2005 Freestyle Safety

"Just as the interior of the new Ford Freestyle was designed around the occupants, the overall body structure was engineered for safety. We knew right from the start that it was going to perform well in real-world crash situations. This was supported by the results from extensive computer modeling and confirmed by crash testing. We feel this will be among the safest vehicles on the road. That's critical to me as a parent, as well as an engineer, because I have three children under age 11."

- Chris O'Connor, Crash Safety Supervisor

Freestyle is Segment's Safety, Security Leader

Freestyle starts with the notion that nothing is more important in a family vehicle than safety.

To position Freestyle as one of the safest and most secure vehicles in the crossover class, Ford packs in all the elements of its Personal Safety System™, as well as offering its innovative Safety Canopy™ rollover protection system in the new model.

Safety restraints were refined through more than 50,000 crash simulations.

The result is a crossover that combines several active and passive safety systems to exceed all current federal safety standards for front-, side- and rear-impact performance.

When equipped with optional side air bags and Safety Canopy™, Freestyle is expected to earn top crash-test ratings. These independent tests won't be conducted until after the new model hits U.S. showrooms.

Among the Freestyle's safety systems are:

- Energy-channeling frame structures engineered by Ford and Volvo that help absorb crash forces before they reach the passenger compartment
- A strong roof cross-member and energy absorbing cross-car tube that provide exceptional side-impact protection
- Available side air bags and Safety Canopy™ for industry-leading head and chest protection for occupants in all three rows during side impacts and rollovers
- Energy-absorbing adaptive steering column and collapsible drive shaft
- Occupant-sensing technology, dual-stage front air bags and load-limiting safety-belt retractors and pretensioners that tailor safety system response to the severity of the crash

New Standard of Safety

Freestyle will be available with Ford's innovative Safety Canopy™, which offers head protection for all three rows of occupants in side-impact and rollover situations. This type of rollover protection is an industry exclusive for Ford. Freestyle also will feature Ford's leading Personal Safety System™ with new features that address front-, side- and rear-impact protection, including best practices inspired from Volvo.

The all-new Freestyle is expected to meet the stringent new Federal Motor Vehicle Safety Standard 208, which governs front-impact protection for variously sized occupants, whether belted, unbelted or out of position.

Under FMVSS 208, a vehicle's restraint system must be able to sense whether the front passenger seat is occupied and whether the occupant is an adult, a child or a child in a child seat. It also must

determine whether the passenger is unbelted or otherwise out of position. Air-bag deployment is then tailored to provide the proper level of response, or, if appropriate, suppressed entirely.

Class-leading protection for third-row passengers also was an important part of the Freestyle program, so the new crossover is expected to meet a proposed future standard for rear impacts.

Managing Impacts

Front, side and rear structural elements also were designed with crash safety in mind. In each case, Ford safety engineers balanced the need for structural strength to safeguard the passenger compartment from intrusion with the need for collapsible elements that absorb energy and reduce the overall crash "pulse" that ultimately reaches vehicle occupants.

The front structural elements of the new Ford Freestyle incorporate a "tripod" design that channels frontal crash forces upward and downward into a high-strength steel "ring" of protection surrounding the passenger compartment.

The structure begins with two octagonal frame rails and "shotgun"-style structures near the top of the wheel wells. These two elements are tied together with steel bracing. The front portion of the frame rails is engineered with failure points for an energy-absorbing, controlled collapse during impact.

Laser welding creates varying thicknesses within the front frame rails, providing strength and rigidity toward the rear to support the car's suspension and controlled deformation at the front in the event of a collision. Energy not absorbed by these structures is directed through the "tripod" around the passenger compartment.

The upper energy path leads through a strong A-pillar and on into the roof structure. The lower energy path further splits the forces, channeling impact energy into the structural rocker panels and toward the drive shaft tunnel, which also is designed to help manage frontal crash energy. A cross-member by the firewall maintains side-to-side integrity that helps other structural elements do their jobs.

"The Freestyle has a seamless flow of metal up through the A-pillar that extends past the B-pillar," said Chris O'Connor, safety supervisor. "With the one-piece stamping, there is no weld or joint at the windshield or above the front door. This design promotes structural strength and consistent crash performance."

Like other elements of the vehicle's design, many structural components are engineered to do more than one job. For example, the strong roof brace that connects the B-pillars is a key to providing occupant protection in side impacts, as well as offering support in the event of a rollover. It also contributes to overall vehicle stiffness for a smooth, quiet ride.

"We expect strong rollover protection, both from the safety cage design and the Safety Canopy™ air bags," O'Connor said.

Similarly, the side-impact beams inside the vehicle's front doors protect against intrusion in side crashes while serving as important structural elements in managing frontal impact energy. The door beams are mounted so that they run from the upper door hinge to the latch area at the rear of the door - the two strongest areas of the door frame. They are engineered to handle both bending and compression loads.

