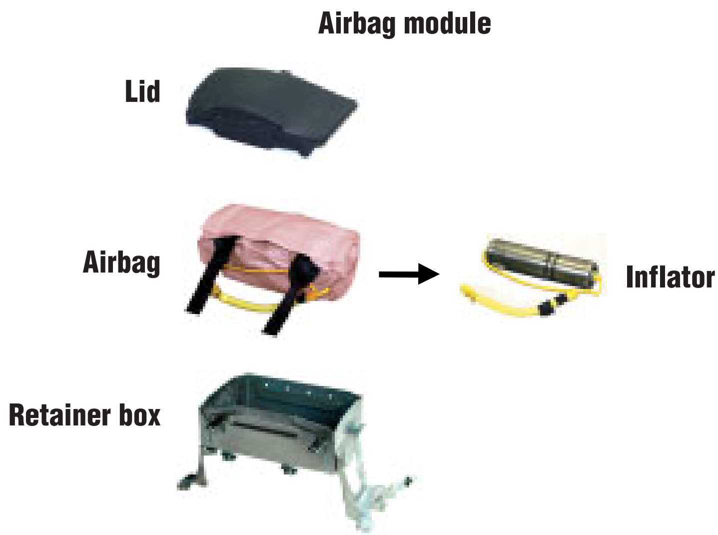

**Location of Principal Components**

# System Composition and Functionality

## Airbag module

Stored in front of the rider, the airbag module is comprised of the following components:

- The airbag, which inflates to absorb some of the rider's kinetic energy
- The inflator, which causes the airbag to inflate
- A lid, which covers the other components stored in the airbag module, and which opens when the airbag is deployed
- A retainer box, which contains and secures the airbag and inflator




## Airbag

The airbag is made of the same type of material as automobile airbags: a strong nylon with an inner coating of silicon. Reaching a volume of some 150 liters when filled with the nitrogen gas used in deployment, the airbag is designed with a V-shaped back to help secure the rider in position. To prevent the airbag from going forward along with the rider, it is secured to the motorcycle with tethers. And to further cushion the impact of the airbag with the rider, deflation vents are located on each side of the back of the airbag.

## Inflator

Similar in structure to the inflator used in a passenger-side automobile airbag, the inflator is a metal container and encloses an electronic ignition device, ignition agent, nitrogen gas ignition agent and other components. The inflator instantaneously responds to an electronic impulse from the airbag ECU, initiating the flow of nitrogen gas to inflate the airbag.

## Lid

The lid is on the surface of the motorcycle and covers the airbag system components stored in the retainer box. During deployment, the pressure of the gas released by the inflator causes this lid to open.

# System Composition and Functionality

## Airbag ECU

The airbag ECU continuously monitors the data received from the crash sensors, and by comparing this data to standard vehicle behavior determines whether or not it is necessary to deploy the airbag. The data from each of the two sets of two sensors is evaluated independently, and if, according to the data of both sets of sensors, vehicle behavior deviates from standards to a certain predetermined degree, an electronic signal is sent to the airbag inflator, which causes the airbag to inflate. This design endows the airbag system with a high degree of reliability. In the event of an accident, even if power to the airbag ECU is completely or partially disrupted, a backup power source and circuitry are available to help maintain the system's functionality.

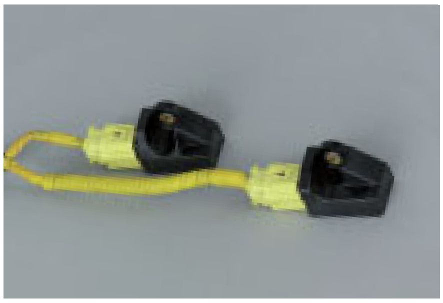
In addition, the airbag ECU has a diagnostic function that enables it to detect faults in the system. In case a problem is detected, a light located adjacent to the instrument gauges illuminates to alert the rider.

## Crash Sensors

The crash sensors are attached to the front fork for earliest possible frontal impact detection. No alteration of the structure of the motorcycle is needed. To optimize the accuracy of collision detection, a set of four sensors are arranged-two on each side of the front fork. Thus mounted, these sensors are designed to detect acceleration changes with a high degree of precision and reliability even when a collision is accompanied by swerving.

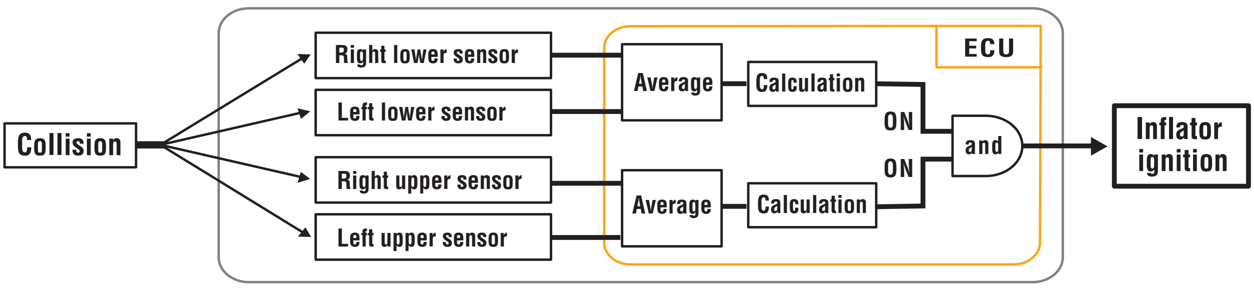
In the unlikely event that one of the sensors malfunctions, the other sensors can provide backup functionality to help prevent unnecessary deployment of the airbag. When the motorcycle's ignition switch is on, the crash sensors continuously measure acceleration and relay this data to the airbag ECU.

