Object Retention System for Automobiles

In 2004, ABC News reported that according to Strategic Safety, "everything from the size of luggage to soda pop cans that were not tied down were responsible for more than 13,000 injuries in accidents nationwide in just one year". It is clear that having a proper object retention system is an urgent requirement for future vehicles. Although containers currently exist to restrain objects, they tend to be larger than needed and inconvenient to access while driving; thus making the present systems ineffective. The goal of this project is to increase transportation safety by altering the way drivers store their belongings in a vehicle while minimizing additional user effort.

For the object retention system to be effective, there were several engineering specifications implemented into the design. The system will need to accommodate objects that are often placed on top of the passenger's seat. The compartment must be between a volume of 2000 in^3 (20 in x 10 in x 10 in) and 12000 in^3 (20 in x 20 in x 30 in). These dimensions came from the average size of a duffel bag to the full size of the Cadillac ATS® seat given. The system should be a pre-production system and not possibly be replicated by aftermarket systems. Using lubricated leather and plastic as materials in the vehicle, the coefficient of friction must be larger than 0.2. According the vehicle safety standards, the latch system must be able to withstand an acceleration of 98 m/s^2 in the horizontal and vertical directions and an acceleration of 294 m/s^2 in the longitudinal direction. The system should also not take more than two seconds of a driver's attention within a six second window to access an item. The system must be stow-able when not in use. It should not affect comfort, functionality, or safety of a car seat. The design must be reachable for the 5th percentile female and 95th percentile male. The driver should also be able to operate the device with no more than two seconds of visual attention.

From these specifications, each team member formulated several designs. The designs were either seat contained, meaning they didn't affect the dimensions of the seat, or seat attachment, meaning they alter dimensions but exploit space that is underutilized. After careful consideration of feasibility, ease of manufacturing, and weighted score of the Pugh Chart, a final design was chosen. The final design is a seat-contained design that utilizes the seat-back cushion for storage. It requires the driver to pull the system out of the seat-back and have it rest on the seat bottom cushion. Then, three panels would deploy creating the barriers of the container. A cover for the system would be attached to the rear and connect to the front panel through Velcro creating a secure container to retain objects.

The dimensions of the final design were determined after dismantling the Cadillac ATS® seat, and the materials were selected based on strength, weight, and price. Using the machine shop, X50 assembly room, and Johnson Controls facilities, the prototype was manufactured. Several tests were then performed to validate the specifications. These tests included a static load test, a comfort test, and a reach, accessibility, and visual attention test. Through the static test, it was determined that the detached system could hold 2691.17 N (605 lbs) before slight plastic deformation occurred. Through the comfort test, it was determined that random subjects were not able to feel a difference in comfort with the system stowed in the seat. The reach, accessibility, and visual attention test confirmed that the final product was easy to reach, easy to access, and required less than two seconds of visual attention. The remaining specifications, such as mass and cost, were validated by Johnson Controls or by visual confirmation and measurement. The total mass of the system was determined to be 1.1 kg which, according to Johnson Controls, was a permissible weight. The total cost of the system was approximated to be between $18.62 and $23.62, approximately four times the maximum required value. Of the eleven requirements, the only ones that were not met were: room for objects ranging in size from a cell phone to a duffel bag, inexpensive, and no buzzing, squeaking or rattling while in use or stowed. In the end, the prototype achieved its goal which was to demonstrate a novel seat-contained system that is capable of retaining objects, is highly accessible for the driver, stow-able when not needed, and does not affect the comfort or dimensions of the seat. The final prototype met most of the user requirements and, although not perfect, paves the way for future development of back seat cushion contained object retention systems.