For the first time, Ford used crash-test dummies in the second- and third-row seats to assess the performance of these extensive safety systems. Because adults and children both can be expected to use the Freestyle's third-row seats, engineers employed test dummies representing a 6-year-old child,

a small adult female and a 95th-percentile male to confirm that Freestyle offers appropriate protection for occupants of all sizes.

Innovative Bumper Plate Serves Up Competitive Advantage

One innovation made possible by sophisticated computer crash modeling is the shape of the front bumper plate - the steel mounting point for the front bumper.

"We used a lot of Cray supercomputer and workstation time optimizing everything," O'Connor said. "We discovered that changing the shape and mounting system of the front bumper plates gave us a dramatic improvement in reducing intrusion through managing crash forces."

Ford has applied for a patent on the shape of the new plate, which helps optimize frame-rail functionality. In a typical installation, the bumper plates are attached to both sides of the frame rails. But Ford safety engineers found that this design places more load on the inside face of the frame rail - the side closest to the engine - in the first moments of a frontal impact, creating a twisting force that tends to collapse the rail unevenly.

By mounting the plates only to the outer portion of the rails, they could reduce this initial force on the inside face of the frame rail by 14 percent and promote a more even collapse of the energy-absorbing structures. This transfers more than 21 percent of the crash energy from the inner face of the frame rail to the outer face, evening the forces and reducing intrusion into the passenger compartment by 15 percent.

The safety team also has applied for a patent on a new drive shaft design. On all-wheel-drive models, it provides a rigid connection from the engine to the differential, playing an important role in transmitting the peak energy pulse - one of the most important factors in a crash - throughout the vehicle.

To reduce the peak energy pulse generated in a frontal impact, the team designed a "trigger point" into the drive shaft that would allow it to collapse under crash loads. This indentation, forged into the shaft at the point where computer modeling shows impact forces to be the greatest, allows the shaft to absorb some of the crash pulse in a more controlled manner.

Tops in Side-Impact Protection

As with the front crash structure, safety engineers used tailor-welded blanks to help manage energy in side impacts. Tailor-welded blanks use laser-welding techniques to create steel sheets of varying thickness that can be stamped into body panels.

For example, the tops of the B-pillars, which use a layer of high-strength steel called DP-600, are thicker for strength, while the lower portions have a thinner cross-section. DP-600 steel also is used in part of the dash panel.

"It's one of the stiffest steels available that is still ductile enough to be stamped into body panels," O'Connor said.

The two B-pillars are braced together at the top by a structural roof bow that crosses the vehicle. This roof bow can handle up to 12 kiloNewtons (nearly 2,700 pounds) of load force. Acting somewhat like a lever or pendulum anchored at the roof rail, the strong, reinforced top portion of the B-pillar helps safeguard occupants while the lower portion collapses and absorbs energy.

These forces are further channeled through a cross-car tube - derived from Volvo's Side Impact Protection System. The SIPS tube directs side-impact forces beneath the front seats. A bend in the middle of the tube, under the center console, serves as a trigger point for deformation under severe

loads, dissipating energy.

As part of the vehicle's sport utility vehicle-inspired "high-package" seating configuration, front seats are mounted atop the SIPS tube. In concert with the other structural safety systems, this command seating position assures that most typical vehicle-to-vehicle side crash forces are diverted underneath the seats. As a side benefit, mounting the front seats on the SIPS tube creates added foot room for second-row passengers, improving comfort.

Rear-impact performance also is very strong, thanks in part to another engineering innovation. The rear frame rails were designed to absorb initial impact forces, then channel remaining energy into a secondary crush zone past the floor well. Ford has proved the design effective in 55-mph rear crash tests and has applied for a patent on the design. Freestyle's third-row seat is located farther from the rear bumper than any competitive vehicle - an extra safety dividend that's derived from the vehicle's generous rear cargo room.

This rear-impact performance is designed to meet a proposed future federal crash standard.

In the Freestyle, all seating positions have adjustable head restraints, which in the second and third rows push down into the seats when not in use, to maximize rear visibility. When passengers sit in any of these positions, the stowed head restraints are designed to provide a bit of a nudge to the upper back, reminding occupants to raise restraints to their proper positions.

The fuel tank is located in front of the rear suspension, surrounded on all sides by subframe rails or cross-members. The horseshoe shape of the rear subframe guides crash energy around the fuel tank and into the vehicle's lower structure.

Ford, Volvo Team Up for Safety Innovation

Volvo's safety expertise and Ford's engineering resources combined to raise the bar on occupant protection in the new Freestyle.

One tangible result of the collaboration is a new adaptive steering column, which collapses in different ways during frontal impacts depending on the amount of crash energy present and the size and position of the driver.

It works by incorporating an energy-absorbing steel "bend sheet" that holds the upper and lower portions of the steering column together. The bend sheet is shaped in a way to better control the collapse of the steering column during impacts.

By tapping into information from various sensors, the safety control module - the computer "brains" of the vehicle's safety system - determines how quickly the steering column should collapse. Factors considered include the driver's seat position and safety-belt use.