**Airbag ECU**



**Crash Sensors**

### Collision Recognition Process



# System Operational Flow

## Deployment Conditions

The airbag is designed to deploy in the case of a frontal collision in which the rider could be thrown forward from the motorcycle.

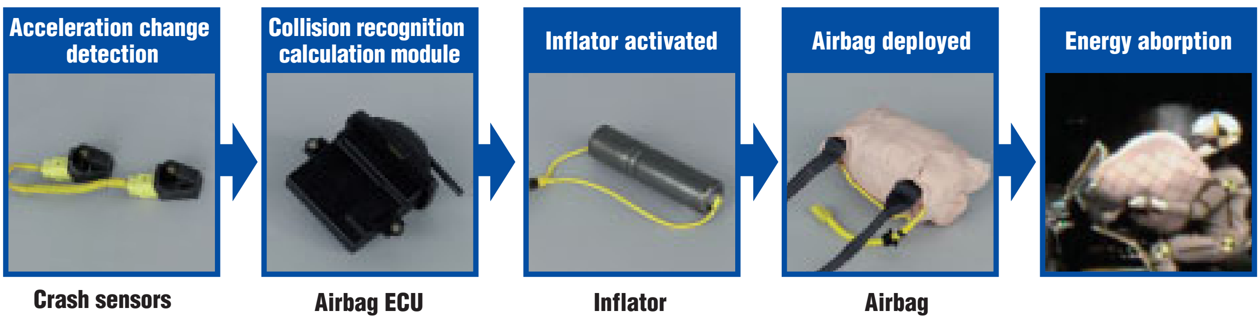
## System Operation

When a frontal collision occurs, the crash sensors convey the data they generate to the airbag ECU, which determines if a collision has occurred and whether or not it is necessary to inflate the airbag. If the calculations performed by the ECU indicate that airbag deployment is necessary, the ECU sends an electronic signal to the airbag inflator, which instantaneously responds by releasing nitrogen gas to inflate the airbag.  To help the inflated airbag absorb some of the forward momentum of the rider, the gas is allowed to escape slowly from two vents, one on each side of the airbag.

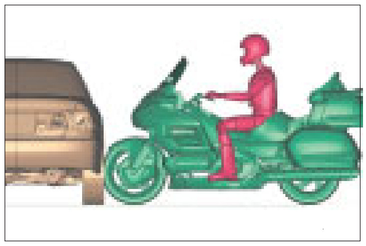
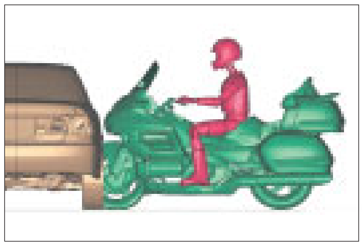
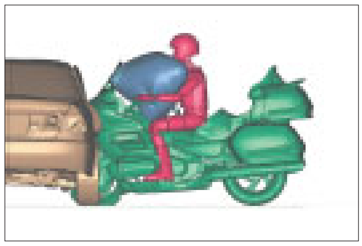
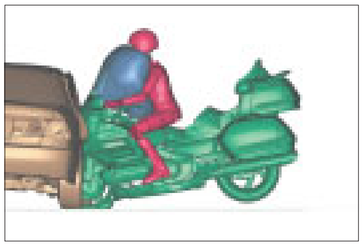
This chain of events takes only approximately 0.15 seconds from start to finish, less than the blink of a human eye (about 0.2 seconds).

(Side collision with a stationary vehicle (Honda Accord) at 50km/h)

## Operational Flow



## System Operational Flow

| Crash Test Video | Computer Simulation |
|---|---|
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

**Impact begins** — 0

**Collision recognized** — approx. 0.015 sec. (15/1000 sec.)

- Inflator activated
- Inflation gas released
- Lid opened
- Airbag inflated

0.05sec.

**Airbay deployment complete** — approx. 0.060 sec. (60/1000 sec.)

- Rider's kinetic energy absorbed by airbag
- Deflation via vents

0.1sec. — Rider's kinetic energy absorbed by airbag

**Rider kinetic energy absorption finishes** — 0.15sec. — approx. 0.150 sec. (150/1000 sec.)

(Side collision with a stationary vehicle (Honda Accord) at 50km/h)