If the situation calls for it, the safety control module fires a pyrotechnic device that pulls a steel pin out of the bend sheet, reducing the column's resistance to collapse. The result is a "softer" column should the driver impact the steering wheel. The steering column response is tailored to work with the air-bag deployment level that is being triggered.

"With the tune-ability built into the system, you're can really adapt it to respond as you need it - for both the belted and the unbelted driver - in varying frontal crash situations," O'Connor said.

Front-seat occupants also are protected during frontal impact by the knee bolster designed into the dash panel and backed by a cross-car tensile strap. More than 50 computer simulations were used to engineer the steel panel into a shape and stiffness that would protect occupants of all sizes, whether belted or unbelted.

Smart Safety Belts, Air Bags

Federal government statistics indicate safety-belt usage saves lives, which is why Ford engineers put considerable emphasis on Freestyle's belt system.

To begin with, three-point belts are used at all seating positions, including Freestyle's third row. When equipped with a second-row bench seat for seven-passenger seating, the middle position uses a seat-integrated belt.

In addition, Freestyle takes Ford's award-winning BeltMinder™ system to the next level, using an instrument-panel icon and gentle chime to remind drivers and front-seat passengers to buckle up. Introduced by Ford in 1999, BeltMinder already is proving to increase real-world safety-belt use.

Ford Freestyle's second row offers two LATCH (lower anchors and tethers for children) mounting points and tether anchors for child seats at the outboard seating positions. A third LATCH position is located in the third row.

LATCH-compatible child seats snap quickly and easily into robust anchor points in the fold between the seat's lower and back cushions, while the upper strap hooks onto a mounting ring on the seat or parcel shelf.

Pyrotechnic pretensioners take up any seatbelt slack during the first moments of impact for optimum response. As the crash progresses, digressive load-limiting retractors behind the B-pillar trim pay out belt material to reduce peak loads on the occupants.

The belts work in concert with dual-stage front air bags to reduce crash forces reaching front-seat occupants. Air-bag deployment is tailored to the individual crash, taking into account occupant size and position, severity of impact and safety-belt use.

In addition, the driver's seat is equipped with an advanced track sensor to gauge the driver's proximity to the steering wheel. The front passenger seat employs Ford's occupant classification system technology to determine the presence and weight of a front passenger. If the seat is unoccupied, or if the system senses a light load like a child or child seat, the passenger air bag is deactivated. This helps prevent unneeded passenger air-bag deployment, offering added protection for some and lowering the cost of vehicle repair.

Side air bags and Ford's exclusive Safety Canopy™ curtain air bags are optional on the new Freestyle. Using data compiled by crash-severity, rollover, seat-track position and belt-usage sensors - plus information from the passenger-seat occupant classification system - the safety computer determines within milliseconds which, if any, air bags to deploy.

During side impacts, side air bags are released from the seatbacks to provide thorax protection. The ceiling-mounted Safety CanopyTM curtain air bags offer head protection for every row of seating, including the third row. And they are designed with a special deployment strategy that keeps them inflated longer for added protection during a rollover.

A recent study by the Insurance Institute for Highway Safety found the combination of head and thorax protection could reduce fatalities by more than 45 percent in side impacts.

Security, Control

Enhancing the feeling of security are standard four-channel anti-lock brakes that can help drivers maintain control under extreme braking conditions. Electronic brake-force distribution monitors braking front-to-rear and optimizes performance under varying loads like when carrying cargo.

Optional traction control constantly monitors slip at all four wheels and can act in as little as 100

milliseconds to help restore or maintain traction. The system first reduces engine power by retarding ignition spark timing and, if necessary, reducing fuel flow. It then selectively activates braking to stop the drive wheels from spinning.

Safety also is enhanced by Freestyle's "high-package" seating, which provides an optimum view of the road. For improved vision, Freestyle's side-view mirrors provide a larger surface area than mirrors on competitive vehicles. Optional heated side mirrors offer added convenience.

The standard key fob allows one-button door locking and unlocking, including the rear hatch, from outside the vehicle. A standard keypad on the driver's door allows quick and convenient access to the vehicle if the keys and key fob are locked inside. Doors lock automatically once the vehicle begins to move.

To protect against theft, Freestyle is equipped with Ford's SecuriLock™ passive anti-theft system. Only a key with the correct code - there are 72 million billion possible combinations - will start the vehicle. A remote perimeter vehicle alarm is optional.

As further protection against theft, the spare tire is located inside the vehicle under the rear compartment floor.

Automatic headlamps on the mid- and high series provide convenient short-time lighting after the vehicle is turned off. Lamps located along the bottom of the side mirrors on some series are activated by the "unlock" button on the key fob, providing perimeter lighting at night.

The optional reverse-sensing system uses radar sensors mounted in the rear fascia to help drivers negotiate tight parking spaces and potentially head off dings and scrapes. It sounds a series of increasingly rapid beeps as the rear bumper closes in on a stationary object.